The policy dilemma of economic openness and seigniorage-maximizing inflation in dollarised developing countries: The Ghanaian experience

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Abstract
In this paper a comprehensive framework for measuring total gross seigniorage as suggested by Neumann was employed to analyze the implications of economic openness and inflation in dollarised developing countries with special reference to Ghana within the context of an extended Cagan model. Using quarterly data, the paper examined the relationship between inflation and seigniorage for the 1996-2005 period and shows how analogous this relationship is to the popular Laffer curve comprising seigniorage generation and inflation rates for Ghana. The main findings of this study are that, in Ghana, economic openness Granger-causes inflation and dollarisation whilst seigniorage-maximizing rate of inflation varies from 102% in the short-run to 74% in the long-run. On the average, foreign currencies constitute more than one-third of the total monetary aggregates in developing countries which is a testimony of high levels of dollarisation making the effectiveness of monetary policies below par. Based on the empirical results, the paper recommends that in dollarised developing countries such as Ghana, the appropriate policy option to deepen the financial sector should not be that which focuses on arbitrary opening of the economy which has the potential of promoting dollarisation of the economy causing inflation and making monetary policy implementation ineffective. Furthermore, considering the high inflation threshold for seigniorage maximization, it would be prudent for Ghana to find an alternative source of budget finance that is non-inflationary in the long-run.

Keywords: Dollarisation, Inflation Tax, Openness, Seigniorage, Ghana
JEL Classification: C22   E41   E58

1.0 Introduction

Underdeveloped economies being traditionally small-open are more exposed to persistent high rate of price fluctuations, high interest rates and foreign exchange risks. Besides these problems, the countries are confronted with low income per capita and hence low levels of consumption and saving which invariably imposes a limit to which government can mobilise tax revenue to finance its huge fiscal and trade deficits. Economic agents, including governments of these countries, as a consequence of the aforementioned problems, more often than not, are engrossed in devising strategies to effectively hedge against the concomitant risks of losing the value of their financial assets. Within the private sector, dollarisation has emerged as a common and easy means of safeguarding the value of wealth and hedging against financial risks in developing countries in recent times. Using a foreign currency such as the US dollar, the British Pound Sterling or the Euro which is *economically hard* in nature in place of the relatively *economically soft* local currency has become even more convenient and cheaper under financial sector deregulation in which flexible exchange rate system is practised.

Dollarisation has the tendency of worsening the macroeconomic imbalance in an already constrained developing economy. For instance, in Latin America, particularly Argentina, Bolivia, Brazil, Mexico and Peru; in Central and Eastern Europe (CEE), notably Vietnam, Estonia, Lithuania, Belarus and Georgia; and in Zambia, Zimbabwe, Togo, Lesotho, Cape Verde, Nigeria and Kenya within the Sub-Saharan Africa (SSA) region, increased business transactions in foreign currencies in recent times, has at one time or the other exacerbated their macroeconomic imbalance. This suggests that the wider the macroeconomic imbalance, the more likely the severity of dollarisation in an economy.

A central issue in the dollarisation theory has been the loss of seigniorage revenue suffered by the dollarizing country as it transfers its money creation monopoly to the more stable advanced economy whose currency is being widely used in the dollarized economy. For countries which seigniorage is a significant source of government revenue, unilateral dollarisation may be prohibitively expensive in the short-run until greater financial stability and credibility is achieved in the long-run. For a country of primary currency such as the United States or the United Kingdom, the currency used by dollarized economies reaps substantial benefits. The United States (US), for instance, derives enormous seigniorage – the difference between the cost of printing or minting money and its face value – from the rest of the world, particularly from dollarized developing countries. Meanwhile, seigniorage is of more importance as a source of revenue to developing countries that are relatively less efficient in raising sufficient funds through bonds, taxation and borrowing to finance public projects. For example, Hochreiter, Rovelli and Winckler (1996) find that seigniorage as a share of gross domestic product (GDP) was approximately 30% in Romania, 4% in Hungary, 1% for Czech Republic, Austria and Germany in 1993. In Southern European countries, seigniorage-GDP ratio varies between two and four percent (Horrendorf, 1997). In developing countries due to underdevelopment of the domestic financial markets and the restrictions on foreign exchange, governments find it difficult to finance budget deficits through sources other than monetisation. As the government finances its budget deficits by borrowing from the central bank, money supply increases resulting in inflation with implications for seigniorage-revenue generation.

Even though openness of an economy is meant to widen and deepen markets, and in effect improve the opportunity for domestic borrowing, one likely consequences of opening the financial sector is the resultant reduced seigniorage creation capacity of the government due to a decreasing demand for local currency in the presence of foreign currencies and foreign financial assets (McKinnon, 1973; Shaw, 1973; Fabris and Vukajlović-Grba, 2004). Thus, severe dollarisation imposes a serious threat to the effective implementation of macroeconomic policies with complex implications for achieving macroeconomic policy objectives. For instance, until demand for money function is correctly defined to encompass foreign currencies in circulation, the traditional monopolistic tendency of the government to generate seigniorage would be inhibited as a result of low demand for the domestic currency.

Given the above, the key policy puzzle challenging governments of developing countries is how to effectively implement economic liberalisation programmes without unduly sacrificing economic stability and seigniorage revenue in an unofficially dollarized economic environment. Unfortunately, till date this puzzle has not received much attention in econometric explorations. Therefore, in an attempt to provide an understanding to this policy dilemma confronting

developing countries, this paper is set out to empirically measure the degree of dollarisation and seigniorage for some selected developing countries as well as explore the specific policy implications for macroeconomic stability for Ghana. The paper also seeks to investigate whether government has succeeded in maximising seigniorage revenue in Ghana during the post-liberalisation era. The specific objectives of this paper are to: (i) determine the correlation coefficients of inflation, inflation tax, economic openness and dollarisation on seigniorage for selected developing countries; (ii) estimate the long-run and short-run dynamics of the relationship between seigniorage and inflation in accordance to the Laffer Effect Model; (iii) calibrate the short-run as well as the long-run seigniorage-maximizing inflation; (iv) unearth the short-run and the long-run macroeconomic determinants of seigniorage and (v) trace the line(s) of Granger-causality among seigniorage, economic openness, dollarisation and inflation.

The remaining part of the paper is organised as follows. Section 2 discusses theoretical issues involving dollarisation, seigniorage, inflation tax and economic openness. Besides, in this section, the Cagan model-Laffer effect, some empirical evidences and a summary of some stylized facts and historical antecedents of dollarisation in SSA are discussed. The data, econometric models, and methodology are specified in section 3. In section 4, the empirical results are reported and interpreted; policy implications and recommendations constitute section 5, whilst concluding remarks are presented in section 6.

2.0 Dollarisation, Seigniorage, Inflation Tax and Openness: The Theoretical Issues
2.1.1 The Concept and Measurement of Dollarisation
Under particularly high inflationary circumstances, the demand for foreign currencies and financial assets denominated in foreign currencies rises resulting in dollarisation. Dollarisation can be defined as the preferred use of foreign currencies over a domestic currency in performing the traditional functions of money without official sanction by a government. Where a government endorses for the use of foreign currencies alongside the domestic currency in performing the basic functions of money in an economy, dollarisation is no longer unofficial but *de jure*. It is quite obvious that dollarisation has far-reaching consequences for government revenue mobilisation through money creation and effective stabilization of macroeconomic environment.

The ratio of Foreign Currency Deposits *(FCD)* to broad money *(M₂)* is the simplest and most widely used proxy for currency substitution in an economy, although this approximation represents only the lower bound for the actual level of currency substitution, given that foreign currencies in circulation are omitted (Komárek and Melecký, 2001). In developing and transition economies where the financial sector is less developed and instability of the macroeconomy is a universal permanent feature, more foreign currencies are likely to be in circulation than banked with formal financial institutions, but it is practically difficult to quantify, and as at now, impossible to accurately and completely determine.

