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Inflation Uncertainty and Inflation: Implications of Adjustment and Economic Recovery Programs in Sub-Saharan Africa

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Abstract

This paper examines the relationship between monthly inflation rates and the uncertainty of inflation in three Sub-Saharan African countries over different regimes based on periods of implementation of IMF/World Bank economic adjustment and recovery programs. The countries involved in this examination are Senegal, Ghana and Uganda considered by IMF and World Bank at a point to be promising among Sub-Saharan African countries in their efforts to emerge from economic stagnation. Employing the GARCH framework, the paper generates a time series of conditional variances of inflation as proxies for uncertainty of inflation in a test to determine the direction of causality between inflation rates and the uncertainty of inflation. Results of Granger causality over the entire period of study confirm the Friedman-Ball hypothesis for all three countries but Senegal also provided significant evidence of the tenancy of the Cukierman-Meltzer Hypothesis. Results in Ghana and Uganda provide indications of possible intervention policies to lower inflation uncertainty during the period of implementation of IMF/World Bank programs. Also, as anticipated by the paper, no evidence is established of the Cukierman-Meltzer hypothesis of the influence of the opportunistic central banker during the adjustment and recovery programs period of IMF/World Bank in the three countries.

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Introduction

Over the last couple of decades, Sub-Saharan African (SSA) countries have faced a myriad of economic downturns and generally poor macroeconomic performance. The factors listed as the cause for the latter have ranged from political instability, economic mismanagement to natural disasters. Within the context of the general economic malaise that has dogged Africa; the histories of economic performance of individual countries in SSA have varied over the years. Under the auspices of the World Bank and IMF, various SSA countries have adopted variations of economic recovery (ERP) and structural adjustment (SAP) programs with a view to improving economic performance by controlling inflation, enhancing real growth rates through increased investment and savings, tightening fiscal discipline and financial sector reforms. Some countries responded positively to these measures and saw improvements especially in inflation control and economic growth. According to an IMF survey paper three of such SSA countries that demonstrated promise were Ghana, Senegal and Uganda, which are the focus of this study. [1]

The macroeconomic variable impacted by the various adjustment programs adopted by the above SSA countries, and of interest to this study, is inflation rate. During the periods of reform for Ghana, Uganda and Senegal, the levels of inflation in the respective countries were lowered and in fact in some situations in very dramatic fashion. Specifically, between 1983 to 1991 inflation in Ghana went from 123% to 10.3%, in Uganda inflation went from 237% in 1986/7 to 3.4% in 1994/5 and in Senegal inflation dropped from 9.8% for the period 1978-84 to -0.4% between 1989-93.[2] As indicated earlier, these changes in the levels of inflation coincided with the adoption of various economic policy adjustments programs and these appear to have created different inflation regimes in each of the three countries respective economic histories. In line with existing literature on the subject matter of this paper, we investigate how the changing economic policy regimes experienced by the three countries affected the observed relationship between inflation and inflation uncertainty, and then attempt to establish the direction of this relationship.

The direction of the relationship between inflation rates and its uncertainty has been the focus of extensive empirical and theoretical investigation. Theoretical arguments have been presented by Friedman (1977), and Ball (1993) positing that generally high inflation causes inflation uncertainty. The main thrust of their argument centers on the uncertainty on the part of agents in an economy trying to gauge the preferences of monetary policymakers toward inflation and the policy responses to rising rate of inflation. The literature provides empirical evidence in support of the endogeneity of the uncertainty of inflation in its relationship with average inflation (Grier and Perry (1998), Tevfik and Perry (2000) among others). Cukierman and Meltzer (1986) on the other hand present a theoretical proposition that advances an opposite directional relationship between inflation and of the countries. Specifically they argue that high uncertainty of inflation and the murky economic environment it engenders may provide monetary policymakers

[1] IMF Survey (November 11, 1996)

[2] Adjustment for Growth: The African Experience (Hadjimihael, Nowak, Sharer and Tahari, 1996)

the latitude and incentive to surprise unsuspecting agents in an economy with measures that serve to increase in inflation rates.[3] Motivation for policymakers to engage in the latter behavior, are the benefits, among others, of seigniorage and reductions in the real value of outstanding government debt. To the extent that policymakers take advantage of the opportunity for monetary innovations, it is conceivable to observe high uncertainty resulting in higher inflation rates.[4] They also posit that the tendency for the latter scenario to occur is likely a function of the credibility of the monetary policymaker. [5]

We juxtapose the behavior of inflation rates over the different policy regimes in Ghans, Senegal, and Uganda. In so doing, we examine the two propositions presented by Friedman-Ball on the ond hand, and by Cukierman-Meltzer on the other. This comparative approach enables one to determine which is tenable for the countries and how regime changes impacted the direction of relationship between inflation and its uncertainty. Employing a GARCH framework and the Granger causality technique, overall we find evidence of the Friedman-Ball proposition dominating in Ghana and Uganda over certain periods but Senegal provide significant support for both Friedman-Ball and Cukierman-Meltzer hypotheses. We also find evidence of actions by monetary policymakers to lower inflation during period of rising uncertainty in Ghana and Uganda. This holds true over the entire period of study and during the respective adjustment regimes.

The rest of the paper will be presented as follows. We first provide an overview of the literature on inflation and the uncertainty of inflation. In turn, we review the recovery and adjustment programs adopted by Ghana, Senegal and Uganda. We then present our econometric model and results, from which we drive present implications and conclusions of the study.

