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COLLEGE OF ARTS AND SOCIAL SCIENCES

FACULTY OF SOCIAL SCIENCE

DEPARTMENT OF ECONOMICS

THE NEXUS BETWEEN GOVERNMENT REVENUE AND INTEREST RATE IN

GHANA: THE SEIGNIORAGE FACTOR.
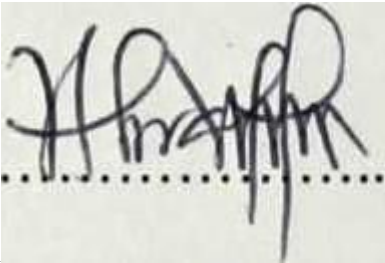
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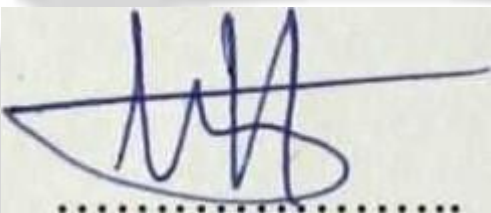MASTER-OFPIIÎLOSOPHY DEGREE IN ECONOMICS

MAY, 2013

DECLARATION

CANDIDATE'S DECLARATION

I hereby declare that this submission is my own work towards the award of the Master of Philosophy Degree and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any degree of the university, except where due acknowledgement has been made in the text.

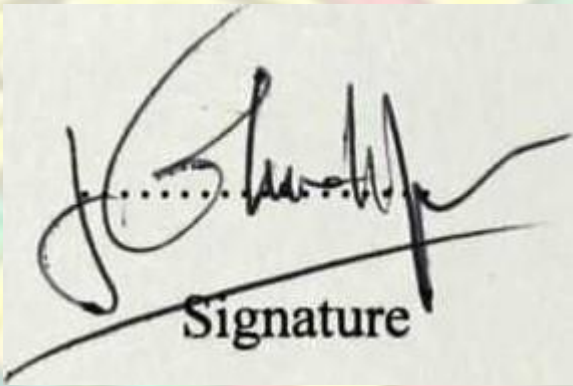Abraham Ababio Gyamfi

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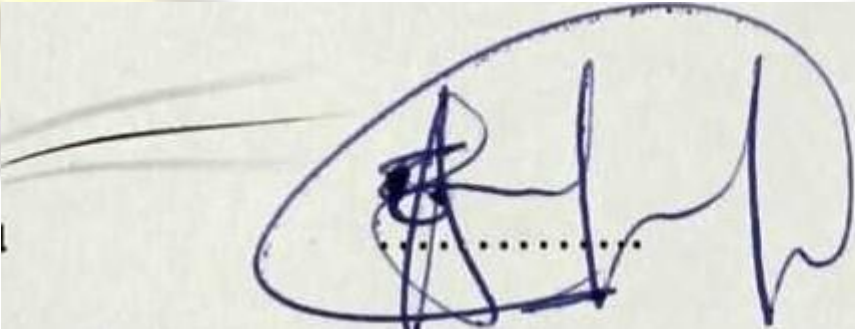Certified by:

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DEDICATION

To Mr. Charles Annorhene and Mrs. Christiana Annorhene for their love and care.

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ABSTRACT

The government of Ghana has repeatedly operated a budget deficit due to its inability to raise enough revenue from conventional taxes amidst a downwardly inflexible expenditure. Though it relies on seigniorage as a public finance tool, it is not certain whether it follows any optimal path in the use of seigniorage. Within an analytical game perspective model according to Andrabi (1997), in countries where seigniorage adjusts as residual revenue to satisfy the budget constraint, the best path is that there should be a positive relationship between cyclical output and seigniorage level. This relationship would be strengthened if current government

expenditure covary positively with cyclical output. Finally, seigniorage level must reduce in trend growth in output. By extension, the latter proposition implies that if seigniorage moves positively with inflation, then there should be a negative relationship between the tax rate and inflation in the long run. This study establishes that Ghana uses seigniorage as a residual source of revenue. We used the Hodrick-Presscott, First difference Filter and Deterministic Trend decomposition methods to obtain the transitory (cyclical) and trend components of output and further established a positive relationship between seigniorage and transitory output using the Prais-Winsten model. We strengthened our finding by juxtaposing this covariation of seigniorage and transitory output on the positive relationship between current government expenditure and transitory output. We also find a negative relationship between the tax rate and inflation rates as well as a negative relationship between seigniorage and trend output which lend support to our results. We invoked Friedman's hypothesis that inflation is always and everywhere a monetary phenomenon wherein we show that reliance on seigniorage even as a residual source of revenue to finance government expenditure is significantly associated with inflation in the long run. Finally, we show that indeed in the long run, inflationary expectations which the study noted is considerably explained by seigniorage indeed explain the level of the nominal interest rate.

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Using the Fractional cointegration technique and rational expectations hypothesis, the study establishes that there is indeed a cointegrating relationship albeit fractionally between nominal interest rate and expected inflation. This shows that changes in the nominal interest rate reflect changes in inflationary expectations in the Ghanaian economy in the long run and that government revenue from seigniorage indeed affect the nominal interest rate in the long run. We established however that the transmission of inflationary expectations through seigniorage into the nominal interest rate is not full and that only a partial Fisher relation holds for the Ghanaian economy. The study encourages policymakers to avoid ad hoc policies that have the intent of affecting the nominal interest rate, ensure financial discipline among Ministries,

Departments and Agencies as well as monitor the expenditure path of Metropolitan, Municipal and District assemblies at the grassroots level as it embarks vigorously on the fiscal decentralization in the short run but adopt policy paths that will catapult the economy on a higher growth trajectory with increased tax base in the long run in order to eliminate the political weakness that breeds externality in the use of seigniorage. We also recommend that the nominal interest rate may serve as a forecasting tool for inflation expectations.

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LIST OF ABBREVIATIONS AND ACRONYMS

ACF   Autocorrelation Function

ADF

    Augmented Dickey Fuller

    Asworth and Evans

AGI   Association of Ghana Industries

ARFIMA Autoregressive Fractionally Integrated Moving Average

ARIMA Autoregressive Integrated Moving Average

CPI   Consumer Price Index

DOLS

    Dynamic Ordinary Least Square

    Deterministic Trend

ECOWAS Economic Community of West African States

Fdf   First Difference Filter

GCC   Ghana Chamber of Commerce

GDP   Gross Domestic Product

GNP   Gross-National Product

GPH   Geweke-Porter Hudak
     Goff and Toma

    Hodrick Prescott

VOSS   Kwiatkowski Philips Schimdt Shin
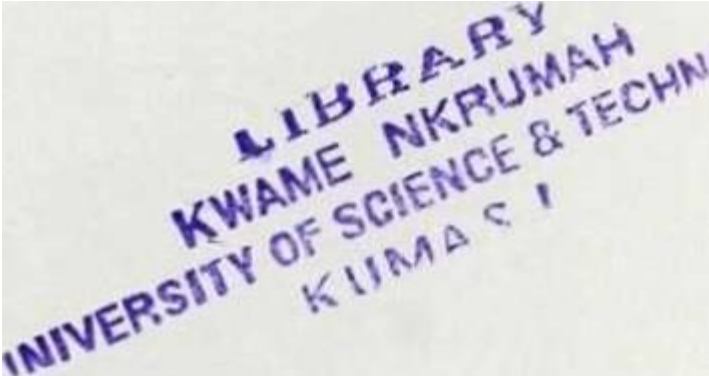
MDA Ministries, Departments and Agencies

MMDA Metropolitan Municipal and District Assemblies

Maddala Wu

Modified Rescaled Range

Poterba and Rotemberg

PAT Phase Average Trend

UTAG United Traders Association of Ghana

U.S.A United States of America

VAT Value Added Tax

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Public expenditure in the Ghanaian economy has shown persistent growth since independence due to the quest for development. Absolute figures indicate that public expenditure rose from 0.4679 billion cedis in 1970 to 4.668 billion cedis in 1980 and further to 254 billion cedis in 1990. By the year 2000, public expenditure has reached 7564.13 billion cedis. In percentage terms, government expenditure as a percentage of GDP rose from 18% in 1970 to 28% in 2000 and further to 34% in 2004. In 2012, government payments amounted to 23,640.60 million Ghana cedis accounting for 32.91% of GDP. In its annual report, the monetary policy committee of the Bank of Ghana noted, "The potential threats to the 2011 budget were identified to be the management and settlement of payment arrears, the pace of settlement of wage arrears and the inflexibility of the expenditure programme, especially by the continued earmarking of revenues for specific expenditures".

Several models have been proposed to explain the increasing size of government in an economy. Musgrave (1969) and Rostow's (1971), Wagner cited by Bird (1971), Peacock and Wiseman (1961), Baumol's (1972) are among the notable ones. Amedzrovi (2010) in an empirical study of the growth of public expenditure in Ghana shows that the growth of public expenditure in the Ghanaian economy is explained by the Baumol 's cost disease syndrome.

Tax revenue has traditionally constituted one of the major bases for financing government expenditure. However, tax revenue has not fared well and this position is encapsulated in a statement made by the Finance Minister in his address to the parliament house of Ghana when he

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noted in 2011 that ' , tax collection... remain low relative to the size of the economy. Non-oil tax revenues as a share of non-oil GDP amounted to 12 per cent in 2009, lower than the ECOWAS convergence target of not less than 20 per cent of GDP."The problem has become more pronounced in recent years when it is accounted that for every one cedi tax raised in the economy, almost 70% goes into emoluments.

Among the litany of alternatives for financing government expenditure, one that has received much attention from economists is the famous inflation tax or seigniorage. Seigniorage is simply defined in the literature as the product of inflation rate and real money balances. Real money balances is considered the tax base. Historically, during the commodity money regime, seigniorage was defined as the difference between the face value of minted coins and the actual market value of the precious metals they contained. Keynes cited by Agenor and Montiel (2006) notes "government can live for a long time . . . by printing paper money. That is to say, it can by this means secure the command over real resources, resources just as real as those obtained by taxation. The method is condemned but its efficiency up to a point must be admitted... so long as the public use money at all, the government can continue to raise resources by inflation.. ."

Indeed, Click (1998) reported estimates of seigniorage for 90 countries for the period 1971-90. Seigniorage as a proportion of GDP ranged from 0.38% to 14.8% with more than half of the countries having less than 1.7% and about 75% of them having less than 2.5%. Seigniorage as a proportion of government spgndiag-ranged from 1% to above 20% with ten countries above this level. On average, seigniorage was about 2.5% of GDP and financed about 10% of government spending. Haslag (1998) in his study, using 67 countries reports that approximately three fourth of the countries collect on average less than 2% of GNP through seigniorage. He noted that Ghana relies most heavily on seigniorage collecting revenue equal to of output through new money creation.

However, as Romer (1996) citing Bresciani-Turroni (1937) and Cagan (1956) noted, "the underlying cause of most, if not all episodes of high inflation and hyperinflation is government's need of seigniorage-that is government revenue from printing money. Wars, fall in export prices, tax evasion and political stalemate frequently leave government with large budget deficits. And often investors do not have enough confidence that the government will honor its debt to be willing to buy its bonds. Thus government's only choice is to resort to seigniorage."Even if government can continue to rely on bond financing, Sargent and Wallace (1993) argued that when deficits continues to build up, then tighter monetary policy being pursued today has to give way to more inflationary policy tomorrow because it comes a time when bond issuance reaches its saturation point. Greater outstanding stock of bonds level could pose a temptation to governments to inflate away the real value of these demands and obligations through inflation.

In recounting the classic experience of the Ghanaian economy of the relationship between increasing public expenditure, low revenue mobilization, deficit, debt, seigniorage and inflation, Bawumia (2008) citing Leite et al (2000) noted "revenue and grants declined from 16.7% of GDP in 1992 with tax revenue falling from 12.4% of GDP to 10.8%. Notwithstanding the decline in government revenue, government expenditure increased from 18% of GDP in 1991 to

24.6% of GD&jn 1992. As a_ygsult-of-these developments, the overall government budget deficit which had declined to 1.3% of GDP in 1991 increased sharply to 9.4% of GDP in 1992. The domestic debt stock increased from a low of 4.0 percent of GDP in 1991 to of GDP by 1993 when expenditure further increased from 24.6% of GDP in 1992 to 29% of GDP in 1993. The government resorted to monetary financing of the deficit. Money supply growth was 53.0% in 1992, 50.3% in 1994 and 45.4% in 1997. Inflation which had fallen to 10% by the end of 1992 began to increase reaching 74.3% by 1995."

