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A Regional Analysis of Inflation Dynamics in Ghana

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A Regional Analysis of Inflation Dynamics in Ghana: Persistence, Causes and Policy Implications

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Abstract
The welfare implications of aggregate inflation are fairly well-documented in the literature and are also fairly intuitive. However, the potential welfare losses that can be attributed to inflation (and persistence of inflation) in sectors that can be considered to be core/necessities, for example food and fuel, are arguably, likely to be higher. At the same time, keeping inflation to acceptable limits is no longer just the goal of domestic price stability, but is often times also a requirement for consideration for membership of feasible monetary union. This study examined the crucial issue of inflation persistence in Ghana in order to better inform welfare and policy implications thereof. Specifically, the study investigated the existence of persistence at both aggregate (national) and regional levels. Moreover, the study included investigation of persistence across thirteen sectors, hence spanning both core and headline inflation persistence. Employing fractional integration methods, the study provided some important additions to the literature. Our main contributions include empirical evidence suggesting *i*) asymmetries in the degrees of inflation persistence both regionally and sectorally; *ii*) high potential for significantly different conclusions about inflation persistence being drawn, depending on whether month-on-month inflation or year-on-year inflation is assessed. We discuss some possible causes and policy implications of these findings.

Keywords: *Inflation persistence, regional and sectoral inflation, fractional integration, Ghana*
JEL: *C22, E31, E52*

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1. Introduction

The tendency of inflation rates to, in some instances, revert slowly to its long-run/equilibrium level following a shock or, in extreme cases, be explosive and *non*-mean reverting (often defined as *inflation persistence*), has long been an issue of interest for both policymakers and academics. For policymakers, deviations of the inflation rate from a specific target, the speed of reaction to correcting measures, and the output cost of implementing, say, a disinflation policy are critical; while for academics, the underlying dynamics of inflation and how the theory fits the facts are crucial. Arguably, for developing countries, the extent of such persistence would have important policy implications for domestic stabilisation policy and also poverty reduction and inequities in wealth distribution and growth and development implications thereof. Furthermore, as argued by Ball and Mankiw (1994), forward looking firms in setting prices for several periods incorporate the effects of positive trends in inflation and are thus more likely to respond by a larger absolute magnitude following a positive shock than to a negative one. In addition, regional asymmetries in the dynamics of inflation play a crucial role in monetary policy and output growth. In the context of regional distribution of the welfare impact of inflation, it is very likely that regions that lag behind may suffer significant welfare losses due to inflation persistence. Specifically, in the case of Ghana, which is the focus of this study, meeting the convergence criteria required for accession to the single currency status of the West African Monetary Zone (WAMZ) adds to the importance of studies on the dynamics of inflation and underscore the need for immediate consideration. This is against the backdrop that, as some earlier research finds (see Alagidede *et al.*, 2011), there is evidence of asymmetries in both inflation dynamics and common trends in the real gross domestic product (GDP) among the potential member states.

A growing number of studies have established that asymmetric price-related shocks appear pervasive for members of a common currency area/or economic bloc [Fielding and Shields (2011) for the USA, Mayes and Vire´n (2005) for the Euro area, and Ceglowski (2003) for Canada; and Coleman (2010) and Fielding and Shields (2006) for a sample of developing economies]. In a more recent study, Coleman (2012) uncovered evidence of asymmetries in spatial and sectoral inflation persistence in Ghana. Specifically, the study concluded that some regions and sectors are more likely to feel the impact of inflationary shocks than in others, and the attendant welfare losses are likely to be high for those regions and sectors with high inflation persistence. Although, owing to such studies, there has been a significant advance in our understanding of inflation dynamics both regionally and nationally, a number of lingering questions remain, *inter alia*: Are there significant asymmetries in the regional and sectoral inflation levels in Ghana? What could be the likely causes of potential asymmetries in inflation persistence (regional and sectoral) in Ghana? If, indeed, regional and/or sectoral asymmetries in inflation

persistence exist, where is it prevalent and in which sectors? Finally, what are the potential causes and the possible/likely macroeconomic implications *vis-à-vis* regional poverty, government macroeconomic policy, support, and regulation/controls?

This study attempts to answer these questions and chart a path for future policy on price stability and monetary policy. Briefly the results are as follows: *a*) there is persistence in inflation both regionally and sectorally *b*) inflation at the micro level affects the 'poor' more, and, thereby, impact economic growth and/or economic development.

The remainder of the study is structured as follows. Section 2 reviews inflationary episodes in Ghana. The section identifies five distinct episodes and discusses the peculiar macroeconomic and political economy factors that are responsible for the patterns. The monetarist and structuralist view of inflation are also discussed and the empirical review of the literature pertaining to these views for Ghana is presented. In Section 3, an overview of the Fractional Integration (FI) methods, is presented. The properties of the data, descriptive statistics and data sources are presented in Section 4. The estimations arising from tests for persistence are presented in Section 5. Section 6 discusses the implications of the results, and considers a number of policy options for government and policymakers at the regional and national levels, particularly in respect of infrastructure planning, provision and support, regulation and price interventions; and competition monitoring. Finally, Section 7 summarises the salient points of the research.

2. Inflationary trends in Ghana: a review (1960 – 2012)

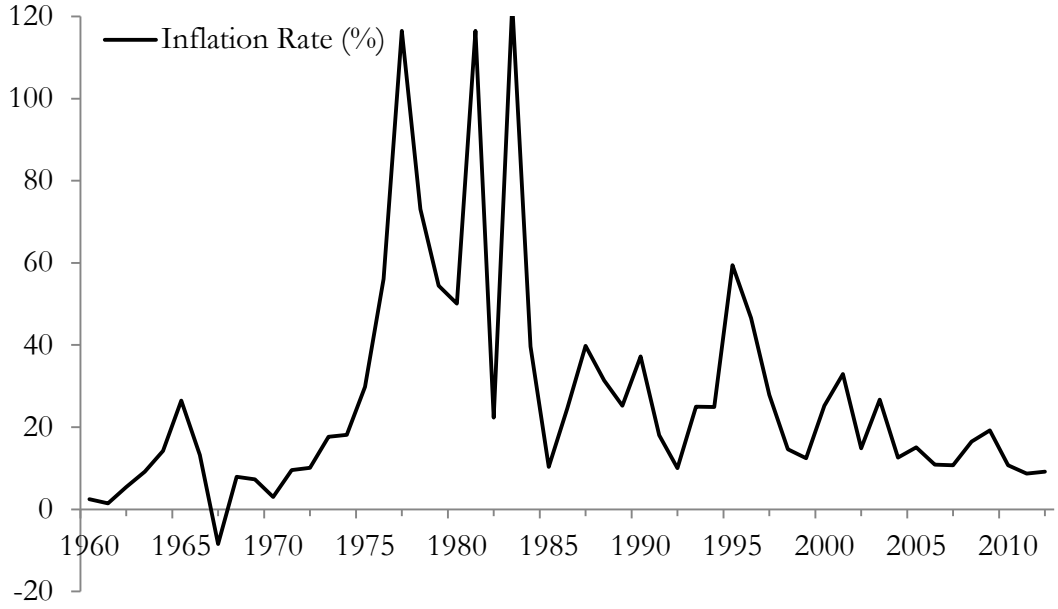
2.1. Five episodes of inflation

Figure 1 illustrates the trends in Ghana's CPI inflation between 1960 and 2012, at an annual frequency. An interesting perspective is offered by Ocran (2007), who described Ghana's inflation experience since independence as episodic and identified four distinct episodes up to 2003. Since 2003 to date, we posit an additional episode, thus making five distinct episodes: the immediate post-independence period which ended in 1966; immediate 'post-Nkrumah' (1966 – 1972); the deterioration phase (1972 – 1982); stabilization phase (1982 – 2003); and relatively creeping phase (2003 – 2012/13).

Prior to independence, the government financed spending through taxation or borrowing and not printing of money since that was the sole preserve of the West-African Currency Board (WACB). The board was responsible for issuing notes and coins which were legal tender in the four British colonies of West-Africa (Ghana, Nigeria, Sierra Leone, and The Gambia). The immediate corollary is that, inflationary trends during this period were quite unruffled. Upon attaining independence in 1957, Ghana opted out of the WACB and

consequently embarked on massive industrialization and social developments. Huge investments in infrastructure, the creation of import substitution industries, a multitude of social welfare programmes and services in an attempt to restructure the Ghanaian economy to modern standards and to be competitive resulted in huge fiscal deficits. To finance the deficits, the government resorted to printing more currency (seignorage), which was possible because it had severed ties with the WACB. Indeed, this fuelled inflationary pressures, which averaged 4.6% between 1960 and 1963, and thereafter more than tripled to about 18% between 1964 and 1966. However, between 1960 and 1966, inflation averaged 10.3% per annum. This sharply contrasted inflation during the periods when Ghana was a member of the WACB. The apparent swift escalation in inflation rates for less than a decade after the break up from the currency board fomented some opprobrium, albeit massive developments have been chalked within the same period. This period marked the first episode in the inflationary experience in Ghana.

Figure 1: Trends in CPI Inflation, 1960 – 2012



The 1966 military revolution and the consequent overthrow of the Nkrumah administration marked the beginning of the second inflation episode. This was the period when the succeeding government embarked on macroeconomic stabilization policies in order to cool down the economy. A considerable number of social welfare programmes initiated by the previous government were curtailed. The government liberalized external trade, and tightened monetary and fiscal policies. The currency was devalued by approximately 30% against the US dollar and a massive retrenchment exercise in the public sector, which resulted in a significant number of wage earners losing their jobs (Hutchful, 2002). These arrangements, instituted as part of the

stabilization programme by the International Monetary Fund (IMF) resulted in a negative inflationary rate of 8% − first and unprecedented in the economic history of Ghana. Though this seems appealing, it had some repercussions on other macroeconomic variables particularly output growth. Between 1967 and 1972, inflation averaged 4.9% per annum --- the second episodic inflation rates were generally in single digits.

The period between 1972 and 1982 marked the third episode, the *deterioration phase*. This period was marked by alternating military and civilian rule. A plethora of distortions in the financial sector and real economy and general mismanagement exerted pressure on domestic prices, culminating in Ghana's highest inflation rate of 123% in 1983.

