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Price Stability and the Growth Maximizing Rate of Inflation for Ghana*

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Abstract

Monetary policy in Ghana, which is typical of many central banks, over the years, has focused on ensuring price stability or low inflation. The aim of the policy of price stability is to provide a stable environment for real sector activities to flourish. However, the outcome of the policy on real sector activities has not been subjected to any empirical investigation and this forms the focus of the study. For instance, the Central Bank has focused on single digit inflation and whether such a low rate is growth maximizing is yet to be ascertained. The study therefore investigates the revenue maximizing and the 'growth maximizing' rate of inflation for Ghana using data from Bank of Ghana and WDI. The study finds that economic performance is higher under low inflation era than when inflation is high. It also established the revenue maximizing rate of inflation using the Laffer curve approach is lower than the growth maximizing rate of inflation. Also, from the results, it can be deduced that the single digit inflation target set by the Central bank is not growth maximizing.

Keywords: Economic Development, Fiscal and Monetary Policy

1. Introduction

The maintenance of low inflation and or price stability has been the focus of many countries since evidence abound that sustained and predictable high rates of inflation can have adverse effects on economic growth or real sector activities [1]. Although there is no general consensus on the effect of inflation on growth, several empirical studies have found that inflation negatively affect the real sector [2]. Of particular interest is a study on both industrialized and developing countries on the inflation growth nexus which found the existence of a threshold level of inflation beyond which the inflation growth relationship is negative [3,4].

Many developing countries have historically recorded persistently high rates of inflation particularly from early 1970 to the 1990s. Similarly, Ghana has had a long history of very high rates of inflation over the same period. In 1971, inflation measured as the change in the consumer price index was 9.6% but rose consistently and by 1977 it had reached 116.4% [5]. Although the rate of inflation declined thereafter, it was short-lived and by 1983 it had reached 122.9%. The introduction of the Economic Recovery programme (ERP) saw inflation declining to 40% in 1984. Subsequently, the rate of inflation has been within 10% to 40% except in 1995 when the rate of inflation increased to 59.5% but declined consistently to 12.4% in 1999. The year 2000 was an election year and many of the macroeconomic fundamentals including inflation were unstable. It is not surprising that the high inflationary era also coincided with low real sector performance in Ghana (see **Figure 1**).

In view of the inverse relationship between inflation and economic performance, the Bank of Ghana has consistently pursued low inflation policies in order to accelerate real sector performance. Since 2002, consistent with its mission statement, the Bank of Ghana has followed the policy of price stability[1], particularly; low inflation and a fairly stable exchange rate [6] It must be emphasized that although the Central Bank has been

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[1]The Bank of Ghana's mission statement states 'Our mission is to pursue sound monetary and financial policies aimed at price stability and create an enabling environment for sustainable economic growth'. See www.bog.gov.gh/

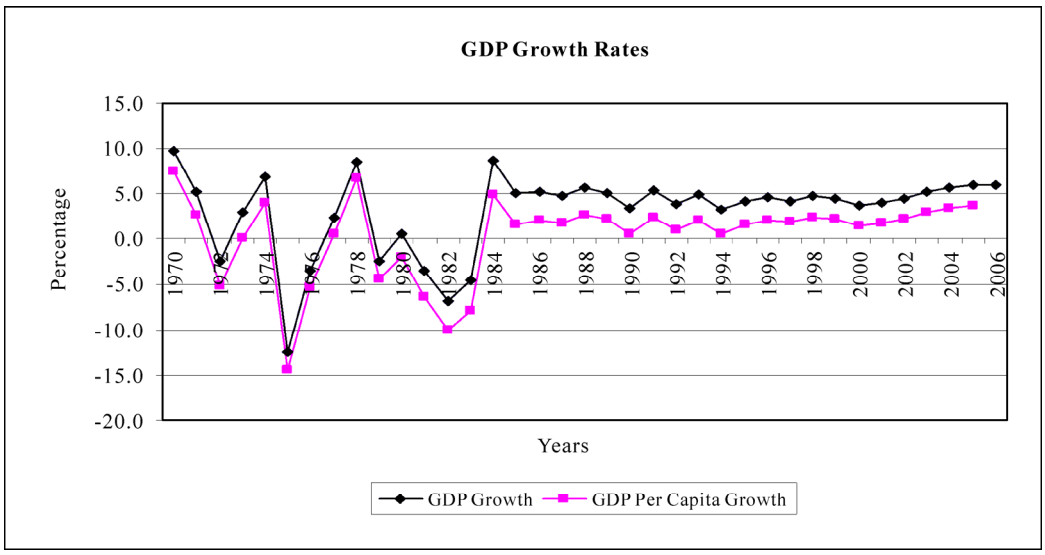

Figure 1. Real GDP and real per capita GDP growth rates (1970-2006). (Source: World Development Indicators, 2007.)

pursuing low inflation policies as of 2002 it does not follow an explicit inflation targeting framework. The earlier framework however mimics an inflation targeting regime in which a specific level of inflation is set and targeted jointly by the Central Bank and the Ministry of Finance, but the target does not involve the usual modelling and minimizing of the loss functions as is typically done under inflation targeting regimes [6-9]. The rationale for promoting price stability is that it will enhance private sector activities which will in turn increase real sector economic activities through increased output, employment, income and consequently lead to poverty reduction. The outcome of the policy of price stability on the real sector critically depends on the extent to which private sector activities respond to these incentives. However, the absence of this will imply that short-run trade-off between inflation and unemployment will occur. As Fischer [10] argued, while there may be good political reasons to wish there were no short-run trade off, empirical evidence confirms its existence.

Evidently, since the Bank of Ghana adopted price stability or low inflation as its major objective, the economy has witnessed stable exchange rate, low inflation and a rising trend in economic activity. However, although the trends observed above imply correlation between price stability and economic performance, they do not imply causation. Thus, it is not too evident whether the price stability policy has provided the necessary incentives for the real sector to flourish. Besides, should price stability necessarily set a single digit inflation target? What is the revenue maximizing rate of inflation for Ghana? Is the revenue maximizing rate of inflation growth maximizing? The study aims to address the foregoing issues. Two key issues investigated are: 1) ascertain the revenue maximizing rate of inflation for Ghana 2) Investigate whether the revenue maximizing rate of inflation is also growth maximizing.