Overview of Inflation Uncertainty

Most finance and economic variables are quoted in nominal terms and therefore the behavior of inflation is fundamentally relevant to the anticipated path of these variables. This renders the unpredictable or uncertain aspect of inflation even more important in the behavior of nominal data (Ireland (1996); Mishkin (1990a & 1990b); Frenkel and Lown (1994)). Specifically, the path of a crucial variable like market quoted nominal interest rate is important to decision making at all levels. The important role interest rates play in the process of asset valuation serves to underscore the importance of factors that influence its path. Business and individual decisions on investments are largely predicated on the direction of rates. Therefore, given that real rates hardly change, the uncertainty aspect of inflation rates may tend to define reactions to the expected path of interest rates. So, knowing the direction of the relationship between inflation and its

[3] This behavior of the policymaker is what Cukierman-Meltzer described as the opportunistic central banker.

[4] Grier and Perry (1998) found relatively weak empirical support for the uncertainty to inflation argument. Of the G-7 countries in the study only Japan and France provide support for the uncertainty to inflation relationship.

[5] Kontonikas (2004) reports that the adoption of inflation targets in the U.K. reduced long run inflation uncertainty and inflation rates. The announcing of an inflation target may have signaled an enhancement of inflation control credibility of policymakers.

uncertainty, at a minimum, equips investors at all levels with additional information with which to gauge the predictability of rates and appropriate decisions to make.

Various studies have attempted to establish the relationship between inflation and its uncertainty (Ball, Cecchetti and Gordon (1990); Evans (1991, 1993); Evans and Wachtel (1993); Holland (1993 & 1995); Golob (1994) among a others). In an earlier study of 17 OECD countries from 1951 – 1968 and using standard deviation as a gauge for inflation variability, Okun (1971) reported that countries with average high inflation tended to display higher variability in inflation. In a related study, Logue and Willett (1976) using 41 industrialized and developing countries found over the period of study from 1950-1970 a positive relationship between inflation and its variability. However, upon disaggregating the sample into industrialized and developing in a regression model, reported that the some countries in the industrialized economies displayed a negative coefficient. The authors reasoned that the results may reflect more effective monetary policy measures in periods of increasing uncertainty in the industrialized as against developing economies. Like Okun they used the standard deviation of inflation as proxy for variability and uncertainty of inflation. The use of standard deviation as proxy for inflation uncertainty does not always fully capture actual uncertainty since in certain cases variability is predictable (Grier and Perry (1998)).

Subsequent efforts to capture true inflation surprise and uncertainty entailed the use of variations of ARCH/GARCH models. These models permit one to extract and generate conditional variances of the error term of autoregressive models of inflation rates (Engle (1983); Bollerslev (1986); Grier and Perry (1998); Nas and Perry (2000); Fountas, Loannidis and Karanasos (2003) and Bhar and Hamori (2004)).[6] In large part, as stated earlier, tests conducted established a positive relationship between inflation and its uncertainty; however the direction of the relationship has been a matter of considerable debate.[7] Grier and Perry (1998) Ball (1992) after obtaining series representing inflation uncertainty for G7 countries from a GARCH model employed Granger Causality procedure to test the direction of causality between inflation and its uncertainty. Results indicated that inflation rates increase inflation uncertainty in significant fashion. Evidence establishing an inflation uncertainty to inflation connection was frail and inconclusive.

In the same paper Grier and Perry found that for U.S., U.K. and Germany a rise in inflation uncertainty resulted in lower inflation rates while opposite results obtained in France and Japan. The results seem to be in line with each countries measure of credibility of monetary policymaker's commitment to inflation control as presented by Cukierman's (1992) central bank independence indexes. U.S. and Germany have higher measures of central bank independence as compared to France and Japan. Evidence presented by Fountas, Loannidis and Karanasos (2003) appear to confirm Grier and

[6] Evans, M. (1991) shows that the changing behavior of agents and policymakers toward inflation can precipitate 'both ARCH effects and time variation in the structure of inflation.'

[7] Bhar and Hamori (2004) examine the inflation and uncertainty relationship using a markov switching model on G7 countries and reported that the relationship depended on whether the shock was transitory and differed by country.

Perry's findings. They reported a negative relationship between increased inflation uncertainty and average inflation for Germany and Netherlands and opposite results for Spain, Italy and France.[8] The latter group has lower central bank independence measures than the former pair. These results perhaps underscores Kydland and Prescott's (1977) proposition of the adoption 'rules' to enhance monetary policy consistency, a notion presented by Cukierman and Meltzer (1986) as credibility of policymakers. The latter perhaps reduces ambiguity of commitment of policymakers to inflation control and reduces uncertainty of future inflation expectations by agents following stabilization actions by policymakers.

Taking account of the results and findings reported above and how policy differences across countries influence the relationship between inflation and its uncertainty, the special economic experiences of the SSA countries in this study affords an opportunity to further examine the tenancy of inflation-uncertainty relationship over changing policy regimes. As stated by Bhar and Hamori (2004), the nature of the relationship between inflation and its uncertainty appear to differ from country to country within the European Union (EU). Given the peculiar macroeconomic policy path of Ghana, Senegal and Uganda it is useful to investigate the behavior of the inflation-uncertainty of inflation relationship as policy regimes have changed.