Thus, due to lack of data on the amount or quantity of foreign currencies in circulation *(FCC)*, the determination of dollarisation has been narrowly dependent on the observable amount of foreign currency deposits *(FCD)* as a component proxy for dollarisation. Given that foreign currencies are not issued by the local central bank and there are good reasons to suspect that significant amount of money transfers from overseas pass through unofficial routes, the difficulty

in determining the amount of FCC is obvious. Therefore, though inadequate, empirical studies involving dollarisation and currency substitution, associated with the International Monetary Fund (*IMF*), often employ the ratio of *FCD* to broad money *(FCD/BM)* as the measure of the extent to which an economy is *dollarized*. We denote this traditional dollarisation index (*DDI*) which is adopted in this study as:

$$DDI \equiv (FCD/BM) \equiv (FCD/M_2)$$ [2.1.1]

2.1.2 The Concept and Measurement of Seigniorage and Inflation Tax
Theoretically, classical literature seems to suggest different definitions of seigniorage[1]. Perhaps, the summary of the most common definition of seigniorage is the value of real resources acquired by the government through its ability to print money (Begg, Fischer and Dornbusch, 1994). The various definitions have led to the emergence of four main approaches to understanding and determining adoption of money creation by governments to generate revenue. These approaches are the fiscal dominance, optimal taxation, seigniorage-maximization and opportunity cost seigniorage hypotheses. The *fiscal-dominant seigniorage hypothesis* as proposed by Klein and Neumann (1990); and Neumann, (1996) suggests that if fiscal policy is dominant such that the monetary authorities cannot influence the real deficit net of interest payments, money supply becomes endogenous. At a certain level of the debt ratio, the public is no longer willing or able to absorb the excess government debt. In effect, fiscal seigniorage measures the proportion of seigniorage received by government purposely for budget financing. According to Sargent and Wallace (1981) under this circumstance, the monetary authorities will be compelled to finance the deficit by creating money in the economy. Mathematically, fiscal seigniorage can be computed as $\dfrac{G_d + G_r}{P_t}$; where G_d represents government debt; G_r denotes net profit allocated from central bank to the government; and P_t is the general consumer price level.

The *optimal-taxation seigniorage hypothesis* put forward by Bailey (1956), Mankiw (1987), Poterba and Rotemberg (1990), and Edwards and Tabellini (1991) aligns itself with the minimisation of the social costs from different forms of resources, mainly conventional tax and seigniorage. Under this circumstance, seigniorage is defined as inflation tax and measured as $\pi\gamma$ where π is the rate of inflation and γ is the real high-powered money and computed as total base money divided by consumer price level. The empirical work of Campillo and Miron (1996) is consistent with the view that optimal tax considerations are necessary in determining the rate of inflation.

The *seigniorage-maximization hypothesis* focuses on maximizing specific variety of revenue which is basically the total revenue derived from money creation and possession due to the monopoly powers of the central bank. Seigniorage as total revenue associated with money creation can be determined as $\dot{m}\gamma + r\theta$ such that $\dot{m}$ is the growth rate of nominal high-powered money; r is real rate of interest minus rate of population growth; and θ denotes the real stock of interest bearing government assets, in a manner that $\gamma > \theta$. The *opportunity cost seigniorage hypothesis* is formulated to determine the additional real income that the household sector would

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[1] The term seigniorage originated from the French word *seigneur* which was used for the feudal lord of the Middle Age because he had a monopoly power on his land to coin money (Blanchard, 1997).

have earned if they had held interest-bearing financial assets instead of non-interest bearing money. The real interest earnings sacrificed for holding money is the opportunity cost. Mathematically, real opportunity cost seigniorage is measured as $i\gamma$ where i is the nominal interest rate. The *monetary seigniorage hypothesis*, arguably, is the most commonly used seigniorage measure in empirical works, captures the transactions value of non-monetary assets that money holders trade in with the monetary authority to obtain the desired increase in the real base money balances (ΔM). Alternatively, monetary seigniorage can be defined as the change in base money outstanding (ΔM) deflated by the consumer price level.

Honohan (1996) proposes the under-listed alternative approaches for measuring of seigniorage revenues which should be chosen based on the focus of any particular empirical work:
- the product of the rate of growth and real monetary base which captures the actual amount of tax received by the government. This cash flow measure illustrates the real purchases the government finances by printing money;
- the product of nominal interest rate and the real monetary base which determines the opportunity costs households suffer for holding money rather than other liquid assets which also embrace the tax component of seigniorage; and
- the product of inflation and the real monetary base, which represents the dwindling purchasing power of money balances. This, thus, reflects the capital levy aspect of seigniorage to the amount that it varies from the interest measure by the unanticipated inflation.

From the above and in the context of this study, seigniorage is decomposed into two components – real seigniorage and inflation tax. Given that seigniorage is defined as $S_t \equiv (\Delta M) = \dfrac{M_t - M_{t-1}}{P_t}$ where M_t is the monetary base at time t and P_t is the price level at time t; it follows that if real holding of monetary base by residents is defined as $m_t = \dfrac{M_t}{P_t}$; then seigniorage can be transformed into:

$$S_t = (m_t - m_{t-1}) + m_t \pi_t \text{; where } \pi_t = \frac{P_t - P_{t-1}}{P_t}. \hspace{2cm} [2.1.2]$$

The first term of S_t is the *real seigniorage* because it connotes the rise in money holding emerging from money demand by residents; whereas the second term captures *inflation tax*. In this case, π_t is considered as inflation tax rate and m_t is the tax base, such that if $\pi_t = 0$, then the government receives no revenue from inflation, but as inflation rate rises, people would reduce their holdings of the money base due to the fact that monetary base is now more costly to hold. In effect, a government can decrease the real value of the non-interest-bearing part of the government debt by using inflation (Begg, Fischer, and Dornbusch, 1994). Inflation is considered a tax within this framework because it reduces the government's liability to residents with regard to the local currency issued, which implies that if real balance is small, higher inflation is required to raise inflation tax. Inflation tax is, thus, the increase in nominal money balances which households have to accumulate to keep their real balances constant in an inflationary environment.

Technically, since seigniorage is related, but not identical, to inflation tax, seigniorage can be positive or high without inflation being necessarily positive or high.[2] This can occur when an economy is experiencing rapid real growth especially during the early stages of transition, emergence or recovery. The government of such an economy may be compelled to print more money for the payment of public investment activities thereby increasing money supply to meet the increased demand in the growing economy. This condition can generate seigniorage in a non-inflationary environment. In an economic environment where seigniorage is used excessively as a means of revenue generation, seigniorage is pro-inflation. Broadly, the hypotheses suggest that the role of monetary authorities in creating money and maintaining money is the cause of seigniorage. Seigniorage generation has the potential of influencing aggregate money supply and hence the rate of inflation if supply of money does not equate supply of goods and services which might increase rent-seeking activities including dollarisation.

2.1.3 Concept and Measurement of Economic Openness
An economy is opened when its key sectors are less restricted and controlled by the state such that the increased private sector participation leads to increasing significance of the foreign sector through higher exports and imports. Economic openness (EOP) is synonymous to economic liberalisation that involves essentially trade (both domestic and foreign) and finance (that includes banking and non-banking such as trade). In this study, the conventional index for EOP is used albeit it has a number of shortcomings. Thus:

$$EOP = (X + M)/GDP ; \qquad\qquad [2.1.3]$$

where *X* denotes total exports; *M* stands for total imports; and GDP is the gross domestic product.

The most obvious limitations of this measurement include the differences in magnitude of *X* and *M*, and the exclusion of policy variables that impact on trade. Given these setbacks, Sachs and Warner (1995) constructed a dummy-variable-based index of economic openness of various thresholds relating to non-tariff barriers of external trade, tariff barriers of foreign trade, and the variation in the black market exchange rate vis-à-vis the official rate. Other components of the index include the degree of government control for the most important exports, and whether or not the economic system of a country is socialist or capitalist inclined[3]. This study adopted the conventional measure specified in [2.1.3] due to problems relating to data availability, adequacy of policy coverage, and questionable application of weights to the various components of the dummy-variable-based index.

2.2 Seigniorage-Maximizing Inflation and the Cagan Model: The Laffer Curve Effect
Komárek and Melecký (2001) observe that where there is a high substitutability of the domestic currency with foreign currencies, it becomes difficult for governments to pursue deficit finance by printing money, which in the recent past, has been a common practice in most developing countries. The demand for foreign currencies, on one hand, enhances seigniorage, whilst on the

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[2] Mundell (1971) and Obstfeld and Rogoff (1999) also separate seigniorage from inflation tax. In the words o Obstfeld and Rogoff (1999), seigniorage revenue typically exceeds inflation tax revenue in a growing economy as the government can print money to offset a rising demand for real balances without generating inflation.
[3] Quinn (1997), Miniane (2004), and Chinn and Ito (2007) propose different measures of financial openness which are narrow in scope and focus on only international financial flows.

other hand; it may act as an inflationary tax. Thus, in a *dollarized* economy, the resulting government revenue will be reduced at each level of inflationary tax (Komárek and Melecký, 2001). In the same vein, it has been observed that, to a reasonable extent, the displacement of a domestic currency by a foreign currency may promote macroeconomic stabilization and credibility of economic policies in small-open economies. For example, in transition and developing countries, credibility can increase when foreign currencies in circulation depress the efforts of monetary authorities to manipulate domestic currency. Thus, in the past, stabilization policies in emerging economies were characterized by the fixing of nominal exchange rates or establishing crawling pegs, which normally results in progressive appreciation (or over-valuation) of exchange rates. However, when a domestic currency is significantly displaced by a foreign currency in an economy, there should automatically be narrower fluctuations in exchange rates to ensure stabilization (Komárek and Melecký, 2001).