The rest of the paper is organized as follows: the next section discusses price stability and economic performance. Section three presents the study methodology. This is followed by a presentation of key findings. The final section provides the concluding remarks.

2. Price Stability and Economic Performance

2.1. Stylized facts on the Ghanaian Economy

In pursuant of the price stability or low inflation policy in Ghana, inflation had declined from 40.5% in 2000 to 21.3% and 15.2% in 2001 and 2002 respectively. However, petroleum price increases of about 100% in the first quarter of 2003 led to increased demand for higher wages which led to an increase in end of period inflation of 23.6% in 2003 but thereafter, it fell to 11.8% in 2004. Although in September 2005, inflation had increased to 13.5%, by June 2007, inflation had declined to 10.7%. The rate of depreciation in the exchange rate was also relatively stable compared to the period preceding the price stability policy. The local currency (¢) depreciated by 49.8% against the US dollar in 2000 but again, due to the policy of price stability, the rate of depreciation in the local currency against the US dollar declined to 8.3% and 9.3% in 2002 and 2003 respectively. The Cedi depreciated by 2.3%, 0.4% and 0.2% against the US dollar[2] in 2004, 2005, and 2006 respectively. The Cedi also depreciated by 23% against the Euro in 2002 but the rate of

[2]The dollar was weak against the major international currencies during this period.

depreciation declined subsequently and by end 2006 it had depreciated by 14.4% against the Euro. A similar declining trend was observed for the British pound [5].

In terms of real sector performance, GDP and GDP per capita growth rates demonstrate consistent and appreciable increases during the period 2001-2006 (see **Table 1** & **Figure 1**).

It is also expected that under price stability, the lending rates will decline as inflation and the exchange rate remains stable. This will increase access to credit by the private sector which will in turn stimulate real sector activity [11]. The average lending rate was 47% in 2000 but declined consistently thereafter and by end 2004, the lending rate was 28.75% declining further to 27.75% by September 2005. As of March 2007, lending rates ranged from 15% to 33.5%. The decline in the prime rate and the lending rate between 2001 and 2007 also led to marginal declines in the interest rate margins (**Figure 2**). From the above, it is intuitively obvious that the key macroeconomic fundamentals (especially inflation, exchange rate and the interest rate margin) have been stable but whether this has translated into improved real sector performance remains to be investigated.

2.2. The Inter-Relationship between Price Stability and Real Sector Performance

Inflation leads to a reduction in future profitability of investment, especially when inflation is associated with price variability. It leads to conservative investment strategies, slows investment and economic growth [12]. Inflation affects the international competitiveness of a country by making exports more expensive which in turn leads to balance of payments problems. However, although the general consensus is that inflation negatively impacts growth in the long-run, there have been studies that have found the inflation-output-growth relationship to be either positive or non-existent. Tobin [14], for example, derives a positive effect of inflation on growth by augmenting the classical model of growth to allow for substitution between physical capital and money. His theoretical framework suggests that an increase in the inflation rate would cause economic agents to shift away

Table 1. Sectoral Growth Rates (1990-2006).

	SECTORS			
Period	**Agriculture**	**Industry**	**Services**	**All**
1998	5.1	3.2	6.0	4.7
1999	3.9	4.9	5.0	4.4
2000	2.1	3.8	5.4	3.7
2001	4.0	2.9	5.1	4.2
2002	4.4	4.7	4.7	4.5
2003	6.1	5.1	4.7	5.2
2004	7.5	5.1	4.7	5.8
2005	6.5	5.6	5.4	5.8
2006	5.7	7.3	6.5	6.2
Averages				
1990-94	1.1	4.1	7.0	4.3
1995-99	4.4	4.7	5.3	4.4
2000-06	5.2	4.9	5.2	5.1

Source: Computed from GoG Budget Statements, Several Issues.

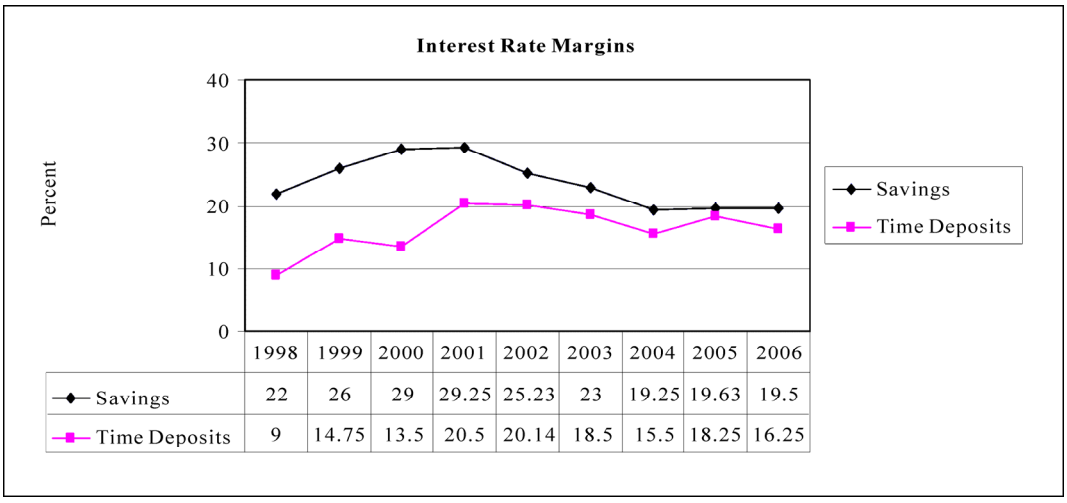

Figure 2. Interest Rate Margins. The difference between the lending rate and the two rates (savings and time deposit rates). (Source: [13])

from holding money and to move towards more capital investments, thereby increasing output. The money-in-utility function model developed by Sidrauski [15], on the other hand, finds that in the long run money is neutral such that a rise in the rate of monetary expansion would raise prices but leave the capital stock and output level unaffected.