Indeed, in the time series data under the study (1970-2009), the economy of Ghana has shown a significant positive relationship between inflation (INF) and seigniorage (SEIG) as shown in Figure 1
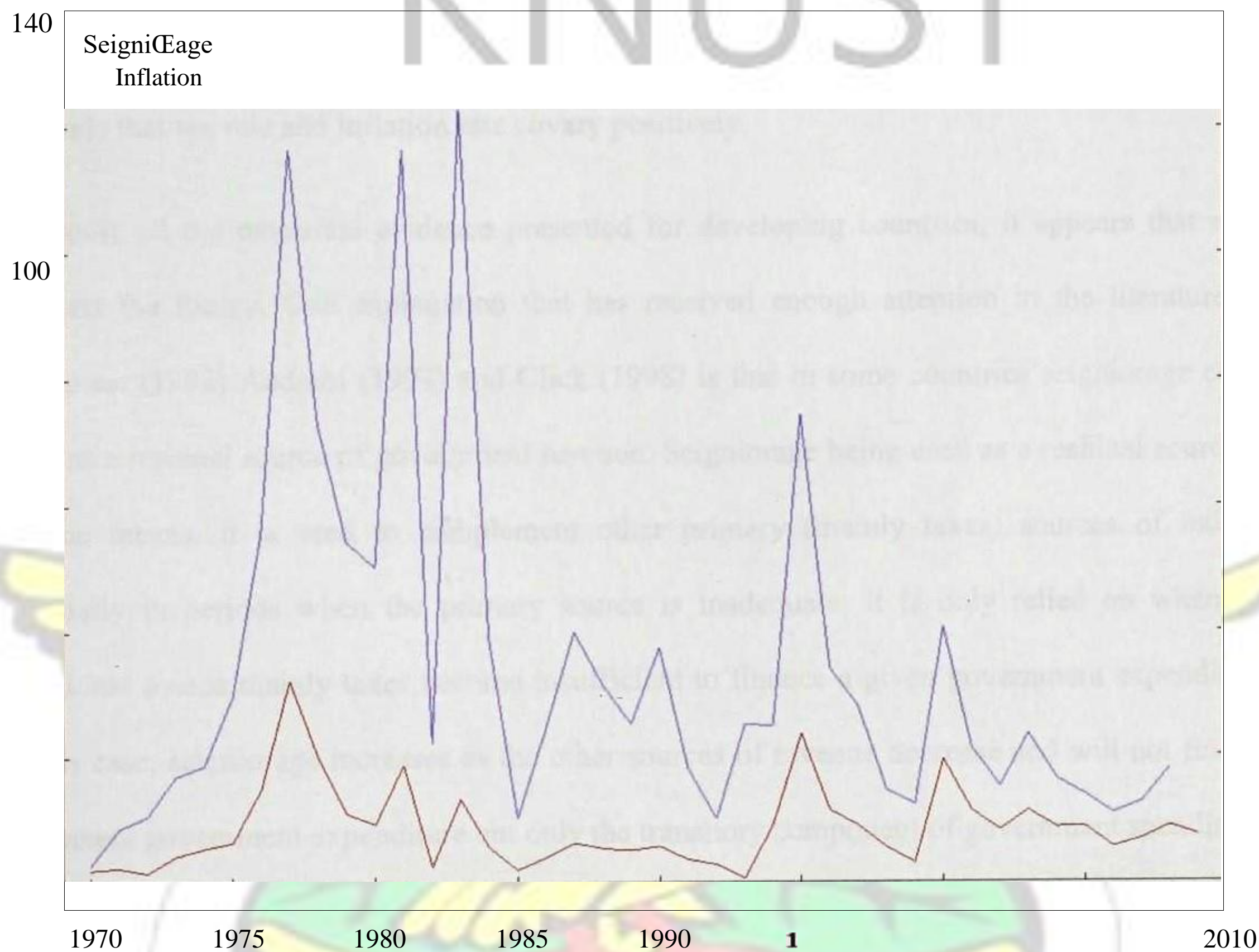
Figure I : Relat@onshin between Inflation and Seiøniorage

Bailey (1956), Mundell (1965), Marty (1967), Friedman (1958) argue against the use of inflation finance, but Phelps (1973) believes that against the backdrop that government has no sources of lump-sum taxes and that government only has distortionary taxes available for financing expenditure, it will be optimal to rely on seigniorage to some degree. Reducing the nominal rate of

interest to zero would increase the inefficiencies by the higher level of other taxes needed to replaced loss inflation tax revenues.

Mankiw (1987), Grilli (1989), Poterba and Rotemberg (1990) Trehan and Walsh (1990) and others have developed models in which seigniorage and conventional taxes were set to minimize deadweight losses across all available taxes and time periods in consonance with Barro (1979 and 1986). Throughout these models, it has emerged that optimal seigniorage considerations demands that tax rate and inflation rate covary positively.

In almost all the empirical evidence presented for developing countries, it appears that none supports the theory. One explanation that has received enough attention in the literature by Aizenman (1992) Andrabi (1997) and Click (1998) is that in some countries seigniorage could react as a residual source of government revenue. Seigniorage being used as a residual source of finance means, it is used to complement other primary (mainly taxes) sources of income especially in periods when the primary source is inadequate. It is only relied on when the traditional source mainly taxes become insufficient to finance a given government expenditure. In this case, seigniorage increases as the other sources of revenue decrease and will not finance permanent government expenditure but only the transitory component of government spending

Aizenman (1992) used a static game analysis to show that in countries where decentralization is inherent in the budget makíñãGs] seigniorage will act as a residual source of revenue therebycreating competitive externalities among the agents resulting in inflation. His description of these agents could be different states in a monetary union, provinces or even ministers of one state. He also equates the decentralization thesis in some countries to situations where it is difficult to impose discipline on the various ministries.

The budget decision making in Ghana is consistent with the decentralization thesis. In recent times, the issue of fiscal discipline among ministries has taken centre stage in the political debate. In 2012, the huge fiscal deficit (12.5%) that the country recorded was attributed to fiscal indiscipline on the part of various ministries to stay within their budgetary allocations.

Perhaps, the proposed Fiscal decentralization in Ghana which in general, involves the redistribution of roles and responsibilities in the conduct of government fiscal policy will increase the indiscipline if not properly monitored. The minister of finance in the 2011 budget proposed the introduction of the Composite Budget system as part of the fiscal decentralization policy in which the aggregate revenue and expenditure of all departments and organizations under the District Assembly and the District Coordinating Directorate including the annual development plans and programmes of the departments and organizations are put under the Assembly.

Unlike Aizenman (1992) who uses a static game analysis to arrive at the conclusion that such decentralization only breeds inefficiencies resulting from externalities in the use of seigniorage, Andrabi (1997) placed the budget decision making process in a repeated game setting and sought to characterize the equilibrium cooperative tax-seigniorage function. Andrabi (1997) realized that for countnes where sei orage adjusts as a residual source of revenue to satisfy the budget constraint, the seigniorage-tax cooperative equilibrium depends on the stochastic nature of output and that seigniorage positively correlates with transitory changes in output and in the long run, its usage reduces as output level increase. A positive (negative) covariation between current-period government spending and transitory changes in output strengthens (weakens) the positive correlation between seigniorage and transitory increase in output.

Transitory increases in output may result when the economy experiences a boom or if it realizes positive terms of trade. In Ghana, this upswing in the business cycle is normally associated with periods in which prices of gold, cocoa and other commodities assume significant growth paths in the world market. Such periods presumably boost confidence in the economy leading to increasing aggregate demand. The price level begins to take an upward trend because as Harrington and Haltinwanger (1991) established, most firms price their commodities procyclically. During such times too, government, frenzied by the boom may be tempted to increase his expenditure though it may be impossible to raise additional tax revenue within such periods. The increased expenditure may be financed by debt monetization and this exacerbates the price hikes associated with the boom.

One implication of seigniorage being used as a residual source of revenue is that in the long run, the growth in size of the economy's output should reduce the use of seigniorage and hence inflation. If the Fisher relation holds, nominal interest rate must reduce as well. This means that nominal interest rate and expected inflation should be cointegrated. Mishkin (1992), Evans and Lewis (1995), Crowder and Hoffman (1996), Soderland (1998), Kasman, Kasman and Turglutu (2006) have shown that the interest rate and expected inflation rate are cointegrated and that the Fisher relation holds. The implication of the Fisher's relation is that inflation determines the level of nominal interest rate in the long run. If the path followed by the use of seigniorage can be shown to influence the level of inflation by invoking Friedman's hypothesis that inflation is always and everywhere a monetary phenomenon, then one can assert as well that in the long run, there is a connection between government revenue and the level of the nominal interest rate which reflect inflationary expectations provided that the Fisher relation holds as well for the economy.

1.2 Statement of the Problem.

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Increasing demand for the provision of goods and services for Ghanaians has called for huge public expenditure. Over the years, the economy has repeatedly operated a budget deficit. In fact, ISSER (2012) admits that the rigidities in government expenditure are such that they appear almost impossible to be removed in nominal terms. The inability of the revenue agencies to mobilize enough revenue is also well noted. There is enough evidence that the Ghana government has relied on seigniorage to some extent as a public finance tool Haslag (1994).

The particular path followed by government in the use of seigniorage can cause major distortions in the economy. Particularly, it can cause the inflation level to rise and may as well introduce downward rigidities in the nominal interest rate. In recent years, macroeconomic instability such as higher inflation has been cited by banks as one of the principal reasons for charging higher nominal interest rates. There has been a huge public outcry against higher interest rate. Such public outrage has come from important group such as the Association of Ghana Industries (AGI), United Traders Association of Ghana (UTAG), and Ghana Chamber of Commerce (GCC). Recently, Kwakye (2011) cited the visiting Executive Vice President of the International

Finance Corporation, an affiliate of the World Bank, Mr. Lars Thunell as reiterating the call to Ghanaian banks to reduce their lending rates. In a survey conducted by PricewaterCoopers in the early part of 2012, high credit risk was identified to be one of the top five risks that threaten the banking industry. It was identified in the study that one of the patterns in the banking sector that increases credit risk is the high interest rate on most lending facilities because higher interest rate as a result of inflation increases the risk of default.

It appears that we do not know the path followed by the Ghana government in his use of seigniorage. Two strands of argument have emerged on the optimal use of seigniorage. One strand of argument due Mankiw (1987) is that optimal use of seigniorage will mean that the tax rate move

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positively with the level of inflation. Some have also opined that optimal use of seigniorage requires that three conditions hold: a positive relationship between seigniorage level and cyclical output; a positive relationship between current government expenditure and cyclical output and a negative relationship between trend growth in output and the use of seigniorage. The three latter propositions due Andrabi (1997) indicates that seigniorage adjusts as a residual source of revenue to satisfy the budget constraint. However, we do not know the path followed by government in the use of seigniorage. What is the optimal path followed by government in the use of seigniorage in Ghana? Is there any connection between the path followed by government in the use of seigniorage and the level of the nominal interest rate in the long run? Does the use Of seigniorage increase during booms? Does government expenditure increase in response to the boom? In other words, does seigniorage acts as residual source of revenue to finance a given government expenditure? Is there any positive relationship between inflation and the tax rate? Does the use of seigniorage increase inflation? Does the level of the nominal interest rate in the long run reflect inflationary expectations? This study aims to find answers to these staggering questions.

1.3 Objectives of the Study

The study generally seeks to understand how government uses seigniorage as a revenue source in Ghãñíand the effect of seigniorage as a source of revenue on inflation and the nominal interest rates.

Specifically, the study seeks to:
1. To determine whether seigniorage is used as a residual source of revenue by:

- Finding a possible relationship between cyclical output and seigniorage. A positive relationship indicates that seigniorage act as a residual source of government revenue.

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- Finding the relationship between cyclical output and current government spending. A positive relationship between transitory output and current government spending strengthens the argument that seigniorage act as a residual source of government revenue.

- Finding the relationship between trend growth in output and seigniorage. A negative relationship between trend growth in output and seigniorage also indicates that seigniorage acts as a residual source of revenue

- Finding the relationship between inflation and the tax rate. A negative relationship, strengthens the argument that seigniorage is used as a residual source of revenue

2. .To determine the relationship between seignior-age as a source of revenue and how it impacts on the level of the nominal interest rate level in the long run by:

- Finding the relationship between inflation rate and seigniorage. A positive relationship means that the use of seigniorage increases the level of inflation rate. • Finding the relationship between expected inflation and nominal interest rate. If seigniorage IS used as residual revenue, then in the long run, seigniorage and hence inflation and nominal interest rate will reduce as the economy grows. A positive relationship between inflation and nominal interest rate means that in the long run, seigniorage impacts on the nominal interest rate.

1.4 Hypothesis Testing

The study tests the following null hypotheses against their respective alternatives

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- There is a positive relationship between seigniorage and transitory increases in output.

- There is a positive relationship between transitory increases in output and current government spending.

- There is a negative relationship between seigniorage and trend growth in output.

- There is a negative relationship between the tax rate and inflation rate.

- There is a positive relationship between inflation and seigniorage.

- Expected inflation and nominal interest rate are cointegrated.

The first four hypotheses together help test the general hypothesis that: Seigniorage is used as residual revenue in Ghana. The last two hypotheses test the general hypothesis that: Seigniorage affects the level of the nominal interest rate in the long run.

1.4 Significance of the Study

High interest rates reduce the incentive to invest, slow down industrial growth and consequently lead to slower economic growth. High interest rate increases the cost of production. Forward shifting of higfiêF cost of prodúõÑÇffllead to increased prices. A reactionary policy to reduce interest rates, avoid higher prices, and help ameliorate the dampening aggregate demand may call for increased money supply from the monetary authorities which will cause inflation. In simple terms, higher interest rate causes inflation.

The various interest rates in Ghana including the interbank rates, the lending and deposit rate, Treasury bill rate and the bond rates are all related by the fact that they reflect the policy rate which is fixed on inflationary expectations. Among the principal causes of higher interest rates in Ghana is government revenue needs. We provide in this study a framework to deepen citizens understanding on how expected inflation inherent in revenue needs via seigniorage affects nominal interest rate.

The study also takes full cognizance of the cost of inflation. Inflation widens the gap between the returns on money and other assets. The continued conversion of money to other assets cannot be justified because it costs little to produce money. Inflation results in a situation where nominal prices and wages must be changed more often or the adoption of an indexing scheme. Inflation could raise the effective tax on capital income. Such distortions can lead to the substitution of less economic viable activities where taxes are low for more productive ones where taxes are high. Inflation can cause households and firms which normally do their planning in nominal terms to make large errors in saving for their retirement, in assessing the real burdens of mortgages, or in making long term investments.

When inflation is variable and unexpected, it distorts the efficient functioning of the market system. It causes variations in prices for different firms due to the friction in price adjustment. There is an increased price departure and such price variability due to inflation disturbs long term relationships among maÿets-fer-firms and customers where frequent price adjustment is not needed. For example, workers may press for premature renegotiation of their contracts, forms may incur additional costs of changing prices and individual may be forced to engage in additional transactions in order not to lose their worth of their liquidity. Since many assets are denominated in nominal terms, unanticipated inflation changes causes redistribution of wealth.