From the above scenarios, when the rate of inflation is zero, the government obtains no revenue from inflation; however, the quantum of inflation tax received by the government would increase as the rate of inflation increases. As the inflation rate increases, people would reduce their holdings of the money base due to the fact that 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 declines (Dornbusch and Fischer, 1994). Similarly, Fischer (1982) asserts that currency substitution or dollarisation can be substantially costly in terms of seigniorage that would be paid to a foreign country to import high-powered money, together with the excess welfare burden incurred by sacrificing independent control over the domestic rate of high-powered money creation for the domestic economy.

There is a possible nonlinear Laffer effect of a change in the rate of inflation on seigniorage revenue generation. Cagan (1956) proves that the semi-elasticity of the demand for money affects the ability of government to derive seigniorage when inflation rate exceeds a certain threshold, then seigniorage begins to decline. By implication, seigniorage revenue and inflation rate are not proportional to each other.

Given that generally the capacity of a government to receive tax revenue depends on the efficiency of the revenue collecting institutions, then following Huang and Wei (2006) and Alseina and Tabellini (1987) government's balanced budget constraint can be specified as:

$$G_t = \pi_t + \ell T_t; \text{ such that } (0 \leq \ell \leq 1) \qquad [2.2.1]$$

where G is the government's budgeted expenditure; ℓ is the efficiency coefficient of tax revenue mobilisation by revenue institutions which captures the proportion to tax revenue collected receivable by government; and T is the total amount of tax actually collected by the revenue institutions. If $\ell = 0$, then there is complete leakage, and the government collects no tax revenue; but if $\ell = 1$, then the institutional quality is at its peak and there is no leakage of revenue.

To capture the Laffer curve effect in seigniorage, equation [2.2.1] is transformed into equation [2.2.2] as follows:

$$G = \ell T + \pi^e(-\theta\pi); \qquad [2.2.2]$$

where π^e represents expected rate of inflation; $\theta \geq 0$ and is considered as the semi-elasticity of the demand for real money balances and captures the strength of the Laffer effect. The fact is that whenever $\pi \leq \frac{1}{\theta}$, then any rise in the rate of inflation would lead to an increase in gross seigniorage; but whenever the rate of inflation exceeds the threshold of π^* or $\pi > \frac{1}{\theta}$ then any further increases in the rate of inflation will result in a total decline in gross seigniorage. This means that as $\pi \sim \infty$, the private sector avoids holding on to the domestic currency; hence the government collects no seigniorage revenue. In effect, given that all other things are remaining the same, rising inflation causes rising dollarisation but declining seigniorage-revenue in an economy, at least, in the short-run. The Laffer curve of seigniorage revenue maximizing inflation is presented in Figure 2.2 below.

Figure 2.2: Seigniorage-Maximizing Inflation Laffer curve
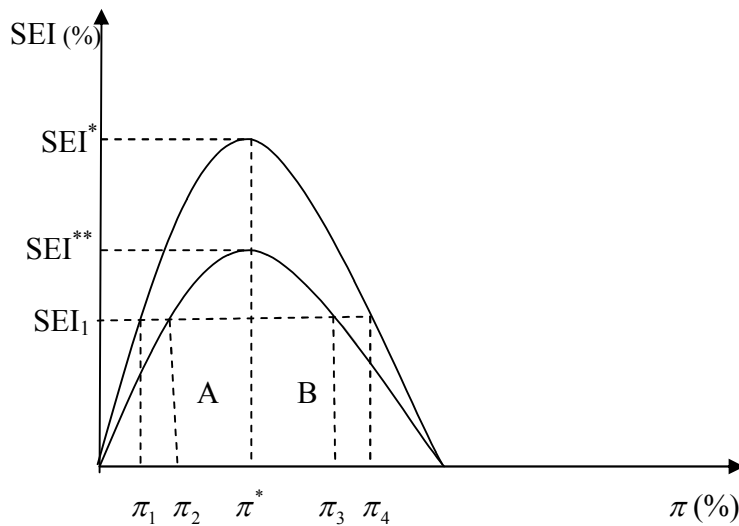
In Figure 2.2 above, *SEI* denotes seigniorage revenue as a proportion of the GDP while π denotes the rate of inflation in a domestic economy. The seigniorage-maximizing inflation position is where the average rate of inflation is π^* and the maximum seigniorage receivable in the long-run is SEI^{**} whereas SEI^* is receivable in the short-run. This is where the slope of the Laffer curve is zero (i.e. $dSEI/d\pi = 0$). Prior to this point, higher rates of inflation were necessary to generate higher seigniorage revenue by means of increases in base money. However, beyond this point, higher rates of inflation results in lower revenue from seigniorage because economic agents would attempt to avoid holding base money balances so as to hedge themselves from incurring inflation tax as a result of the reduced real money balances in their hands. It can be deduced from Figure 2.2 that apart from the unique seigniorage-maximizing inflation rate (π^*), the same amount of seigniorage revenue (such as SEI_1) is obtainable at two different rates of inflation as shown by π_1 and π_4 in the short-run and π_2 and π_3 in the long-run. Thus, by implication the Laffer curve has a *benefit side* and a *cost side*. The *benefit side* of the Laffer curve is the rising side labelled *A* where $dSEI/d\pi > 0$, because it is this side that provides

governments with the opportunity of generating higher seigniorage revenues by raising the rates of inflation through the printing of money. This is the side where higher tax rates match with higher tax base. Clearly, the *cost side* of the Laffer curve is falling part of the curve labelled *B*, where $dSEI/d\pi < 0$ such that any further increase in the tax rate reduces the tax base resulting in lower seigniorage.

It should be conceivable that at any positive rate of inflation such as the optimum rate of inflation (π^*), the level of seigniorage-maximization revenue is likely to be higher in the short-run than in the long-run due to the fact that in the short-run households are more likely to suffer from money illusions, moral hazards and information asymmetry. In the long-run, however, economic agents by rational expectations and behaviour are capable to reconstituting the aggregate composition of their demand for money portfolio. Usually, this would be done by converting liquid assets such as cash into less liquid assets such as bonds; or from a local currency into foreign currencies such as the US dollar and the British pound sterling to which their local currency depreciates.

According to the fundamental Cagan (1956) model, demand for money is a function of inflation:
$$m_t^d = \alpha e^{-\beta_1 \pi} \qquad\qquad [2.2.3]$$
which is transformed into
$$InM_t - InP_t = \beta_0 - \beta_1 \pi_t + \varepsilon_t \qquad\qquad [2.2.4]$$
in its natural logarithmic form, and where β_1 is the semi-elasticity of money demand with respect to inflation which captures the opportunity cost of holding money due to inflation. In the original Cagan model, although factors other than determinants of money demand were stated, under hyperinflationary circumstances, the Cagan model focuses on the rate of inflation as principal determinant of real money balances. Given the foregoing, the seigniorage-maximising rate of inflation is $\pi^* = 1/\beta_1$. Thus, the money demand function with real GDP (y) and rate of inflation is $m_t^d = \alpha e^{-\beta_1 \pi} y^{\beta_2}$ which is transformed into a natural logarithmic function as:
$$InM_t - InP_t = A_0 - \beta_1 \pi_t + \beta_2 y_t + \varepsilon_t \qquad\qquad [2.2.5]$$
where β_2 is the elasticity of the money demand with respect to y, so that $1/\beta_1 - \beta_2 y$ becomes the seigniorage-maximizing inflation. This implies that as more explanatory variables are included in the model, estimated elasticity changes resulting in lower critical level of inflation rate. Therefore, being on the *benefit side* of the Laffer curve may have a different meaning now. Obviously, policies geared towards increasing revenue through inflation results in higher inflationary paths.

2.3 The Empirical Nexus
Saatçioğlu and Korap (2006) investigate the courses of inflation tax and seigniorage revenue for policy makers of the Turkish economy and observe that for the post-1980 period, the Turkish economy lies on the *benefit side* of the seigniorage-maximizing-inflation Laffer curve. On the contrary, the empirical works of Sauer and Lange (2006) reveal that dollarisation results in significant static losses of seigniorage revenue in Argentina, Brazil, Chile and Mexico. Besides, the results also show that revenue-sharing by the United States may fail to fully compensate the dollarized countries for the redistribution of seigniorage income; and that the resulting under-

compensation worsens the burdens of dollarisation in all the four Latin American countries considered in the study.

Fritz-Krockow, *et al* (2005) observe that between 1996-2003 revenues derived from seigniorage reduced as a result of increasing dollarisation in Suriname. Between 1999 and 2001, seigniorage revenue was mainly obtained from inflation tax when inflation rate was about 66%. Thus, as inflation brought about a temporary rise in seigniorage, it also brought in its wake an increase in dollarisation in Suriname. Specifically, seigniorage revenue which traditionally forms 25% of tax revenue and approximately 6% of GDP between 1998 and 2000 declined to a mere 0.3% in 2003 due to extreme dollarisation.