One of the early works that established a negative long-run association between inflation and growth is that of Stockman [16] who presented a cash-in-advance model of an economy in which money complemented capital. Later work by Fischer [17] reinforced this negative relationship by stressing the role of macroeconomic uncertainty in reducing the level of productivity and the rate of investment. Rousseau and Wachtel [18] empirically explored the indirect role of financial sector development in explaining the negative relationship between inflation and growth. They argue that, a well developed and active financial sector encourages a higher level of capital formation and most importantly leads to improved allocation of capital.

In an inflationary environment, however, financial intermediaries would be reluctant to offer long-term financing for capital formation and growth, and the various measures (e.g. interest rate ceilings and credit allocation) instituted by government to protect certain sectors of the economy would lead to inefficient allocations of capital that inhibit growth. Other studies have also found a negative link between inflation and growth. For instance, Gillman *et al.* [19] studied 29 OECD and 18 APEC (Asia-Pacific Economic Cooperation) countries from 1961 to 1997 and found a negative relationship between inflation and economic performance. Similarly, Barro [20] examined over 100 countries between the years 1960 and 1990 and found a negative relationship between inflation and growth.

Recent literature on the inflation-growth relationship has been focused on the threshold effects of inflation on growth. The possibility of this nonlinear effect of inflation on growth was first examined by Fischer [17] who found that the association between inflation and growth weakens as inflation rises. The general view now, however, is that there exists a threshold level of inflation below which the effect of inflation on growth is either positive or zero, and above which inflation has a negative impact on growth. Bruno and Easterly [21-23], for example, have cited evidence of a negative, short-to-medium term relationship between high inflation (*i.e.* an inflation rate of 40 percent or more) and growth, and no evidence of a relationship between inflation and growth at annual inflation rates less than 40 percent.

Khan and Senhadji [3] using a sample of 140 developing and industrial countries between 1960 and 1998 and also find evidence of the existence of a threshold level of inflation beyond which the inflation-growth relationship is negative. Their findings also indicated that this threshold level of inflation is higher for developing countries (at 7-11 percent) than for industrialized ones (1-3 percent). Similarly, Nell [4] study on the inflationary episodes in South Africa (over the period 1960-1999) also finds that single digit inflation may be beneficial to growth while double digit inflation rates may be growth retarding. Mariotti [2] using the Johansen Cointegration approach found an inverse relationship between inflation and economic growth. Similarly, Hodge [24] in examining the inflation-growth nexus for South Africa over the period 1950-2002 confirmed the negative relationship between inflation and growth over the medium to long-run using the OLS method. He also adds that countries that maintain low inflation enjoy higher rates of economic growth than countries with high rates of inflation. It is important to add that 'a certain amount of inflation may help grease the wheels of the economy' [25,26].

Thus, the evidence abounds from the above literature that inflation negatively affects economic performance and goes to confirm the existence of the threshold effect. Unfortunately, these studies are mostly cross-country, used simple OLS and have not been applied to Ghana except in the case of [27,28] where the optimal rate of inflation from 1970 to 1993 were estimated. It must be noted that a lot has happened after this period and the optimal rate of inflation as well as the inflation growth nexus may have change and it is this gap in our knowledge that this study intends to fill.

2.3 The Transmission Mechanism from Inflation to Real Variables

The process through which changes in the monetary policy get transmitted to the ultimate objectives like inflation or growth has come to be known as "monetary transmission mechanism". Interestingly, economists often refer to the channels of "monetary transmission" as a black box–implying that we know that monetary policy does influence output and inflation but we do not know for certain how precisely it does so. Moreover, the impact of inflation on real variables is not certain.

Nevertheless, in the literature, a number of transmission channels have been identified: (a) the quantum channel (e.g., relating to money supply and credit); (b) the interest rate channel; (c) the exchange rate channel; and (d) the asset price channel. How these channels function in a given economy depends on the stage of development of the economy and its underlying financial structure. Illustratively, in an open economy, one would expect the exchange rate channel to be important; simi-

larly, in an economy where banks are the major source of finance (as against the capital market), credit channel seems to be a major conduit for monetary transmission. Besides, it needs to be noted that these channels are not mutually exclusive – in fact, there could be considerable feedbacks and interactions among them.

Although the channels explain how inflation or price stability affects the real sector there is lack of consensus on the adverse effect of inflation on real sector variables. Studies have shown that at lower rates of inflation, the relationship is not significant and can be positive; but at higher rates, inflation has a significantly negative effect on growth. For instance, [21] demonstrated that a number of economies have experienced sustained inflation between 20-30% with no major adverse consequences on the real sector but once the rate of inflation exceeds a critical level estimated at 40% inflation, significant declines in the level of real sector activity is recorded. In a later study [3] estimated the inflation threshold level to be 1-3% for industrial countries and 11-12% for developing countries. Thus, there is some kind of consensus that excessively high rates of inflation adversely affect real sector activities. However, the main channel through which this occurs is yet to be established. Empirical studies have suggested that the financial market might be an important channel through which inflation affects growth. Under this hypothesis, there is a critical rate beyond which inflation has a significantly negative effect on financial markets, but below which inflation has no significant effect on financial markets [1,29,30].

If the inflation-finance nexus is true, then one would expect that the effect of inflation on growth shows a similar pattern to that of inflation on financial market performance. The general transmission mechanism is as follows: inflation reduces the real return on savings and therefore exacerbates an informational friction afflicting the financial system [1,31]. This financial market friction can cause credit rationing which will affect the level of investment, reduce the efficiency of investment and consequently affect real sector performance. Reference [32] argue that inflation exacerbates the frictions in the credit markets. However, in a well functioning credit market, banks can easily adjust nominal interest rates when they need to but frictions create obstacles that impede this adjustment. Ceilings on interest rates imposed by governments are typical examples of such obstacles.