Reestablishing the original distribution of wealth may require the use of distortionary taxes or subsidies. Increased uncertainty about inflation may make firms and individuals reluctant to undertake investment projects especially long term investment. The argument is that higher inflation may feed into the perception that government is operating bad policies and may resort to confiscatory taxes in future to pay its debt. Empirical evidence abounds that inflation and investment are negatively related. The literature also provides large body of empirical evidence of a negative relationship between inflation and growth of output.

It has been widely recognized by many economists including Romer (1996), and Cagan (1956) that the underlying cause of most episodes of high inflation is government's need of seigniorage. Bailey (1956) found that, even under very restrictive assumptions that inflation is fully anticipated, the welfare costs of inflation finance is huge. After incorporating growth into the inflation finance thesis, Mundell (1965) finds that even under very rapid inflation, one can hardly add less than 1.5% to the growth rate. Marty (1967) found that if we add the growth effect to the measurement of inflation finance, it does not reduce the welfare cost of inflation and one has no case using inflation tax as a financing tool.

This study provides a framework to understand how the failure to ensure discipline in the expenditure path at government Ministries, Departments and Agencies during such times when the economy experiences transitory increases in output can impact on inflation and hence on nominal interest rate which will plunge the economy into the complications discussed above. The study also makes a case for strictly monitoring the fiscal decentralization programme at the local government level to maintain discipline in their expenditure. The study provides evidence that, those policies that promote sustainable growth of output with the intent of increasing the tax base reduces the welfare cost associated with financing government expenditure from seigniorage.

These provide the justification of this study.

1.5   Organization of the study

The study is organized into five main chapters. Chapter one gives the background to the study. It also states the problem, objectives and the hypotheses to be tested as well as the significance of the study. Chapter two discusses the theoretical and empirical literature on the optimal use of seigniorage. We also discussed the empirical literature on the relationship between inflation and the nominal interest rate as contained in the Fisher relation. Chapter three discusses the methodology used for the study whiles chapter four analyzes the results. Finally, chapter five contains a summary, conclusion and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

Introduction

This chapter reviews both the theoretical and empirical literature on the efficient use of seigniorage. Fishers' equation which is another strand of the argument in this study will also receive attention in this chapter. The former literature review will help deepen our understanding on the existing knowledge on the efficient use of seigniorage while the latter enriches this study by bringing to fore

the work done by others on the relationship between expected inflation and nominal interest rate. The literature review will be organized as follows; section 2.1 will review some theoretical models of optimal seigniorage. Section 2.2 will review the empirical studies of the theory of optimal seigniorage. In section 2.3, a snapshot of the Fisher's equation theory will be taken and we will follow briefly with a review of the empirical results of studies on the

Fisher's equation.

2.1 Theoretical Literature Review of Optimal Seigniorage

Mankiw (1987) was among the foremost to synchronize the ideas of of Barro (1979) and Phelps (1973) in his model as a way of harmonizing fiscal and monetary policies in his attempt to provide a comprehensive theory of optimal seigniorage. He examined the optimal intertemporal monetary and fiscal policy of3-gæernment.

Mankiw—assumes government expenditure to be exogenous. The model also assumes that government raises revenue from two main sources; taxes on output and seigniorage. Following Barro (1979) both ways of raising revenue cause deadweight losses and government chooses these variables (tax and seigniorage) to minimize the present value of these social losses which are assumed to be homogenous in output. However, the losses are convex in both the tax rate and inflation rate. Following Mundell (1965), he decomposed revenue raised from seigniorage into the part raised by inflation (inflation tax) and the part realized as a result of growth of the economy due to increased demand for money. The government seeks to minimize the expected present value of the social losses subject to the budget constraint and Mankiw follows the work of Hansen and Singleton (1982), Mankiw, Rotenberg and Summers (1985),to solve for the first order conditions

According to Mankiw, harmonizing the fiscal and monetary policies to meet the revenue needs of the government requires that three conditions are satisfied. The first is the intertemporal first order

condition that the marginal social cost of taxation should be equal in all periods. This reechoes the tax smoothing hypothesis a la Barro (1979, 1986). The second condition demands that the marginal social cost of inflation must be equal in all periods. Finally, the third condition expresses that the level of taxation moves together with inflation and hence nominal interest rate a la Fisher. This requires that the policymaker equates contemporaneously the marginal cost of raising revenue through inflation and direct taxation. Mankiw relaxes the assumption that real balances do not respond to the level of inflation. However, such emendation of the model generates almost similar testable implications as the former.

Poterba and Rotemberg, hereafter called P-R (1990) extended Mankiw's (1987) model to other developed countries. The thrust of the model was to analyze the budgetary implications of an optimizing government who chooses the level of taxes and inflation only for revenue purposes. They considered two cases. In the first case, they considered government behaviour characterized by a commitment to its inflation and tax target .The second scenario investigates .

government behaviour characterized by non-commitment to inflation and tax target. Government's objective is to minimize the expected total cost of raising revenue by taxes and seigniorage a la Barro (1979). Like Mankiw, P-R (1990) assumes that the cost of revenue is convex in the tax and seigniorage rate. According to the model, the government budget constraint evolves as a function of government debt which is a function of previous debt, previous nominal interest rate, previous and current money supply, government spending which is assumed to be exogenous and real income which depends on the tax rate. Nominal interest rate depends on anticipated inflation between current and future periods

In the commitment case, P-R (1990) considers a government who chooses the tax schedule which specifies payment as a function of past behaviour. This commitment may be as a result of time lags embedded in the legislating process in some countries. P-R realized that commitment from monetary authorities may be difficult but reputational effects may guide their activities in following an agreed upon policy path. To these extents, commitment with respect to tax and inflation can be possible

P-R (1990) modeled optimal policies with commitment by allowing the government which minimizes the social losses associated with taxes and seigniorage subject to the budget constraint defined as the evolution of government debt at time, to currently pick a contingency plan for tax rates and by choosing future money supplies, for prices in the next period. The contingency plan allows taxes_and-ffi-flation to depend on the future realizations of government spending and real income variables. Households also choose their money holdings after the government chooses the next period's taxes and inflation. In choosing the taxes and the rate of inflation for the next period, the government takes as given the end-of —period stock of government liabilities, defined as current government debt plus current money supply. The stock

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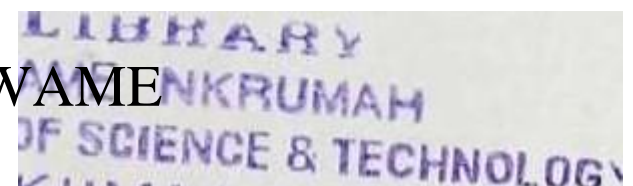
of liabilities is the only state variable for the government's problem, the sole channel through which policy choices in the current period affect future values of money demand, prices and output. The division of these liabilities between money and bonds however depends on the government decisions in the current period If we assume that end of period liability is constant and inflation between the current periods and the next future as well as taxes is changed, output will be affected in the next period and real demand for money and interest rates would be affected in the current period and such changes would leave government revenue needs unchanged. P-R, (1990) provides a more formal interpretation that a differential change in the next period tax rate that raises enough revenue to offset a change in inflation for a an exogenous level of government liabilities at the end of the next period gives a revenue constraint such that a government minimizing the social losses will choose the tax rates and inflation rates to satisfy the first order condition which equates the excess burden for each of the revenue sources with the implication that positive shocks to government spending that raise taxes and their associated excess burden should correspond with increases in inflation that raise the marginal excess burden from seigniorage. More so, it implies that inflation between the current period and the next period is increasing in the current money supply to next period output ratio

According to P-R model, when commitment is impossible, the government can only choose both the tax rate and the price level currently. The only state variable when taxes and the price level are chosen is the total beginning period level of liabilities, defined as previous debt plus previous money supply. This being the case, the government then choúšvoth the tax rate and the nominal balances and these in turn determine the interest rates and the price level At the policy optimum without commitment, the government must be indifferent to small disturbances inthe policy mix which leave, next periods beginning of period stock of

government liabilities, unchanged. Any differential change in the tax rate or inflation rate gives a revenue constraint such that minimizing the social losses subject to this revenue constraint gives a first order condition which shows that inflation is a positive function of both taxes and government liabilities as a percentage of GNP. Similar to the commitment case when high deadweight burdens are being imposed with the tax instrument, higher inflation taxes will also be appropriate. The model's testable implication either when government is committed or not is that inflation covary positively with taxes, a conclusion analogous to Mankiw's (1987) conclusion

Goff and Toma (1993) hereafter to be referred to as G-T sought to incorporate institutional factors into the theory of optimal seigniorage because they realized that earlier theories make the implicit assumptions that: The monetary authority has control over money creation, money is produced at zero cost, and all the money produced is sent to the treasury. The work of Klein and Neuman (1991) suggest that in many countries the size of seigniorage that goes to the treasury from the central bank may differ significantly based on institutional factors which influence the cost of operating the central bank. G-T model was built to illustrate that, taking on board the money production costs, optimal seigniorage may not always predict perfectly well a positive comovement in the tax rate and inflation rate. High money production costs along with the requirement that the money branch of government self-finance its operation can alter the connection between the two tax rates. For example, they wanted to know what would be the implication for optimal seigniorage in a situation where the monetary authority may confrõexternal constraints on its ability to exercise policy discretion. The theory provides that to ensure the positive comovements in tax rates and interest rates, then the necessary conditions are that the monetary authority must control the tax on money in which case a gold standard cannot be in place. Also there should be no self-financing constraint binding on the monetary authority. These two conditions will ensure that tax rates will commove positively with the interest rate or the level of inflation. But they recognized that even though the gold standard was no longer in place with the creation of the federal reserve bank, there was some connection of the US economy to gold and this constituted a constraint

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to long term money growth. Furthermore, Mankiw and Miron (1986) and Barsky (1987) found that events occurring after the fall in the gold standard brought the time series of inflation and nominal interest rates to approximately random walk whereas they were stable before 1914. For Mankiw and Miron, the shift was due to the Federal Reserve monetary policy discretion. G-T used Mankiw and Miron (1986) conclusion as a rationale to model the worldwide gold standard and the Federal Reserve banking as two different monetary regimes. The underlying reason was to trace whether tax rates commove positively with interest rates as the theory of optimal seigniorage seems to suggest under these two regimes.

They allowed for the possibility of collection cost in contrast to traditional paradigm that collection cost is zero. Exploiting the idea of Slemrod (1990) and Meyer (1990), they built an analogy for tax collection cost in which the collection cost is a function of tax rate on money as well as the tax base and specified a revenue function net of money production cost. They also utilized the ideas of Mankiw (1987), Trehan and Walsh (1990), Poterba and Rotemberg (1990) as guides for specifying the losses associated with the collection of government revenue made up of seigniorage and tax on output. Minimizing these losses subject to the government revenue requirement, G-T provides a gold standard solution and central bank solution.

To differentiate gold standard solution from the central bank's, G-T assume a given money supply and hence expected inflation and thereby eliminates the nominal interest rate as a control device such that at a given nominal interest rate and seigniorage, the task of the government would be reduced to choosing the income tax rates that reduces the distortions associated with such taxes for the current and future period for a given intertemporal budget constraint. The optimizing problem gives two first order conditions that expresses Barro's (1979) random walk property of taxes on output for zero expected output growth rate. In the second first order condition, a permanent increase in real and nominal interest rates would require significant decreases in current and future

tax rates to ensure an intertemporal budget balance. But under the assumption of constant interest rates, with regard to the long run budget problem, the difference between the current real rate and the expected future real rates is not new information and hence the government need not plan significant changes in present or future tax rates and approximately, one concludes that there should be no correlation between interest rates and tax rates.

On the central bank solution, G-T assumes that the government can make decisions both on the tax rate on output and on money. In the basic model G-T assumes that the treasury funding is provided by taxes on income taxes and central bank transfers remaining after the dayto-day operation funds of the central bank. The central bank can use the fund for both its monetary and regulatory capacity. They noted that the central bank uses its funds to replace worn-out currency, for dividend payments on central bank equity, for periodic examinations of the balance sheets ofprivate banks, to provide check-clearing services for member banks, rent on central bank buildings, for transfers to _____ central bank surplus account and for insuring that member banks satisfy reserve requirement. Some of these outlays vary with the level of seigniorage collected and was labeled as variable costs by G-T. Examples are replacement of currency and check clearing services. Others like-rent payments occur irrespective of seigniorage revenue and are considered as fixed cost. With control over both income tax rate and the interest rate, the government minimization problem results in the intratemporal condition that shocks to government spending that raise taxes and the excess marginal burden of taxes induce the central bank to increase the interest rate (inflation rate) if we assume that there are no variable cost of the central bank. On the other hand, G-T provides a case where the central bank faces a selffinancing constraint. A self-financing constraint imposes the restriction that the central banks transfer ratio is nonnegative. The transfer ratio is defined as the ratio of seigniorage collected to the real interest rate times real money. If the government seeks to minimize the distortionary cost associated with raising the two taxes subject to its revenue and the additional constraint that its transfer ratio is nonnegative, such minimization problem result that for any positive shock to government funding needs, government

is constrained to raise revenue only from tax rates because the interest rate is already high. Conversely, the central bank has to increase interest rate in response to higher fixed cost. This implies that, if self-financing constraint is binding, the connection between tax rates and interest rate will be severed and higher tax rates may not necessarily call for higher seigniorage and hence higher inflation

Aizenman (1992) in an attempt to explain the optimal use of seigniorage modeled the budget decision making as a decentralized process. He noted that in most countries, the budget decision making is a bargaining process between different interest groups. Some of these interest groups according toThem are provinces in a country, defense establishment, the bureaucracy, the agricultural sector, the labour unions, and representatives of the people. He even equated the decenfrûlization thesis to situations where it is impossible to impose discipline on the various ministries. The model major proposition is that these agents can raise revenue in such manner as to minimize the distortions (from taxes) associated with financing a given government

expenditure if they are to follow a socially optimal path. But if there exists a residual means of financing a given government expenditure which can be adjusted to meet the budget constraint and whose burden falls equally on the agents, then a chasm will be created between decentralized decision making and socially optimal policy. To the extent that the burden of the use of the residual means of financing falls on all players nondiscriminatory, agents will not take this into account in 'their taxes' and an externality would result which would lead to heavy reliance on the residual means of financing. He recognized that an example of such residual means of financing government expenditure is seigniorage.