Economic Paths to Growth and Development: Ghana, Senegal, and Uganda

Imbedded in the general picture of lackluster performance of African economies over the last decades are stories of some reform efforts and degrees of success in quite a few of SSA countries. Three of the notable SSA countries are Ghana, Uganda and Senegal. All three countries at some point in their economic histories adopted IMF and World Bank sponsored programs of economic reform and structural adjustments. These three countries were faced with typical problems besetting not only African economies but most developing countries. These problems include: excessive government intervention in their respective economies leading to an inefficient and distorted resource allocation mechanism in the economy with direct implications on growth of private sector; low savings rates and investment in flows which further stifled sustained growth; low productivity and increasing exposure to external shocks.[9] Complicating the latter economic issues were a plethora of political problems and excessive vulnerability of the agriculture sector to the vagaries of weather. Collectively, these problems resulted in low growth, high government deficits, high inflation, a stunted financial sector and a generally unstable macroeconomic environment.

In adopting reform and structural adjustment programs, Ghana, Senegal and Uganda objectives were to improve macroeconomic environment through a series of measures. These measures include: lowering and stabilizing inflation, removing price controls, promoting domestic savings to supplement meager foreign investment, reducing import and export tariffs and promote trade, remove exchange rate controls, efforts to improve, enhancing and expanding the financial sector. In general, these measures generally have

[8] The observation on Spain, Italy, France and Japan perhaps may represent some support for Cukierman and Meltzer(1986) idea of an opportunistic policymaker.

[9] Hadjimichael, Nowak, Sharer and Tahari (1996)

involved a reduction in government participation in the economy and measures to facilitate the growth of the private sector. The impact of these measures on the economic circumstances of the three countries was generally described as positive. However, each country experienced different degrees of success. Below is a summary of achievements.

Ghana: Over the period of reform, i.e. 1983 – 1991, Ghana appears to have made some progress in some of the problem areas outlined above. While encouraging private savings, the country significantly reduced trade restrictions, liberalized and removed controls on exchange rates. The result was a positive change in national savings from -7.6% in the pre-adjustment period (1970-83) to 8.7% over the adjustment period (1983-91) and also, export as a percentage of GDP increased from 2% in 1982 to 17% in 1987. Efforts to enhance productivity seem to have been fruitful, productivity went from -2.57% from 1976-82 to 2.22% for the 1983-86 and eventually to 2.48 from 1987-91. Additionally, real GDP growth went from -1.6% during the pre-adjustment period (1978-83) to 3.6% during the first half of the adjustment program (1983-86) to 4.8% in the second half (1987-91).[10] Of particular interest to this study was the impact of the reform and adjustment measures on inflation, over the period of adjustment the annual inflation rate went from 122.88% in 1983 to 18% in 1991 and to 10% in 1992. The purpose of this study will be to determine the direction of inflation-uncertainty of inflation relationship of Ghana before, during and after the reform and adjustment period.

Senegal: Between 1974 and 1977, Senegal experienced relatively strong economic growth of 5% which was largely motivated by good weather and increased exports. This was followed by a period of declining agriculture production due to poor weather conditions, macroeconomic uncertainty and a slow economic growth of 2%. During 1978 – 1984, Senegal adopted adjustment programs supported by the World Bank in an attempt to arrest the deteriorating economic situation but results were weak and not particularly successful. Efforts were revamped and more rigorous adjustment measures were put in place from 1985-1988 and this led to improvements in the trade balance and economic growth increased to 4% a year. Measures taken during this period involved financial restructuring and injecting fiscal discipline in managing the economy. In the final period of the third phase of the adjustment period, i.e. 1989-93, economic circumstances deteriorated again with growth averaging below 1%. Over the entire adjustment period (1978-93) inflation went from 3.4% in 1978 to -0.59% (IFS) in 1993.

Uganda: After a lengthy and brutal civil war that ravaged and virtually paralyzed the Ugandan national economy, the country adopted structural and reform policies to rebuild the infrastructure and correct severe economic imbalances. Inflation in 1987 was in the region of 200%. The economy was almost dependent upon coffee production. Real GDP growth rates were -2.4% and 0.3% in 1984/5 and 1985/6 respectively. The currency was overvalued within the fixed exchange rate regime, thus reducing the country's competitiveness against a backdrop of deteriorating terms of trade. Over 1987-95, the country embarked on several adjustment programs. These programs included trade and exchange rate liberalization, removal of price controls, rationalizing state employment

[10] Nowak, Basanti, Horvath, Kochhar & Prem(1996) *Ghana, 1983-91.*

levels and fiscal discipline. The latter effort resulted in an increase in the real growth rate from 3.8% in 1987 to about 10% in 1995, for an average of about 6.4% a year,[11] The realignment of the currency improved external competitiveness. In turn, trade increased by 2.6% in 1986/7 to 21.6% in 1994/5 and inflation was reduced from about 200% to 3.4% in 1994/5. Uganda also registered progress in areas of national savings and fiscal deficits. The country's efforts and progress has been described as one of the significant success stories in SSA.

Clearly, progress was made in all three countries but Ghana and Uganda appeared to have benefited more from the adjustment programs. The question to be examined is to determine how the policy effects on inflation affected the nature of the relationship between inflation and its uncertainty.