Dornbusch (2000) concedes that dollarisation leads to loss of seigniorage. However, this critical issue will be offset by "reduction in public debt service costs that result from reduced interest rates". Globally, developing countries issue external debt in foreign currencies, hence the reduction in domestic interest rates is relevant only for international debts and governments always have the option of issuing even internal debts in foreign currencies so that the cost of debt service is reduced to the extent of exchange rate risk. For dollarisation to succeed in reducing the cost of debt service it must reduce country risk, otherwise if it produces a recession, country risk might increase instead.

Jefferson (1998) based on data from 1977 to 1995 reveals that seigniorage is an important source of government financing in the United States of America; a considerable proportion of which is obtained from emerging and transitional countries which have not succeeded in stabilizing their own currencies. This implies that dollarisation in developing countries improves seigniorage revenue mobilisation in advanced economies which have currencies circulating globally.

Lizano (1997) predicts that if full dollarisation policy is pursued in Costa Rica, exchange risks and country risk would disappear. However, Goldfajn and Olivares (2000) reveal that though exchange risk does not exist in Panama following full dollarisation, Panama pays a higher premium than Costa Rica on the United States dollar bonds its government floats in international financial markets.

Cukierman, *et al* (1992) prove that seigniorage is an important source of government revenue for developing countries. Using time series data for the period 1971-1982, seigniorage defined as an increase in base money to a share of total government revenue accounted for more than 10% on the average. For example, the study reveals that seigniorage was 28.0%, 24.8%, 23.9%, 21.6%, and 13.1% for Ghana, Uganda, Mexico, Bolivia and India respectively.

2.3.1 Relevant Macroeconomic Stylised Facts on Sub-Saharan Africa
Developing countries embarked upon massive economic reforms and restructuring programmes in the 1980s towards recovery. These programmes were essentially aimed at opening, deregulation and transformation of these developing economies to become more competitive and market-oriented. As a result of this, foreign exchange regimes were switched from fixed to flexible which, in effect, increased and made easier access to foreign currencies by the public. Economic openness and the implementation of trade and financial liberalisation programmes

then became the mainspring of dollarisation in most of these developing economies that are traditionally characterised with higher growth rates in money supply and prices.

Consequently, since the past-two decades, it has become quite common to find firms in developing countries, especially those within the services sector pricing their services in foreign currencies. For instance, in Sub-Saharan Africa (SSA) as well as in Latin America nearly all highly-rated hotels, esteemed private schools, travel and tour companies, construction companies, research and consultancy institutions and mortgage firms quote the prices of their services in foreign currencies. Apart from these services, many durable household items such as DStv and computers; and sophisticated fixed assets such as brand new motor vehicles and other machinery of foreign origin are priced in foreign currencies. The preference of the foreign currencies over the local currency emancipates from the fact that foreign currencies are more stable in value than the highly downward-oscillating local currency.

Adenutsi and Yartey (2007) provide ample evidence that there exits a high degree of dollarisation, measured as FCD/M_2, in transition and developing countries. Overall, out of the 24 sampled countries, developing countries are 16 including seven SSA countries while the remaining eight countries are transition the average index of dollarisation was 34.88%. For countries in transition the average rate of dollarisation was 30.23% whilst for developing countries it was 37.21%.

According to Adenutsi and Yartey (2007) the general likely reasons behind the high prevalence of dollarisation in developing and transition economies are:
- Macroeconomic instability as a result of high rates of inflation, wide fluctuations and volatility of nominal exchange rates, wide interest rates spread, and the loss of confidence in the domestic currency;
- Episodes of financial market crisis and risk-averse attitude of investors, firms and households in an attempt to hedge against potential financial risk of holding local currency;
- A history of colonialism (i.e. the continuous link with former colonial masters in trade and public finance);
- Size of the economy and its openness and dependency on international trade;
- Lack of credible macroeconomic policy and non-autonomy of the central bank;
- Over-dependence on imports and continuous current account deficit;
- The lack of higher denomination of bank notes issued by the local central banks;
- The active prevalence of large underground or unofficial economic activities such as money laundering, public sector corruption and bribery, the manufacturing (or smuggling routes or centres) of banned drugs;
- Political instability or uncertainty;
- Imperfect and costly money market information;
- Non-existing or underdevelopment of capital and money markets;
- Low involvement in international capital markets;
- Excessively high international reserves;
- Relative convenient portability;
- Loss of confidence in the domestic economy due to a combination of the above factors; and,

- High level of international tourism and its allied socioeconomic activities.

3.0 Model Specification, Data and Methodology
3.1 The Empirical Models
3.1.1 The Laffer Curve Effect Model
In an attempt to determine the seigniorage-maximizing rate of inflation (π^*) as shown in Figure 2.2 above, a simple quadratic model involving seigniorage *(SEI)* and inflation *(INF)* of the form (3.1.1.1) and (3.1.1.2) are estimated for the long-run and short-run relationships respectively:

$$SEI_t = \beta_0 + \beta_1 INF_t + \beta_2 INF_t^2 + \mu_t; \qquad\qquad a\ priori\ \beta_1 > 0; \beta_2 < 0 \qquad [3.1.1.1]$$

$$\Delta SEI_t = \beta_0 + \beta_1 \Delta INF_t + \beta_2 \Delta INF_t^2 + \beta_3 \varepsilon_{t-1} + \mu_t; \qquad a\ priori\ \beta_1 > 0; \beta_2, \beta_3 < 0 \qquad [3.1.1.2]$$

where μ is the white-noise residual; β_0 is the constant term of the regression line that is not expected to be necessarily significant statistically. In the case of (3.1.1.2), ε_{t-1} is the error-correction term. The estimated parameters imply that seigniorage falls after an optimal rate of inflation.

3.1.2 The Extended Cagan Model
In an attempt to establish the macroeconomic determinants of seigniorage a more comprehensive model of Cagan origin which also reflects the works of Komárek and Melecký (2001) and Fritz-Krockow *et al* (2005) is considered. This model is relevant because its estimation would unearth the relevant short-run and long-run macroeconomic determinants of seigniorage compared with the Laffer Curve Effect model which is aimed at just determining the functional relationship between seigniorage and inflation. The general form of the extended Cagan model is:

$$SEI_t = f(FBB_t, INF_t, DDI_t, EOP_t, DAB_t, FND_t) \qquad\qquad [3.1.2.1]$$

where SEI measured in consonance with the monetary seigniorage hypothesis, *INF, EOP,* and *DDI* are as previously defined, *FBB* represents fiscal budget balance $(G_r\text{-}G_e)$, *DAB* stands for domestic absorption *(GDP-NX)* which is a proxy for domestic market size, *FND* denotes financial deepening measured as (M_2/GDP) to capture the level of financial development.

The empirical Long-Run Equilibrium Condition Model formulated for evaluation in line with [3.1.2.1] is:

$$SEI_t = \phi_0 + \phi_1 \Delta FBB_t + \phi_2 \Delta INF_t + \phi_3 DDI_t + \phi_4 DAB_t + \phi_5 \Delta EOP_t + \phi_6 FND_t + \mu_t \qquad [3.1.2.2]$$

It is expected *a priori* that the estimated coefficients of equation (3.1.2.2) shall possess the following signs: $\phi_0, \phi_4, \phi_5 > 0$; $\phi_1, \phi_3, \phi_6 < 0$, and $\phi_2 <> 0$.

The empirical SRECM models that are determinable alongside [3.1.2.2] are the simple linear Autoregressive Distributed Lag (ARDL) models associated with the Short-Run Equilibrium-Correction Mechanism Models (SRECMMs) that are evaluated to provide short-run information *SEI* are of the form:

$$\Delta SEI_t = \theta_0 + \sum_{i=1}^{4} \theta_{1i} \Delta SEI_{t-i} + \sum_{i=1}^{4} \theta_{2i} \Delta FBB_{t-i} + \sum_{i=1}^{4} \theta_{3i} \Delta INF_{t-i} + \sum_{i=1}^{4} \theta_{4i} \Delta DDI_{t-i} +$$
$$\sum_{i=1}^{4} \theta_{5i} \Delta DAB_{t-i} + \sum_{i=1}^{4} \theta_{6i} \Delta EOP_{t-i} + \sum_{i=1}^{4} \theta_{7i} \Delta FND_{t-i} + z\hat{\varepsilon}_{t-1} + v_t \qquad [3.1.2.3]$$

where $\hat{\varepsilon}_t \sim I(0)$ because *SEI* and the explanatory variables are cointegrated such that the residual $v_t \sim iid(0, \sigma^2)$. The composition of v_t is similar to that of μ_t as observed in above (3.1.2.3). The symbol Δ represents the first-differenced form of the variables in the model. The coefficient of the various explanatory variables, $\theta_1, \theta_2, \ldots \ldots, \theta_7$, are the impact multipliers that measure the immediate impact that a change in the explanatory variables has on a change in the dependent variables. The feedback or adjustment effect is z and it indicates how much of the disequilibrium is being corrected.