The fourth inflation episode dubbed the *stabilization phase* lasted for about two decades. To arrest the economic decline the government adopted IMF and World Bank's Economic Recovery Programme (ERP) and subsequently the Structural Adjustment Programme (SAP) in 1983 and 1986 respectively. These injected some doses of market reforms and removed a number of distortions in the incentive structure and thereby facilitating production as well as restoring broken down social and economic infrastructure. Average annual inflation plummeted from a high of 123% in 1983 to 39.7% in 1984 and a further 10.3% in 1985. During the first decade of stabilization, inflation averaged 26.1% while the second decade recorded an average inflation of 28.5%. The second decade witnessed two election periods following a transition of the country from military to democratic rule. Obviously, election years are fraught with huge government expenditure, which tends to be inflationary – a phenomenon that possibly explains the higher average inflation rate during the second decade. Nevertheless, for the entire period, the average inflation rate within the stabilization phase was 27.3% excluding the 1983's figure. Considering, however, the period for the reform (1983–2000), inflation averaged 33.1% per annum. It is worth noting that, within the period of the economic reform, there were occasions when inflation was brought down to as low as 10% (in 1985 and 1992) but these could not be sustained. Compared to the previous episodic experience where inflation averaged over 50% per annum, then an elusive conclusion is that the economic reform could not achieve one of its primordial objectives of keeping inflation to an appreciably lower level.

The final episode we consider, which we refer to as the *moderation phase*, runs from 2004 to present. This phase has been characterized by periods of single digit inflation – an achievement that was the first of its kind after four decades. Inflation rates lowered to near 10% in 2006 and stabilized until late 2007. Among the factors that contributed to this downward trends include the use of resources from debt relief and debt cancellation from the Heavily Indebted Poor Countries (HIPC) and Multilateral Debt Relief Initiative (MDRI), new aid flows

and external loans and inward private transfers by the central bank to 'buy off' the otherwise accelerated rates of inflation in the economy (CEPA, 2009). The trend could also be attributed to the inflation targeting framework the Bank of Ghana adopted which after the second quarter of 2008 had well anchored inflationary expectations in its new monetary policy agenda of maintaining price stability (Marbuah, 2011). The moderation experience truncated after 2007 due to external shocks following the global financial crisis and high food prices. Given that Ghana is susceptible to external shocks, the crisis resulted in fiscal deficit of 13.9% of GDP and rising exchange rate depreciation coupled with the fact that 2008 was an election year. Following a change in government in January 2009, and with the rippling effects of the global financial crisis, the economy experienced sustained downward trend in inflation for eighteen months consecutively since June 2009. With a rate of 20.7% in June 2009, the downward inflationary trends continued into single digits until 2012, where the trend reversed.

In sum, the economy of Ghana has evolved through several episodes of inflation and hence the concern with inflation has emanated not only from the need to maintain macroeconomic stability, but also from the fact that inflation affects the poor severely as they do not possess effective inflation hedges.

2.2. Causes of inflation in Ghana

The causes of inflation in Ghana are not different from those found elsewhere. Broadly, two schools have emerged to explain the patterns of price development in Figure 1: the *monetarist* and the *structuralist*. The monetarist view suggests that inflation is a matter of excessive aggregate demand. In the famous dictum of Milton Friedman "*Inflation is always and everywhere a monetary phenomenon*". According to the monetarist, therefore, unbridled expansion in aggregate demand, fuelled by government deficits, financed in part by increases in money supply and directed credit allocation is the main culprit of inflation. Studies such as Lawson (1966), Ahmad (1970), Ewusi (1977), Steel (1979), Chhibber and Shafik (1990) and Adu and Marbuah (2011) affirmed the monetarist hypothesis for Ghana. The monetarist argument is particularly evident in the third phase of inflation episode in Ghana from 1972 to 1982. Expansionary monetary policy coupled with large external inflows exerted an upward pressure on domestic prices (see Chhibber and Shafik, 1990). Between 1973 and 1982 for instance, inflation averaged 54.5% per annum and in 1983 (see Figure 1), and the Ghanaian economy recorded the highest ever inflation rate of approximately 123%. What is the way out of demand induced inflation? Monetarists argue that the solutions are inherent in the causes, i.e. monetary and fiscal restraint. Should these fail to moderate inflation, a second best solution is to clamp down on restrictions and price controls that distort relative prices. Consequently, in 1983 Ghana launched the Economic Recovery

Programme (ERP) and this was followed in 1986 by the Structural Adjustment Programme (SAP). Among other goals, these two reform packages were aimed at reversing the decline in the Ghanaian economy by opening several sectors of the economy that had hitherto been rigidly controlled. Among the policies is the liberalisation of interest rates, exchange rate reform, stemming the tide of monetary growth to cure inflation, curtailing trade deficits and introducing market administered prices in the financial sector. Following the adoption of the ERP, average annual inflation plummeted from a high of 123% in 1983 to 39.7% in 1984 and a further 10.3% in 1985 (see Figure 1). During the first decade of stabilization, inflation averaged 26.1% while the second decade recorded an average inflation of 28.5%.

In spite of the reforms, inflation has remained high in most of the ERP/SAP period, suggesting factors other than excessive demand pressure may be at play. Now, enter the structuralist. Sowa and Kwakye (1993) argue that supply-side dynamics like food prices are vital in price variations in Ghana. Thus a basic weakness in the domestic production and industrial base, coupled with structural rigidities in the agricultural sector translate to high food prices which then feed into the general price level. Added to this, domestic policy inconsistency and output volatility seem to be more important in explaining both the short and long run dynamics of inflation than monetary factors (Sowa 1994, 1996). Implementing consistent fiscal policies, and attention to the supply rigidities, argue Sowa (1994), hold the key to a successful domestic price stability framework.

At one level, a truce between the monetarist and structuralist views can be sought. While structural bottlenecks may form the root of the inflation problem, demand driven factors cannot be excluded. Subsequent studies examine these two views either separately or together in trying to explain price developments in Ghana. Thus specific drivers of inflation such as exchange rate depreciation, wages, and exogenous shocks in the domestic food supply, petroleum prices, and government fiscal policy, among others are frequently cited in the literature. Dordunoo (1994) argues that the rapid exchange rate depreciation and the resultant hikes in import prices are inflationary, and (Ocran, 2007) opines that the devaluation of the Ghana Cedi by 991% (from ¢2.75 to ¢30 to the US dollar) in 1983 was partly the reason for the 123% inflation recorded that year.

Adu and Marbuah (2011) present an interesting amalgamation of the two views. In their exploration of the determinants of inflation in Ghana for the period 1960 – 2009, the authors argued that fiscal deficits, money supply and production constraints exert pressure on domestic price levels. They argue that domestic production constraints are critical while monetary expansion in the long-run underlie most of the inflation experience in the recent phase. Thus

they conclude that, removing constraints to production and controlling unrestrained monetary expansion is a key to the success of the disinflation effort in Ghana.

Beyond the studies on the traditional causes of inflation, one notable development in the literature has been on the extent to which persistence of inflationary shocks (and, potentially, regional asymmetry in such persistence) is likely to impact welfare – collectively and regionally. The suggestion in the literature is that, all things being equal, the larger and more persistent an adverse inflationary shock, the greater would be the accumulated welfare losses, particularly for vulnerable groups. Investigating this issue for 12 *Communauté Financière Africaine* (CFA) countries, Coleman (2010) examines persistence in (*food* and *non-food*) inflation and finds evidence of significant asymmetries across countries within the zone. Other studies (see examples including Fielding and Shields, 2006 on South Africa; and Coleman, 2012 focussing on Ghana) go further to posit that policy formulation which ignores regional heterogeneity can be welfare-depreciating. Both conclude that to the extent that consumers in different regions, which are subject to common shocks, experience different inflation dynamics, then the distribution of inflation rates resulting from, say, a common monetary policy shock becomes relevant and this should be of concern to policymakers. More specifically, for Ghana, the study we have found which is most related to this study is Coleman (2012), which is based on monthly data spanning 2005:07–2010:06 (for 9 regional groupings) and 1997:09–2010:06 (for 12 sectors), and uncovers evidence of inflation persistence in 3 out of the 9 regions and in 5 of the 12 sectors at the national level. Coleman (2012) further argues that most of the 5 sectors identified are 'basic necessities', therefore establishes a welfare link and makes an empirical case for targeted policy responses to adverse shocks. Our study attempts a closer scrutiny and we investigate inflation persistence in the 9 regional groupings and also at the national level. Secondly, for each of these regional groupings, we investigate same for 13 sectors and also the regional aggregate. For robustness, we employ two widely used methods of estimating the degree of fractional integration in each of the sectors, regional groupings and also for the national aggregate.

3. Modelling inflation persistence and asymmetries

In this section we present a brief overview of the typical measure of persistence employed in the literature.

Typically, inflation persistence may be defined as the tendency of inflation to revert slowly to its long-run/equilibrium level following a shock. Usually, in order to get an estimate of the speed with which inflation converges to its long-run level after a shock i.e. the persistence, an econometric model is often specified and estimated. Over the last three decades, there has been a

marked growth in attempts to model hyperbolically decaying autocorrelations and impulse response weights. To this end, the use of long memory, fractionally integrated (FI) methods have gained prominence. Pioneering work on FI models is provided by Granger and Joyeux (1980), Granger (1980), and Hosking (1981), and some more recent theoretical justification, in terms of duration of shocks (using an Error-Duration model), has been provided (See Parke, 1999). Baillie and Bollerslev (1994), and Gil-Alana and Robinson (1997) and Baum *et al.* (1999 a,b) also provide some relevant empirical applications of fractional models. For completeness, we provide a brief description below. Generally, the model of an autoregressive fractionally integrated moving average process of order (*p,d,q*) is denoted by ARFIMA (*p,d,q*). For a series y_t with mean l, such a process may be written using operator notation as: $\Phi(L)(1-L)^d(y_t-\mu)=\Theta(L)\dot{o}_t$ where $\dot{o}_t\, iid(0,\sigma_{\dot{o}}^2)$ L is the backward shift operator.

While many variations of long memory/fractional integration measures have been developed, the common theme is that they each aim at estimating the presence, and the degree of long memory in a series. The presence of long memory can be defined from an empirical, data-oriented approach in terms of the persistence of observed autocorrelations. Long memory, though consistent with a stationary process, portrays autocorrelations that take far longer to decay than the exponential rate associated with 'short memory' (ARMA) processes, thus associated with persistence in the series. Thus, long memory processes may be predictable at long horizons. When a series exhibits long memory, it is neither stationary (I(*0*)) nor is it a unit root (I(*1*)) process; it is an I(*d*) process, with *d* a real number.