Andrabi (1997) on the other hand extended this static game model to a simple dynamic model and sought to characterize the cooperative tax-seigniorage mix that may result from the

agent's actions by assuming that these agents can commit to a particular policy for an indefinite period. He found that the stochastic nature of output in terms of its growth rate, its fluctuations in current income as well as the covariation of output with government expenditure determine greatly the extent to which this cooperative tax-seigniorage mix can be maintained and hence the degree of inefficiency associated with the use of seigniorage. He sets the cooperative level such that the gains from future cooperation are greater than the static incentive to deviate and agents will cooperate because they fear the threat of other players reverting to the static Nash equilibrium where distortions associated with seigniorage are greater. In other words, players fear that if they deviate to paying lower taxes, the corresponding cost which is seigniorage and the further distortion associated with seigniorage goes up. Therefore, if current output increases relative to future output such that players expect future output to remain unchanged, their tax base increases and this threaten the cooperative equilibrium as players may deviate. Given the high cost associated with this deviation in terms of seigniorage and its distortions, the central bank maintains the cooperative level of current period tax by increasing the level of seigniorage. He derived that the testable implication of the model is that there is a positive relationship between seigniorage and transitory output. Also to the extent that future growth in output increases the punishment of current noncooperation by players, he derived that trend growth in output should decrease the use of seigniorage. This implies economies that achieve higher growth should use less seigniorage to finance government expenditure. He also derived that if as current output is increasing, current government is also increasing, then the level of the cooperative tax and hence cooperative seigniorage will be increasing to finance government expenditure. He derived the testable implication that a covariation of current government expenditure and transitory output strengthens the positive relationship between seigniorage and transitory output.

Major Testable Implications of the Model in the Case of the Ghanaian Economy

Over the years, the Ghanaian economy has significantly recorded budget deficits. This has largely been attributed to the failure of government to follow its expenditure path and also raised the

required revenue from taxes. The major cause of the deficit stems from the inability of various ministries, departments and agencies to stay within their budgetary allocations as well as the inability of the economy to meet its revenue target. This is the political weakness espoused by the decentralization theory which may push government to finance its excess expenditure from seigniorage and hence the decentralization theory and its testable implications by Andrabi (1997) can be alluded to and extended to the Ghanaian economy.

Every economy committed to its inflationary and growth path has inherent tax systems that help the economy to maximize revenue. For 'normal' periods, an economy committed to its growth target will follow this optimal path to avoid the distortions associated with financing government expenditure from other sources such as seigniorage. In these normal periods, the government will be committed to its tax rates (Poterba and Rotemberg, 1992). In the long run, it can plan and acquire the necessary legislative backing to vary the tax rate consistently with the growth of the economy and expenditure needs to create minimal distortions on the economy. Therefore in the long run, if the economy shows appreciable growth and tax revenue significantly improves, the use of other residual sources of revenue such as seigniorage should significantly reduce. This reasoning is in line with the predictions of Andrabi (1992) model that trend growth in output is negatively associated with seigniorage. The testable implication of this position is that trend growth in output is negatively associated with seigniorage.

To the extent that trend growth in output reduces the use of seigniorage, given the positive relationship between inflation and seigniorage, if the Fisher relation holds, one can infer that in the long run, nominal interest rate must fall to reflect the fall in inflationary expectations associated with trend growth in output which reduces the use of seigniorage The testable implication of this inference is that nominal interest rate and expected inflation is cointegrated.

Also, if the growth in the economy results in higher tax bases necessary to finance government expenditure, he must reduce his use of other sources of residual revenue which cause more distortions. Hence, we can infer in contrast to Mankiw (1987) that in the long run tax rates should move negativelyvith ingat10*¥-çate-if the economy uses seigniorage as a residual source of revenue.

All economies encounter recessions and booms due to the inherent business cycle. Such booms and recessions cause the economy to deviate from the trend. One theory that has gained an increasing popularity in developing countries such as Ghana is the political business cycle. According to the political business cycle, the economy largely deviates from its trend due to election cycles. During such times, various economic activities pick up as politicians start their campaign activities and increase their expenditure on wide range of economic activities, including the free distribution of money. The economy experiences what is akin to a boom. Most businesses experience major boost in their operations. The aggregate demand curve shifts to the right causing increased income, higher demand for money and hence higher prices.. Another period in which the economy may experience a boom is the period in which the economy experiences good terms of trade. During such periods, prices of commodities such as cocoa and gold receive appreciable increases and a lot of confidence is injected into the economy. Indeed, Haltiwanger and Harrington (1991) confirmed in their study that the gain from deviating from a collusive agreement is greatest during booms, but, firms still find it very difficult to collude during recessions because during such times the amount of profit that is sacrificed from inducing a price war is relatively low though. It follows logically that firms set prices higher during booms than during recessions Also, in his bid to win the election, government intensifies his scope of operations in the economy to win the confidence of the people. To this end, most Ministries, Departments and Agencies are likely to overspend their budgetary allocations to meet the expectations of their constituents. But such times are too short for the government to vary taxes to raise the required revenue for this short spurt in increased expenditure and the Treasury could rely on the centi7áŸ bank to fiúãifiß—excess expenditure through debt monetization The combined effect from the reactions from the boom and subsequent government expenditure

increases money demand and supply and results in taxing the economy with inflation.. This reasoning is also in line with the prediction of Andrabi (1992) model that transitory output increases covary positively with seigniorage. His assertion that such relationship is strengthened by the positive covariation of current government expenditure and transitory output increases is validated by the political business cycle. The testable implication of this inference which is also consistent with standard theory such as Andrabi (1992) is that there is a positive relationship between seigniorage and transitory increases in output if seigniorage is used as residual revenue.

2.2 Empirical Literature Review of Optimal Seigniorage

Following the work of Trehan and Walsh (1990) and Roubini (1991), Asworth and Evans (1998) hereafter called A-E, extended the revenue smoothing hypothesis to 32 developing countries. The main premise of the argument was that much as seigniorage constitutes an important source of revenue in developing countries, government in these countries may not follow optimal policy path as espoused by the theory and that other consideration other than optimal behavior may explain the huge reliance on seigniorage.

Their study used three main variables to test for the tax-smoothing hypothesis. The key time series variables which constituted the base of their study was the log of the average tax rate, the rate of inflation and the log of money velocity. The core of their study was to find out if these variables were stationary or non-stationary. Their study sought to defy the notion that money has constant velocity as espoused in the work of Roubini (1991). They argued that if one finds that all the variables are I (1), then evidence of cointegration between any pair of variables is enough to make void the evidence of exteúGÇRoothing hypothesis. According to them, if one finds

a cointggrating relationship between the tax rate and inflation rate on the assumption of a constant velocity of money, any inference on the tax smoothing hypothesis would be misleading .Citing Evans and Amey (1996), according to them where a cointegrating vector is found, it will take the following

form $\ln T_t = a_o + (\beta/a)\pi_t + (1/a)\ln(y/m)_t$, where Π_t is the inflation rate, T_t is the tax rate and (y/m) is the velocity of money. They argue that in addition to a unique cointegrating vector, the estimated coefficients on the three variables must be of the correct sign and size to be consistent with the tax smoothing hypothesis. By normalizing the tax rate, the parameters on inflation(β/a) and velocity ($1/a$) must be positive and lie between 1 and

O.These parametric restrictions are necessary to ensure that the marginal distortionary costs associated with the two forms of revenue are convex in both the inflation rate and the tax rate .

Using countries from Africa, Asia and the Western Hemisphere, and following Dickey-Fuller, they found that in first difference form, all the three variables were stationary. They proceeded to test the cointegrating relationship between the three variables and found that in most cases, there is no evidence of a unique cointegrating vector except in five cases. Even in these countries when the parametric restrictions were applied, the study found that they do not stand the test of cointegration and hence the tax smoothing hypothesis.

A-E therefore concluded that, for the 32 developing countries sampled, there were no evidence of tax smoothing hypothesis and that tax smoothing elements have not been significant in determining the behavior of seigniorage in these countries.

Saadi-Sedik (2003) sought to extend optimal monetary and fiscal policies to developing countries. Three main variables were examined (seigniorage, tax revenue and public spending). He imposed on each country to have at least 20 observations and found that only forty countries satisfy this criterion and tested the revenue smoothing hypothesis on the forty countries but extended the analysis to 112 countries to test for the revenue smoothing hypothesis. Following Grilli (1989) and Trehan and Walsh (1990), revenue smoothing hypothesis as already explained implies that the variables are cointegrated. Notably, the existence of a unit root is a necessary but not a sufficient condition of the tax smoothing hypothesis.

He used a panel unit root test developed by Fisher (1932) and proposed by Maddala and Wu (1999) and Choi (2001). The test is non-parametric and may be combined for any arbitrary choice unit root test. The test can be used for unit root or cointegration hypothesis. He rejected the null hypothesis of unit for most of the countries on seigniorage. The Maddala and Wu (MW) test is explosive and therefore rejects the null hypothesis of unit root. He also conducted an individual unit root for inflation tax and found that for most countries the variable is stationary. The MW test rejects the null hypothesis of unit root nonstationarity which connotes that inflation tax and government spending is not cointegrated.

In testing the Phelps hypothesis, following Mankiw (1987), he captured cross national variation into the efficiency of the system of taxation. His methodology was

$$S_{i,t} = aX_{i,t} + e_{i,t}$$

Where St is the seigniorage,Xt is a set of control variables including the variable that reflects the theory of optimal seigniorage, r represents asset of unobserved time —invariant country-specific effects,e is the error term and the subscript i and t represent country and time periods respectively. Tahir used urban population a percentage of total population, the size of the country, per capita GDP, trade openness and institutional constraints that limit money creation as control variables to reflect partially the efficiency of the tax system and administration. This was a major recommendation Mankiw made to those who would want to extend the theory to other countries.

Using forty countries and three sub-periods each of ten years, Tahir found a significant positive relationship between public spending and inflation tax. He found that an increase in public spending by one percentage point increases inflation tax by the same one percentage point. For the relationship between tax revenue and inflation tax, he employed the Generalized-Method- of Moment to control for unobserved country specific effects and potential endogeneity of the explanatory variables. He found that tax revenue was significantly positively related to inflation tax. Specifically, an increase

in GDP by one percentage point is associated with an approximately one percentage point increase in inflation tax revenue.

Mankiw (1987) was among the foremost researchers to test for the theory of optimal seigniorage after his breakthrough on the extension of the work of Phelps and Barro in which he derived three main testable implications in his paper the optimal collection of seigniorage. In line with this, Mankiw goal was to test the theory that overtime, higher tax rates are associated with higher inflation rates and hence higher nominal interest rates. Mankiw used three main nominal variables: The nominal three month Treasury bill rate INT. For average tax rate, he used the Federal government receipts as a percentage of GDP. For inflation he used the percentage change in the CPI (all urban consumers) from December to December INF.

Mankiw estimated several regressions; in levels, difference, in log form, and even in the second difference form. He also used the first difference filter. He found that the relationship between the nominal interest the»rage-taxrate was significantly positive. The study revealed also that there is a significant positive relationship between the tax rate and inflation in line with the prediction of the theory.

He tested for sub-sample stability to ensure the robustness of the results by breaking the data into two. This according to Mankiw should account for the macroeconomic volatilities, the frequent supply shocks, and a slowdown of productivity and hence a breakdown of many empirical macroeconomic variables which characterized the US economy in1969. For both samples Mankiw's results show a significant positive relationship between the nominal interest rate and tax rate.

Poterba and Rotemberg (1990) hereafter called P-R sought to evaluate the empirical implications of their model by examining the relationship between taxes and inflation in several nations including the USA, France, Germany, Britain and Japan over several time periods.

In line with their theory, they fitted different regressions for both cases where commitment is valid or not valid. In the case where commitment is possible, and where government can tax outstanding liabilities without resorting to inflation, they estimate the first order condition implied by the government optimization by relaxing. Mankiw's assumption of constant velocity of money. Assuming a constant elasticity function and therefore using a generalized version of the CES welfare function, they specified the functional form for tax rate and inflation (deflation) as well as their associated deadweight losses and estimated the corresponding function using OLS. For the US economy, they analyze the time series evidence by using two measures of tax rate; the first being the ratio of federal government receipts to GNP and the second was the weighted average marginal tax rate on labour income computed by Barro and Sahasakul (1986). Using a variety of different time periods, they found that for the US economy, there is always a positive relationship between the tax rate and the rate of inflation and they noted that these results strengthen Mankiws (1987) conclusion.

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They however noted that the results do not generalize for other nations in the study. For France and Britain they found a significantly negative relationship between inflation and taxes. For Germany, the relationship was positive but not significant. However, they found that the evidence appears to support that of Japan

To ensure robustness for their model, they considered a situation where the government cannot commit or cannot tax outstanding debt without resorting to inflation. They reported that with this functional specification, the evidence stands unaltered. Specifically, they report a significant positive relationship between inflation and the tax rate for Japan and the USA, a significant negative relationship for France and Britain and a positive but insignificant relationship between inflation and the tax rate for Germany. They concluded that it may not generalize that in their (government) attempt to raise revenue, optimal consideration will allow the inflation rate to commove positively with the inflation rate as government objective on inflation changes overtime and also political instabilities may feed into higher inflation expectations.