3.2 Methodology and Data

The data are quarterly over the 1996(1)-2005(4) period. This period was selected to reflect the post-liberalisation era in Ghana. Other sources were obtained from the Statistical Bulletins of the Central Bank of Ghana and the Ghana Statistical Service (GSS). The required quarterly data used in the study include local currency in circulation (*LCC*), foreign currency deposits *(FCD)*, narrow money (*M₁*), broad money (*M₂*), fiscal budget balance *(FBB)*, inflation measured as the growth of consumer price index *(π or INF)*, income measured as real GDP, exports *(X)* and imports *(M)*.

The study adopted the general to specific approach, which initially involved, a very general dynamic lag structure between the dependent and explanatory variables comprising their lagged levels and first differences with Ordinary Least Squares (OLS) estimation procedure. Subsequently, this overly long general specification is reduced into a parsimonious dynamic adjustment equation, using the variable deletion tests by ensuring that the overall summary statistics do not become significant, the Akaike and Schwarz Information Criteria reach their minimum such that the random error term does not violate the fundamental underlying classical assumptions of the estimation technique.

In fact, since the exact functional form of quantitative relationships in econometrics are rarely deduced theoretically, but more often determined empirically; and with the notion that the Laffer curve effect may be violated or not exactly evidenced on Ghana, other functional forms such as linear, logarithmic and right-sided semi-logarithmic models were estimated so that the best observed result is reported. The estimation of the appropriate functional form of the Laffer Curve Effect Model is essential because it is possible that the shape or the *cost side* of the Laffer curve may not necessarily hold if any the following conditions prevail in an economy:

- if the rate of currency substitution or dollarisation is equal to the rate of inflation in excess of the optimal rate of inflation (i.e. $\pi^* - \pi_t = DDI$) such that $\pi^* < \pi_t$;
- where information asymmetry is equitably efficient;
- where moral hazards and money illusions are at minimum;
- where population growth rate is at constant and equal to inflation; and,
- where tax revenue leakages are equal to zero due to improvements in the collection of taxes and efficient mechanisms are put in place to make tax collectors honestly committed to the tax collection exercise.

3.2.1 Granger-Causality Test: Dollarisation, Openness, Seigniorage and Inflation

McKinnon (1973) and Shaw (1973) postulate that a probable consequence of embarking upon a financial liberalisation programme is a loss of seigniorage generating capacity for the

government emerging from decreases in demand for the local currency in the presence of alternative financial assets normally denominated in different currencies. Specifically, during the era of high inflation demand for foreign currencies and foreign currency denominated financial assets upsurges precipitating dollarisation. Dollarisation can have significant implications for the capacity of the government to derive revenue normally in the form of inflation tax[4] from money creation.

To verify empirically whether or not the openness of the Ghanaian economy *(EOP)* is the cause of inflation, dollarisation, and seigniorage generation, the study adopted the statistical test suggested by Granger (1969, 1988) and further developed by Sims (1972). Thus, this study, upon the selection of a reasonable lag length, *l*, estimated a general bivariate regression of the form:

$$A_t = \alpha_0 + \alpha_1 A_{t-1} + \ldots\ldots\ldots + \alpha_l A_{t-l} + \beta_1 B_{t-1} + \ldots\ldots\ldots + \beta_l B_{t-l}$$ [3.2.1]

where the Wald statistics for the joint hypothesis is specified as $\beta_1 = \ldots\ldots\ldots = \beta_l = 0$ was estimated using the reported *F*-statistics. *A* and *B* in [3.2.1] represent the combinations of variables of empirical interest in this context namely *EOP* through *INF*, *DDI* to *SEI*. It is expected *a priori* that there exist a uni-directional line of causality from *EOP* through *INF*, *DDI* to *SEI*.

3.2.2 Stationarity Tests
The study commenced with the tests for stationarity of the endogenous and exogenous variables within the framework of Augmented-Dickey-Fuller (ADF) test procedure. This test is important in order to avoid spurious regression which is a common problem when estimating a regression line with data whose generated process follows a time trend. The ADF test requires estimating an equation of the form:

$$\Delta y_t = A_0 + A_1 y_{t-1} + A_2 t + \sum_{l=1}^{p} B_l \Delta y_{t-l} + z_t; \qquad H_0: \beta=0; \ H_1: \beta>0,$$ [3.2.2]

where y_t is a vector for all time series variables under consideration in a particular regression model; z_t is the error term; *l* is the optimal lag length of each variable chosen according to the Akaike and Schwarz Information Criteria such that first-differenced terms make z_t a white noise.

3.2.3 Cointegration Test
In order to determine the equilibrium-correction condition for the introduction of the equilibrium-correction term into the Short-Run Equilibrium-Correction Mechanism Model (SRECMM), the study follows the Engle-Granger Cointegration test procedure. The classical

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[4] Fischer (1982) and Friedman (1971) analyzing from the framework of the quantity theory of money pointed out that seigniorage can be obtained without necessarily creating inflationary pressure if high-powered money is adequately provided to meet the rapidly growing demand for goods and services in the economy. However, the fact remains that in practice, seigniorage is likely to result in inflation tax because that parallelism in the growth of money and the rate of real growth does not take place, especially in LDCs, since lack of simultaneous equilibrium conditions in the product, assets and foreign exchange markets.

limitations of this approach was improved by the alternative use of each I(1) variable as a regressand in order to determine the number of cointegrating equations.[5]

4.0 The Empirical Evidences
4.1 Degree of Dollarisation in Developing Countries
There is a high incidence of dollarisation in nearly all the twenty sampled countries irrespective of geographical location and monetary zone. In Sub-Saharan Africa, for instance, average the incidence of dollarisation is 34.8% close to the 37.68% prevailing in the other developing countries. Averagely, at least, one-third of the total money supply in most developing countries comprises of foreign currencies. With the exception of Burundi (12.88%) and Estonia (16.03%) during the decade of 1996-2005, each of the twenty emerging economies sampled has foreign currencies constituting at least 20% of money supply. Detailed results on the degree of dollarisation in developing countries are provided in Table 4.1 below.

Table 4.1: Dollarisation Indices of Some Selected Developing Countries											1996-2005
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	
Selected Sub-Saharan African Countries (34.80)											
Angola	29.4	42.9	53.0	66.7	66.4	63.9	67.3	58.9	57.7	56.0	56.20
Benin	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Botswana	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Burundi	2.7	4.3	6.3	6.0	6.5	6.6	12.1	21.7	32.7	29.9	12.88
Ghana	28.2	28.2	20.8	24.4	36.6	30.2	30.1	27.6	27.1	23.3	27.65
Nigeria	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Sierra Leone	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Tanzania	14.8	18.0	17.7	20.2	21.8	24.7	26.4	28.4	28.2	25.3	22.55
Zambia	29.7	35.7	55.7	57.8	67.9	60.1	62.2	58.4	64.6	54.9	54.70
Other Selected Developing Countries (37.68)											
Albania	21.9	18.3	16.8	18.2	19.4	22.4	22.1	22.1	22.8	26.4	21.04
Armenia	21.0	33.5	39.8	48.1	49.1	50.3	49.7	53.9	55.5	60.3	46.12
Belarus	24.2	27.3	55.6	43.7	58.7	52.0	49.6	53.6	58.4	58.1	48.12
Bolivia	77.0	77.7	78.8	78.5	79.1	75.9	75.5	73.8	67.2	58.1	74.16
Cambodia	63.1	62.6	54.2	60.9	68.0	69.8	69.3	69.3	71.1	71.4	65.97
Estonia	10.3	15.4	15.7	14.6	19.2	12.3	16.8	16.0	18.8	21.2	16.03
Georgia	15.0	20.9	29.1	35.6	46.2	45.0	44.4	45.6	42.1	44.7	36.86
Kyrgyz Republic	8.7	15.4	23.9	27.8	28.1	25.1	29.7	27.2	26.1	28.1	24.01
Latvia	30.8	31.3	28.6	29.9	31.1	30.8	31.3	30.7	34.5	37.2	31.62
Lithuania	24.4	21.2	24.1	30.4	34.0	33.0	24.4	19.5	19.9	21.4	25.23
Vietnam	19.4	22.1	25.3	28.2	29.7	31.2	28.7	23.1	23.2	22.4	25.33

Author's computations (%)   *n/a = not available because of absence of relevant data*

4.2 Correlation Matrix of Inflation (INF), Economic Openness (EOP), Inflation Tax (INFTAX) and Dollarisation (DDI) on Seigniorage (SEI) in Developing Countries
The correlation matrix shows that generally inflation tax (INFTAX) and economic openness (EOP) have a strong positive relationship with seigniorage (SEI) in developing countries. In rare

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[5] According to Mukherjee, White and Wuyts (2003) there is no point specifying and estimating a simultaneous model once the variables are stationary and cointegrating because such equations do not suffer from simultaneity bias.

cases where there is a negative relationship between EOP and SEI, such correlations are not statistically strong. With the exception of Zambia (-40%), this casual relationship is often less than 30%. On the whole, dollarisation does not seem to have any strong correlation with seigniorage except for Latvia (85%), Ghana (72%), Tanzania (52%) and Lithuania (-55%). It can, thus, be concluded that dollarisation leads directly to loss of seigniorage in Lithuania (-55%), Belarus (-28%), Vietnam (-28%), Kyrgyz Republic (-17%) and Bolivia (-7%).