In this study, we employ two widely used methods: The first approach, proposed by Geweke and Porter-Hudak (GPH, 1983), estimates the long memory (fractional integration) parameter, *d*, of a time series, using nonparametric methods (a spectral regression estimator) to evaluate *d* without explicit specification of the 'short memory' (ARMA) parameters of the series. In brief, the GPH estimate of the fractional differencing estimator, *d*, is based on a regression of the ordinates of the log spectral density on trigonometric function. The estimator exploits the theory of linear filters to write the process: $(1-L)^d y_t = u_t$, where $u_t \sim I(0)$ as $g(w)_y = \left|1-e^{-iw}\right|^{-2d} g(w)_u$, where $g(w)_y$ *and* $g(w)_u$ are the spectral densities of y_t and u_t respectively, which can be expressed as follows:

$$\log\{g(w)_y\} = \left\{4\sin^2\left(\frac{w}{2}\right)\right\}^{-d} + \log\{g(w)_u\}$$

$$\log\{g_y(w)_j\} = -d\log\left\{4\sin^2\left(\frac{w_j}{2}\right)\right\} + \log\{g_u(0)\} + \log\left[g_u(w_j)\Big/ g_u(0)\right] \qquad (1)$$

GPH suggests estimating *d* from a regression based on equation (1) using spectral ordinates $w_1, w_2, \ldots . w_m$ from the periodogram of y_t, which is $I_y(w_j)$. Therefore for *j*=1, 2, 3, …, m; and

$$\log\{I_y(w_j)\} = a + b\log\left\{4\sin^2(\frac{w_j}{2})\right\} + v_j, \qquad (2)$$

where $v_j = \log\left[g_u(w_j)\Big/g_u(0)\right]$ and v_j is assumed to be *i.i.d*, with zero mean and variance $\pi^2/6$.

When u_t is white noise, then the regression (2) should provide a good estimate of *d* and when it is autocorrelated, GPH show that equation (2) holds approximately for frequencies in the neighbourhood of zero. Depending on the number of ordinates, the OLS estimator of *d* in (2) will have the limiting distribution $(\hat{d}_{GPH} - d)/\left[\{var((\hat{d}_{GPH})^{0.5}\right] \rightarrow N(0,1)$. The $var((\hat{d}_{GPH})$ is obtained from the usual OLS regression formula, either using the regression residual variance or alternatively setting it as $\pi^2/6$. It is clear from this result that the GPH estimator will converge at a slower rate.

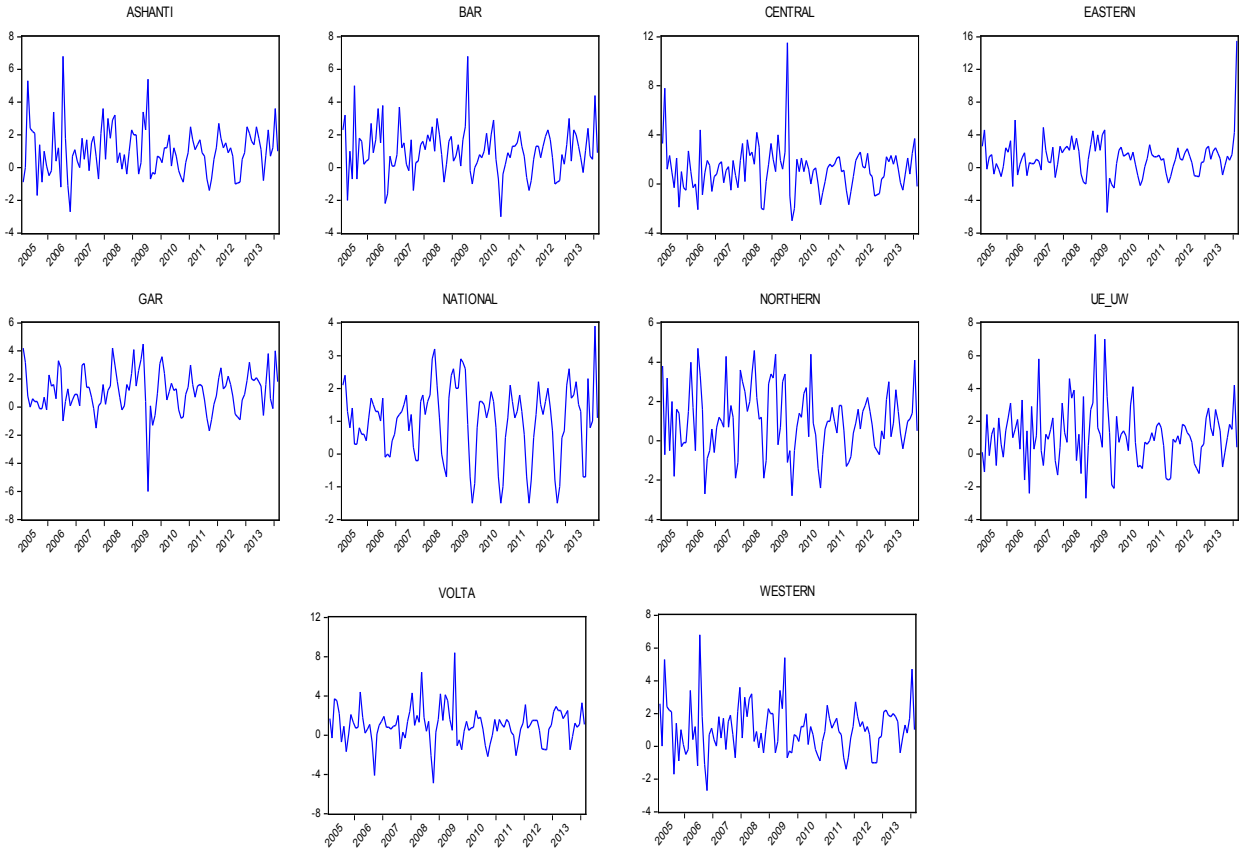
The second method we compute in this study, proposed by Phillips (1999a, 1999b), is a modified form of the GPH and estimates the long memory parameter, *d*, of a time series. Distinguishing unit-root behavior from fractional integration may be problematic, given that the GPH estimator is inconsistent against *d*>1 alternatives. Phillips' Modified Log Periodogram Regression estimator addresses this weakness of the GPH estimator in which the dependent variable is modified to reflect the distribution of *d* under the null hypothesis that *d*=1 and the estimator gives rise to a test statistic for *d*=1, (a standard normal variate under the null). It is worth noting that the number of harmonic ordinates to be included in the spectral regression needs to be specified with the regression slope estimate being an estimate of the slope of the series' power spectrum in the vicinity of the zero frequency. On the one hand, inclusion of too few ordinates would imply that the slope is calculated from a small sample and on the other hand, if too many are included, medium and high-frequency components of the spectrum will contaminate the estimate. A choice of root (T), or power = 0.5, is often employed.

4. Data

The dataset we employ is sourced from the Ghana Statistical Service (GSS) and we consider, at monthly frequency, both *month-on-month* (MoM) *inflation* and *year-on-year* (YoY) *inflation*. We note that the data is seasonally-adjusted, and based on the Consumer Price Index (CPI) publications for Ghana's regions and sectors. More specifically, for each region in Ghana, we analyse the MoM and YoY inflation across 13 sectors and also analyse the aggregate inflation i.e. *Overall* for

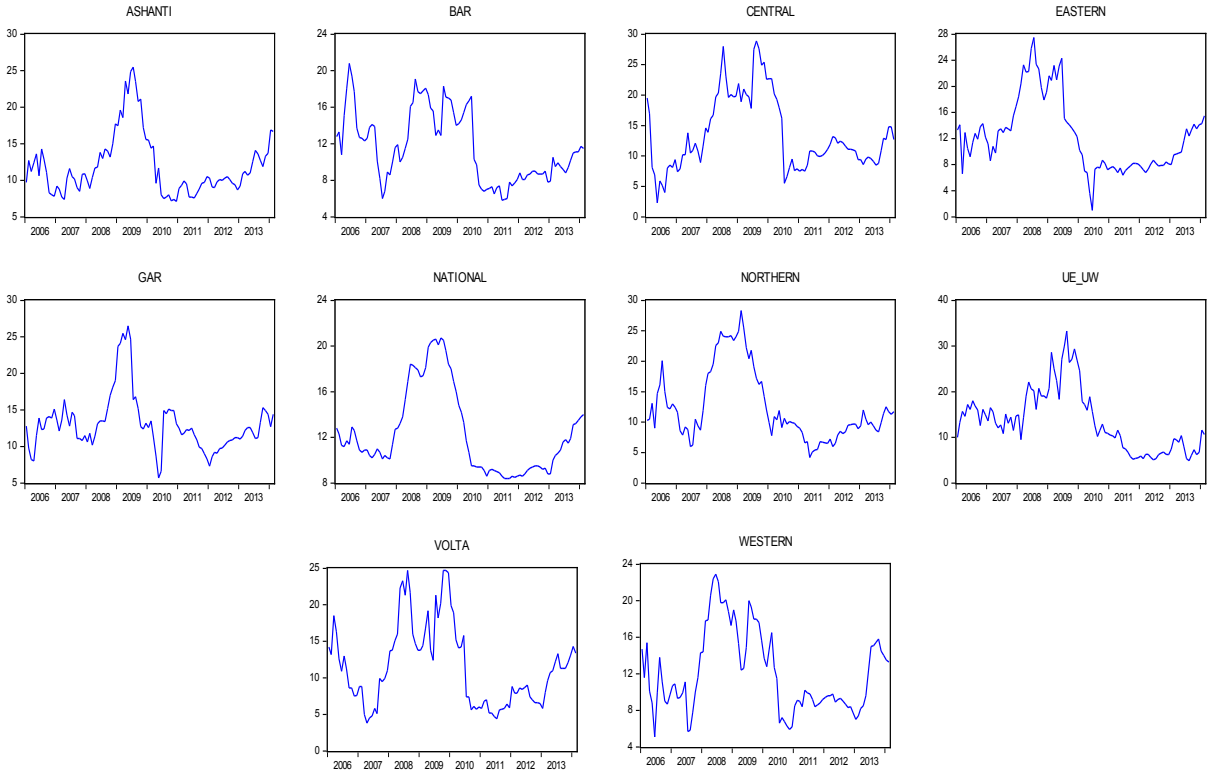
each regional grouping and also for the national.[1] The MoM inflation spans 2005:02 – 2014:02 i.e. 109 observations, whereas the YoY inflation spans 2006:01 – 2014:02 i.e. 98 observations and the *National* dataset, which for the same sectors, span 1997:01-2014:02.

Figure 2a: Time series plots (2005:02 – 2014:02), individual regions and National series [Month-on-month inflation]



[1] Data compiled from Regional and National inflation CPI reports published by the GSS [see http://www.statsghana.gov.gh/cpi.html]. Prior to seasonal adjustment, we compute and measure inflation as the monthly change in the price indices, calculated as $100(P_t - P_{t-1})/ P_{t-1}$). Further, we note that in the dataset, *Upper East* and *Upper West* regions have been grouped and are considered as one unit.