However, Choi *et al.* [31] suggest that credit market friction is less harmful at low rates of inflation, that is, at low inflationary environments, credit rationing might not occur at all and the adverse effect of inflation on capital accumulation is no more. In such a case, higher inflation reduces the rate of return on savings and consequently increases capital accumulation; a Mundell-Tobin-effect that makes higher inflation lead to higher long run levels of real activity. However, once inflation exceeds a critical level, credit rationing occurs and higher rates of inflation can have adverse consequence on the real sector. The transmission from low inflation to real sector performance is described in **Figure 3**.

Inflation can affect the real sector through financial intermediaries and subsequently directly affect growth. Empirical studies have shown that different measures of financial sector development are strongly and positively correlated with the level of investment, the efficiency of investment and real economic growth [34-35]. A major channel through which inflation affects the real sector through the banking system is by reducing the overall amount of credit available to businesses. Higher inflation can decrease the real rate of return on assets which will in turn discourage saving but encourage borrowing. New borrowers who enter the market are likely to be of lesser quality and are more likely to default on their loans. Banks may respond to the low real rates coupled with the influx of riskier borrowers by rationing credit. When financial intermediaries ration credit in this way, the result is lower investment in the economy. Lower investments tend to reduce the present and future productivity of the economy which in turn lowers real economic activity [32]. It must be emphasized that the effect of inflation on the financial sector occurs at a certain threshold of inflation. Credit rationing occurs when inflation rises above some critical level but beneath a certain threshold, higher inflation might actually lead to increased real economic activity.

Inflation can also affect the real sector by reducing business or consumer confidence through future price uncertainties, general loss of confidence in the economy, or through price distortions (**Figure 3**). Inflation confuses price signals and makes it difficult for firms to ascertain whether an increase in their price reflects a general increase in the overall price level (shared by all goods) or an increase in their price relative to all other prices–this increases uncertainty and reduces economic activity. Inflation also increases the effective tax to firms and individuals. For firms, inflation reduces the value of depreciation allowance thereby increasing the effective tax rate. For individuals, inflation increases the effective tax rate on capital income and it discourages capital formation and long term growth.

From the discussions so far, evidence strongly support the view that high inflation above a certain threshold negatively affect real sector performance and low inflation spurs real sector activity. The next section adopts the above transmission mechanism or framework in **Figure 3** to ascertain the effect of low inflation policy or price stability on the real sector in Ghana.

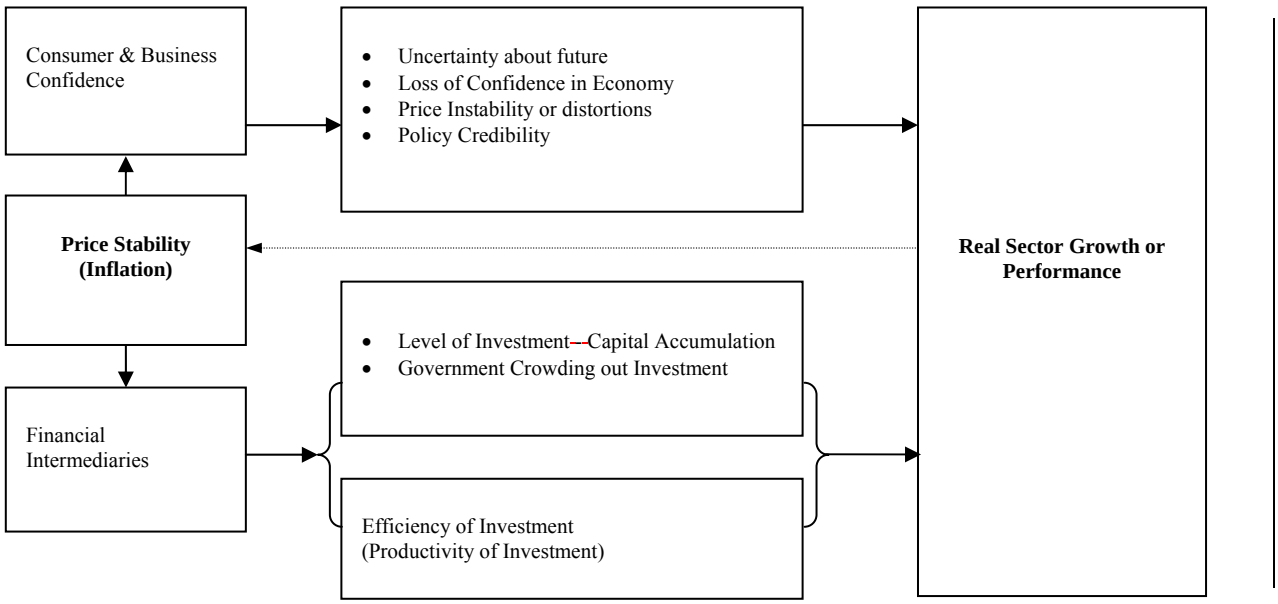

Figure 3. Transmission Mechanism from Inflation to Real Sector Growth. (Source: [1,28-30,36,37])

3. Methodology

3.1. Theoretical Framework

The framework of analysis is that of [27,28] where a revenue maximizing rate of inflation is derived by estimating the laffer curve. Subsequently, an inflation-growth relationship is estimated to obtain a growth maximizing rate of inflation. The two rates are then compared and using existing literature and economic theory one of these estimates is then used to define inflation thresholds, which in this study, four categories are identified. These are: 1) 0 <Inflation < 22.0; 2) 22.0 ≤ Inflation ≤ 40 3) 40 <Inflation ≤ 100; 4) Inflation > 100.