Inflation Uncertainty and the GARCH Model

Data-wise, the tests conducted are broadly divided into two, first we delineate the data of each country into three periods, namely, pre-adjustment period, the adjustment period and the post adjustment period and second we extend the analysis to include the entire data set encompassing the various prior regime demarcations. For the period by period aspect of our examination, based on autocorrelation, total R-Square and likelihood ratio tests we assumed that inflation rates in the three countries follow an AR(1) process and to obtain the conditional mean and GARCH (1, 1) model was the best amongst alternatives considered to generate the conditional variances as gauges for inflation uncertainty.[12] In the tests involving the entire data sets, the optimal lags on the AR(p) process differed from one country to the other in the process of obtaining the conditional means for the GARCH(1,1) model.[13]

The employment of a GARCH framework for this study follows publications by Grier and Perry (1998) Nas and Perry (2000) and Fountas *et al* (2003), among others, and the effort to capture better gauges of inflation uncertainty than the standard deviation of inflation rates. As explained earlier, the latter approach may fail discount the predictable aspects of the standard deviation of inflation and therefore provide an inaccurate estimate of inflation uncertainty. In a similar vein, efforts to capture the uncertainty of inflation from standard deviations of survey responses to inflation expectations tends to lead to an underestimation of inflation uncertainty. The latter occurs due to the observed tendency of survey respondents to give similar estimates of inflation regardless of their actual future expectations of the path of inflation.[14]

The GARCH (1, 1) framework, described by Engle (2001) as 'the simplest and most robust of the family of volatility models,' side steps the shortcomings of the latter

[11] This was higher than the average of 1.6% in SSA(Hadjmichael et al, 1996, P. 5).
[12] We looked higher order GARCH models like GARCH(2,2) and different combinations thereof but found GARCH(1,1) to be better suited.
[13] For the AR (p) process over the entire period of examination, Ghana(p=11), Uganda(p=12) and Senegal (p=10)
[14] Zarnowitz and Lambros (1987) provide an indepth examination on what they describe as 'consensus' forecasts.

approaches and provides a measure of uncertainty of inflation presented by Ball (1993) and Cukierman and Meltzer (1986). The AR (1) – GARCH (1, 1) model employed in this study is as follows:

$$Inf_t = \delta_0 + \sum_{i=1}^{p} \delta_i \, Inf_{t-i} + \varepsilon_t \qquad (1)$$

$$\sigma_{\varepsilon t}^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 \sigma_{\varepsilon t-1}^2 \qquad (2)$$

Equations (1) and (2) are the general GARCH (1, 1) framework which assumes that residual variance of inflation follows an AR process.

Stationarity of Inflation Data

Stability of data is critical to quality of the inferences that can be drawn from the respective estimation process. This may compromise the accuracy of the conditional variance estimates of the process. To this end, to ensure stability of data and therefore the model, a test of stationarity is conducted for monthly inflation data for the three countries in this study, i.e. Ghana, Uganda and Senegal. The Dickey-Fuller (DF) and Phillip Perron (PP) were used to test for stationarity and results confirmed the inflation series for Ghana and Senegal to be stationary but not for Uganda.[15] Upon differencing by order one (d=1) the Ugandan inflation rate series rejected the null of non-stationarity.

Regime estimates of the AR (1) - GARCH (1, 1) Model

Below are estimates of the AR (1) –GARCH (1, 1) mode based on equations 1 and 2. This model is employed to capture the time varying variances of the inflation for the three countries in this study, namely Ghana, Senegal and Uganda. Results in tables 2a – 4b show resilient persistence of the ARCH term across the different regimes and in all the countries. The GARCH term, however, display consistent volatility clustering across all the economic regimes in only Senegal; in Uganda and Ghana, persistence is shown only in the adjustment regime. For the latter two countries, both the pre-adjustment and post-adjustment regimes show a lack of persistence of volatility clustering. These observations may be implications of changing economic measures and circumstances and underscore the need to examine according to the regimes identified. However, for all three countries results of the AR(1)- GARCH (1,1) tests of the entire data display a persistence in volatility confirming the presence of both ARCH and GARCH effects over the period of study.

Ghana

Table 2a

Least Squares Estimates

Regime	δ_0	δ_1	R^2
Pre-Adjustment (1964:3-1982:12)	**0.83 (0.75)**	**0.98* (0.01)**	**0.95**
Adjustment (1983:12-1991:12)	**0.86 (1.28)**	**0.97* (0.02)**	**0.94**
Post - Adjustment	**0.46**	**0.98***	**0.97**

[15] Ghana and Senegal rejected the null hypothesis of non-stationarity.

(1992:12-2004:2)	**(0.45)**	**(0.01)**	
Overall (1964:3-2004:2)	**23.40 (2.07)**	**0.31* (0.04)**	**0.09**

Table 2b
Integrated AR(1)-GARCH(1,1) Estimates

Regime	δ_{0+}	δ_{1+}	α_0	α_1	α_2	Likelihood Function
Pre-Adjustment	**o.88 (0.50)**	**0.96* (0.02)**	**34.10 (4.46)**	**0.74* (0.17)**	**-0.06* (0.02)**	**-757.08**
Adjustment	**1.25 (0.46)**	**0.95* (0.01)**	**1.73 (0.56)**	**0.74* (0.26)**	**0.23** (0.13)**	**-276**
Post-Adjustment	**0.66 (0.00)**	**0.98* (0.00)**	**4.85 (0.03)**	**0.33* (0.00)**	**-0.08* (0.00)**	**-341.92**
Overall	**19.14 (0.73)**	**0.15* (0.01)**	**7.35 (2.41)**	**1.05* (0.11)**	**0.09** (0.05)**	**-1891.26**

δ_{0+} & δ_{1+}: Constant and AR(1) Coefficient generated by GARCH(1,1) Model.
*** Significant at the 5% level**
**** Significant at the 10% level**

Senegal

Table 3a
Least Squares Estimates

Regime	δ_0	δ_1	R^2
Pre-Adjustment (1968:1-1977:12)	0.97 (0.55)	0.90* (0.04)	0.81
Adjustment (1978:1-1993:12)	0.26 (0.20)	0.94* (0.02)	0.89
Post-Adjustment (1994:12-2004:3)	0.09 (0.26)	0.96* (0.02)	0.93
Overall (1968:1-2004:3)	4.39 (0.51)	0.30* (0.05)	0.09