Figure 2b: Time series plots (2005:02 – 2014:02), individual regions and National series [Year-on-year inflation]



Figures 2a and Figure 2b show time series plots of the overall inflation indices for each of the regional groupings and also for the national index. Despite some noticeable similarities across the regions, particularly during the 2007-2009 global financial crisis, there are also some visible differences in the behaviours. On the one hand, a cursory look at the plots in Figure 2a suggests that there is significant volatility in Ghana's month-on-month inflation, at both regional and national levels; and the extent of volatility seems to vary across regions. On the other hand, visual inspection of the plots in Figure 2b suggests that volatility in the year-on-year inflation measure is more muted, and the indices tend to trend over periods of time. However, similar to the MoM inflation, there appears to be noticeable differences across the regions. Moreover, the range of the YoY inflation also varies significantly across the various regional groupings. The suggestion here, which this study proceeds to test, is that there is likely to be the presence of asymmetric behaviour in both the MoM and YoY inflation rates. The relevance of this line of thought is that, in such a situation, the impact of a common monetary policy shock is likely to be different across regions. In addition, fiscal policy could be better tailored for greater impact and less wastage when policymakers are better informed about the areas that require fiscal intervention the most.

5. On the persistence and asymmetry of inflation in Ghana: evidence

In this section, we present the results of the long memory (fractional integration) analyses performed for each of the 9 regional groupings and the aggregated (national) data. Specifically, as stated earlier, for each of these 10 groupings, we report the estimates of both the GPH and the Modified Log-Periodogram Regression for each of the sectors included in Table 1. Furthermore, in the light of the visual differences we highlighted in Figures 2a and 2b, we perform these tests for both the MoM and YoY data. Based on these estimates, we are then able to highlight and uncover asymmetries that may exist across the regions, and then go on to infer the implications of opting to focus policy on either the MoM or the YoY inflation dynamics. We posit that policymakers interested in short term controls of inflation would focus on the MoM inflation dynamics, whereas analysis of the YoY inflation dynamics will suit policy aimed at controls over relatively longer horizons.

Table 1: Abbreviations used for the Sectors and their meaning

CODE	KEY (Sector)
Overall	Overall Index (Regional CPI)
F&NAB	Food and non-alcoholic beverages
NF	Non-food
ABT&N	Alcoholic beverages, tobacco and narcotics
C&F	Clothing and footwear
HWEG&O	Housing, water, electricity, gas and other
FHE	Furnishings household equipment etc.
Health	Health
Transp.	Transport
Communications	Communications
R&C	Recreation and culture
Education	Education
HC&R	Hotels, cafés and restaurants
MG&S	Miscellaneous goods and services

Table 2a: Unit root tests (Month-on-month inflation)

Region	Overall	F&NAB	NF	ABT&N	C&F	HWEG&O	FHE	Health	Transp.
Ashanti	-8.75***	-10.23***	-9.74***	-9.54***	-8.37***	-9.82***	-12.28***	-11.80***	-9.30***
Brong-Ahafo	-8.94***	-10.26***	-9.09***	-9.44***	-11.35***	-9.35***	-8.56***	-13.14***	-7.04***
Central	-8.62***	-8.99***	-8.75***	-9.93***	-8.97***	-8.77***	-9.96***	-9.53***	-8.35***
Eastern	-5.19***	-7.89***	-3.38**	-9.48***	-11.44***	-13.41***	-10.01***	-6.23***	-8.89***
Greater-Accra	-6.73***	-7.18***	-9.26***	-8.65***	-12.41***	-9.42***	-8.35***	-8.98***	-11.06***
Northern	-7.77***	-6.07***	-9.17***	-13.14***	-10.14***	-9.14***	-10.02***	-12.95***	-14.83***
Upper-East & *Upper-West*	-8.82***	-8.57***	-9.83***	-10.16***	-10.68***	-3.53***	-10.65***	-7.87***	-11.14***
Volta	-7.61***	-8.78***	-8.60***	-10.76***	-8.94***	-10.64***	-9.61***	-9.08***	-9.96***
Western	8.76***	-10.18***	-9.74***	-9.54***	-8.37***	-9.82***	-12.28***	-11.80***	-9.30***
National	-7.72***	-7.04***	-6.64***	-5.46***	-6.59***	-7.81***	-13.66***	-15.80***	-15.02***

Notes: For individual regions, *Overall*, *F&NAB*, and *NF* span 2005*m*2 – 2014*m*2, whereas all the other sectors span 2005*m*2 – 2012*m*8. For the *National*, data (bottom row) spans 1997*m*10-2014*m*2, except for NF which spans 2005*m*2 – 2014*m*2. ***,**,* indicates rejection of null of unit root at the 1%, 5% and 10% level respectively.

Table 2a (cont'd): Unit root tests (Month-on-month inflation)

Region	Communications	R&C	Education	HC&R	MG&S
Ashanti	-9.73***	-11.39***	-9.69***	-13.35***	-10.75***
Brong-Ahafo	-10.01***	-9.86***	-8.02***	-8.90***	-10.45***
Central	-9.72***	-12.76***	-8.72***	-8.69***	-8.08***
Eastern	-9.85***	-3.71***	-5.44***	-6.51***	-15.35***
Greater-Accra	-9.93***	-9.17***	-10.76***	-8.87***	-9.38***
Northern	-10.02***	-7.35***	6.73***	-9.87***	-9.60***
Upper-East & *Upper-West*	-9.84***	-9.72***	-9.66***	-8.85***	-8.81***
Volta	-10.03***	-8.69***	-8.38***	-8.21***	-12.39***
Western	-9.73***	-11.39***	-9.69***	-13.35***	-10.75***
National	-15.29***	-11.50***	-17.88***	-13.01***	-7.10***

Notes: For individual regions, *Overall*, *F&NAB*, and *NF* span 2005*m*2 – 2014*m*2, whereas all the other sectors span 2005*m*2 – 2012*m*8. For the *National*, data (bottom row) spans 1997*m*10-2014*m*2, except for NF which spans 2005*m*2 – 2014*m*2. ***,**,* indicates rejection of null of unit root at the 1%, 5% and 10% level respectively.

Table 2b: Unit root tests (Year-on-Year inflation)

Region	Overall	F&NAB	NF	ABT&N	C&F	HWEG&O	FHE	Health	Transp.
Ashanti	-1.77	-2.68*	-1.37	-2.31	-1.39	-1.92	-1.76	-1.89	-4.36***
Brong-Ahafo	-2.06	-2.57	-2.59*	-2.37	-2.19	-2.26	-2.29	-3.11**	-1.74
Central	-2.15	-2.35	-2.18	-1.81	-1.52	-4.83***	-1.64	-1.59	-2.75*
Eastern	-1.82	-2.56	-1.60	-3.36**	-2.09	-3.95***	-2.14	-3.60***	-2.36
Greater-Accra	-2.34	-2.28	-3.51***	-1.82	-2.68*	-1.85	-2.39	-2.53	-2.12
Northern	-2.10	-2.37	-1.97	-3.10**	-2.51	-1.72	-2.10	-1.51	-1.79
Upper-East & *Upper-West*	-1.95	-2.21	-2.08	-1.70	-2.25	-2.04	-1.63	-2.30	-1.75
Volta	-2.12	-2.29	-2.36	-2.22	-1.37	-2.13	-2.09	-1.63	-2.26
Western	-2.33	-2.47	-2.54	-2.28	-1.76	-1.78	-2.07	-3.22**	-3.72***
National	-3.28**	-3.46**	-1.35	-3.11**	-4.06***	-1.35	-4.02***	-2.69*	-3.56***

Notes: Data for *Overall*, *F&NAB*, and *NF* span sample period 2006*m*1 – 2014*m*2. All other sectors span 2006*m*1 – 2012*m*8. ***,**,* indicates rejection of null of unit root at the 1%, 5% and 10% level respectively.

Table 2b (cont'd): Unit root tests (Year-on-Year inflation)

Region	Communications	R&C	Education	HC&R	MG&S
Ashanti	-1.87	-2.36	-4.32***	-1.04	-2.63*
Brong-Ahafo	-2.45	-5.20***	-1.89	-2.24	-2.37
Central	-2.73*	-1.82	-1.51	-1.44	-3.60***
Eastern	-2.02	-2.55	-3.67***	-1.79	-1.34
Greater-Accra	-2.03	-3.31**	-2.26	-2.43	-1.78
Northern	-1.96	-2.98**	-2.34	-1.68	-2.90**
Upper-East & *Upper-West*	-2.16	-2.82*	-2.19	-2.32	-2.33
Volta	-2.47	-1.50	-1.99	-1.63	-3.05**
Western	-2.31	-2.71*	-2.01	-1.15	-2.48
National	-2.93**	-2.81*	-3.60***	-2.08	-4.76***

Notes: Data for *Overall*, *F&NAB*, and *NF* span sample period 2006*m*1 – 2014*m*2. All other sectors span 2006*m*1 – 2012*m*8. ***,**,* indicates rejection of null of unit root at the 1%, 5% and 10% level respectively.

The estimates of degree of integration, based on standard ADF unit root tests, and reported in Tables 2a and 2b, provide the initial support for the visual observations we alluded to earlier i.e. the MoM inflation demonstrating volatility around a mean, while the YoY series did not

demonstrate that tendency. Specifically, the estimates in Table 1a (for the MoM series) strongly reject the null hypothesis of a unit root, implying stationary series and suggesting mean reversion. On the other hand, the estimates in Table 2b are not as clear-cut. In each regional group, we find some sectors for which we are unable to reject the null of a unit root. We note that the *Upper East* & *Upper West regions* group and the *Volta region* are the 2 regional groups for which we are unable to reject the unit root hypothesis in most of the sectors. Based on these results alone, for each of the regional groupings, the MoM inflation would be considered to be stationary whereas the YoY inflation would be stationary in only some sectors.

Presented in the Appendix of this paper, Tables A1 - A2 report our estimates of the GPH fractional integration tests for the MoM and YoY series respectively, whereas Tables A3 – A4 report our estimates of the Modified Log Periodogram fractional integration tests for the MoM and YoY series respectively.

Considering our aim of analysing sectoral inflation persistence at the regional level, we highlight below, some of the salient results region by region. Based on the results, we are able to identify and establish the presence of inflation persistence or long memory in some of the sectors, where they occur, within regional groups. Importantly, we also find evidence of explosive behaviour in certain sectors, which should be of significant policy interest. In this study, we define explosive behaviour to be when we are able to reject both $d = 0$ and $d = 1$, when the estimated value of $d > 1$. In other words, the series is non-stationary, with the shock duration and variance both being infinite (see Table 3).

Table 3: Parameter values and implications for fractional integration

d	Variance	Shock duration	Stationarity
$d = 0$	Finite	Short-lived	Stationary
$0 < d < 0.5$	Finite	Long-lived	Stationary
$0.5 \leqslant d < 1$	Infinite	Long-lived	Non-stationarity
$d = 1$	Infinite	Infinite	Non-stationarity
$d > 1$	Infinite	Infinite	Non-stationarity

Source: Tkacz (2001)

Table 4 presents a summary of some of the significant results – for each region, the sectors for which there is evidence of long memory is reported. We note that, for the MoM series (Column 2), for series not reported, we are unable to reject the null of d=0, but reject $d = 1$. The reported sectors exhibit long memory i.e. inflation persistence. For the YoY series (Column 3), we are able to reject d=0, but unable to reject d=1. The reported series either exhibit long memory or explosive behaviour.

