ORDER FLOW AND EXCHANGE RATE DYNAMICS IN EMERGING ECONOMIES:

The Case of Ghana

by

KWABENA DUFFUOR

A thesis submitted in partial fulfillment of the requirements for the Degree of

DOCTOR OF PHILOSOPHY

in

FINANCE

March 2010

FACULTY OF FINANCE

Cass Business School
CITY UNIVERSITY LONDON

Table of Contents

List of Tables

List of Figures

ACKNOWLEDGEMENT

My principal acknowledgement is to my supervisors Ian Marsh and Kate Phylaktis for their tireless guidance, advice and support throughout the duration of my research. I am also indebted to Star Assurance Company Limited for granting me study leave and for sponsoring my undergraduate and postgraduate studies in the United Kingdom.

The list of others to whom I am indebted is extensive, and include Dr. Kwabena Duffuor (past Governor of Bank of Ghana; currently the Minister of Finance and Economic Planning, Ghana), whose constructive feedback has been invaluable to me, and Dr. Samuel Donyina-Ameyaw (Technical Advisor to the Minister of Finance and Economic Planning) for his forthright appraisal of the study and assistance in data acquisition. Great thanks also extend to Dr. Johnson Assiamah and Mr. Sammy Adjei, all of Bank of Ghana, Accra, for their unfailing support throughout my study. I am grateful for constructive comments from the participants of the Exchange rates and Capital Flows Conference, at the Bank of England in 2007 and 2008 and Brazilian Finance Association in 2009.

I also owe thanks to my friends (Myria, Stefan, Takis, Svetlana, Lorenzo, Emmanuel, Hafiz, Margaret, Malla and Wilfred) for making my stay at CASS an enjoyable one.

Most importantly, gratitude extends to my parents, Dr Kwabena Duffuor and Mrs Akosua Duffuor, who taught me the virtue of hard work, perseverance and tenacity of purpose; and to my siblings Kofi, Panin, Kakra and Nana Adoma, for their unyielding patience, understanding and tremendous support throughout the study. I would also like to thank my spiritual father, Rev. Nkrumah, for his continuous prayers. Last but not least, I would like to thank Abena and Isaac for keeping me sane during stressful times. I am alone responsible for any errors or omissions. Furthermore, all views expressed are mine, and not necessarily those of any specific institution or individual.

DECLARATION

I declare that the contents of this thesis are the author's own work and that the thesis has not been submitted for a degree in any other university.

To Dada and Mama,

For always believing in me

ABSTRACT

The aim of this thesis is to study customer order flow and its impact on a small open emerging economy in Sub-Saharan Africa. Customer order flow, as a key concept in the microstructure approach to exchange rate, deals with signed transaction volumes between market-makers and their customers. The study specifically attempts to explore what the data tells us about the role of customer order flow in the market for local currency (Ghanaian CEDI) using the standard analytical framework of FX microstructure literature.

The study also examines short-run exchange rate dynamics in an emerging market based on the recent microstructure framework of foreign exchange markets where the main explanatory variable is the order flow. First, the study modifies the model to take account of a unique feature of the majority of emerging markets, namely the existence of a parallel market for FX. Secondly, it uses a unique proprietary database covering almost the complete Ghanaian market, and for a long time span compared to previous studies, which uses data for a single market-maker and for a short period of time. The study confirms contemporaneous relationship (between flows and exchange rate) suggested by previous literature (Evans and Lyons 2002a) but we also observe a lagged interaction between order flow and exchange rates. These lagged effects are due to the delays in the price transmission which are associated with inefficiencies. Additionally, the study confirms the connection between the price impact of the order flow and the degree of liquidity in the FX market. Furthermore, our findings corroborate the fact that in Ghana, banks provide liquidity to their customers in the short-run whiles the central bank acts a liquidity provider in the long-run.

Finally, our results confirm that there exists a strong relationship between order flow, commodity prices and macroeconomic fundamentals in an emerging economy.

CHAPTER ONE

1.1 Introduction

The failure of traditional exchange rate models in explaining short-run movements has been well documented (Meese and Rogoff 1983a). Exchange rate economics is concerned with the variety of variables that interact to determine the exchange rate level in the short-to-long term. Studies have shown that in the short run in particular, exchange rates are much more volatile than the macroeconomic fundamentals that influence them. This erratic behaviour of exchange rates is responsible for the discrepancies that make it difficult to detect a distinct relationship between the level of exchange rate and the underlying macroeconomic fundamentals.