Details of this correlation matrix and seigniorage as a percentage of GDP are presented in Table 4.2 below.

Table 4.2: Seigniorage and the Correlation Matrix against INF, EOP, INFTAX and DDI

Developing Countries	INF-SEI	EOP-SEI	INFTAX-SEI	DDI-SEI
Sub-Saharan African Countries (4.84%)				
Angola *(4.64)*	0.3506	0.27945	0.60552	0.0194
Benin *(0.03)*	0.2646	0.14576	0.50256	*n/a*
Botswana *(0.09)*	-0.3676	-0.03000	0.48532	*n/a*
Burundi *(0.04)*	-0.4911	-0.02953	0.86143	0.3077
Ghana *(0.03)*	0.1796	0.08656	0.75005	0.7216
Nigeria *(38.55)*	0.0895	0.70629	0.70537	*n/a*
Sierra Leone *(0.06)*	0.1467	0.65879	0.67868	*n/a*
Tanzania *(0.02)*	-0.3172	0.61967	0.67941	0.5196
Zambia *(0.09)*	0.2650	-0.40155	0.76585	0.2682
Other Developing Countries (0.06%)*				
Albania *(0.01)*	0.0458	0.10155	0.90644	0.3732
Armenia *(0.02)*	0.2332	-0.22394	0.43404	0.1493
Belarus *(0.03)*	-0.6728	0.24120	0.93133	-0.2835
Bolivia *(0.06)*	0.2763	0.18476	0.92655	-0.0739
Cambodia *(0.03)*	-0.2069	0.40429	0.68784	0.4533
Egypt *(0.16)*	0.2476	0.22068	0.93632	0.1720
Estonia *(0.07)*	-0.2061	0.02667	0.57277	0.1510
Georgia (0.03)	0.1832	0.28552	0.53010	0.0315
Kyrgyz Republic *(0.02)*	-0.8884	-0.08985	0.89386	-0.1718
Latvia *(0.07)*	0.2570	0.61245	0.61934	0.8447
Lithuania *(0.05)*	-0.1002	0.66885	0.56621	-0.5503
Vietnam *(0.11)*	0.1196	0.42284	0.33129	-0.2784

Author's computations   Average (SEI/GDP)% for the decade (1996-2005) in parenthesis
n/a = not available

With the exception of Angola (4.64%) and Nigeria (38.55%), generally seigniorage revenue is low and less than one per cent in developing countries. Though the correlation between dollarisation and seigniorage appear to be weak across nations, except for Latvia (84%), Ghana (72%), Lithuania (-55%), and Tanzania (52%), this could be attributed to the limitations in the

measurement of dollarisation as foreign currencies in circulation are indeterminable and hence ignored from the dollarisation index.

4.3 Results of Stationarity Tests

The results of stationarity test, as presented in Table 4.3 have suggest only *DDI*, *EOP* and *FBB* are stationary on levels, hence I(0). All other variables used in this study are stationary after first-differencing and hence are I(1). The number of lags used in the computation was determined by the Akaike and Schwarz Information Criteria.

Table 4.3 Results of Stationarity Tests

VARIABLE	NUMBER OF LAGS[*]	ADF TEST STATISTIC	CRITICAL VALUE	LEVEL OF SIGNIFICANCE (%)	ORDER OF INTEGRATION
DAB	2	-4.874517	-3.6228	1	I(1)
DDI	1	-4.110695	-4.0990	1	I(0)
EOP	3	-4.228308	-3.5386	5	I(0)
FND	4	-2.144500	-1.9456	5	I(1)
FBB	1	-3.560665	-3.5312	5	I(0)
INF	5	-3.581365	-3.4824	5	I(1)
SEI	2	-3.042957	-2.9422	5	I(0)

Author's computations   [*]*Determined according to Akaike and Schwarz Information Criteria*

4.4 Results of Granger Causality Test

The estimated results of the Granger Causality Tests are presented in Table 4.4.

Table 4.4: Results of Pairwise Granger Causality Tests					
Null Hypothesis:	*F-Statistics*				
	At Lag 1	At Lag 2	At Lag 3	At Lag 4	At Lag 5
DDI does not Granger Cause SEI	0.88134	1.53027	2.76403	0.67205	0.94961
SEI does not Granger Cause DDI	3.07400[*]	2.05214	3.30032[**]	5.81590[**]	8.59928[**]
EOP does not Granger Cause SEI	0.17257	0.61771	0.50472	0.84480	0.92196
SEI does not Granger Cause EOP	0.50460	0.20981	0.12850	0.49336	1.10498
EOP does not Granger Cause DDI	3.55125[**]	0.88306	1.47971	1.38582	1.50404
DDI does not Granger Cause EOP	0.00890	2.29002	1.61888	0.82871	0.95738
INF does not Granger Cause SEI	0.24114	0.24262	0.25851	1.29477	2.58490
SEI does not Granger Cause INF	0.20442	0.08586	0.13269	0.10526	0.75112
INF does not Granger Cause EOP	1.14044	0.27743	0.11574	0.08054	0.11034
EOP does not Granger Cause INF	5.14043[**]	0.32333	0.54006	1.32416	1.05000
INF does not Granger Cause DDI	2.93706[*]	2.97768[*]	0.68244	0.42394	0.25480
DDI does not Granger Cause INF	1.02868	1.18123	1.74605	0.90918	1.55068

Author's computations   *[**](*) = 1%(5%) level of significance*

4.5 Results of Modelling SEI by Ordinary Least Squares (OLS)

The estimated results of the Long-Run Equilibrium Regression Model (LRERM) and the Short-Run Equilibrium-Correction Mechanism Model (SRECMM) are presented in Table 4.5 below. From the estimated LRERM, financial deepening (FND) and inflation (INF) are the most

significant long-run positive determinants of seigniorage whilst economic openness and the constant of the estimated regression line are the long-run negative determinants of seigniorage within the Ghanaian economy. The results also demonstrate that the estimated regression line is a good-fit with joint relevance of the explanatory variables. The Durbin Watson (DW) statistic of 1.69 lies within the acceptable range of no serial correlation (i.e. between 1.05 and 2.95) at 1% level of significance. In the long-run, dollarisation, economic openness and fiscal budget balance are not statistically significant in determining the level of seigniorage.

Table 4.5: Estimated Results of Modelling SEI by OLS			
LRERM Variables	**Coefficient**	**t-statistic**	***Summary Statistics and Diagnostic Tests***
CON	-20.69778	-4.133159**	*R-squared* *0.654599*
DAB	-0.000115	-3.757291**	*Adjusted R-squared* *0.589544*
DDI	13.96669	1.458988	*F-statistic* *7.132032*
EOP	-10.71351	-1.846840	*Prob(F-statistic)* *0.0000***
FBB	-9.01E-05	-0.795680	*Durbin-Watson stat* *1.689770*
FND	1388.625	5.295530**	*Cointegration Test (Residual ADF)* *-4.9193*
INF	0.045674	3.751055**	*Residual Critical Value (-3.612)**; DW=2.00*
SRECMM Variables	**Coefficient**	**t-statistic**	
CON	-0.00958	-3.098885**	
Δ(SEI(-1))	-0.01222	-2.161253*	
Δ(SEI)	0.97000	1.18E+03**	
Δ(FBB(-1))	-0.02671	-3.345819**	
Δ(INF(-4))	-0.17103	-3.073221**	
Δ(INF(-1))	0.13460	1.484411	
Δ(INF)	0.04562	2.646446*	
Δ(DDI(-4))	-0.07564	-2.149015*	
Δ(DDI)	-0.01475	-2.229893*	
Δ(EOP(-3))	0.07686	2.713139*	
Δ(EOP(-2))	-0.04433	-2.300441*	
Δ(EOP(-1))	-0.04648	-2.410129*	
Δ(EOP)	-0.02546	-1.548705	***Summary Statistics and Diagnostic Tests***
Δ(DAB(-3))	-0.08298	-2.601772*	*R-squared* *0.97549*
Δ(DAB(-1))	0.06321	2.643729*	*Adjusted R-squared* *0.95762*
Δ(FND(-4))	0.06377	2.921713*	*RESET Test Statistic* .... *-2.49366*
Δ(FND(-3))	0.03519	2.717293*	*RESET Prob.* *0.99980*
Δ(FND(-2))	0.06180	3.133726**	*F-statistic* .... *1.1E+08*
Δ(FND(-1))	0.05464	2.784877*	*Prob(F-statistic)* *0.0000***
Δ(FND)	-0.02795	-1.890358	*ARCH Test Statistic* *0.303674*
RESID(-1)	-0.03384	-3.110352**	*ARCH Probability* *0.585415*