2.4. Empirical Literature Review on Fisher's Equation

Fisher's theory that nominal interest rate is the sum of a constant and expected inflation has received mixed results empirically. Typically the estimated coefficient on expected inflation has substantially been less than one especially if tax considerations are excluded.

Rose (1988) cited byCrowder and Hoffman (1996) analyzing the time series used a univariate approach to analyze the unit root representation of the two variables involved. He found that whereas interest rate possesses a unit root, inflation rate does not and that any regression of inflation on interest rate would be spurious and this rejects the Fisher equation.

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Mishkin (1992) applied the Engle and Granger (1987) methodology to test for the cointegration relationship between interest rates and inflation. Mishkin finds a long run relationship between interest rate and inflation in line with fisher's hypothesis

But using DOLS (dynamic least square) estimator to estimate the long run response of nominal interest rate to inflation Evans and Lewis (1995) observed a less than unity expected inflation coefficients to the changing dynamics of inflation over the sample. Early on, using post war US data they found a cointegrating relationship between nominal interest and inflation. They contended that the DOLS results failed because inflation is characterized by a Markov switching process and this generates a downward bias in a long run coefficient as evidenced by a Monte Carlo experiment. They concluded that, once one recognizes that agents have been forced to form expectations from an inflation process which has undergone several structural changes in the postwar period, then the fisher hypothesis is consistent with the post war data and the only reason their result failed with the DOLS may be attributed to a small sample bias.

Riding on the work of Mishkin (1992), Evans and Lewis (1995), Crowder and Hoffman (1996) used the cointegration technique a la Johansen (1988) to test for the cointegrating relationship between interest rate and inflation. They found a long run Fisher relation in which nominal interest rates fully respond to movements in inflation even after allowing for changes in the marginal tax rates. Using the generalized version of Fisher's equation

$$it(1 - Tt) = rt + tApt+1 + 0.5VartApt+1 - \gamma Cov_t(\Delta c_{t+1}, \Delta p_{t+1})$$

Where pt is the price level in period t , Ctis the level of consumption in period t and Et is the expectations operator conditional on information available in period t Lowercase letters denote

natural logs of prices and consumption and it and rtare the continuously compounded nominal and real rates of interest respectively. Also y represents the coefficient of relative risk aversion

The generalized form of the Fisher equation is derived from a representative household that maximizes periodic utility subject to intertemporal budget constraint. The utility function is assumed to be a hyperbolic absolute risk aversion type and that expected consumption growth and expected inflation are jointly log normally distributed and consistent with rational expectations. The above relation says that the after tax nominal interest rate relates positively with the real rate and expected inflation per Fisher's theory.

Using the three month Treasury bill and annualized log changes in prices as proxy for nominal interest rate and expected inflation respectively and quarterly data from 1952 to 1991, they could not reject a unit root in the nominal interest and inflation. They also tested for cointegration relationship (given the nonstationarities that characterizes the data) under three alternative specifications for the deterministic components of the system using a lag length of four in the autoregressive specification. They found an evidence of a cointegrating vector between the nominal interest rate and inflation. They found that in the long run, nominal interest rate increases by a factor of about 1.35 due to a one unit increase inflation. They realized that, the results were robust across the different deterministic trend specifications.

To account for the effect of time varying average marginal tax rate on the Fisher equilibrium, they conducted the cointegration analysis using a tax- adjusted nominal interest rate and still found a—cointegrating vector. They found the coefficient on inflation to be insignificantly different from unity

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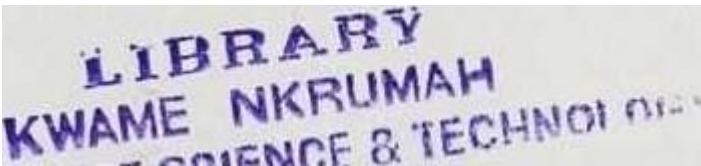
The standard cointegration analysis assumes that the variables are integrated of order one and that the linear combinations are stationary and therefore restricts the error correction term to a 1(0) which is stationary. But the error correction model may respond to shocks more slowly than anticipated in the conventional cointegration.This implies that the equilibrium errors might be fractionally integrated and may not be stationary.

It was within this paradigm of thinking that Kasman,Kasman and Turgutlu (2006) sought to analyze the long run Fishers equation. They recognized that applying unit root tests that limit the differencing parameter to integer value could be misleading because such tests cannot identify the long memory process. They therefore relaxed this assumption and basically used the concept Of fractional cointegration for their analysis. Fractional cointegration can distinguish between cases in which the equilibrium errors are non mean reverting and mean reverting but exhibiting significant persistence in the short run. The existence of fractional cointegration implies that the system of economic series may randomly walk away from equilibrium for long episodes but finally return. They applied the fractional cointegrating technique to 33 countries. They found that, with the conventional cointegration approach, the residuals from only five countries shows stationarity. However, they noted that, the stationarity of the error term is supported by fractional cointegration for vast majority of the countries. Their results show that there is a long run stable relation between nominal interest rates and inflation and these results validated Fisher's hypothesis. What is noteworthy about their findings is that in addition to the validity of the Fishers equation, the equilibrium errors display long memory and these deviations from the long run relattöffbetween nominal interest rates and inflation take a long time to disappear and return to their equilibrium relationship.

CHAPTER THREE

METHODOLOGY

This chapter explains the empirical paradigm within which this study is conducted. The work in the chapter is conducted in three sections. Section 3.1 presents the model specification and the empirical strategy of the study. Section 3.2 attempts to define the variables used in the study and explain how these variables are measured. In section 3.3, a unit root test description of the variables is considered.

3.1 Model Specification and Empirical Strategy

The objective of this study is to broaden our understanding on the optimal use of seigniorage in Ghana and the connection between this path of the use of seigniorage and the level of nominal interest rate. To establish this nexus, we follow the theoretical contribution by Andrabi (1997) and estimate five empirically implications/relationships. These five relationships together help to establish the optimal path followed by the government of Ghana in the use of seigniorage and how this path impinges on the nominal interest rate level in the long run. The first three relations specifically help to determine whether seigniorage is used as a residual source of revenue. First, we estimate the relationship between seigniorage and transitory output. A possible comovement between transitory output and current government spending is expected to strengthen the relationship between sei@niorage and transito output. We therefore augment the baseline model with current government expenditure. The second testable proposition of Andrabi (1997) model is that seigniorage depends negatively on the trend growth of output. Thus as the economy grows over time, the use of money to finance government spending tends to decline.

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Having established the causal linkages between seigniorage on one hand and transitory component of output and trend on the other hand, we tum to the examination of the relationship between seigniorage as a means of public finance and inflation. Invoking the Friedman proposition that

inflation is always and everywhere a monetary phenomenon, we expect inflation to depend positively on seigniorage. Also, if seigniorage is negatively associated with trend output growth and positively associated with inflation, then in the long run as output grows and the tax base widens, the use of seigniorage declines. We expect the tax rate to be negatively associated with inflation in contrasts with Mankiw (1987) view that inflation should be positively related to the tax rate. Finally, we examine the relationship between inflation and nominal interest rate. Given that the real interest is stationary according to the Fisher hypothesis, inflation and nominal interest rate must exhibit a common stochastic trend (i.e. inflation and nominal interest rate must be cointegrated). We test for this relationship using the Engle-Granger two-step procedure to testing of cointegration relationships and where necessary the technique of fractional cointegration. In what follows in this section, we explicitly specify the econometric models for the above identified relationships.

3.1.1 Seigniorage and Transitory Output

Andrabi's (1997) model and our inference suggest that during booms, the use of seigniorage increases as a result of the increased demand for money due to higher output and perhaps higher government expenditure. The test>lmplæation of this is that seigniorage covaries positively with transitory increases in output. This study will therefore estimate the model:

$$Seig_t = ß_o + ß_1 Cycoupt_t + E_t \tag{1}$$

Per our inference and in consistent with the model, we expect the coefficient on Cycouptt to be positive because seigniorage must move in tandem with cyclical output. i.e. $ß_1 > 0$

3.1.2 Current government expenditure and transitory output

Our analysis predicts that a positive correlation between transitory output and current government spending will strengthen the positive relationship between seigniorage and transitory output. This could be true because during booms, as demand for money increases, if government keeps his

expenditure high, it cannot legislate in the short run to increase taxes. He may finance his expenditure by debt monetization. Such action increases the level of seigniorage. We shall find the relationship between current government expenditure and cyclical output with the model:

$$AExpt = + \delta 1 Cycouptt + wt \qquad (2)$$

Since current government expenditure and cyclical output must be positively related, we expect the coefficient of cyclical output to be greater than zero. i.e. $61 > 0$

To capture the effect of current government spending on the relationship between transitory output and seigniorage to strengthen the position that indeed, seigniorage is used as residual revenue, the study will estimate model:

$$Seigt = bo-+ blCycouptt + b2AExpt + et \qquad (3)$$

The effect of using the first difference government expenditure is to remove the trend that may be present in government expenditure since we are interested in current government expenditure. Even when we condition the relationship between seigniorage and transitory increase in output

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on the covariation of seigniorage and current government expenditure, the study expects the coefficient on cyclical output to be positive. i.e. $bl > 0$

3.1.3 Seigniorage and Trend growth in Output

As the economy grows, government has enough fiscal space to legislate new taxes on its revenue trajectory bearing in mind the need to achieve minimum distortions in the economy. The use of

such residual source of revenue such as seigniorage should decline substantially. Therefore trend growth in output is negatively related to seigniorage. We estimate the model:

$$Seig_t = a_o + a_l \ Trendoupt_t + u_t \tag{4}$$

In this model, we expect the coefficient on Trend output to be negative. i.e. $a_l < 0$.

The first four equations together will help us to establish whether seigniorage is used as a residual source of revenue in Ghana.

3.1.4 Inflation and Seigniorage

Alluding to Friedman hypothesis that inflation is always and everywhere a monetary phenomenon, we expect the reliance on seigniorage to finance government revenue to generate inflation. To do this, we will estimate the model:

$$Inf_t = a_o + CISeig_t + V_t \tag{5}$$

If inflation is positively associated with seigniorage, then the coefficient on seigniorage should be positivúe.Œ1 > 0.

To the extent that inflation is positively associated with seigniorage, for a trend growth in output, the tax base widens and the use of seigniorage declines. This means that there should be a

negative relationship between the tax rate and inflation rate if seigniorage is used as residual revenue. We find this by estimating the model:

$$Inf_t = + 81Tax_t + E_t \qquad (6)$$

We expect the coefficient of Tax to be negative and therefore < 0.

Equation (6) tests Mankiw's proposition on the optimal use of seigniorage. If we find that seigniorage is used as a source of revenue in Ghana, then we do not expect any positive relationship between inflation and the tax rates. On the contrary, we would expect a negative relationship between the two variables. Equation (6) and the a priori expectations on the sign of the coefficient should lend more support to the proposition that seigniorage is used as a residual source of revenue in Ghana.

3.1.5 Inflation and Nominal Interest Rate

If trend growth in output should decrease the use of seigniorage, then expected inflation should decrease as well in the long run. This inference is congruent to the famous Fisher hypothesis that maintains that the nominal interest rate is the sum of the real interest rate and expected inflation. To test this empirically, we will find the cointegrating relationship between nominal interest rate and expected inflation. The Fisher relation can be stated as:

$$Nomint_t = y_0 + Y_1 Inf_e \qquad (7)$$

To estimate this relation empirically, we shall assume the hypothesis of rational expectations.

Expected inflation is split as the realized inflation and the deviations from what was expected. We will therefore estimate the model:

$$Nomint_t = Y_0 + Y_1 Inf_t + E_t \qquad (8)$$

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If Nomintt and Inft are each 1(1) but Et is 1(0), then equation (7) is a cointegrating equation which means that there is a long run relationship between nominal interest rate and inflation. The error term will only denote short term deviations from the long run equilibrium.

For the relationship between nominal interest rate and expected inflation, this study will first employ the Engle-Granger technique for cointegration. The conventional method for investigating unit root in time series are based on the autoregressive integrated moving average (ARIMA) p, d, q model which restricts the integrating parameter,d to either one or zero. Nonstatonarity is realized when d = 1 in the mean and stationarity is characterized by integrating parameter equal to zero in the mean. The implication of this is that, the autocorrelation function decays at a quick exponential rate.

The ARIMA process does not consider the alternative where the ACF falls slowly. To the extent that the equilibrium error can portray slow mean reversion, which is usually not considered by the traditional I (1), a general test for codomination such as fractional cointegration will be more apposite. The study will therefore employ the concept of fractional cointegration if the conventional method fails. Two integrated time series are called fractionally cointegrated, if there is a linear combination that is fractionally integrated. The linear combination may include an intercept or a time trend. An autoregressive fractionally integrated moving average

(ARFIMA) model allows the d to take a noninteger value. The implication of this is that the ARFIMA process haš-a long memory and deviates from its mean for a long time. A representative ARFIMA model is:

$$(1 - L)^d \emptyset(L) x_t = \theta(L) \varepsilon_t, t = 1,2, ...,T.$$

Where d is the fractional differentiation parameter,Ø is the autoregressive polynomial of order p and e is the moving average of order q.The roots of Ø(L)and 9(L) all lie outside the unit circle and

Et is a white noise. In fractional cointegration, we test the hypothesis of no cointegration with a test that is powerful against fractionally cointegrated alternatives.