Table 4: Summary of sectors exhibiting inflation persistence in Month-on-month (MoM) and Year-on-year (YoY) series, by region.

Region	Month on Month inflation*	Year on Year inflation+
Ashanti	Long memory *C&F*, *HWEG&O* and *Transp.*	Long memory *Transp.*
Brong-Ahafo	Long memory *HWEG&O* and *R&C*	Long memory *HWEG&O*, *Health* and *R&C.*
Central	Long memory *F*&NAB and *Communications*	Long memory *HWEG&O, Transp.* And *MG&S* Explosive *Education*
Eastern	Long memory *F*&NAB, *Health* and *R&C* ($0 < d < 1$) *Overall* and *NF* ($d = 1$)	Long memory *Health* and *Communications* Explosive *R&C* and *HC&R*
Greater-Accra	Long memory *R&C* and *HC&R*	Long memory *NF* and *R&C*
Northern		
Upper-East & *Upper-West*	Long memory *HWEG&O*	Long memory *Transp.*
Volta		
Western	Long memory *HWEG&O*	Long memory *HWEG&O, Health, Transp.* and *Communications*
National	Long memory *C&F*, *FHE, Transp. HC&R and MG&S.*	Long memory *Transp.* Explosive *C&F* and *FHE*

Notes: * For each region all other sectors not listed, we are unable to reject $d = 0$. + For each region, all other sectors not listed, we are unable to reject $d = 1$.

6. Discussion of results: Causes and implications

Based on the results of our empirical analyses, the first observation we highlight is that there are noticeable differences in the occurrence and degree of inflation persistence across Ghana's regions – not only across aggregate regional data, but also across sectors within the individual regions. This observation points to the reality of asymmetric behaviour of inflation across Ghana's regions and also across sectors and hence the importance of targeted responses both geographically and according to sector, wherever possible. A possible implication, particularly given our finding of some explosive behaviour in some of the series', is that prices are unbounded. From the consumer's point of view, this is not desirable, particularly in a developing country setting where the potential for imperfect information is likely to be higher. In fact, attempts at setting price controls have not been positive across Africa. For Ghana, Sowa and Kwakye (1993) report on the economic controls and restrictions from 1972–1982 and the

resulting non-progressive behaviours of economic agent e.g. including smuggling, parallel market activities in goods and foreign currencies, and corruption. The authors indicate the limited success chopped by, and the inadequacies of, the price controls citing inflation per annum averaging 50% over the period (with 1977 and 1981 recording the highest-ever rates of 117% each) and, by 1982, the declines in income per capita, mounting external deficits, and seriously run-down social and economic infrastructure, which led to a considerable re-direction of economic management. Other studies, including Clark (1988) and Killick (1973) have indicated the reality, albeit limited success of price controls in Ghana's foodstuff sector and across Africa respectively. More recently, attempts at price controls in some products in Ghana's economy (cement, foodstuff) have been contentious, but underscores the reality of limited success of price controls. Although it may seem surprising that price and/or inflation asymmetries would occur in the absence of any apparent barriers to the flow of goods and services across regional boundaries, this is not unusual. Several examples of such asymmetries have been discussed in previous literature (see Ceglowski (2003); Coleman (2010, 2012). In a developing country, such as Ghana, the possible reasons for such asymmetries across regions, without any obvious barriers to such asymmetries, may include imperfect information and other supply-side factors such as the weather, Ghana's production structure and even inadequate infrastructure such as roads to transport goods and services which therefore create *de facto* monopolies.

The second observation we like to emphasize is that, our results, reported in Section 5, confirm, explicitly, the earlier observations we made based by visual inspection of the plots in Figures 2a-2b. There are some stark differences in the dynamics of the MoM and YoY inflation series for Ghana over the period under investigation. While the MoM data for almost all the regional series is typically stationary, the YoY data for almost all the regional series is nonstationary. We posit that, since *non*-mean reversion (and persistence) is associated with the nonstationary behaviour, there is a higher proclivity for the YoY inflation series to exhibit persistence and even, in some cases, explosive behaviour, where both the variance and shock-duration are infinite. For the MoM data, we find that it is only in one case i.e. for the *Eastern region*, where we find evidence for explosive behaviour – in the regional aggregate (*Overall*) and in the *non-food* (NF) sector. Against this background, we summarize as follows. On the one hand, for the MoM series, mean reversion appears to be the norm, however, we are able to identify some sectors which exhibit long memory (see Column 2, Table 4), which, we note, include sectors which can be considered as basic necessities. Though we find evidence of long memory in a broader range of sectors, at a more disaggregated level, our findings corroborate earlier studies conducted using more aggregate data for Ghana (see Coleman, 2012). On the other hand,

for the YoY series, *non*-mean reversion appears to be the norm and the YoY inflation is, indeed, persistent across *all* regions. There are few sectors, however, which are characterized by long memory and fewer still, explosive behaviour. While stationarity implies that the effects of a shock will diminish relatively quickly, such that the series will revert to the long-run mean, it follows that, for each of the regions, the sectors identified (as listed in Table 4) as exhibiting long memory are most likely to take a longer time to revert to their means. Although it is not unusual for higher frequency data to exhibit higher volatility, there is no consensus that lower frequency data should exhibit higher persistence. The relevance of such an obvious fact – lower frequency data exhibiting higher persistence and higher frequency data exhibiting higher volatility – is fundamental to the decision making process. Therefore, over the short term, inflation is largely stationary, however, when policymakers seek to adhere to an inflation target over a prolonged period (the long term view), then the reality of persistence must be factored into the decision making process and any loss functions thereof. Simply, policies aimed at maintaining short term inflation versus those aimed at long term inflation should differ, with more aggressive policies toward the long term, relative to the shorter term targets, as the dynamics of the latter are largely stationary.

In summary, inflationary shocks can and do have asymmetric impacts across Ghana's regions and also across sectors. Inhabitants of regions where inflation persistence is pervasive are likely to bear the brunt of any adverse effects of such persistence, particularly as price controls have not had much success in Ghana (and even across Africa) and have been seen to aggravate economic woes, misbehaviour by agents and political disagreements (Ghanaian Chronicle, 2004) . In addition, consumers who spend a larger proportion of their incomes in the sectors where inflation is persistent are likely to be adversely affected. Although it can be argued that some producers may benefit from higher prices following a positive inflationary shock, we posit that the welfare implications for the wider population are likely to be negative. Additionally, while, in general, the effects of an inflationary shock on MoM inflation is likely to diminish relatively quickly even without policy intervention, for each of the regional groupings (and the national aggregate), we have also identified certain sectors within which the effects of such shocks will take longer to diminish if there is no intervention i.e., long memory exists, and shocks may require some policy intervention if a quicker reversion is required. Furthermore, the effects of shocks on Ghana's YoY inflation are markedly different in comparison to that for the MoM series. For the YoY inflation series, it is rather characteristic for the effects of inflationary shocks to linger on, without the likelihood of the YoY inflation reverting to a long run mean i.e., the shock duration is considered infinite. However, as for the MoM series, we have identified, for

each region, the sectors which exhibit long memory and are mean reverting. The results imply that shocks to YoY inflation in Ghana, across almost all regions and sectors, bar the ones identified as exhibiting long memory, do not show a tendency to revert to their long run equilibrium. Simply, the effects of a shock will not diminish on their own accord and will require a concerted effort to redirect its path. Several links to consumer welfare can be made thereof. For example, all other things equal, for the longer term i.e., YoY analyses, the effects of a positive inflationary shock will imply decreasing real wages, which in turn would lead to decreasing welfare.

The findings in this study, reported in Section 5 and summarised in Table 4 can be viewed and assessed in many dimensions including *i*) a region by region comparison – aggregate and/or sector *ii*) a sector by sector comparison – across regions and/or national level. Out of the many important policy inferences and implications, we, in this study, focus on the salient ones. At the national level, the finding that *C*&*F*, *FHE*, *Transp.*, *HC*&*R* and *MG*&*S* exhibit long memory when the MoM series is considered is significant. As argued by Coleman (2012), inflation persistence in a sector(s) that could be considered as a basic necessity should be a major policy concern because of the welfare-limiting implications it could have. Arguably *C*&*F*, *FHE*, and *Transp.* (and even *MG*&*S*) fall into this category, which should be noted. Interestingly, an observation which underscores the need for concern in Ghana's inflation is the fact that both *C*&*F* and *FHE* are found to exhibit explosive behaviour when the YoY inflation series is considered. The expectation is that the persistence tendencies, at the national level, are high and as 'basic necessities' should affect a lot of Ghanaian consumers, particularly the poor. Another important observation is that each region, except *Volta region* exhibits long memory in at least one sector, when we consider the MoM inflation. However, the *Eastern region* and the *Central region* also exhibit explosive behaviour in certain sectors i.e., *R*&*C* and *HC*&*R* and *Education* respectively, which, we would argue should be an important consideration in policy design.

7. Summary and Conclusions

In this study we analysed the persistency in Ghana's inflation dynamics using both national and regional level data as well as sectoral. Also both month-on-month (MoM) and year-on-year (YoY) series are examined at the national, regional and sectoral levels. In all 13 sectors are considered in 9 regions (the Upper East and the Upper West regions are merged to constitute one region for the purposes of measuring consumer prices indexes used in this study resulting in 9 regions instead of the 10 politically administrative regions). In all 14 series are examined for month-on-month inflation and year-on-year inflation at both the regional and national level. This consists

of 13 sectors that make up the basket of consumer goods and overall consumer price index (CPI).

The examination of the unit root properties of the month-on-month and year-on-year inflation series for each of the 13 items in a typical consumer's basket as well as the aggregate price index yielded interesting but contrasting results. Using the augmented Dickey-Fuller (ADF) test for unit root, we were able to reject the null hypothesis of unit root (lack of mean reverting adjustment mechanism) in all the 13 sectors as well as the overall CPI at both the regional and national levels for the month-on-month inflation series. However, when the sectoral inflation is measured on year-on-year basis, the ADF test for unit root indicated that the underlying series have mixed order of integration across different sectors at both the national and regional level. For instance, the null hypothesis that the year-on-year rate of inflation for food and non-alcoholic beverages follows a unit root process is rejected only for the Ashanti region and at the national level. The null hypothesis that non-food inflation follows a unit root process is also rejected only for Brong-Ahafo and the Greater Accra regions. For the transport sector, the unit root null is rejected for Ashanti, Central, and Western regions and also at the national level, for the year-on-year inflation series. Also, the unit root null was rejected for clothing and footwear in the Greater Accra region and at the national level only. Educational price inflation measured on year-on-year basis also appeared to be stationary only in the Ashanti, and Eastern regions and at the national level, while the health sector is stationary for Eastern and Western regions as well as at the national level. At the national level, however, there were few cases of non-rejection of the unit root null; the null hypothesis of unit root in the year on year inflation is not rejected for the non-food, housing and utilities sector and hotel, cafes and restaurant sectors at the national level.