Table 3b
Integrated AR(1)-GARCH(1,1) Estimates

Regime	δ_{0+}	δ_{1+}	α_0	α_1	α_2	Likelihood Function
Pre-Adjustment	0.86 (0.42)	0.90* (0.04)	8.28 (6.57)	0.33* (0.14)	0.27 (0.38)	-337.98
Adjustment	0.15 (0.17)	0.94* (0.02)	0.09 (0.11)	0.05** (0.03)	0.93* (0.04)	-419.36
Post-Adjustment	0.14 (0.10)	0.85* (0.03)	0.11 (0.07)	0.20* (0.08)	0.72* (0.08)	-212.39
Overall	1.00 (0.26)	0.27* (0.03)	2.79 (0.51)	0.82* (0.12)	0.18* (0.07)	-1232.15

Uganda

Table 4a
Least Squares Estimates

Regime	δ_0	δ_1	R^2
Pre-Adjustment (1981:1-1986:12)	1.95 (2.88)	0.99* (0.03)	0.95
Adjustment (1987:1-1994:12)	0.83 (2.47)	0.96* (0.02)	0.95
Post-Adjustment (1995:1-2004:2)	0.38 (0.25)	0.91* (0.04)	0.83
Overall (1981:1-2004:2)	11.71 (3.79)	0.70* (0.04)	0.49

Table 4b
Integrated AR(1)-GARCH(1,1) Estimates

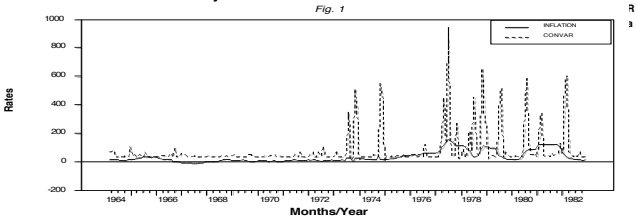
Regime	δ_{0+}	δ_{1+}	α_0	α_1	α_2	Likelihood Function
Pre-Adjustment	**2.65 (0.02)**	**1.00* (0.00)**	**46.55 (7.89)**	**1.39* (0.10)**	**-0.02 (0.00)**	**-263.57**
Adjustment	**0.89 (0.73)**	**0.93* (0.02)**	**1.54 (1.12)**	**0.41* (0.13)**	**0.63 (0.06)**	**-340.27**
Post-Adjustment	**0.41 (0.23)**	**0.91* (0.04)**	**3.55 (0.94)**	**0.22** (0.13)**	**-0.44 (0.24)**	**-208.98**
Overall	**3.59 (0.48)**	**0.45* (0.01)**	**3.76 (1.09)**	**1.20* (0.13)**	**0.08 (0.33)**	**-1080.31**

Graphs of the series of time varying variances of inflation as proxies of uncertainty obtained from AR(1)-GARCH (1,1) process and inflation rates for the three countries appear to underscore in general, the positive relationship between the two variables. Figures (1) – (12) map the relationship between inflation and the uncertainty of inflation over the three regimes for the countries and visually display a variation in patterns plotting the inflation and uncertainty of inflation relations among the different periods.[16] Figures (3, 4, 5, 7) and to some extent, (11) provide relatively stronger visual indication of the positive relationship between inflation and the uncertainty of inflation.

[16] 'Convar' in the graphs represent the conditional variance which is a proxy for the uncertainty of inflation.

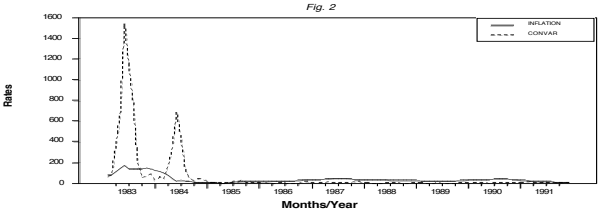
Ghana -Pre-Adjustment Period Inflation and Inflation Uncertainty

Fig. 1



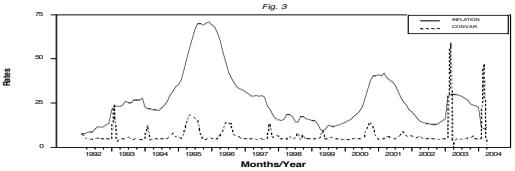
Ghana -Adjustment Period Inflation and Inflation Uncertainty

Fig. 2



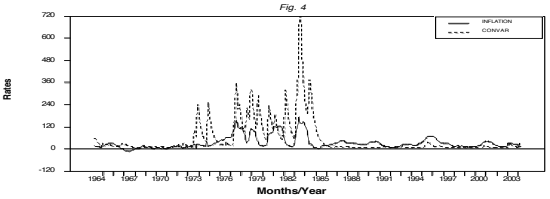
Ghana -Post-Adjustment Period Inflation and Inflation Uncertainty

Fig. 3



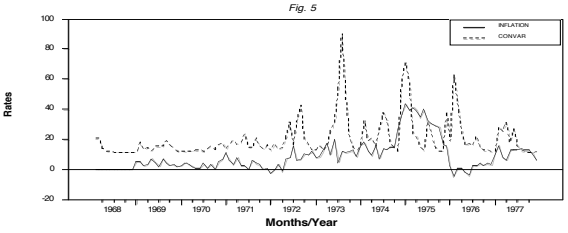
Ghana -Overall Period Inflation and Inflation Uncertainty