Author's computation Δ=*first difference*   **Notes:** *5% significance level; **1% significance level
LRERM= Long-Run Equilibrium Regression Model; SRECMM= Short-Run Equilibrium-Correction Mechanism Model

Similarly, the results from the estimated SRECMM are statistically impressive given the reported partial R-squared of 96% in the absence of misspecification of functional form, serial correlation and the appropriate sign and significance of the lagged residual (RESID(-1)). Overall, the current level of seigniorage and inflation promote seigniorage revenue mobilisation in the short-run just

as the depth of the financial sector from the first to the past-four quarters, economic openness during the last-three quarter as well as the rate of inflation and domestic absorption of the immediate past quarter. On the contrary, the current levels of economic openness and financial deepening; fiscal balance and economic openness during the immediate past-quarter; economic openness at the second quarter; domestic absorption during the third quarter, dollarisation and inflation during the fourth quarter impede seigniorage-revenue mobilisation potential of Ghana by the extent of their respective coefficients for a one per rise in any of these variables.

The finding that dollarisation of the Ghanaian economy is the consequence of low seigniorage-revenue generation validates the theoretical and empirical works of McKinnon (1973), Shaw (1973), Fischer (1982), Dornbusch and Fischer (1994), Dornbusch (2000), Komárek and Melecký (2001), Fabris and Vukajlović-Grba (2004), Fritz-Krockow, *et al* (2005), and Sauer and Lange (2006).

The estimated OLS results do not appear to lend empirical support to Sargent and Wallace (1981), Klein and Neumann (1990), and Neumann (1996) fiscal-dominant seigniorage hypothesis, since fiscal budget balance does not promote seigniorage revenue mobilisation in Ghana. Conversely, the consistent positive relationship between financial deepening and seigniorage in the short-run and the long-run seems to give credence to the monetary seigniorage hypothesis as well as the seigniorage-maximization hypothesis.

4.6 Estimated Results of the Laffer Curve Effect Models

The estimated Laffer Curve Effect Models for the long-run and short-run relationships are presented in equations (4.6.1) and (4.6.2) respectively.

$$S\hat{E}I = 357.2003 + 61.27377INF - 0.412756INF^2; \qquad\qquad [4.6.1]$$
$$(1.1815) \quad (2.802157)^{**} \qquad (-1.22974)$$

$$\textit{F-statistic = 19.34694 (0.000}^{**}$$
$$R^2 = 0.5111 \qquad \overline{R}^2 = 0.4848 \quad DW = 0.9285$$
$$\textit{Cointegration Test:}$$
$$\textit{Residual ADF: -4.8511(-4.2165)}^{**}$$
$$\textit{Residual DW statistic: 2.000424}$$

$$\Delta S\hat{E}I = 45.30253 + 89.01617\Delta INF - 0.437151\Delta INF^2 - 0.111954\varepsilon_{t-1}; \qquad [4.6.2]$$
$$(1.617049) \quad (7.931150)^{**} \quad (-2.719031)^{**} \quad (-2.667963)^{**}$$
$$\textit{F-statistic = 62.7094 (0.000}^{**}$$
$$R^2 = 0.8431 \qquad \overline{R}^2 = 0.8297 \quad DW = 2.441$$

The estimated results of the Laffer Curve Effect Models have given credence to the quadratic relationship between seigniorage and inflation within the context of Ghana. For the short-run model, there exists no autocorrelation as the DW statistic of 2.44 lies within the region of no autocorrelation ranging from the lower limit of 1.14 to the upper limit of 2.86 at 1% level of significance. The presence of positive autocorrelation associated with the long-run model is not strange given the strong positive correlation among the explanatory variables. The non-significance of the estimated β_2 in [4.6.1] does not undermine the relevance of the results since under estimation of quadratic functions the marginal effects are not captured by any single parameter rather it is $(\beta_1 + 2\beta_2 INF_t)$.

4.7 Summary of Empirical Findings

The main findings of this study are summarized below:

i. SSA countries generate higher revenue from seigniorage than other developing countries across the globe. An average of 4.84% of GDP is generated as seigniorage by SSA countries compared to 0.06% by other developing countries bears a testimony to this fact.

ii. The inverse correlation between the rate of inflation and seigniorage for Belarus (-67%), Botswana (-37%), Burundi (-49%), Cambodia (-21%), Estonia (-21%), Kyrgyz Republic (-89%), Lithuania (-10%), and Tanzania (-32%) is an indication that these countries might be lying at the *cost side* of their seigniorage-maximizing inflation Laffer curves.

iii. Economic openness directly leads to leakages in seigniorage revenue generation in Armenia (-22%), Botswana (-3%), Burundi (-3%), Kyrgyz Republic (-9%), and Zambia (-40%).

iv. Dollarisation inversely varies with seigniorage-generation potentials of Belarus (-28%), Bolivia (-7%), Kyrgyz Republic (-17%), Lithuania (-55%) and Vietnam (-28%).

v. The Laffer Curve Effect Model in its original state is applicable to the Ghanaian economy in a manner where higher seigniorage-revenue can be generated in the short-run than in the long-run. The estimated coefficients for the short-run and long-run Laffer curve effects, given an inflationary threshold of 74% are 24.32 and 0.1859 respectively. The estimated results of seigniorage models presented in Table 4.5 have underscored further evidence to this finding. Thus, as far as the Ghanaian economy is concerned there is a hyperbolic relationship between seigniorage and inflation with a seigniorage-maximizing inflation rate of 102% in the short-run and 74% in the long-run[6].

vi. For Ghana, the rate of inflation and financial deepening are the most consistent short-run and long-run macroeconomic determinants of seigniorage in a positive direction in Ghana. A 100% rise in the rate of inflation leads to a five percent rise in seigniorage mobilisation in the short-run and long-run. Similarly, a 100% improvement in financial deepening results in a five percent rise in seigniorage on average in the short-run and more than 1000% rise in seigniorage in the long-run.

vii. In the long-run, economic openness and dollarisation are not statistically significant in determining seigniorage in Ghana. In the short-run, however, economic openness and dollarisation have adverse effects on seigniorage. Domestic absorption also undermines seigniorage generation both in the short and long run. Fiscal budget balance reduces seigniorage in the short-run.

viii. The results of Granger Non-Causality Test show that seigniorage generation by government has caused economic agents to hedge against the tendencies of inflation by way of dollarisation. Economic openness Granger-causes inflation; inflation in turn Granger-causes dollarisation.

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[6] Refer to Appendix for details.

5.0 Policy Implications and Recommendations

Seigniorage is undoubtedly a vital source of revenue for all countries. The rate of inflation is crucial to seigniorage generation therefore there is the need for developing countries to effectively implement macroeconomic policies to ensure that the rate of inflation does not exceed the seigniorage-maximizing threshold rate so as to remain at the *benefit side* of the Laffer curve. For Ghana, this optimal rate of inflation is 74% in the long-run and 102% in the short-run. Since it is apparently unsound to prescribe the adoption of inflationary policies to generate seigniorage revenue due given overt adverse welfare implications, there is the need for policy re-direction by the Ghanaian government to generate revenue from other alternative sources rather than in the form of inflation tax and seigniorage. Economic policies that would, in the long-run, reduce the degree of dollarisation in the Ghanaian economy must be vigorously pursued. In the short-run, any rate of inflation exceeding the threshold of 102% would force the Ghanaian economy to the *cost side* of the Laffer curve as far as seigniorage maximization is concerned.

The study also reveals that economic openness is one of the causes of inflation in Ghana. Besides, the rate of inflation and seigniorage-generation tendencies result in higher degree of dollarisation which would, in the long-run, have negative repercussions for effective monetary policy implementation. Consequently, the policy dilemma confronting Ghana as a developing country and, indeed, other developing countries of similar macroeconomic structure and size is how to determine the optimal level of economic openness that would not result in excessive dollarisation and spark inflation beyond the optimal rate in the long-run. This problem is more complicated given that openness of an economy is a modern development strategy that seeks to widen the benefits from foreign trade and promote social and economic progress through job creation, capital mobility and consumer sovereignty.