The rather large number of cases of non-rejection of the unit root null at the regional level year-on-year inflation for large number of sectors suggests that shocks to regional inflation will have permanent effect on the path of inflation. Since the non-rejection sectors differ from region to region, and from sector to sector, the welfare implication also differs across regions. Also since expenditure on necessary goods such as food and essential social services such as education and health care take bigger share of the budget of low-income households shock to prices in different sectors have different implications for both intra- and inter- regional poverty incidence and inequities in income distribution.

Based on the results of our study, we propose the following: First, it is important to move beyond targeting national consumer price inflation to a situation where, in conjunction with the national inflation target, there is a credible public declaration of specific inflation policy targets set for different sectors and different regions. Admittedly, implementation of such

tailored policies in Ghana's economy in the light of a national policy of inflation targeting and the resources available to the country may entail some short term cost, however, the potential gains could be larger in the long run. Given the differences in behaviour of inflation in different sectors across regions, there is room for a trade-off in inflation between sectors and regions, without affecting the national average for assessing policy performance. Second, Ghana's fiscal policy should be guided by the impact, not only on the national inflation target, but on the proposed regional (and sectoral) inflation targets. It is likely that, following such public policy announcements on regional inflation targets, the activities of market agents aimed at making arbitrage gains, is likely to enhance the reality of a national inflation target which will be similar across regions and sectors.

As indicated above, our conclusion on whether inflation is stationary or not depends on the sector and the region as well as whether one uses month-on-month inflation series or year-on-year inflation. However, the results from the unit root test did not tell us much. When a series is stationary, it has a mean reverting property but we are not able to tell how quickly the process reverts to its mean when there is a shock, information which is important for the decision for active intervention by policy makers. Similarly, we are unable to tell whether the path of a variable that has a unit root follows explosive path. Thus, for proper assessment of the memory behaviour of sectoral and regional inflation in Ghana, we moved beyond the traditional unit root approach by employing fractional integration techniques. Employing the Geweke and Porter Hudak (GPH) and the modified log-periodogram regression tests, the following facts were revealed about the memory behaviour of inflation across sectors and regions depending on the measure of inflation (month-on-month versus year-on-year). In the Ashanti region month-on-month inflation for the clothing and footwear, housing and utilities (water, electricity, gas, etc) and transportations sectors exhibit long-memory behaviour. However, based on the year-on-year inflation, long memory exists only in the transportation sector.

In the case of Brong-Ahafo, long-memory behaviour (persistence) was found to be present in the housing and utilities sector and recreation and culture for both month-on-month and year-on-year inflation. Health sector year-on-year inflation also showed persistence in the Brong-Ahafo region. Month-on-month inflation in the Central region exhibits some degree of persistence in the food and non-alcoholic beverages, and communications sectors whiles for the year-on-year inflation, long-memory behaviour was found in the housing and utilities, transport and miscellaneous goods and services sectors. Interestingly, the path of year-on-year inflation in the Central region in the education sector exhibits explosive behaviour.

Overall inflation (regional CPI inflation), food and non-alcoholic beverages and recreation and culture month-on-month inflation rates were found to exhibit long-memory behaviour in the Eastern region. On the basis of year-on-year inflation, presence of long-memory behaviour were found in health and communications sectors whereas the path of recreation and culture and hotel, cafes and restaurant sectors exhibits explosive patterns in the Eastern region. In the case of Greater Accra region, evidence of long-memory behaviour was established in the month-on-month inflation for the recreation and culture and hotel, cafes and restaurant sectors. On the basis of year-on-year inflation, however, non-food inflation and recreation and culture inflation exhibits long-memory behaviour. In the Upper East and Upper West regions (considered as one economic region for this purpose), we found evidence of long memory behaviour of inflation in housing and utilities and transport sectors for month-on-month and year-on-year inflation respectively.

On the basis of month-on-month inflation, evidence of long-memory behaviour was found in the housing and utilities sector in the Western region. However, in the same region, year-on-year inflation exhibited long-memory behaviour in the housing and utilities, health, transport and communications sectors. At the national level, evidence of long-memory behaviour in month-on-month inflation was established in the clothing and footwear, furnishing, household equipment, hotels, cafes and restaurant and miscellaneous goods and services sectors. National level year-on-year inflation in the transportation sector showed long-memory behaviour whereas the paths for cloth and footwear, and furnishing, household equipment were found to be explosive.

In conclusion, we posit that such analyses of inflation at the micro level is crucial for developing country policy making, particularly when governments aim to make genuine efforts to alleviate poverty. Our results have suggested that, overall, the 'poor' are more likely to be adversely affected, thereby increasing the welfare cost of inflationary shocks by distorting consumption choices and the resource allocation function of markets. This ultimately impacts on poverty and income distribution with ramifications for economic growth and/or development.

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APPENDIX

Table A1: Fractional integration tests (Geweke & Porter Hudak (GPH) tests, monthly inflation)

Region	Overall[+]	F&NAB[+]	NF[+]	ABT&N	C&F	HWEG&O	FHE	Health	Transp.
Ashanti	-0.01 (0.19)	0.07 (0.21)	0.07 (0.13)	0.06 (0.20)	0.40 (0.23)	-0.43 *** (0.18)	0.08 (0.14)	-0.09 (0.15)	-0.26 (0.17)
Brong-Ahafo	-0.234 (0.20)	-0.14 (0.21)	0.02 (0.25)	-0.05 (0.17)	-0.05 (0.15)	-0.21 (0.11)	-0.10 (0.10)	-0.06 (0.15)	0.19 (0.15)
Central	0.00 (0.23)	-0.03 (0.16)	-0.06 (0.12)	0.22 (0.16)	0.09 (0.14)	-0.07 (0.12)	0.07 (0.21)	0.08 (0.16)	-0.34* (0.19)
Eastern	0.27 (0.17)	0.11 (0.18)	0.13 (0.12)	0.00 (0.16)	-0.23 (0.24)	-0.04 (0.13)	-0.05 (0.18)	0.31* (0.16)	-0.06 (0.15)
Greater-Accra	0.00 (0.16)	0.08 (0.18)	-0.21* (0.10)	0.13 (0.13)	-0.16 (0.19)	-0.14 (0.25)	0.35* (0.19)	-0.10 (0.13)	0.03 (0.23)
Northern	0.07 (0.16)	-0.11 (0.19)	0.07 (0.19)	-0.184 (0.17)	-0.28** (0.13)	-0.05 (0.13)	-0.05 (0.14)	0.23 (0.21)	0.05 (0.22)
Upper-East & *Upper-West*	-0.05 (0.17)	-0.02 (0.19)	-0.08 (0.16)	0.07 (0.14)	-0.07 (0.16)	-0.39* (0.19)	0.03 (0.08)	0.05 (0.11)	-0.36* (0.18)
Volta	0.06 (0.16)	0.21 (0.18)	-0.02 (0.23)	-0.08 (0.16)	0.22 (0.18)	0.02 (0.16)	-0.17 (0.12)	-0.05 (0.17)	0.019 (0.13)
Western	0.02 (0.15)	-0.07 (0.16)	0.06 (0.11)	0.05 (0.20)	0.30 (0.22)	-0.43*** (0.15)	0.08 (0.14)	-0.09 (0.15)	-0.26 (0.17)
National	0.23 (0.19)	0.22 (0.16)	0.07 (0.22)	0.29** (0.12)	0.34** (0.17)	-0.06 (0.14)	0.40** (0.18)	-0.07 (0.15)	-0.10 (0.18)

Notes: ^ Table reports the Geweke/Porter-Hudak (GPH, 1983) estimate of the long memory (fractional integration) parameter, *d*, of a time series. For individual regions, *Overall*, *F&NAB*, and *NF* span 2005*m*2 – 2014*m*2, whereas all the other sectors span 2005*m*2 – 2012*m*8. For the *National*, data (bottom row) spans 1997*m*10-2014*m*2, except for NF which spans 2005*m*2 – 2014*m*2. ***,**,* indicates rejection of null of no long memory i.e. $d = 0$, at the 1%, 5% and 10% level respectively.

Table A1 (cont'd): Fractional integration tests (Geweke & Porter Hudak (GPH) tests, monthly inflation)

Region	Communications	R&C	Education	HC&R	MG&S
Ashanti	0.02 (0.12)	-0.08 (0.13)	-0.07 (0.20)	0.01 (0.18)	-0.01 (0.14)
Brong-Ahafo	0.07 (0.13)	-0.46*** (0.13)	0.01 (0.07)	-0.03 (0.19)	0.08 (0.10)
Central	-0.18 (0.11)	-0.05 (0.16)	0.27 (0.17)	0.13 (0.18)	-0.35*** (0.12)
Eastern	-0.02 (0.15)	0.27*** (0.05)	-0.02 (0.12)	0.10 (0.13)	0.05 (0.16)
Greater-Accra	0.00 (0.19)	-0.20 (0.16)	-0.11 (0.23)	-0.04 (0.17)	0.16 (0.15)
Northern	0.06 (0.19)	0.32** (0.17)	0.07 (0.10)	0.25 (0.23)	-0.42 (0.17)
Upper-East & *Upper-West*	0.08 (0.12)	-0.32* (0.17)	0.02 (0.03)	-0.02 (0.17)	-0.17 (0.16)
Volta	0.12 (0.21)	0.20 (0.21)	0.16 (0.09)	-0.13 (0.19)	-0.10 (0.17)
Western	0.02 (0.12)	0.08 (0.12)	-0.07 (0.20)	0.01 (0.17)	-0.01 (0.14)
National	0.01 (0.12)	0.07 (0.16)	0.11 (0.12)	0.17 (0.18)	0.36*** (0.12)

Notes: ^Table reports the Geweke/Porter-Hudak (GPH, 1983) estimate of the long memory (fractional integration) parameter, *d*, of a timeseries. ***,**,* indicates rejection of null of no long memory i.e. $d = 0$, at the 1%, 5% and 10% level respectively.