In an ARFIMA process, the value of the differencing parameter d can be any real number. If —0.5 < d < 0.5, we have a covariance-stationary invertible process. All the autocorrelations are negative and tend hyperbolically toward zero when —0.5 < d < 0.This case also illustrates an antipersistent or an intermediate memory process. The autocorrelations are positive, decline hyperbolically, they are persistent and have a long memory if 0 < d < 0.5. Here, the ACF falls more slowly than an ACF in an ARIMA process. For 0.5 d < 1, although the process is mean reverting, the covariance is nonstationary.

In the literature, fractional cointegration can proceed in two ways. One way is to specify and estimate a full parametric model and proceed further to test for fractional cointegration as in Dueker and Starz (1997). The other way is to estimate the potential contegration via OLS and proceed further to test the residuals for a unit root with an appropriate semi parametric test. For the semi parametric test, we estimate only those parameters that determine the long run relationship in the model. This approach has been adopted by Cheung and Lai (1993) as well as Booth and Tse (1995). Dittman (1998) considers two classes of residual based tests for fractional Cointegration. He considers the classical residual based tests which though are not meant for fractionally cointegrated series have still proved consistent. They include the Philip-Peron t-test, the Philip-Peron rhe-test and the—augmenVŒDickey-Fuller test. The second test is based on a univariate long memory method. He identifies the modified rescaled range (MRR) by Lo (1991), the Geweke Porter-Hudak (1983) which estimates the differencing parameter from the residuals. The other method is the LM test proposed by Lobato and Robinson (1998). He proposed after simulation using Monte Carlo experiments that GPH test constitutes one of the most powerful tests of the hypothesis of no cointegration against its alternative of fractional cointegration. Fractional cointegration analysis

involves two steps. The study will first use OLS to estimate the equation (7). For the cointegration between the nominal interest rate, real interest and inflation rate, the study will first examine the stationary or otherwise for the series using the KPSS test. We shall use this test to complement the ADF test because the latter approach may have a low power stationary near-unit root processes since its null hypothesis is that a series contains a unit root unless there is strong evidence against it. But the null hypothesis of the KPSS is that a series is stationary. Both tests complement each other and provide a powerful test for stationary or otherwise of a series. A stationary series has significant ADF statistics and insignificant Kwiatkowski et al (1992) (KPSS) statistics.

To test the Fisher hypothesis, this study will proceed in two steps. The Engle and Granger (1987) cointegration test will first be performed. According to this approach, the cointegration between the two series is merited if the residual term is stationary. Here, the augmented Dickey-Fuller test will be used to test the stationary of the residuals from the cointegrating equation.

The conventional Engle and Granger method restrict the differencing parameter to 0 or 1.This assumption may be too restrictive and this study will take the next step to find out if the series are fractionally cointegrated. The traditional unit root tests such as the Dickey-Fuller tests may have low power against fractional alternatives. This view has been expressed by Diebold and Rudebusch (1991),And nd Dittmann (1998). By allowing for fractionally integrated equilibrium errors, it provides for a flexible and parsimonious way to model low frequency of dynamics of deviations from equilibrium, The residual series from equation 3.13 will be used to estimate the differencing parameter,d from the spectral equation following Geweke and Porter-Hudak (GPH) (1983).

The GPH makes use of the fact that the spectral density of Gt = (1 — L)et is given by

$$fG(0)) = Il - exp(-i\omega)|^{-2(d-1)}f_u(\omega)$$
$$-2(d-1)$$

$$= 2sin(\omega/2) \qquad f_u(w) \qquad\qquad (9)$$

Where ut is a stationary process and its spectral density. We can take a sample series of Gt of T,take logarithms of equation (8) and evaluate it at harmonic frequencies =

2 rtj/T,j = O, ...,T - I

This gives $n(f_G(\omega_j)) = n(f_u(0)) $— (d — 1)ln (4sin2(wj/2)) + In$\left(f_u(^{(\omega_j)}/f_u(0)\right)$

Adding   the periodogram at ordinate j to both sides, this yields

$$\text{Inl(WJ)} = \qquad - (d - 1)\text{ln } (4\text{sin2}(W/2)) + ^{ln(I(\omega_j)}$$

GPH suggest that d can be estimated by using the simple linear regression equation

$$\text{In } (I(wj)) = + \text{ßlln } (4\text{sin2}(wj/2)) + \text{et,j} = 1,2 \text{ n,et} = \text{In}^{I(\omega_j)/f_G}$$

GPH shared that the least squares estimates of provides a consistent estimate of 1 — d and hypothesis concerning the value of dcan be based on the t statistic of the regression coefficient

The estimated parameter will be ested under the null hypothesis,d = 1 against the alternative hypothesis-d-< Iwith the aid of the critical values provided by Dittmann (2000) using Monte Carlo simulations. When d < l,a mean reversion process results. In the spectral density function, the number of periodogram ordinates used to estimate d is based on the value of the power factor. The number of periodogram ordinates chosen has traditionally lied in the interval of 0.45-0.55 of the power factor. Hurvich et al (1998) recommended that the optimal order of the power factor to be used for determining the periodogram ordinates is 0.8. We will follow this advice in the study and estimate d accordingly.

3.2 Definition and Measurement of variables

The variables which will be used to test the empirical validity of the logical inferences that follow from Andrabi (1992) model for the Ghanaian economy include seigniorage, output, inflation,, government expenditure, tax rate. To test the Fisher's hypothesis, we shall use the nominal interest rate, real interest rate and inflation. The scope of the definition and the measurement of these variables is the object of this section.

Data Sources

Data on Average Tax Rate and Output are obtained from the Ghana Statistical Service. Nominal Interest rate, Money supply and Inflation were obtained from the Bank of Ghana. Data on Government expenditure was also obtained from the World Bank.

Output (Oupt)

Output will be measured as the annual real GDP of the economy.

Transitory/cyclical ("coupt) output and Trend output (Trendoupt)

In the study transitory output is used synonymously with cyclical output and both refer to the deviation of output from its trend. Three main output decomposition methods were used to obtain the cyclical and trend components of output. The methods include:

- Hodrick-Presscott decomposition,(HP)

- First Difference filter (Fdf)

- Trend deterministic decomposition (Dt)

The idea for employing the different decomposition methods is to build robustness into our study. The methodology for the different decomposition is discussed below:

Hodrick-Prescott Decomposition

If a time series yt is the sum of the a growth (trend) component gt and a transitory (cyclical) componentct: yt = gt + ct, V , t = 1, ...,T the growth component should be smooth and

Hodrick and Prescott recommended that such smoothness could be achieved if one minimizes

$$c_t^2 + \mu \sum_{t}^{T} [(g_t - g_{t-1}) - (g_{t-1} - g_{t-2})]^2 \tag{10}$$

The parameter is positive and the trend becomes smoother the larger the value of g Also, gtapproaches go + ßt if g which penalizes the variability is large enough. The squared second difference of the trend component is a very small term and therefore large changes in g influences the cyclical components only modestly. Hodrick-Prescott suggests that for quarterly data, g = 1600. For annual observations they suggestg = 100 , 400. Baxter and King (1999) also argue that if u = 10 for annual data, better results are generated. It has been argued however that the H-P decomposition has—sãðãuctuations and is less smooth relative to their counterparts such as the Phase Average Trend (PAT). This study will use annual data and report the results for g = 10, 100 and 400.

Deterministic Trend Decomposition

It represents macroeconomic time series as the sum of the deterministic trend and stochastic deviations treated as the residual cyclical component. In this study, output shows a simple linear growth path and we fit a linear trend (Trend) to the Oupt (output) as:

$$\text{Oupt} = a + b\text{Trend} + \qquad\qquad (11)$$

L is the lag operator and Et is a white innovation. The polynomial p(L) must satisfy the stationarity and invertibility conditions and the sum of autoregressive coefficients Pi in p(L) < 1. Zarnowitz and Ozyildirim (2003) noted that the cost of using a linear trend is that the deviations (cycles) from it contain indiscriminately all business-cycles, growth cycle and shorter irregular movements combined.

The First Difference Filter

Most series have unit root in their autoregressive representations. Difference stationary model would be needed if we fail to reject the unit root hypothesis. ARIMA is applied to reduce the series to stationary and hence replaces the assumptions that the series are stationary around their trends. In the difference stationary model, there is no trend. There is only a constant and a stationary and invertible ARIMA term. For equation, 3.6, if we assume that b = 0 implying that there is no trend Pi = 1 as implied by p(L) containing a unit root, then the first

difference leads and $\sum_{i=1}^{k}$ to:

$$\text{AOupt} = a + \text{Et} \qquad\qquad (12)$$

Government expenditure (Exp)

The study defines government expenditure as general government consumption expenditure. This includes government's purchases of current goods and services (labour, consumables, etc) and

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capital goods and services (i.e. public sector investment in roads schools, hospitals etc.). It also includes expenditure on national defense and security but excludes government military expenses.

Inflation (Inf) and Expected inflation (Infe)

Inflation will be measured as the percentage change in the consumer price index (CPI). Under the assumption of rational expectations (perfect foresight, Fama, 1975) actual inflation will be used as the long run proxy for expected inflation.

Money supply (M)

Money supply is defined in this study as the annual growth rate in the supply of broad money base, M2 , as a percentage of the gross domestic product.

Seigniorage (Seig)

Seigniorage is government revenue from issuing base money. The discussion in the study will be conducted in terms of seigniorage as a fraction of Output (Oupt). Andrabi (1997) notes that both seigniorage and revenue increase sim eously and therefore seigniorage/Output is more appropriate for testing the relationship between seigniorage and transitory output.

The total revenue from seigniorage as fraction of output is

$$\frac{\dot{M}}{Oupt} = \frac{\dot{M}}{M}\frac{M}{Oupt} = um \qquad (13)$$

is the growth rate of the money base and m is the money base over output.

Using the quantity theory of money

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$$\underline{\quad} = kOupt \qquad\qquad\qquad\qquad (14)$$

Where P isthe price level, k is the velocity of money assumed to be constant

Following Mundell (1966), this can be expressed in growth terms as:

$$\frac{M\ P\ o\mathring{a}pt}{M\ \text{-p oupt}} \qquad \frac{M\ P\ o\hat{u}pt}{M\ \text{-p oupt}} = (Inf + g) \qquad (15)$$

$$= \underline{Olipt} \qquad\qquad\qquad\qquad \text{output and} \longrightarrow \text{is the rate of growth of the price level}$$
denotes the growth rate in oupt

(inflation).

By combining equations (13) and (15), one obtains:

$$\underline{\qquad} = (Inf + g)m = Infm + gm \qquad\qquad (16)$$
$$Oupt$$

Seigniorage has two-major components; active seigniorage represented as Infm referred to as

the inflation tax and passive seigniorage denoted as gm. The latter reflects the increase in money

demand due to economic growth while the former tells the increase in money demand associated

with increased price level. Though the latter and the former do not have the same distortions and

for which reason inflation tax should be the prefered measure, this study, notwithstanding, will

follow Cagan (1956), Marty (1968), Friedman (1971), Fischer (1982), Barro (1982) Cukierman,

Edwards and Tabellini (1992), Click (1998), Haslag (1995), Andrabi (1997), Saadi-sedik (2003)

measure of seigniorage as the variation of the stock of the money base, during a given year as a

ratio of output.

Nominal interest rate (Nomint)

The Treasury bill rate will be used as the nominal interest rate. The study adopts this rate because it is the most risk free interest rate.

Average Tax Rate (Tax)

As a measure of the average tax rate, the study will use tax revenue as a percentage of Output. This is defined to include personal income tax, company tax, import tax, sales/VAT tax, excise tax etc.

3.3 Unit Root Test

If a process has a unit root, then it is a non-stationary time series. This means that the moments of the stochastic process depend on time. Often, ordinary least squares (OLS) is used to estimate the slope coefficient of the model. Use of OLS relies on the stochastic process being stationary. The conventional method for investigating unit root in time series are based on the autoregressive integrated moving average (ARIMA) p, d, q model which restricts the integrating

parameter,d to either one or zero. Nonstatonarity is realized when d = 1 in the mean and stationarityïs characterized by integrating parameter equal to zero in the mean. The implication of this is that, the autocorrelation function decays at a quick exponential rate.

The study will first examine the stationary or otherwise for the series using the KPSS test. We shall use this test to complement the ADF test because the latter approach may have a low power stationary near-unit root processes since its null hypothesis is that a series contains a unit root unless there is strong evidence against it. But the null hypothesis of the KPSS is that a series is stationary. Both tests complement each other and provide a powerful test for stationary or otherwise of a series. A stationary series has significant ADF statistics and insignificant Kwiatkowski et al (1992) (KPSS) statistics. To estimate the slope coefficients of the models specified above, this study will

first conduct a unit root test, whose null hypothesis is that a unit root is present. If that hypothesis is rejected, we will use OLS to estimate the models. When the stochastic process is non-stationary, the use of OLS can produce invalid estimates. Granger and Newbold (1974) called such estimates 'spurious regression' results: high R^2 values and high tratios yielding results with no economic meaning.
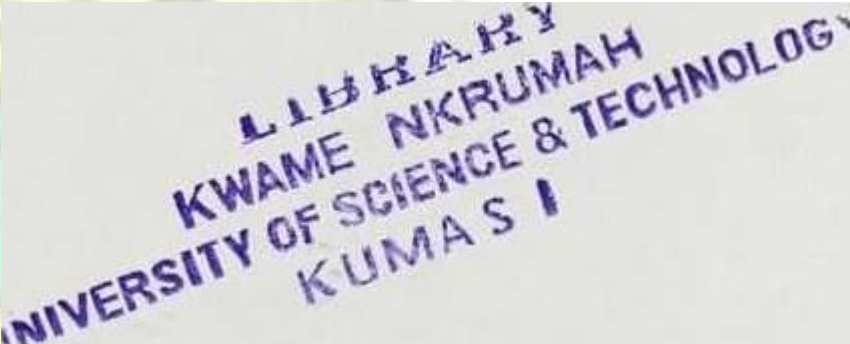
CHAPTER FOUR

ANALYSIS OF RESULTS

In this chapter, the results of the study is presented and analyzed. The chapter is divided into three sections. In section 4.1, the unit root analysis of the data used for the study is investigated and discussed. Section 4.2 estimates and discusses the various empirical models used for the study. In section 4.3, the relationship between nominal interest rate and inflation is discussed.