Fig. 4



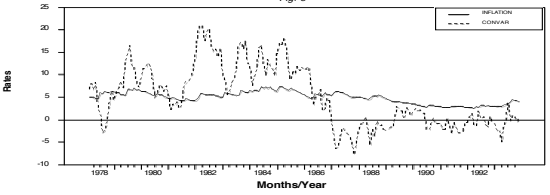
Senegal -Pre-Adjustment Period Inflation and Inflation Uncertainty

Fig. 5



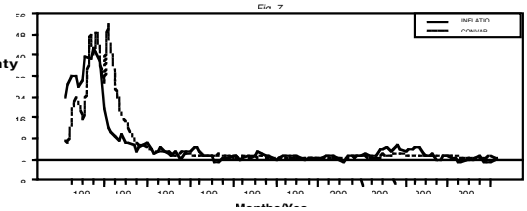
Senegal -Adjustment Period Inflation and Inflation Uncertainty

Fig. 6



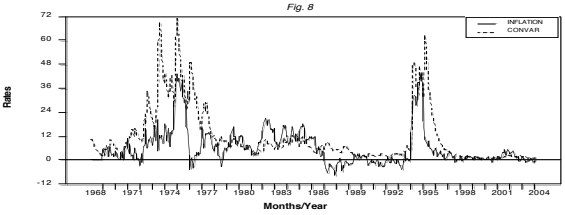
Senegal -Post-Adjustment Period Inflation and Inflation Uncertainty

Fig. 7



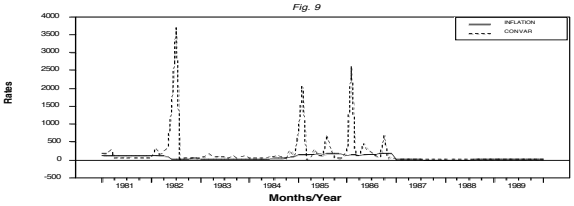
Senegal -Overall Period Inflation and Inflation Uncertainty

Fig. 8



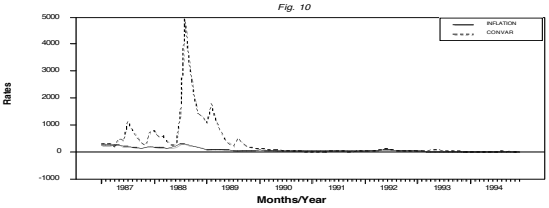
Uganda -Pre-Adjustment Period Inflation and Inflation Uncertaint

Fig. 9



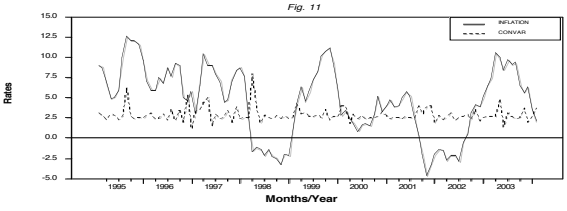
Uganda -Adjustment Period Inflation and Inflation Uncertainty

Fig. 10



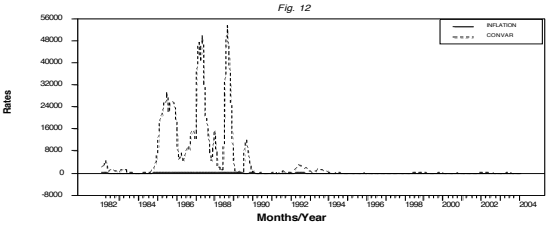
Uganda -Post-Adjustment Period Inflation and Inflation Uncertainty

Fig. 11



Uganda -Overall Period Inflation and Inflation Uncertainty

Fig. 12



Granger Causality

Though the graphs appear to generally show a positive relationship between inflation and the uncertainty of inflation, this is hardly establishes the direction of the relationship.[17] Specifically, the objective of the paper is to attempt to investigate whether the changing macroeconomic regimes of the three countries influenced the nature and direction of the relationship between inflation and the uncertainty of inflation. Granger causality affords the opportunity not necessarily to establish causality in strictest sense of the word but determine to some degree which variable precedes the other. To establish direction of relationship, i.e. which variable granger causes the other, the following equations will be estimated;

$$Inf_t = \sum_{i=1}^{p} \delta_i \, Inf_{t-i} + \sum_{i=1}^{p} \beta_i \, Inuc_{t-i} + \varepsilon_t \qquad (3)$$

$$Inuc_t = \sum_{i=1}^{p} \delta_i \, Inuc_{t-i} + \sum_{i=1}^{p} \beta_i \, Inft_{t-i} + e_t \qquad (4)$$

In equation (3) the testable proposition is if the coefficients on the uncertainty variable (*Inuc*) are zero. If that proposition is rejected, based on an F-test, then it can inferred that inflation uncertainty precede or granger-causes inflation rates. This result gives some credence to Cukierman and Meltzer's (1986) opportunistic central banker argument. The same proposition is examined in equation (4) except that the null hypothesis is to determine if the coefficients of inflation rates (*Inft*) are zero.

Tables 5-7 provide results of granger causality test confirm for the three countries over the three different regimes. A probable expectation is that under the supervision of World Bank and IMF officials during the adjustment regime, Cukierman-Meltzer's opportunistic central banker scenario will be highly unlikely to play out.