Table A2: Fractional integration tests (Geweke & Porter Hudak (GPH) tests, Year-on-Year inflation)^

Region	Overall	F&NAB	NF	ABT&N	C&F	HWEG&O	FHE	Health	Transp.
Ashanti	1.04*** (0.12)	0.96*** (0.10)	1.12*** (0.16)	1.12*** (0.22)	1.29*** (0.16)	1.13*** (0.25)	1.25*** (0.22)	1.13*** (0.18)	0.32 (0.22)
Brong-Ahafo	1.03*** (0.14)	0.99*** (0.15)	1.08*** (0.25)	0.98*** (0.18)	0.99*** (0.19)	0.75*** (0.20)	0.88*** (0.24)	1.10*** (0.21)	1.22*** (0.16)
Central	1.03*** (0.16)	1.10*** (0.23)	1.14*** (0.16)	1.28*** (0.19)	1.22*** (0.22)	0.45*** (0.11)	0.99*** (0.17)	1.16*** (0.14)	0.61*** (0.17)
Eastern	1.09*** (0.24)	0.85*** (0.22)	1.02*** (0.16)	1.04*** (0.21)	1.04*** (0.17)	0.95*** (0.18)	0.90*** (0.21)	0.64*** (0.20)	0.73*** (0.19)
Greater-	0.87***	1.01*** (0.13)	0.52***	0.99*** (0.16)	0.86***	1.07*** (0.20)	1.27***	0.91***	0.95*** (0.31)

Accra	(0.14)		(0.12)		(0.14)		(0.12)	(0.18)	
Northern	1.05*** (0.14)	0.92*** (0.13)	1.07*** (0.21)	0.72*** (0.24)	0.79*** (0.17)	1.05*** (0.25)	0.99*** (0.19)	0.94*** (0.13)	0.79*** (0.21)
Upper-East & *Upper-West*	0.85*** (0.21)	1.13*** (0.18)	0.96*** (0.21)	0.92*** (0.22)	1.00*** (0.16)	0.68*** (0.21)	0.89*** (0.19)	0.97*** (0.15)	0.87*** (0.20)
Volta	1.18*** (0.15)	1.21*** (0.20)	0.99*** (0.17)	0.87*** (0.13)	1.26*** (0.19)	0.96*** (0.27)	0.86*** (0.19)	1.04*** (0.18)	0.95*** (0.21)
Western	0.97*** (0.19)	0.93*** (0.16)	0.87*** (0.16)	1.11*** (0.13)	1.04*** (0.17)	0.74*** (0.20)	0.94*** (0.16)	0.82 (0.18)	0.57*** (0.12)
National	1.39*** (0.16)	1.35*** (0.24)	1.21*** (0.15)	1.21*** (0.24)	1.49*** (0.19)	0.94*** (0.19)	1.52*** (0.23)	0.99*** (0.21)	0.76*** (0.23)

Notes: ^ Table reports the Geweke/Porter-Hudak (GPH, 1983) estimate of the long memory (fractional integration) parameter, *d*, of a timeseries; Standard errors in parenthesis. Data for *Overall*, *F*&*NAB*, and *NF* span sample period 2006*m*1 – 2014*m*2. All other sectors span 2006*m*1 – 2012*m*8. ***,**,* indicates rejection of null of no long memory i.e. $d = 0$, at the 1%, 5% and 10% level respectively.

Table A2 (cont'd): Fractional integration tests (Geweke & Porter Hudak (GPH) tests, Year-on-Year inflation)^

Region	Communications	R&C	Education	HC&R	MG&S
Ashanti	1.15*** (0.23)	1.22*** (0.17)	0.84** (0.31)	1.28*** (0.16)	0.64*** (0.20)
Brong-Ahafo	1.31*** (0.29)	0.47** (0.20)	1.13*** (0.20)	1.09*** (0.27)	0.99*** (0.17)
Central	0.92*** (0.24)	0.92*** (0.13)	1.18*** (0.18)	1.25*** (0.19)	0.75*** (0.17)
Eastern	1.18*** (0.26)	1.34*** (0.14)	1.11*** (0.21)	1.12 (0.13)	0.88*** (0.21)
Greater-Accra	1.06*** (0.32)	0.40** (0.21)	0.97*** (0.15)	0.98*** (0.17)	1.17*** (0.25)
Northern	1.27*** (0.38)	1.17*** (0.16)	1.09*** (0.16)	1.20*** (0.237)	0.72*** (0.24)
Upper-East & *Upper-West*	1.26*** (0.28)	0.79*** (0.17)	1.08*** (0.21)	1.17*** (0.21)	1.00*** (0.16)
Volta	1.30*** (0.29)	1.33*** (0.29)	0.87*** (0.12)	1.01*** (0.20)	0.86*** (0.17)
Western	1.20*** (0.27)	0.96*** (0.20)	1.01*** (0.16)	1.12*** (0.17)	0.83*** (0.18)

National	1.07*** (0.21)	0.96*** (0.26)	0.91*** (0.18)	1.20*** (0.23)	1.41*** (0.23)

Notes: ^Table reports the Geweke/Porter-Hudak (GPH, 1983) estimate of the long memory (fractional integration) parameter, *d*, of a timeseries. ***,**,* indicates rejection of null of no long memory i.e. $d = 0$, at the 1%, 5% and 10% level respectively.

Table A3: Fractional integration tests (Modified Log-Periodogram Regression tests, month-on-month inflation)^

Region	Overall	F&NAB	NF	ABT&N	C&F	HWEG&O	FHE	Health	Transp.
Ashanti	-0.08$^{>>>}$ (0.16)	-0.17$^{>>>}$ (0.17)	0.03$^{>>>}$ (0.11)	0.14$^{>>>}$ (0.22)	0.34$^{\xi\xi,>>>}$ (0.23)	-0.22$^{\xi\xi,>>>}$ (0.18)	0.11$^{>>>}$ (0.14)	-0.12$^{>>>}$ (0.14)	-0.26$^{\xi\xi,>>>}$ (0.17)
Brong-Ahafo	-0.03$^{>>>}$ (0.20)	-0.01$^{>>>}$ (0.19)	-0.01$^{>>>}$ (0.20)	-0.03$^{>>>}$ (0.17)	-0.10$^{>}$ (0.15)	-0.52$^{\xi,>}$ (0.12)	-0.05$^{>>>}$ (0.11)	-0.11$^{>>>}$ (0.15)	0.08$^{>>>}$ (0.18)
Central	0.18$^{>>>}$ (0.21)	0.30$^{\xi\xi,>}$ (0.16)	0.11$^{>>>}$ (0.10)	0.23$^{\xi\xi,>>>}$ (0.16)	0.07$^{>>>}$ (0.14)	-0.02$^{>>>}$ (0.13)	0.07$^{>>>}$ (0.26)	0.07$^{>>>}$ (0.18)	-0.04$^{>>>}$ (0.15)
Eastern	1.16$^{\xi}$ (0.15)	0.70$^{\xi>>}$ (0.18)	1.08$^{\xi}$ (0.14)	-0.03$^{>>>}$ (0.17)	-0.08$^{>>>}$ (0.20)	-0.10$^{>>>}$ (0.12)	-0.02$^{>>>}$ (0.18)	-0.33$^{\xi\xi,>}$ (0.16)	-0.01$^{>>>}$ (0.18)
Greater-Accra	0.09$^{>>>}$ (0.16)	0.03$^{>>>}$ (0.19)	-0.15$^{>>>}$ (0.12)	0.20$^{>>>}$ (0.14)	-0.01$^{>>>}$ (0.15)	-0.11$^{>>>}$ (0.17)	0.10$^{>>>}$ (0.17)	-0.14$^{>>>}$ (0.11)	0.01$^{>>>}$ (0.17)
Northern	-0.04$^{>>>}$ (0.17)	-0.23$^{\xi\xi,>}$ (0.20)	-0.08$^{>>>}$ (0.18)	-0.16$^{>>>}$ (0.17)	-0.23$^{\xi\xi,>}$ (0.13)	-0.22$^{\xi\xi,>}$ (0.14)	-0.05$^{>>>}$ (0.14)	0.09$^{>>>}$ (0.17)	0.09$^{>>>}$ (0.21
Upper-East & *Upper-West*	-0.12$^{>>>}$ (0.16)	-0.07$^{>>>}$ (0.20)	-0.22$^{\xi\xi,>}$ (0.15)	-0.01$^{>>>}$ (0.12)	-0.11$^{>>>}$ (0.15)	-0.73$^{\xi,>}$ (0.18)	0.01$^{>>>}$ (0.07)	-0.04$^{>>>}$ (0.10)	-0.17$^{>>>}$ (0.21)
Volta	-0.06$^{>>>}$ (0.15)	0.21$^{\xi\xi,>}$ (0.20)	-0.02$^{>>>}$ (0.22)	-0.11$^{>>>}$ (0.20)	-0.16$^{>>>}$ (0.15)	-0.00$^{>>>}$ (0.15)	-0.10$^{>>>}$ (0.11)	0.18$^{>>>}$ (0.16)	0.20$^{>>>}$ (0.16)
Western	0.00$^{>>>}$ (0.15)	-0.14$^{>>>}$ (0.17)	0.06$^{>>>}$ (0.11)	0.09$^{>>>}$ (0.19)	0.34$^{\xi\xi,>}$ (0.23)	-0.37$^{\xi\xi,>}$ (0.15)	-0.11$^{>>>}$ (0.14)	-0.12$^{>>>}$ (0.15)	-0.26$^{\xi\xi,>>>}$ (0.17)
National	0.12$^{>>>}$ (0.23)	-0.07$^{>>>}$ (0.21)	0.20$^{>>>}$ (0.20)	0.04$^{>>>}$ (0.10)	0.39$^{\xi\xi,>}$ (0.15)	0.03$^{>>>}$ (0.17)	0.44$^{\xi\xi,>}$ (0.22)	0.11$^{>>>}$ (0.18)	0.31$^{\xi\xi,>}$ (0.14)

Notes: ^ Log-Periodogram Regression tests is estimated as a modified form of the Geweke/Porter-Hudak (GPH, 1983) estimate of the long memory (fractional integration) parameter, *d*, of a timeseries, proposed by Phillips (1999a, 1999b). + indicates a sample period 2006*m*1 – 2014*m*2. All other sectors span 2006*m*1 – 2012*m*8.
$\xi\xi\xi, \xi\xi, \xi$ (>>>,>>,>) indicates rejection of null of $d = 0$ ($d = 1$), at the 1%, 5% and 10% level respectively.