3.2. The Revenue Maximizing Rate of Inflation

In recent times, Bank of Ghana has been placing greater emphasis on maintaining low inflation but how low should inflation be? Whereas some have argued that the current level of inflation is acceptable, others including the Government of Ghana hold the view that the acceptable level of inflation should be a single digit. To obtain the revenue maximizing rate of inflation, the study makes use of the inflation seignorage revenue relationship [28,38-40]. Seigniorage can be defined as the value of real resources acquired by the government through its ability to print money. For instance, let SE represent the real seigniorage revenue, M nominal money balances or the non-interest bearing high powered money and P price level. The real money balances and seigniorage relationship is as follows:

$$SE = \frac{\Delta M}{M}\frac{M}{P} = \mu m \quad (1)$$

where μ is the change in nominal money balances, m the real money balances and Δ the difference operator. Intuitively, the larger the real money balances held in the economy, the higher the amount of seigniorage corresponding to a given rate of money growth. A distinction can also be made between Inflation Tax and seignorage revenue. Inflation tax refers to the increase in nominal money balances which individuals have to accumulate to keep their real balances constant in an inflationary framework. This can also be represented as follows:

$$IT = \frac{\Delta P}{P}\frac{M}{P} = \pi m \quad (2)$$

where IT is the inflation tax and π is the inflation rate. Equation 2 shows that government can reduce the real value of the non-interest-bearing part of the government debt by using inflation. In this sense, we can interpret π as the inflation tax rate and m as the tax base. When the inflation rate is zero, the government gets no revenue from inflation but the amount of inflation tax received by the government would increase as the inflation rate rises. However, as the inflation rate rises, people would reduce their holdings of the money base because the monetary base is now more costly to hold. Thus, individuals hold less currency, and banks hold as little excess reserves as possible, and eventually the real monetary base falls so much that the total amount of inflation tax revenue received by the government falls.

Clearly, the difference between seigniorage and inflation tax arises from changes in real money demand,

which in turn may be the consequence of financial liberalization or changes in the inflation rate, real income, and interest rates. This difference is sometimes referred to as the non-inflationary component of seigniorage, as it is the increase in money demand that is consistent with a zero inflation rate. As the economy grows the government can obtain some revenue from seigniorage even if there is no inflation. This is because as the demand for real money grows, the government can create some base without producing inflation. In the literature, a Laffer curve is usually used to show how seigniorage revenue changes with the inflation rate with an analogy to the conventional tax revenues and tax rate. On the Laffer curve, there is a critical level of inflation at which the government can 'maximize its seigniorage revenue' and this critical level is called the revenue maximizing inflation rate.

If the observed inflation rate is less than the estimated seigniorage-maximizing inflation (optimal inflation rate) the economy is said to be on the 'correct side' of the Laffer curve and thus there is still opportunity for a higher seigniorage at higher inflation rates. Also, there is an implicit loss of seigniorage revenue if the economy moves to a lower level of inflation. However, this might have serious implications if the current inflation is perceived to be less than the estimated critical level. Any attempt to raise seigniorage revenue higher than the critical level by printing money may put the economy in a higher inflationary path which could lead to hyperinflation. A typical Laffer curve is depicted below

Point S represents the seigniorage revenue as a proportion of GDP and π the domestic inflation rate. In **Figure 4**, it is evident that the seigniorage maximizing inflation rate is B with a corresponding inflation rate of π_0. Below this point the higher the inflation rate the larger the seigniorage revenue by means of an increase in the base money. However, to the right of the point B the higher the domestic inflation the lower the seigniorage revenue, since economic agents would try to avoid holding base money balances so as to protect them from incurring inflation tax. From **Figure 4**, it is evident that the same seigniorage revenue can be collected by imposing different inflation rates such as π_2 and π_1, where the tax rate is higher but the tax base is lower, that is the wrong side of the seigniorage maximizing Laffer curve in the latter case with respect to the former. In this line, the former coincides with the correct or efficient side of the Laffer curve in which there is still opportunity for a higher seigniorage at higher inflation rates and there is an implicit loss of seigniorage revenue if the economy moves to a lower level of inflation.

There have been a number of estimates of the magnitude of seigniorage revenue from both developed and developing economies. It is important, however, to distinguish between measures of pure inflation tax and measures of seigniorage revenue since only in the static steady state will the two estimates be equivalent [28,41] provides two benchmark estimates of seigniorage and inflation tax for a range of countries. He found that seigniorage usually accounts for approximately 0.5 percent of GDP per annum. [28] also found that seignorage revenue accounted for 2.5% of GDP in Ghana using quarterly data from 1970 to 1993.

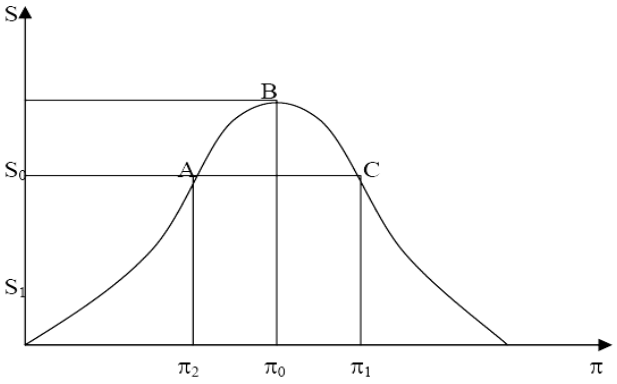

Figure 4. The laffer curve.

3.2.1. The Dynamic Case–Cointegration Approach

At this stage, it is important to determine at what rate of inflation will seigniorage revenue be maximized. According to [42], seigniorage revenue is maximized at the rate of inflation at which the point elasticity of demand for money is unity. This holds when the economy is in the static steady state where the demand for real balances is a function solely of inflation [28]. Implicitly, when the economy is growing the revenue maximizing rate of inflation must lie below the optimal value. This is because while the revenue from taxation of a given stock of real balances is increasing in inflation, the real value of additional money balances held by agents in a growing economy is monotonically decreasing in inflation. In other words, π and M/P move in opposite directions.

In the quantity theory of money framework, government can raise revenue without any inflationary pressure by a parallel money growth to the rate of real growth. Hence, an accompanying increase in the demand for real money balances provides government with some 'free' resources. However, an excessive monetary growth beyond this real growth rate leads to inflation reducing the purchasing power of the outstanding stock of real balances. This second phenomenon is the inflation tax, emphasizing this involuntary tax-like loss in the value of money holdings although governments issue new currency through a set of voluntary transactions.