Both in the short-run and the long-run, financial deepening has been found to be a positive determinant of seigniorage in Ghana. This implies that in order to generate substantial revenue from seigniorage, there is the need to further deepen the financial sector through the implementation of prudent monetary and fiscal policies by the relevant authorities. The appropriate policy option for financial deepening should not be directed at further arbitrary opening of the macroeconomy by way of increasing imports resulting in capital flight, and promotion of unofficial dollarisation through widespread underground and rent seeking activities. This is because since economic openness causes inflation and dollarisation in the short-run, policies should be directed at export promotion and diversification. It is also suggested that complementary policies such as value addition to export commodities in order to stabilize the cedi against the major currencies which would, in effect, discourage dollarisation especially by way of asset substitution should be aggressively pursued.

In the short-run, dollarisation significantly reduces seigniorage generation capacity of the Ghanaian economy. This is possible because in most emerging economies such as Ghana and those of SSA, dollarisation driven by asset substitution motive is used as an instrument for hedging against higher rates of inflation and exchange rate risks. This implies that as a fiscal policy, the implementation of seigniorage-generation policies might be complex and ineffective in a small-open dollarized economy unless there is a policy-mix that ensures the growth in

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money supply is not in arbitrary excess of the relative growth in GDP that maximizes the benefits and minimizes the costs of generating seigniorage and monetary policy effectiveness.

6.0 Concluding Remarks
This paper has provided an insight into seigniorage-maximization and inflation within the analytical framework of economic openness and dollarisation in developing countries. The main objective of this paper is to evaluate how economic openness affects seigniorage maximization in emerging economies with special reference to the Ghanaian economy in the face of unofficial dollarisation. The main contribution of this paper is to include in the analysis the effects of dollarization as precipitated by economic openness on seigniorage-maximizing inflation in emerging economies using Ghana as a case study. The formulation of the empirical model is hinged on two key issues – (i) the degree of synchronization of economic openness and dollarisation for seigniorage maximization, and (ii) the effect and relative importance of inflation tax as a component of seigniorage rather than a substitute.

The main empirical results are:
i. Dollarization leads to loss of seigniorage in Ghana.
ii. Dollarisation is high whilst seigniorage is low in developing countries.
iii. Economic openness impacts negatively on seigniorage generation in Ghana.
iv. Seigniorage-maximizing inflation is higher in the short-run than in the long-run.
v. The Ghanaian economy will remain at the *benefit side* of the seigniorage-maximizing inflation Laffer curve so long as the rate of inflation does not exceed the long-run threshold of 74%.
vi. Seigniorage and inflation tax move together in a positive fashion, the two are not perfectly correlated an indication that the two are not identical.
vii. Financial deepening and inflation are significant positive determinants of seigniorage in the short-run as well as the long-run whilst domestic absorption negatively affects seigniorage in the long-run in Ghana.
viii. Within the short-run, fiscal budget balance, dollarisation and economic openness are the main factors that undermine seigniorage creation in Ghana.

The empirical results assert that as a revenue mobilisation instrument, seigniorage is more efficient in the short-run than in the long-run. Therefore, dollarized developing countries should not excessively rely on seigniorage as a source of government finance.

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Appendix: Calibration of Laffer Curve Seigniorage-Maximization Inflation Rate

Calibration of Estimated Short-Run Laffer Curve for Ghana						
$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_2$	INF	$\hat{\beta}_1 *INF$	$\hat{\beta}_2 *INF^2$	Calibrated SEI
45.30253	89.01617	-0.43715	1	89.01617	-0.43715	133.881549
45.30253	89.01617	-0.43715	2	178.0323	-1.7486	221.586266
45.30253	89.01617	-0.43715	5	445.0809	-10.9288	479.454605
45.30253	89.01617	-0.43715	10	890.1617	-43.7151	891.74913
45.30253	89.01617	-0.43715	15	1335.243	-98.359	1282.186105
45.30253	89.01617	-0.43715	20	1780.323	-174.86	1650.76553
45.30253	89.01617	-0.43715	25	2225.404	-273.219	1997.487405
45.30253	89.01617	-0.43715	30	2670.485	-393.436	2322.35173
45.30253	89.01617	-0.43715	50	4450.809	-1092.88	3403.23353
45.30253	89.01617	-0.43715	55	4895.889	-1322.38	3618.810105
45.30253	89.01617	-0.43715	60	5340.97	-1573.74	3812.52913
45.30253	89.01617	-0.43715	65	5786.051	-1846.96	3984.390605
45.30253	89.01617	-0.43715	70	6231.132	-2142.04	4134.39453
45.30253	89.01617	-0.43715	75	6676.213	-2458.97	4262.540905
45.30253	89.01617	-0.43715	80	7121.294	-2797.77	4368.82973
45.30253	89.01617	-0.43715	85	7566.374	-3158.42	4453.261005
45.30253	89.01617	-0.43715	90	8011.455	-3540.92	4515.83473
45.30253	89.01617	-0.43715	95	8456.536	-3945.29	4556.550905
45.30253	89.01617	-0.43715	96	8545.552	-4028.78	4562.071234
45.30253	89.01617	-0.43715	97	8634.568	-4113.15	4566.717261
45.30253	89.01617	-0.43715	98	8723.585	-4198.4	4570.488986
45.30253	89.01617	-0.43715	99	8812.601	-4284.52	4573.386409
45.30253	89.01617	-0.43715	100	8901.617	-4371.51	4575.40953
45.30253	89.01617	-0.43715	101	8990.633	-4459.38	4576.558349
45.30253	**89.01617**	**-0.43715**	**102**	**9079.649**	**-4548.12**	**4576.832866**
45.30253	89.01617	-0.43715	103	9168.666	-4637.73	4576.233081
45.30253	89.01617	-0.43715	104	9257.682	-4728.23	4574.758994
45.30253	89.01617	-0.43715	105	9346.698	-4819.59	4572.410605
45.30253	89.01617	-0.43715	106	9435.714	-4911.83	4569.187914
45.30253	89.01617	-0.43715	107	9524.73	-5004.94	4565.090921
45.30253	89.01617	-0.43715	108	9613.746	-5098.93	4560.119626
45.30253	89.01617	-0.43715	109	9702.763	-5193.79	4554.274029
45.30253	89.01617	-0.43715	110	9791.779	-5289.53	4547.55413

Calibration of Estimated Long-Run Laffer Curve for Ghana						
$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_2$	INF	$\hat{\beta}_1*INF$	$\hat{\beta}_2*INF^2$	Calibrated SEI
357.2003	61.27377	-0.41276	1	61.27377	-0.41276	418.061314
357.2003	61.27377	-0.41276	2	122.5475	-1.65102	478.096816
357.2003	61.27377	-0.41276	5	306.3689	-10.3189	653.25025
357.2003	61.27377	-0.41276	10	612.7377	-41.2756	928.6624
357.2003	61.27377	-0.41276	20	1225.475	-165.102	1417.5733
357.2003	61.27377	-0.41276	25	1531.844	-257.973	1631.07205
357.2003	61.27377	-0.41276	30	1838.213	-371.48	1823.933
357.2003	61.27377	-0.41276	40	2450.951	-660.41	2147.7415
357.2003	61.27377	-0.41276	50	3063.689	-1031.89	2388.9988
357.2003	61.27377	-0.41276	60	3676.426	-1485.92	2547.7049
357.2003	61.27377	-0.41276	65	3982.795	-1743.89	2596.10125
357.2003	61.27377	-0.41276	70	4289.164	-2022.5	2623.8598
357.2003	61.27377	-0.41276	71	4350.438	-2080.7	2626.934974
357.2003	61.27377	-0.41276	72	4411.711	-2139.73	2629.184636
357.2003	61.27377	-0.41276	73	4472.985	-2199.58	2630.608786
357.2003	**61.27377**	**-0.41276**	**74**	**4534.259**	**-2260.25**	**2631.207424**
357.2003	61.27377	-0.41276	75	4595.533	-2321.75	2630.98055
357.2003	61.27377	-0.41276	76	4656.807	-2384.08	2629.928164
357.2003	61.27377	-0.41276	77	4718.08	-2447.23	2628.050266
357.2003	61.27377	-0.41276	78	4779.354	-2511.21	2625.346856
357.2003	61.27377	-0.41276	79	4840.628	-2576.01	2621.817934
357.2003	61.27377	-0.41276	80	4901.902	-2641.64	2617.4635
357.2003	61.27377	-0.41276	85	5208.27	-2982.16	2583.30865
357.2003	61.27377	-0.41276	90	5514.639	-3343.32	2528.516
357.2003	61.27377	-0.41276	95	5821.008	-3725.12	2453.08555
357.2003	61.27377	-0.41276	100	6127.377	-4127.56	2357.0173
357.2003	61.27377	-0.41276	105	6433.746	-4550.63	2240.31125
357.2003	61.27377	-0.41276	110	6740.115	-4994.35	2102.9674