Table A3 (cont'd): Fractional integration tests (Modified Log-Periodogram Regression tests, month-on-month inflation)

Region	Communications	R&C	Education	HC&R	MG&S
Ashanti	-0.07$^{>>>}$ (0.13)	-0.08$^{>>>}$ (0.12)	-0.01$^{>>>}$ (0.22)	-0.07$^{>>>}$ (0.22)	0.00$^{>>>}$ (0.13)
Brong-Ahafo	0.01$^{>>>}$ (0.14)	-0.45$^{\xi,>}$ (0.13)	0.03$^{>}$ (0.07)	-0.01$^{>}$ (0.22)	0.07$^{>>>}$ (0.11)
Central	-0.28$^{\xi\xi,>}$ (0.12)	0.04$^{>}$ (0.16)	0.18$^{>}$ (0.18)	0.21$^{>}$ (0.15)	-0.32$^{>}$ (0.12)
Eastern	-0.17$^{>>>}$ (0.19)	0.27$^{\xi,>}$ (0.05)	-0.13$^{>}$ (0.14)	-0.13$^{>}$ (0.14)	0.05$^{>>>}$ (0.16)
Greater-Accra	-0.10$^{>>>}$ (0.19)	-0.25$^{\xi,>}$ (0.12)	-0.16$^{>}$ (0.17)	-0.29$^{\xi,>}$ (0.15)	0.10$^{>>>}$ (0.11)
Northern	-0.05$^{>>>}$ (0.23)	0.33 (0.17)$^{\xi,>>>}$	0.05$^{>>>}$ (0.11)	0.19$^{>>>}$ (0.25)	0.41$^{\xi\xi,>>>}$ (0.18)
Upper-East & *Upper-West*	0.03$^{>>>}$ (0.13)	-0.25$^{>}$ (0.17)	-0.01$^{>>>}$ (0.03)	0.01$^{>>>}$ (0.16)	-0.30$^{\xi\xi,>}$ (0.15)
Volta	-0.06$^{>>>}$ (0.17)	0.11$^{>>>}$ (0.14)	0.17$^{>>>}$ (0.08)	-0.13$^{>>>}$ (0.23)	-0.13$^{>}$ (0.15)
Western	-0.07$^{>>>}$ (0.14)	-0.08$^{>>>}$ (0.12)	-0.02$^{>>>}$ (0.22)	-0.07$^{>>>}$ (0.22)	0.00$^{>}$ (0.13)
National	0.02$^{>>>}$ (0.11)	0.15$^{>>>}$ (0.17)	0.00$^{>>>}$ (0.13)	0.29$^{\xi\xi,>}$ (0.19)	0.38$^{\xi\xi,>>>}$ (0.12)

Notes: ^ Log-Periodogram Regression tests is estimated as a modified form of the Geweke/Porter-Hudak (GPH, 1983) estimate of the long memory (fractional integration) parameter, *d*, of a timeseries, proposed by Phillips (1999a, 1999b). $^{\xi\xi\xi,\xi\xi,\xi\,(>>>,>>,>)}$ indicates rejection of null of $d = 0$ ($d = 1$), at the 1%, 5% and 10% level respectively.

Table A4: Fractional integration tests (Modified Log-Periodogram Regression tests, Year-on-Year inflation)^

Region	Overall^{+}	F&NAB^{+}	NF^{+}	ABT&N	C&F	HWEG&O	FHE	Health	Transp.
Ashanti	1.14$^{\xi\xi\xi}$ (0.13)	0.84$^{\xi\xi\xi}$ (0.13)	1.31$^{\xi\xi\xi}$ (0.16)	0.89$^{\xi\xi\xi}$ (0.15)	1.28$^{\xi\xi\xi}$ (0.11)	1.06$^{\xi\xi\xi}$ (0.18)	1.20$^{\xi\xi\xi}$ (0.11)	1.11$^{\xi\xi\xi}$ (0.17)	0.42$^{\xi,>}$ (0.14)
Brong-Ahafo	1.05$^{\xi\xi\xi}$ (0.16)	0.92$^{\xi\xi\xi}$ (0.13)	1.09$^{\xi\xi\xi}$ (0.24)	0.99$^{\xi\xi\xi}$ (0.14)	1.04$^{\xi\xi\xi}$ (0.19)	0.72$^{\xi,>}$ (0.22)	0.36$^{\xi\xi,>}$ (0.26)	0.75$^{\xi,>}$ (0.13)	1.08$^{\xi\xi\xi}$ (0.16)
Central	1.02$^{\xi\xi\xi}$ (0.15)	1.12$^{\xi\xi\xi}$ (0.29)	1.17$^{\xi\xi\xi}$ (0.17)	1.29$^{\xi\xi\xi}$ (0.24)	1.14$^{\xi\xi\xi}$ (0.18)	0.45$^{\xi,>}$ (0.12)	0.96$^{\xi\xi\xi}$ (0.15)	1.18$^{\xi\xi\xi}$ (0.17)	0.76$^{\xi,>}$ (0.13)
Eastern	1.12$^{\xi\xi\xi}$	1.10$^{\xi\xi\xi}$	0.99$^{\xi\xi\xi}$	0.87$^{\xi\xi\xi}$	0.97$^{\xi\xi\xi}$	0.92$^{\xi\xi\xi}$ (0.17)	0.89$^{\xi\xi\xi}$	0.67$^{\xi,>}$	0.79$^{\xi\xi\xi}$

	(0.18)	(0.23)	(0.17)	(0.24)	(0.14)		(0.20)	(0.12)	(0.14)
Greater-Accra	0.92*** (0.14)	1.06*** (0.16)	0.55*,> (0.19)	1.01*** (0.16)	0.85*** (0.11)	1.02*** (0.13)	1.17*** (0.12)	0.84*** (0.22)	0.93*** (0.16)
Northern	1.11*** (0.22)	0.93*** (0.13)	1.05*** (0.21)	0.82*** (0.19)	0.89*** (0.17)	0.73**,>> (0.14)	0.87*** (0.22)	1.20*** (0.19)	0.88*** (0.16)
Upper-East & *Upper-West*	0.80*** (0.22)	0.94*** (0.13)	0.83*** (0.26)	0.90*** (0.24)	0.92*** (0.16)	-0.04> (0.21)	0.99*** (0.08)	0.91*** (0.17)	0.73*,> (0.17)
Volta	1.10*** (0.16)	1.19*** (0.21)	1.05*** (0.22)	0.94*** (0.19)	1.16*** (0.10)	0.91*** (0.20)	0.90*** (0.21)	1.09*** (0.34)	0.96*** (0.22)
Western	1.00*** (0.20)	0.96*** (0.19)	0.87*** (0.15)	1.07*** (0.10)	1.03*** (0.09)	0.77*,> (0.38)	1.01*** (0.12)	0.74*,> (0.23)	0.47*,> (0.14)
National	1.07*** (0.13)	1.01*** (0.12)	1.21*** (0.16)	1.16*** (0.19)	1.41*,> (0.17)	0.92*** (0.19)	1.42*,> (0.22)	0.93*** (0.17)	0.69*,> (0.23)

Notes: ^ Log-Periodogram Regression tests is estimated as a modified form of the Geweke/Porter-Hudak (GPH, 1983) estimate of the long memory (fractional integration) parameter, *d*, of a timeseries, proposed by Phillips (1999a, 1999b). + indicates a sample period 2006*m*1 – 2014*m*2. All other sectors span 2006*m*1 – 2012*m*8. ***, **, * (>>>,>>,>) indicates rejection of null of $d = 0$ ($d = 1$), at the 1%, 5% and 10% level respectively.

Table A4 (cont'd): Fractional integration tests (Modified Log-Periodogram Regression tests, Year-on-Year inflation)

Region	Communications	R&C	Education	HC&R	MG&S
Ashanti	0.92 $^{\xi\xi\xi}$ (0.16)	1.20 $^{\xi\xi\xi}$ (0.17)	0.81 $^{\xi\xi\xi}$ (0.26)	1.17 $^{\xi\xi\xi}$ (0.11)	0.79 $^{\xi\xi}$ (0.12)
Brong-Ahafo	0.93 $^{\xi\xi\xi}$ (0.21)	0.48 $^{\xi,>}$ (0.17)	1.10 $^{\xi\xi\xi}$ (0.18)	0.95 $^{\xi\xi\xi}$ (0.18)	1.13 $^{\xi\xi\xi}$ (0.18)
Central	0.60 $^{\xi\xi\xi}$ (0.21)	0.95 $^{\xi\xi\xi}$ (0.17)	1.25 $^{\xi,>}$ (0.29)	1.18 $^{\xi\xi\xi}$ (0.14)	0.72 $^{\xi,>}$ (0.15)
Eastern	0.79 $^{\xi,>}$ (0.16)	1.29 $^{\xi,>}$ (0.13)	0.98 $^{\xi\xi\xi}$ (0.15)	1.22 $^{\xi\xi\xi,>}$ (0.17)	0.92 $^{\xi\xi\xi}$ (0.12)
Greater-Accra	0.82 $^{\xi\xi\xi}$ (0.17)	0.38 $^{\xi,>}$ (0.16)	0.94 $^{\xi}$ (0.20)	0.34 $^{>}$ (0.20)	0.96 $^{\xi}$ (0.17)
Northern	0.96 $^{\xi\xi\xi}$ (0.24)	1.12 $^{\xi\xi\xi}$ (0.14)	1.04 $^{\xi\xi\xi}$ (0.15)	1.05 $^{\xi\xi\xi}$ (0.20)	0.76 $^{\xi\xi\xi,>}$ (0.14)
Upper-East & *Upper-West*	0.90 $^{\xi\xi\xi}$ (0.21)	0.85 $^{\xi\xi\xi}$ (0.18)	1.07 $^{\xi\xi\xi}$ (0.23)	0.85 $^{\xi\xi\xi}$ (0.20)	1.04 $^{\xi\xi\xi}$ (0.13)
Volta	1.02 $^{\xi\xi\xi}$ (0.21)	1.05 $^{\xi\xi\xi}$ (0.20)	0.87 $^{\xi\xi\xi}$ (0.11)	0.97 $^{\xi\xi\xi}$ (0.19)	0.59 $^{\xi,>}$ (0.19)
Western	0.71 $^{\xi,>}$ (0.18)	0.99 $^{\xi\xi\xi}$ (0.19)	0.88 $^{\xi\xi\xi}$ (0.16)	1.00 $^{\xi\xi\xi}$ (0.16)	1.02 $^{\xi\xi\xi}$ (0.20)
National	0.86 $^{\xi\xi\xi}$ (0.27)	1.04 $^{\xi\xi\xi}$ (0.25)	0.83 $^{\xi\xi\xi}$ (0.19)	0.92 $^{\xi\xi\xi}$ (0.20)	1.29 $^{\xi\xi\xi}$ (0.22)

Notes: ^ Log-Periodogram Regression tests is estimated as a modified form of the Geweke/Porter-Hudak (GPH, 1983) estimate of the long memory (fractional integration) parameter, *d*, of a timeseries, proposed by Phillips (1999a, 1999b). $^{\xi\xi\xi,\xi\xi,\xi\ (>>>,>>,>)}$ indicates rejection of null of $d = 0$ ($d = 1$), at the 1%, 5% and 10% level respectively.

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