The inflation tax (IT) can be measured as

$$IT = \left[\frac{P - P_{-1}}{P}\right]\frac{M}{P}. \quad (3)$$

The demand for real money balances takes a central place in the study of seigniorage. However, other factors apart from inflation explain the demand for money. In the standard analysis the money demand is mainly a function of inflation, and real income:

$$\left(\frac{M}{P}\right)^{D} = \theta(\mathrm{Y}, \Pi). \quad (4)$$

Domestic and foreign assets substitution effects affect the demand for money. Thus, the demand for money function can be expressed in a homogenous logarithmic form as

$$\left(\frac{M}{P}\right) = \phi_{my} y + \phi_{m\pi}\Pi + \phi_{mb} b + \phi_{mr} r \quad (5)$$

where M and P are the log of nominal money and prices respectively, y is real income, Π is the rate of inflation, b is the rate of return on foreign assets (expected depreciation in the parallel exchange rate) and r is the domestic interest rate (opportunity cost of domestic base money). b and r have been expressed in the form of log (1 + x). Re-arranging (5) and taking its time derivative gives the growth in nominal money demand as

$$M^{g} = \phi_{my} y^{g} + \phi_{m\pi}\Pi^{g} + \phi_{mb} b^{g} + \phi_{mr} r^{g} \quad (6)$$

where, g denotes the growth rate (approximated by dlog x/dt) of the variables. Substituting the above into (1), the long run seignorage revenue expression is derived as

$$S = mM^{g} = m\left[\phi_{my} y^{g} + \phi_{m\pi}\Pi^{g} + \phi_{mb} b^{g} + \phi_{mr} r^{g}\right]. \quad (7)$$

Assuming a money market equilibrium where $\Pi^{g} = 0$ so that maximizing S with respect to Π and rearranging the first order conditions, a revenue maximizing value of inflation rate is obtained as

$$\Pi^{*} = \frac{m}{\partial m/\partial \pi} - \left(\phi_{my} y^{g} + \phi_{mb} b^{g} + \phi_{mr} r^{g}\right) \quad (8)$$

The first term on the right represents the inverse of the semi-elasticity of the demand for money with respect to inflation since the demand for money function is the semi-logarithm form in inflation. Cagan's unit-elasticity results is arrived at by imposing the restrictions $y^{g} = b^{g} + r^{g} = 0$. However, unit-elasticity only holds in the static steady state. However, in general, the overall tax rate on real balances is the sum of the inflation tax component and the real money balances component. The revenue maximizing rate of inflation will be affected by the rate of income growth. Thus when income is growing, all other things constant, the overall tax rate is above the inflation rate. This occurs when inflation elasticity is monotonically increasing in the inflation rate then the rate at which revenue remains the same on the margin must be less than the value which will yield unit elasticity. Thus, once asset market effects are incorporated in the demand for money function it becomes impossible to ascertain analytically where it will lie but it is possible to examine a number of stylized facts such as periods of stagnation or stabilization and liberalization [28].

Using an econometric approach, the money demand function above is estimated. Two key issues worth noting are that the results are derived from the long run equilibrium demand for money function. Also, the possibility of implicit weak exogeneity of the regressors of the conditional model derived above is violated if inflation is endogenous. To address these two issues, the [43,44] cointegration method is employed.

The long-run money demand function can be reformulated in a cointegrating system as follows:

$$X_t = \Pi_1 X_{t-1} + \ldots + \Pi_k X_{t-k} + \mu + \theta D_t + \varepsilon_t \quad (9)$$

where X is a p x 1 non-stationary vector of variables, namely, real money balances, real income, the domestic interest rate, the premium on the parallel market rate and the rate of inflation. Whereas μ contains the constants of the system, D is a vector of centred seasonal dummies while $\varepsilon_1 \ldots \varepsilon_T$ are error terms which are assumed to be independently normally distributed. The variables are integrated of Order one and therefore a first difference operator (Δ) is applied. Subsequently, the equation in first difference can be written as

$$\begin{aligned}\Delta X_t = {} & \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_k \Delta X_{t-k} + \Gamma_k \Delta X_{t-k-1} \\ & + \Pi_k X_{t-k} + \mu + \theta D_t + \varepsilon_t\end{aligned} \quad (10)$$

where $\Gamma_1 = -(I - \Pi_i - \Pi_i)$ (i = 1…k-1), and $\Pi = -(I - \Pi_i - \Pi_i)$

The above equation shows the stationary error-correction first difference Vector Autogressive (VAR) framework where the $\Gamma_i \Delta X_{t-k}$ terms measure the short run dynamic behaviour of the system while the $\Pi_i X_{t-k}$ terms is the long-run information (in levels) between the variables in the VAR. $\Pi_i X_{t-k}$ will be consistent with the stationary VAR as long as it is also stationary and also the elements of X are cointegrated. Thus, the number of cointegrated vectors v between the elements of X will therefore determine the rank of the vector Π. Π= -αβ' where α and β are v x p, with β containing the cointegrating vectors while α measures the speed of adjustment from disequilibrium or the feedback mechanism.

The next section will estimated the revenue maximizing rate of Inflation for Ghana from 1970 to 2006 using the following data sources:

1) Domestic Money Bank Credit (1970-2006)-obtained from WDI and ISSER SGER

2) GDP (1970-2006)–available from the World De-

velopment Indicators 2007

3) Lending and Deposit Rates (from 1970-2006)-obtained from Bank of Ghana

4) Inflation (both monthly, quarterly and annual from 1970-2006) obtained from World Development Indicators and/or Bank of Ghana

5) Business Confident Index (Available from June 2003 to June 2007). This is a bi-monthly data collected by the Central on Business Perceptions about economic progress

6) World Development Indicators (investment, population growth, income per capita, secondary enrolment)

4. Findings

4.1. The Optimal Rate of Inflation

The evidence from the early 1990s to date is particularly interesting; although inflation has declined, seigniorage revenues have fallen further. Seigniorage revenues averaged 0.9 per cent of GDP from 2001 to end 2006 with inflation tax revenues averaging approximately 2.3 per cent of GDP over the same period (*i.e.* 2001-2006). The results are particularly striking because the liberalization pursued to date has lowered transactions cost and increased the opportunities for substitution between domestic base money and foreign currency holding.