In Ghana, generally the Friedman-Ball hypothesis that inflation causes high uncertainty appears to dominate even though during the adjustment period both hypotheses appeared to hold. However, the net negative sign on the inflation uncertainty coefficient contradicts the Cukierman-Meltzer hypothesis of an opportunistic central banker who takes advantage of an uncertain environment to increase inflation. By their argument, a net positive sign is expected instead. The negative sign during the adjustment may reflect reactions of both government and monetary policy authorities to reduce the inflation in response to increased uncertainty in their effort to stabilize the economy.[18]

[17] Correlation between inflation and the uncertainty of inflation for the entire data for Ghana, Uganda and Senegal was +0.62, +0.73 and +0.64 respectively.

[18] The three countries are in an environment where both fiscal and monetary policy discipline on the part of the government and the central bank historically has not been forthcoming. This may have led to lingering and lagging uncertainty of stabilization policies enacted by the authorities.

Ghana

Table 5

Results of Granger Causality Test

Regime	H_0 : Inflation does not granger cause Inflation Uncertainty	H_0 : Inflation Uncertainty does not granger cause Inflation	AIC Determined Lag Lengths
Pre-Adjustment (1964:3-1982:12)	**(+)1.89***	**(-)0.87**	**12**
Adjustment (1983:12-1991:12)	**(+)5.90***	**(-)9.44***	**11**
Post - Adjustment (1992:12-2004:2)	**(+)1.89****	**(-)0.15**	**8**
Overall (1964:3-2004:2)	**(+)4.66***	**(+)1.30**	**12**

*** Significant at the 5% level.**

**** Significant at the 10% level.**

(+/-) Net sign on coefficients

Results for Senegal, i.e. table 6, display the expected positive relationship between inflation and the uncertainty of inflation across all three regimes, however it appears to give credence to both the Friedman-Ball and Cukierman-Meltzer hypotheses about the direction of relationship between inflation and inflation uncertainty. During the pre-adjustment period, the dominant significant influence seems to be the Cukierman-Meltzer hypothesis suggesting that inflation uncertainty granger causes inflation rates. The latter seem tenable given that the lack of 'external' monitoring may actually facilitate opportunism on the part of the central banker as proposed by Cukierman-Meltzer. Adjustment shows no definite direction but the post-adjustment period suggests significant bi-directional relationship between inflation and uncertainty. Results of the entire data reinforce the post-adjustment regime outcome. Two of the three regime results suggest the Cukierman-Meltzer hypothesis, so considering all things; the Senegalese outcome seems to be inclined towards the Cukierman-Meltzer hypothesis.

Senegal

Table 6

Results of Granger Causality Test

Regime	H_0 : Inflation does not granger cause Inflation Uncertainty	H_0 : Inflation Uncertainty does not granger cause Inflation	AIC Determined Lag Lengths
Pre-Adjustment (1968:1-1977:12)	(+)1.48	(+)2.03*	5
Adjustment (1978:1-1993:12)	(+)0.96	(+)0.63	9
Post-Adjustment (1994:12-2004:3)	(+)26.93*	(+)4.71*	12
Overall (1968:1-2004:3)	(+)2.33*	(+)4.53*	12

Uganda

Table 7

Results of Granger Causality Test

Regime	H_0 : Inflation does not granger cause Inflation Uncertainty	H_0 : Inflation Uncertainty does not granger cause Inflation	AIC Determined Lag Lengths
Pre-Adjustment (1981:1-1986:12)	(-)13.05*	(+)0.44	1
Adjustment (1987:1-1994:12)	(+)6.22*	(-)2.74*	10
Post-Adjustment (1995:1-2004:2)	(-)0.48	(-)1.34	5
Overall (1981:1-2004:2)	(+)7.76*	(-)3.73*	12

In Uganda, following the pre-adjustment era during which the null hypothesis that inflation granger causes the uncertainty of inflation is supported, the adjustment regime seem to provide evidence for both directions, i.e. inflation granger causes uncertainty and vice versa. In effect the results give credence to both the Friedman-Ball and Cukierman-Meltzer hypotheses. However, the negative sign on the coefficient of uncertainty of inflation does not meet the Cukierman-Meltzer expectations of the opportunistic central banker springing surprise inflation on agents under the cover of high uncertainty. The latter result appear to reinforce expectations of this paper that during IMF/World Bank programs implementation and monitoring period the Cukierman-Meltzer argument is unlikely to hold in its true form. Over the entire period, even though both hypotheses appear to be significant, the negative sign on the uncertainty sign discounts the Cukierman-Meltzer hypothesis, therefore the Friedman-Ball argument appear to characterize the relationship between inflation and uncertainty in Uganda both during the adjustment regime and over the period of study.

Conclusion

This paper employed a GARCH model to generate conditional variances of inflation as proxies for inflation uncertainty in a test to determine the direction of its relationship to monthly inflation rates in Ghana, Senegal and Uganda. This was examined within the context of IMF/World Bank economic programs in these countries with a view to determining how the latter policies impacted the direction of relationship between inflation and uncertainty of inflation. To this end, each country's data was divided into three sub-periods representing pre-adjustment, adjustment and post adjustment regimes. As anticipated by this paper, results indicate that during the adjustment period and under the monitoring of IMF/World Bank Cukierman-Meltzer's hypothesis failed to gain support in its true form. In fact during the adjustment period in Ghana and Uganda, the negative sign on uncertainty seem to suggest the efforts of monetary policymakers to reduce the level of inflation in response to increased uncertainty.

The differing changes in significance or net signs of the coefficients of the inflation and uncertainty of inflation relationship in the countries from the pre-adjustment to the post adjustment periods. As also captured by figures 1 to 12, the model provides evidence of varying influences on the changing economic polices and environment. Over the entire period, the outcome of Ghana and Uganda provide credence for the Friedman-Ball hypothesis but results of Senegal display evidence of both Cukierman-Meltzer and the Friedman-Ball hypothesis.