4.1: Unit Root Tests Analysis

The ADF and KPSS Tests were used to analyze the unit root characteristics of the variables used for the study. The null hypothesis of the ADF test is that the series is nonstationary against its alternative that it is stationary. The null hypothesis of the KPSS test is that the series is stationary. The lag length of the ADF test was based on the BIC criterion. For the KPSS, the lag truncation parameter is T 0•25 where T is the sample size. The results for the unit root tests are reported in Table 4.1.

All the variables are stationary in their first differences across both tests. There is overwhelming evidence that seigniorage, cyclical output and trend output are stationary in their levels. The unit root test for trend output indicates that all variables are stationary in their levels. In the table, we report only the result for trend output when the smoothing parameter is g = 100. Inflation and nominal interest rates-are not stationary-in-thêir levels but are stationary in their first differences.. The KPSS test provides evidence that the tax rate is stationary though this is not supported by the ADF test.

Table 4.1: Unit Root Tests

Variable	ADF				KPSS			
	Levels		FD		Levels		FD	
	C	C+T	C	C+T	NT	T	NT	T
SEIG	-3.532**	-3.501**	-6.00	-5.958	0.066***	0.066***	0.07	0.057
INF	-2.266	-3.193**	-4.877	-4.942	0.310***	0.108***	0.11	0.072
NOMINT	-1.857	-1.838	-6.107	-6.162	0.556*	0.169*	0.122	0.072
RINT	-2.057	-2.926	-6.013	-5.973	0.492*	0.0.107	0.108	0.083
TAX	-1.899	-2.371	-5.184	-5.107	0.508*	0.116***	0.093	0.084

NOMINT   -5.452**

NOMINT   -3.989**

CYCOUTP, = 10

.120***   .116***

.056***   .056***

.045***   4

.042***   0.042***

C, C+T represents test with constant and test with constant and trend respectively. NT and T are tests with trend and no trend. The asterisks*, **,*** represents tests which are significant at 1%, 5% and 10% respectively. Trend output is stationary in both levels and in first difference. The result for trend in the table is reported for the HP cycle if the smoothing parameter is 100.

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4.2 Model Estimation
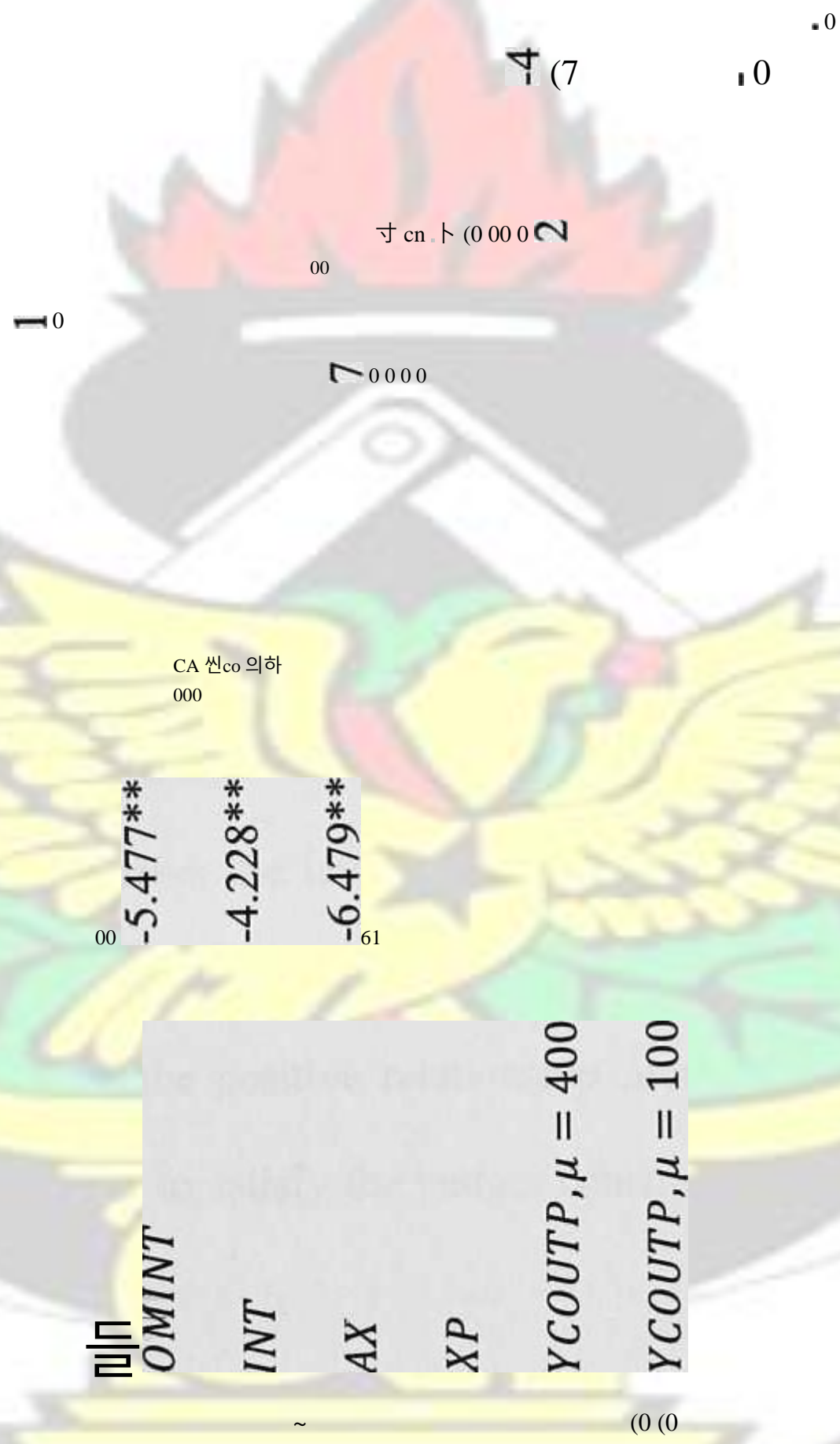
4.2.1 Seigniorage and Cyclical Output

Andrabi's (1997) model and our inference suggest that during booms, the use of seigniorage increases as a result of the increased demand for money due to higher output and perhaps higher

government expenditure, The testable implication of this is that seigniorage covaries positively with transitory increases in output. The study used the different decomposition methods explained early on and to correct for serial correlation, the Prais-Winsten model is used to estimate all the models. Across the different decomposition methods, we found the coefficient of the transitory output to be positive as expected. The results for the estimation are reported in Table 4.3.

When the economy gains from favourable terms of trade such as increased cocoa, gold the prices of other commodities, the entire economy is stimulated and there is increased optimism leading to an increase in aggregate demand. This increased level of aggregate demand shifts the aggregate demand curve to the right with the resultant effect that prices begin to rise. As already stated somewhere in this study, Harrington and Haltmwanger (1993) have established that most firms price their commodities procyclically. What this means is that firms tend to increase their prices during booms. The cumulative effect of increased demand and prices associated with the boom is the increaseg_level of money supply which increases the level of seigniorage in the economy. This explains why we observed a positive relationship between seigniorage and transitory—output. More importantly, the positive relationship found indicates that seigniorage adjust as a residual source of revenue to satisfy the budget constraint during short bursts in the economy when it is very difficult to increase the tax rate necessary to finance a growing momentafry government expenditure.

4.2.2 Current government expenditure and Transitory increases in output

Governments over the years are normally tempted to increase their expenditure during booms. This assertion is validated by the positive covariation of cyclical output and current government expenditure. The behavior is clearly shown when the boom coincides with an electioneering period. Heightened political campaign stimulates aggregate demand. Government increases his expenditure to execute his campaign promises across all ministries, departments and government agencies..ln other words, the MDAs normally deviate from their optimal expenditure trajectory. In

the 2012 fiscal year, the recorded 12.5% deficit was largely attributed to overspending by various MDAs. This is not an exception. Over the years and as explained by the political business cycle, this has been the bane of the Ghanaian economy. Budget deficits are highest during pqriods when we have booms as govemment expenditure tends to increase during this period.

However, such period may be too short for the government to obtain the necessary legislative backing to increase taxes or introduce new taxes to finance this increased expenditure. Even where can be done, the government may shy away for political expediency. Other sources of government revenue may also be insufficient as they may be predetermined. This situation as evidenced by the data exposes the-õãWent to finance his expenditure by increasing the supply oc_money. This may be achieved through debt monetization. In the study, we find a positive relationship between current government expenditure and transitory output. This result is reported in table 4.2. This positive relationship adds to the proposition that seigniorage is used Fdf   -0.082(0.248)   0.013(0.046)

                    -0.061(0234).   0.079(0.062)

If current government expenditure increases cyclical output increases, then conditioning the

as a residual source of revenue during such times when there are increases in cyclical output and where government expenditure is kept high.

Table 42 Relationship between cyclical output and current government expenditure

	δ_0	δ_1
10	-0037(0.242)	0.071(0.072)
g = 100	-0.032(0.239)0	0.075(0.066)
= 400	-0.027(0.23)	0.082(0.063)

relationship between seigniorage and transitory output would be a better way to strengthen our assertion that seigniorage is used as a residual source of revenue. A more realistic way is to

Standard errors are indicated in the parenthesis

juxtapose the covanation of s Igniorage and transitory output on current government expenditure. We still find that seigniorage and cyclical output are positively related as shown in the last three columns of Table 4.3. This result strengthens our position that seigniorage will have to be automatically adjust to satisfy government revenue needs during such transitory periods. This results further enhances the argument that seigniorage is used as a residual source of revenue in the economy.

Table 4.3:Results for the conditional and unconditional covariation of sei iora e and transito output current government expenditure

β_0	β_1	b_0	b_1

| g = 10 | 8.698(1.077) | o. 173(0.269) | 8.763(1.085) | 0.243(0.279) |

_ 100 8.582(1.635) 0.111(0.254) 8.7630.54) 0.186(0.266) g = 400 8.587(1.642) 0.045(0.248) 8.757(1.568) 0.116(0.261)

| | 8.7660.522) | 0.173(0.163) | 8.712(1.446) | 0.185(0.165) |
| | 8.530.602) | 0.036(0.22) | 8.678(1.543) | 0.111 (0.242) |

Notes: Numbers in parenthesis are standard errors. The first two columns is the result for the unconditional variation of seigniorage and cyclical output and the last two columns is the result for the conditional covariation of seigniorage and cyclical output on current government expenditure.

4.2.3 Seigniorage and Trend Output

If seigniorage is a residual source of revenue to the government, then overtime, a high growth economy should be able to reduce its reliance on seigniorage as a public finance tool. Equation (4) estimated the relationship between trend growth in output and the use of seigniorage by the Treasury. Given the distortion a—gated—with seigniorage in terms of higher inflation, government designs policies to reduce their usage. In the long run, the government can plan his revenue needs by, for example, legislating new taxes to finance his expenditure. There is also enough time to introduce new taxes or increase existing ones. More so, a government that plans well to achieve higher growth in output will end up increasing the tax base. The implication is that seigrýorage use declines with economies that have higher growth paths and where tax bases are high. As reported in the table, we obtained evidence that over the years the Ghanaian economy has significantly reduced its use of seigniorage. Across the different values for the Hodrick-Prescott (HP) cycle, and the deterministic trend decomposition, we obtained the expectedasign and the relationship is significant in two cases. There is a significant negative relationship between trend growth in output and the use of seigniorage. Over the years, the scope of government activities has increased. In the 1970s the economy recorded periods when the Bank of Ghana was turned into a printing press. During such times, the economy experienced a massive decline. The culmination of this was the military takeovers that characterized the period on the premise of economic mismanagement and

corruption. The economy during this period relied heavily on seigniorage and Haslag (1994) reported that Ghana financed about 10% of its expenditure from seigniorage. The economic recovery programme carved from the structural adjustment programme and the subsequent financial and tax reforms have provided ample opportunity for the economy to initiate changes to raise government required revenue. The introduction of the VAT, Talk Time Tax, and National Health Insurance Levy among others has contributed significantly to reducing our reliance on seigniorage. The economy has also recorded significant growth and tax base has increased. This has spurred tax revenue. Thus the empirical evidence lends support to the theoretical inferences that trend growth in output reduces the use of seigniorage. The result for such test is shown in Table 4.4. The overall effect of this result is that indeed the economy uses seignioragõÉsîdual revenue because there is ample evidence as shown in Table 4.4 that with increased tax base over the years generated through growth of the eceonomy, our reliance on seigniorage to finance government expenditure is declining.

Table 4.4:Results for Seigniorage and Trend out2ut

	ao		al
g = 10	11.524(2.184)	-0.862(0.500) g = 100	11.819(2.575) -0.9603(0.637) g = 400
	10.674(3.075)	-0.625(0.797)	
		10.263(3.00)	-0.514(0.771)

Notes: Nu%bers in parenthesis are standard errors. The first difference filter removes the trend. The result for the HP is reported across all three levels of the smoothing parameter.

4.2.4 Seigniorage and inflation

We have already established in the preceding analysis that indeed the economy of Ghana uses seigniorage as a residual source of revenue. We invoked Friedman's assertion that inflation is always and everywhere a monetary phenomenon. Following the path in which seigniorage is used as a source of revenue in Ghana, can Friedman's hypothesis hold for the economy? If an economy uses seigniorage as residual revenue, does it impacts on its inflation level in the long run. We find in the study a significant positive relationship between inflation and seigniorage.