Tables 3 and **4** present the estimates of the unit root test and the cointegrating system. The VAR is estimated with a constant, seasonal dummy and six lags on each variable (real income, real money balances, rate of inflation, rate of return on foreign assets proxied by the expected depreciation of the parallel exchange rate and the domestic interest rate) over the period 1990:1 to 2006:4.

The lag length was selected based on the SBC and the Akaike Criteria. Unit root test were carried out on the variables and those found to be non-stationary were differenced (**Table 2** and **3**). The VAR was estimated employing the modified Cagan framework and the revenue maximizing rate of inflation for Ghana is computed (See **Table 4**). The results are robust and show that the revenue maximizing rate of inflation for Ghana is 9.14 per cent using quarterly data over the period 1990-2006. The results also compares favourably with those of other studies [28] where the revenue maximizing rate of inflation between 1973 and 1990 was estimated to be around 15 per cent for Ghana. The study shows that the seigniorage maximising inflation rate for Ghana is below the actual inflation rate, thus making the economy to lie on the 'wrong side' of the Laffer curve. The current inflation of 12.8 per cent is above the optimum level of 9.14 per cent. Another key issue yet to be addressed is whether the revenue maximizing rate of inflation is also the growth maximizing rate. This forms the focus of the next section.

4.2. The Growth Maximizing Rate of Inflation–Cointegration Approach

To address the issue of whether the revenue maximizing rate of inflation is also growth maximizing, a cointegration framework is used to analyze the inter-relationships between growth and inflation. The approach is to build a non-linear model which includes the squared term on

Table 2. Results of the unit root tests.

VARIABLE	Augmented Dickey Fuller (ADF) Test		Phillips Perron (PP) Test	
	Constant No Trend	Constant Trend	Constant No Trend	Constant Trend
Rgdpg	–1.826258	–1.687995	–3.774095	–2.410277
m/p	0.249605	–1.916955	0.852840	–2.979962
Deft	–2.234099	–2.899822	–2.234099	–2.948491
Lexpt	–2.010599	–1.842804	–1.864397	–.842804
Pvtinv	–0.966095	–3.007251	–0.694917	–2.779045
Infl	–2.183748	–2.559441	–2.425247	–2.56546
Test critical values:				
	1% level	–3.540198	1% level	–4.100935
	5% level	–2.909206	5% level	–3.478305
	10% level	–2.592215	10% level	–3.166788

Table 3. Cointegration tests.

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.62755	85.12111	47.85613	0
At most 1	0.2557	24.87424	29.79707	0.1293
At most 2	0.103953	6.860256	15.49471	0.5257
At most 3	0.002697	0.164745	3.841466	0.6848
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.62755	60.24687	27.58434	0
At most 1	0.2557	18.01399	21.13162	0.1293
At most 2	0.103953	6.695511	14.2646	0.5257
At most 3	0.002697	0.164745	3.841466	0.6848

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level; *denotes rejection of the hypothesis at the 0.05 level; **MacKinnon-Haug-Michelis (1999) p-values.

Table 4. Cointegration results (dependent variable–real money balances).

Variable	Cointegration Equation
Y(–1)	–0.9182 [–7.00446]
TB(–1)	–0.06088 [–3.81129]
INF(–1)	0.117043 [6.97001]
C	1.611207

MP = -1.611207 + 0.918y + 0.06tb - 0.117inf; These results yield an optimal inflation rate of (1/0.117 - 0.92*0.03) = 9.14%

inflation as an explanatory variable. Thus, the regression equation is estimated as a second-degree polynomial. This is a widely used technique for estimating non-linear relationships by allowing for changes in slopes as a function of changes in the independent variable [27,28,45]. The squared inflation term is therefore used due to the threshold effects. Hence, the slope of the estimated equation can vary with changes in the inflation rate. This enables us to observe the turning point in the relationship between inflation and growth.

The empirical model is specified as:

Real GDP Growth = $\beta_0 + \beta_1$(real balances) + β_2(Exports/GDP) + β_3(Deficit/GDP) + β_4(Private Investment/GDP) + β_5(Inflation) + β_6(Human Capital) + β_7(Inflation)^2 β_8(Dummies) + ei

Three period dummies were introduced (1983-92; 1993-2000; and 2001-2006). These three periods mark important economic regimes in Ghana. The list of variables and their definitions are provided in Appendix (**Table 5**). Annual data from 1970-2006 were used and the results are reported below. Both the ADF and the Phillips Peron test confirm the existence of unit root in the variables. The I(1) variables were therefore differenced to make them stationary and the results are presented in **Table 6** and **7**.

The long run equation (equation 10) was estimated using Johansen cointegration method and the results indicate that there is one cointegrating vector and this is confirmed by both the trace statistics and the Eigenvalues (**Table 8**). Subsequently, we test restrictions such as unit elasticity. The vector error correction estimates of the inflation growth relationship are presented in **Table 6**.

Table 5. Definition of variables.

Variable	Definition
Rgdpg	Real GDP Growth
m/p	Real Balances
Deft	Budget Deficit as a proportion of GDP
Lexpt	Exports as a proportion of GDP
Pvtinv	Private Investment as a share of GDP
Infl	Inflation

Table 6. Results of the unit root tests.

VARIABLE	Augmented Dickey Fuller (ADF) Test		Phillips Perron (PP) Test	
	Constant No Trend	Constant Trend	Constant No Trend	Constant Trend
Rgdpg	–1.826258	–1.687995	–3.774095	–2.410277
m/p	0.249605	–1.916955	0.852840	–2.979962
Deft	–2.234099	–2.899822	–2.234099	–2.948491
Lexpt	–2.010599	–1.842804	–1.864397	–1.842804
Pvtinv	–0.966095	–3.007251	–0.694917	–2.779045
Infl	–2.183748	–2.559441	–2.425247	–2.56546
Test critical values:				
	1% level	–3.540198	1% level	–4.100935
	5% level	–2.909206	5% level	–3.478305
	10% level	–2.592215	10% level	–3.166788

Table 7. Results of the unit root tests (first difference).