References

Ball, L., ' What Causes Inflation?,' *Business Review*, March/April, pp. 3-13.

Ball, L. , Cecchetti, S. and Gordon, R. 1990, ' Inflation and Uncertainty at the Short and Long Horizons', *Brookings Papers on Economic Activity*, 1990, pp. 215 – 254.

Ball, L., 1992, ' Why High Inflation Raise Inflation Uncertainty,' *Journal of Monetary Economics*, 29, pp 371-388.

Barro, R. and Gordon, D. 1983a, 'A Positive Theory of Monetary Policy in a Natural Rate Model,' *Journal of Political Economy*, 91, pp. 589 – 610.

Bhar, R. and Hamori, S., 2004, 'The Link between Inflation and Inflation Uncertainty: Evidence from G7 Countries,'*Empirical Economics*, 29, pp 825-853.

Bollerslev, T., 1986, 'Generalized Autoregressive Conditional *Heteroscedasticity' Journal of Econometric*s, 31, 307-327

Cukierman, A., (1992), *Central Bank Strategy and Independence: Theory and Evidence*, MIT Press.

Cukierman, A. and Meltzer, A.,1986, ' A Theory of Ambiguity, Credibility and Inflation Under Discretion and Asymmetric Information,' *Econometrica,* 54, pp. 1099-1128.

Engle, R., 1982, ' Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation,'*Econometrica*, 50, July, pp 987-1007.

Engle, R., 1983, ' Estimates of the Variance of U.S. Inflation Based on the ARCH Model,' *Journal of Money Credit and Banking*, 15, pp 286- 301.

Engle, R., 2001, ' GARCH 101: The Use of ARCH/GARCH Models in Applied Econometrics,'*The Journal of Economic Perspectives*, 15, Autumn, pp 157-168

Evans, M. 1991, ' Discovering the Link between Inflation Rates and Inflation Uncertainty,' *Journal of Money, Credit and Banking*, 23, May, pp. 169 – 184.

Evans, M. and Wachtel, P., 1993, ' Inflation Regimes and the Sources of Inflation Uncertainty,' *Journal of Money, Credit and Banking,* 25, pp 475-511.

Fountas, S., Loannidis, A., and Karanaros, M., 2003, 'Inflation, Inflation Uncertainty and A Common European Monetary Policy,'*The Manchester School*, 72, pp. 221 – 242.

Frenkel, J. and Lown, C. 1994, ' An Indicator of Future Inflation Extracted from the Steepness of the Interest Rate Yield Curve Along its Entire Length,' *Quarterly Journal of Economics,* 109, May, pp. 517 – 530.

Friedman, M., 1977 , 'Nobel Lecture: Inflation and Unemployment,' *Journal of Political Economy*, 85, pp 451-472.

Ghana, Senegal and Uganda Adopt Bold Reforms. *IMF Survey,* (November 11, 1996), pp. 1 – 4.

Golub, J., 1994, 'Does Inflation Uncertainty Increase with Inflation?,'*Economic Review*, Federal Reserve Bank of Kansas City, 3rd Qtr, 79, pp. 27-38.

Grier, K. and Perry, M., 1998, ' On Inflation and Inflation Uncertainty in the G7 Countries,'*Journal of International Money and Finance*, 17, pp. 671-689.

Hadjimichael, M., Nowak, M., Sharer, R. and Tahari, A., *Adjustment for Growth: The African Experience*. IMF, Washington D.C. (October, 1996.)

Holland, S., 1993, ' Uncertain Effects of Money and the Link between Inflation Rate and Inflation Uncertainty,' *Economic Enquiry*, 31, January, pp. 39-51.

Holland, S. 1995, ' Inflation and Uncertainty: Tests for Temporal Ordering,'*Journal of Money, Credit and Banking,* 27, pp. 827-837

Ireland, P. 1996, ‘ Long-term Interest Rates and Inflation: A Fisherian Approach,’*Economic Quarterly* (Federal Reserve Bank of Richmond), 82, Winter, PP. 21 – 36.

Judge, Hill, Griffiths, Lutkepohl and Lee, *Introduction to the Theory and Practice of Econometrics,* 2nd ED1988, New York, John Wiley and Sons..

Kontonikas, A., 2004, ‘ Inflation and Inflation Uncertainty in the United Kingdom: Evidence from GARCH Modeling,’ *Economic Modelling*, 21, pp. 525 - 543

Kydland, F. and Prescott, E., 1977, ‘ Rules Rather than Discretion: The Inconsistency of Optimal Plans,’ *The Journal of Political Economy,* 85, June, pp 473-492.

Logue, D. and Willett, T., 1976, ‘ A Note on the Relation between the Rate and Variability of Inflation,’ *Economica*, 43, May, pp. 151-158.

Mishkin, F. 1990a, ‘ What Does the Term Structure Tell us about Future Inflation,’ *Journal of Monetary Economics*, 25, pp. 77 – 95.

Mishkin, F. 1990b, ‘ The Information in the Longer Maturity Term Structure About Future Inflation,’ *Quarterly Journal of Economics*, 105, August, pp. 815 – 828.

Nas, T. and Perry, M., 2000 ‘ Inflation, Inflation Uncertainty and Monetary Policy in Turkey: 1960 – 1998,’ *Contemporary Economic Policy*, 18, April, pp 170- 180.

Okun, A., 1971, ‘ The Mirage of Steady Inflation,’ *Brookings Papers on Economic Activity*, 1971, pp. 485 – 498.