The study finds that one unit increase in the use of seigniorage results in about 4 unit increase in the level of seigniorage as shown by the coefficient of seigniorage. In other words, an increase in the level of seigniorage by 100 basis points will translate into about 400 basis points increase in the level of inflation. The regression result per the coefficient of determination shows that seigniorage explains—about 71% chúCG-úevel of inflation. This is reported in Table 4.5. Notwith$anding our use of seigniorage as a residual source of revenue, this optimal path still accounts for more than 70% in the level of inflation in the long run.

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4.2.5 Inflation and the Tax rates

We have established in the preceding analysis that the use of seigniorage tends to decrease as the economy grows. We have also noted that this may be true because as the economy grows over time, the tax base increases. We have established that the Ghanaian economy has shown significant reductions on its reliance on seigniorage overtime as the economy has considerably grow. This implies that over the years, tax revenue has displaced the fiscal space hitherto occupied by seigniorage and to the extent that it is still growing, the use of seigniorage is declining and inflation levels must also show a downward trajectory. We expect a negative relationship between the tax rate and the rate of inflation. The result for the relationship between the tax rate and inflation is recorded in Table 4.5. As expected, there is a significant negative relationsfiip between inflation rate and the tax rate in the long run. The coefficient of the tax rate shows that one unit increase in the tax rate will reduce the level of inflation by about 3 units. In other words, 100 basis points increase in the tax rate reduces the level of inflation by about 300 basis points. The coefficient of determination also indicates that a change in the tax rate explains about 20% changes in the level of inflation rate. Our result contrasts that of Mankiw (1987) who maintained that given the distortions associated with conventional taxes on output and money (seigniorage), government that seeks to minimize such losses should plan his budget to use both taxes. Mankiw asserted that the distortion is minimized if over time, the tax rate and the inflation rate comrhove positively. We have established in this study that this need not be the case of

Ghana where seigniorage is used as a residual source of revenue. In the case of Ghana, there should be a negative relationship between the inflation rate and the tax rate. The result that there is a negative relationship between the tax rate and the rate of inflation provides another line of defense that seigniorage is used as a residual source of revenue to the treasury.

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Table 4.5:Results for Seigniorage. Inflation rate and the Tax rate

		0.71		-2.472	
-0.807	3.8910		66.5360		
(-0.127)	(9.197)		(4.546)	(-2.430)	0.204

Notes: $R1^2s$ is the coefficient of determination for inflation and seigniorage and RI?T is the coefficient of determination for inflation and tax rate. The t-values are shown in the parenthesis. The left- hand side of the table is the result for the regression of equation (5) .The right- hand side of the table reports the result for equation (6).The coefficient of seigniorage and the tax rate are significant at and 10%.

4.3 Relationship between Inflation rate and the Nominal interest rate

We have established that seigniorage is a residual source of revenue to the Ghana government due to the positive relationship between cyclical output and seigniorage, the negative relationship between seigniorage and trend output as well as the negative relationship between the tax rate and the rate of inflation. We have e also shown that this optimal path followed by the economy in the use of seigniorage still impacts positively on the level of inflation in the long run.

But does<he use of seigniorage affect the level of the nominal interest rate in the long run. In the following analysis we show that indeed the use of seigniorage as a residual revenue to the government can impact positively on the level of the nominal interest rate in the long run.

To find this relationship we use Fisher's equation that the nominal interest rate reflects inflationary expectations in the long run. Our analysis is based on the fact that the relationship between-seigniorage and inflation in the long run is very strong and we expect seigniorage to impact positively on the level of nominal interest rate if the Fisher relation holds for the Ghanaian economy. We assumed in_this study that agents have rational expectations and

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therefore•we used the actual inflation rate as a long run proxy for expected inflation and conducted a cointegration test for nominal interest rate and inflation rate using the EngleGranger two -step approach. The result as reported in Table 4.6 indicates that the two series have no common stochastic trend. In other words, the series are not cointegrated. This means there is no long mn equilibrium relationship between expected inflation and nominal interest rate and the first order condition of Fisher relation which requires a cointegrating relationship is not met at least per the Engle-Granger two step techniques. Within the context of our analysis, this would mean that in the long run, seigniorage as a residual revenue does not affect the level of the nominal interest rate.

We followed the advice of Kasman, Kasman, and Turglutu (2006), Cheung and Lai (1993) and imposed a generic assumption that the equilibrium error term may have a long memory. To this end, the ACF may decay slowly. In other words, we assumed that the series may be fractionally cointegrated and that an ARFIMA p,d,q model will be more apposite to investigate the cointegrating property of the series. We employed the frequency analysis under the spectral density function and use the log periodogram to estimate the long run differencing parameter. The study followed the methodology of Geweke-Porter Hudak (GPH) to estimate the fractional differencing parameter. In testing for fractional cointegration however, the critical values for the GPH test is nonstandard and those derived from the standard distribution cannot be used directly to evaluate the GPH estimate of d. This is because the error term is not observed but obtained

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from minimizing the residual variance of the cointegration regression and the residual series obtained-tends to be bias towards being stationary. We use the critical values provided by Dittman (2000). Traditionally, the number of ordinates used for the periodogram regression points is chosen from the interval.[$T^{\text{Œ}}S$, TOffl as proposed by GPH. However, Hurvich et al (1998) has shown that the optimal size which minimizes the mean squared error is of order

$O(T^{0.8})$.We followed this advice in the study to estimate the log periodogram. The ADF test for coinetgration and the GPH test for fractional cointegration are reported in Table 4.2. Whereas the

ADF test rejects the hypothesis of no cointegration, the GPH test reports that the series are fractionally cointegrated.

Table 4.6 Results for the Conventional an4 Fractional Cointegration tests for inflation and <u>and nominal interest rate</u>

			Conventional cointegration test	Fractional cointegration test	
ADF	$p - value$		d	GPH	$p - value$
-2.783	0.171		0.18	2.551	0.0126

The null hypothesis for the GPH test is Ho: d = 1. The alternative hypothesis is HI: d < 1.Critical values for the test is based on Dittmann (2000)

In the first part of the Table 4.6, we report the results for the Engle-Granger cointegrating technique. The results reject any cointegrating relationship between inflation and the nominal interest rate. The p-value is very high. In the second half of the table, we find indeed that the series have a common stochastic trend. The differencing parameter is significant as indicated by the low p-value. This result suggests that the nominal interest rate reflects inflationary expectations.

But findiåg a cointegrating relationship for nominal interest rate and inflation is only a necessary condition to establish the validity of the Fisher relation. The second order condition requires that the cointegrating parameter does not sognlficantly differ from one or is significantly lower than one but different from zero. The former case connotes a full Fisher effect whiles the latter indicates a partial Fisher effect. We proceeded to test if the cointegrating parameter is significantly different from zero or equal to one. In table 4.7, we report the OLS regression estimates between nominal interest rate and inflation rate of equation (8). Our test indicates that the coefficient on inflation
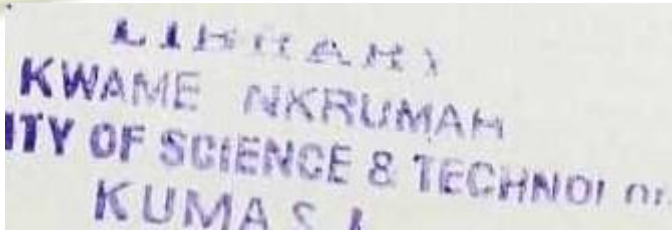
is significantly different from zero but less than one. This result is consistent with a partial Fisher effect for the Ghanaian economy. Fisher explained this result himself when he asserted "when the cost of living is not stable, the rate of interest takes the appreciation and depreciation into account to some extent, but only slightly, and in general indirectly. That is when prices are rising, the rate of interest tends to be high but not as high as it should be to compensate for the rise, and when prices are falling, the rate of interest tends to be low, but not so low as it should be to compensate for the fall." Partial Fisher relationship means that, for example, a 100 basis points increase in prices must not necessarily lead to the same 100 basis points increase in nominal interest rate. In the case of the Ghanaian economy, we estimated that a 100 basis points increase in inflation results in only about 55 basis points increase in nominal interest rate in the long run. This study maintains that in the long run most part of inflation is explained by seigniorage needs. If nominal interest rate shows inflationary expectations as we have shown in the analysis so far, then nominal interest rate must necessarily reflect seigniorage needs.

Table. 4.2: OLS results for Nominal interest rate and the Inflation rate

	γ_0	γ_1	R^2
	14.914	0.545	0.396
	[1.173]	[0.042]	

Notes: Two null hypotheses were tested. The first null hypothesis is Ho: yr = 1 and the other is that Ho: γ_1 = 0. The numbers in the brackets are standard errors. Both parameters are significant at 1%, 5% and 10% levels

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter summarizes the major thematic areas of this study. Specifically; it summarizes the major findings of this study. It also provides some conclusion based on the findings and finally make some few recommendations to policymakers and future researchers.

5.1 Summary of the study

The study proposes that if Ghana uses seigniorage as a residual means of financing government expenditure, then there should be a positive relationship between transitory increases in output and seigniorage. This positive relationship will be strengthened if there is a positive correlation between current government expenditure and transitory output.

The study used the HP filter, First Difference Filter and the Deterministic Trend decomposition to obtain the cyclical and trend components of output. Using the Prais-Winsten model, the study finds a positive relationship between seigniorage and transitory output.

The study finds a positive relationship between current government expenditure and transitory output. By conditioning the relationship between seigniorage and transitory output on this positive correlation, we still reported a positive relationship between seigniorage and transitory output for both the First Difference filter and the HP cycles and the Deterministic Trend Decomposition.

We alsofind a negative relationship between seigniorage and trend growth in output. This result means that as the economy grows over time the tax base widens and the government tends to rely more on taxes than on seigniorage. Cumulatively, these results show that seigniorage is used as a residual source of revenue in Ghana.

This study has also established that there is a significant positive relationship between seigniorage and the rate of inflation. Specifically, we established that in the long run, about 70% of the level of inflation is explained by seigniorage.

For robustness check, we compared the result of the logical imperative of the model to that of Mankiw (1987). Mankiw predicted that for the optimal use of seigniorage, the tax rate and inflation rate should covary positively. The model however contrasts this view. In the case of Ghana, seigniorage is used as a residual source of revenue and there need not be a positive relationship between the tax rate and inflation (seigniorage). The study reports that there is a negative relationship between inflation and the tax rates. This conforms to the prediction of our logical imperative that trend growth in output which widens the tax base should reduce the use of seigniorage and hence inflation and further lends much support to our basis that seigniorage is a residual source of revenue to the government of Ghana.

The study also sought to find the relationship between seigniorage and nominal interest rate via the relationship between the inflation rate and nominal interest rate since seigniorage and inflation are strongly related. To this end, we tested if the Fisher relation holds for the Ghanaian economy. We found that the nominal interest rate and inflation are cointegrated albeit fractionally and thWthere is a paúfrßhâeffect for the Ghanaian economy.

5.2 C6ócÂGsion

Seigniorage acts as a residual source of government revenue in the Ghanaian economy. The use of seigniorage impacts positively on the level of inflation. But inflation and nominal interest rate are tied together in the long run. In other words, a change in the nominal interest rate is determined to a large extent by the level of inflation in the long run. Therefore, seigniorage as

a source of revenue to the government impacts positively on the level of nominal interest rate in the long run because seigniorage explains a greater part of inflation in the long run.

5.3 Policy Implication and Recommendations

This study has established that, in the Ghanaian economy, seigniorage is used as a residual source of revenue. This is because we find a positive covariation between seigniorage and cyclical output. This is further strengthened by the positive relationship between current government expenditure and cyclical output.

To this end, this study proposes that, Government must avoid the temptation to overspend during booms in order not to accentuate the volatile situation caused by the boom in terms of increased prices. This will mean that planned expenditure across Ministries, Departments and various Agencies.must be strictly and religiously adhered to. To ensure fiscal discipline at the ministries to curb excessive spending as a means of reducing the political weakness that produces externality in the use of seigniorage, the study also endorses the enactment of fiscal appropriation bill and perhaps as is the case in the USA, where expenditure is regulated by Congressjonal Budget Office, we can equally consider a Parliamentary Budget Office to strictly monitor the expenditure of various ministries. In the same vein, as we plan to roll out a composite budget-to deepen fiscäTðGGiÉalization at the Metropolitan, Municipal and District Assemblyžs level, the programme should be given proper supervision to curb excessive spending at the MMDA level.

To the extent that trend growth in output reduces the use of seigniorage, policy makers must pursue policy paths that increase growth and generate more tax revenue which have minimal distortions on the economy. Government should encourage far reaching consultations across the broad spectrum of the economy .The focus of such broad consultation should be to look at how to boost tax revenue.

To this end, there should be the provision of adequate time and resources to the legislative process to draft tax laws that are easily implementable in the long run.

The study finds that nominal interest rate and inflation are indeed tied together in the long run and that Vlflation expectations really reflect in the nominal interest rate. We however, uncovered in this study that, it takes a longer time for this to happen. Two policy implications emerge from this finding.

Firstly, ad hoc policies targeted at reducing inflation to affect nominal interest rate will not work satisfactŏrily. Rather policy makers must pursue long term inflationary-reducing measures. In this study, in line with our findings, we recommend long term growth propelling policies.

Secondly, we propose that, the Central Bank can use the nominal interest rate to forecast inflation as was the case in the history of the Central Banks of England and Sweden in the 1990s. We however acknowledge the fact that this recommendation should be implemented to the extent that we know how accurately the nominal interest rate predicts inflation. To this end, future studies should focus on finding whether the nominal interest rate is a good predictor of inflation. _____

Finally, we recommend to future researchers to use fractional cointegration technique to investigate the long term cointegrating properties of economic variables because it gives more general and flexible results than other methods such as the Engle-Granger two step technique.

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