VARIABLE	Augmented Dickey Fuller (ADF) Test		Phillips Perron (PP) Test	
	Constant No Trend	Constant Trend	Constant No Trend	Constant Trend
dRgdpg	–3.155835	–3.30395	–16.02544**	–15.64752**
dm/p	–10.056064**	–10.090342**	–11.35171**	–11.92295**
dDeft	–6.319811**	–6.243196**	–6.7806**	–6.653737**
dlexpt	–7.062333**	–7.281371**	–7.083831**	–7.649226**
dPvtinv	–7.677549**	–6.478208**	–8.439228**	–16.62738**
dinfl	–3.911792**	–6.275686**	–4.376691**	–4.344887**
Test critical values:				
	1% level	–4.110440	1% level	–4.10320
	5% level	–3.482763	5% level	–3.47937
	10% level	–3.169372	10% level	–3.16740

GDP growth is negatively affected by inflation with a one year lag. Private Investment has significantly positive effect on GDP growth. These findings corroborate the work of [2,24]. From **Table 9**, the error correction term or the speed of adjustment carries the right sign (negative) and it is significant. The three period dummies were insignificant except for the period 1983-1992 which was weakly significant.

From **Table 5**, the turning point for the inflation-growth relationship is calculated as follows:

Turning Point = -(Inflation Coefficient)/2*Inflation Squared Coefficient). For the long run model, the turning point or growth maximizing rate of inflation is 22.2% while for the short run model, the growth maximizing rate of inflation is 29.4%. From the above, it can be concluded that the revenue maximizing rate of inflation

Table 8. Cointegration tests.

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.852706	132.8203	95.75366	0.0003
At most 1	0.530721	65.78386	69.81889	0.1006
At most 2	0.404756	39.30433	47.85613	0.2484
At most 3	0.269686	21.14692	29.79707	0.3486
At most 4	0.248448	10.14711	15.49471	0.2696
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.852706	67.03642	40.07757	0.2923
At most 1	0.530721	26.47953	33.87687	0.4821
At most 2	0.404756	18.15742	27.58434	0.6474
At most 3	0.269686	10.99981	21.13162	0.2121
At most 4	0.248448	9.996537	14.2646	0.2923

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level; *denotes rejection of the hypothesis at the 0.05 level; **MacKinnon-Haug-Michelis (1999) p-values.

(9.14%) is not growth maximizing but rather, the growth maximizing rate of inflation is 22.2%. Thus, any inflation rate above 22.2% will lead to moderate gains in GDP growth. This corroborates the work of [45-48] who found that for middle income countries, the inflation threshold is 14-16 percent while for low income countries a range of 15-23 percent was obtained. For the entire sample they consistently found that higher inflation is associated with moderate gains in GDP growth up to 15-18 percent inflation threshold.

5. Conclusions and Policy Implications

The study investigates two key issues, namely, 1) ascertain the revenue maximizing rate of inflation for Ghana 2) Investigate whether the revenue maximizing rate of inflation is also growth maximizing. The analysis involved estimating the revenue maximizing and growth maximizing rate of inflation. Thus, The Johansen cointegration approach was also used to analyze the effect of inflation on long term growth and found that inflation negatively impacts on growth.

The study found that the economy had recorded very high inflation rates during the pre-reform era and in 1982, it was as high as 122.2%. However, after the reforms, inflation rates have been lower and close to single digit. Interestingly, the periods of high inflation were associated with lower growth rates (sometimes negative). GDP growth rates have been positive since 1984 averaging 4.4% in 1995-99 and rising to 5.1% in 2000-2006. Excessively high rates of inflation affect real sector activities. The study found that the revenue maximizing rate of inflation was 9.14 over the period 1990-2006. Thus, the seignorage maximizing rate of inflation is below the inflation, indicating that the economy was operating on the wrong side of the laffer curve. However, the revenue maximizing inflation rate is not necessarily a growth maximizing one. The growth maximizing rate of inflation is 22.2%, thus corroborating observed historical trends in growth and inflation rates in Ghana. Prior to the economic reforms, Ghana had recorded significantly high rates of inflation above the threshold and low (or sometimes negative) growth rates. However, it recorded significantly positive and high growth rates and low inflation during the post reform era.

In conclusion, price stability has led to higher growth rates and the Ghanaian economy has operated below the growth maximizing rate of inflation in recent times. It is also obvious, that the growth maximizing rate of inflation is not a single digit. Some level of inflation is certainly good for economic growth and job creation. The study suggests that the government should pursue the

Table 9. Vector error correction estimates (Dependent variable–real GDP growth).

Variable	Cointegration Equation	Variable	Error Correction Cointegration Equation
EXPT(–1)	–0.107658 [–1.6902]	D(EXPT(–1))	0.440554 [1.66582]
DEFT(–1)	0.261287 [1.85443]	D(DEFT(–1))	–0.042573 [–0.10911]
INFL(–1)	–0.083947 [–1.85164]	D(DINFL(–1))	–0.037792 [–0.33322]
PVTINV(–1)	–0.32954 [–1.97759]	D(PVTINV(–1))	–0.671995 [–1.56096]
INFL SQD (–1)	0.001429 [3.85709]	D(INFL SQD (–1))	0.000851 [1.09857]
C	1.361557	C	–0.850047 [–0.52506]
		Dum1	3.494951 [1.45799]
		Dum2	0.00236 [0.00094]
		Dum3	1.362836 [0.47463]
		EC Term	–0.51846 [–1.72435]
		R-Squared	0.50473
		Adj. R-Squared	0.298367
		Sum sq. resids	617.6098
		S.E Equation	5.072844
		F-statistic	2.445838
		Log likelihood	–99.89675
		Akaike AIC	6.336957
		Schwarz SC	6.825781
		Mean Dependent	0.011429
		S.D Dependent	6.056148
		Log Likelihood	–750.2182
		Akaike Information Criterion	46.9839
		Schwarz Criterion	50.18347

price stability policy but also be mindful of the trade-off between inflation and employment. Secondly, since the growth maximizing rate of inflation for Ghana is not a single digit, it is suggested that the government policy of achieving single digit inflation should be considered carefully taking into consideration inflation thresholds.

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