In recent times, most researchers have argued that the microstructure approach to exchange rates determination should be the key to the underlying factors. Indeed, it has been established that the microstructure models, such as Kyle (1985), highlight that market-makers can extract private beliefs and knowledge about the future value of the exchange rate from customer trades, and then translate these into price changes. Accordingly, they posit that "Customer Order Flow – signed transaction volume between market makers and their customers – is key to exchange rates.

Customer order flow can therefore, on one hand, be a source of information. Other models, such as Evans and Lyons (2002a), emphasize that once an appropriate risk premium is offered, customers are also willing to take over accumulated trading exposures from market makers.

The motivation behind this study is several. Firstly, analysing the link between order flows and exchange rate behaviour is relevant for the practice of monetary policy, especially for a country such as Ghana. Moreover, Ghana is on the path to becoming an emerging economy, and plans to join the West African Monetary Union at some point. Therefore, the country might use, under certain circumstances, foreign exchange intervention to keep the exchange rate within certain tolerable or prescribed band. Knowledge on the nature and the impact of order flows by the authorities may be the key to the success of these operations.

Secondly, we wish to examine whether previous results, obtained using data on major currency pairs, can be extended to an emerging market's currency. To our knowledge, this is the first study of the customer order flow – exchange rate relationship in Africa. The relatively unique database collected by the central Bank of Ghana is particularly suited for such a study.

The relationship between customer order flow and exchange rates was first examined by the pioneering works of Rime (2000), Evans and Lyons (2002a), Fan and Lyons (2002), Mende and Menkhoff (2003) and Froot and Ramadorai (2005).The key findings of these studies are that a) customer order flow dynamics can explain the movements in exchange rates at various frequencies, and b) order flows from different customer types usually behave quite differently from each other.

More recently, a few papers explicitly examined the different behaviour of order flows from different customers. Carpenter and Wang (2007), for example, analyse spot FX transaction data from a major Australian bank. They find that order flow from the

central bank and financial institutions has a positive impact on the exchange rate, whereas non-financial customers' order flow has no influence on it. They suggest that trades with financial institutions carry more information. Mende and Menkhoff (2003), using data from a medium-sized German bank, carry out a similar exercise and find that financial customers' order flow is positively related to the exchange rate, whereas commercial customers' flows are negatively related to it, i.e. commercial customers' currency purchases coincide with depreciations.

It is also an empirical fact that market makers generally close their positions at the end of each trading day. If this is true for the market as a whole, then it is the customers who must absorb the accumulated trading imbalances. Customer order flow thus can also be regarded as the ultimate source of market liquidity.

Existing literature shows that the traditional exchange rate models are based on monetary fundamentals with three main assumptions that agents are homogeneous, information is publicly available and the market structure is unrelated to exchange rate determination. These models enjoy relative success in explaining long-run exchange rate movements. The general equilibrium model of exchange rate determination focuses on welfare analysis and takes into account systematic risks.

Nevertheless, in the short-run, the proportion of exchange rate changes these empirical models can explain is effectively zero. The third branch and new way ahead is the market microstructure approach to exchange rate determination. The present value model of the exchange rate will be the starting point in the introduction of the microstructure approach:

$$s_t = (1-\delta)\sum_{j=0}^{\infty}\delta^j E_t(f_{t+j}) \tag{1.1}$$

$$s_t = (1-\delta)\underbrace{\sum_{j=0}^{\infty}\delta^j E_t(f^m_{t+j})}_{\substack{\text{measured}\\ \text{fundamenta ls}}} + (1-\delta)\underbrace{\sum_{j=0}^{\infty}\delta^j E_t(f^u_{t+j})}_{\substack{\text{unmeasured}\\ \text{fundamnent als}}} \tag{1.2}$$

Where s_t is the log normal exchange rate (defined as the domestic price of the foreign currency), δ is the discount factor, f_t denotes the fundamentals at time t, and $E_t(f_{t+j})$ is the market-makers expectation about future fundamentals conditional on information available at time t.

Equation (1.1) simply states that the log of today's exchange rate is equal to the sum of all discounted expected and future fundamentals. From this formulation, it is clear that the fundamentals referred to are unspecified. Indeed, fundamentals can be broken down into two constituent parts, measured and unmeasured (as shown in equation (1.2) above). The measured fundamentals are those that can be measured like money supply, interest rates or variables that ought to have an effect on exchange rates. The unmeasured fundamentals are those variables that cannot be measured or have not been considered all together.

Despite rigorous research, no group of fundamentals have been found to determine exchange rate movements. This only implies that most of the explanatory powers of a majority models are embedded in the error terms. Consequently, decomposing this error term into unmeasured fundamentals and expectational error components, would

help in extracting the information contained in the error term, and thus, help us explain exchange rate movements and forecasts.

The microstructure approach lays emphasis on the expectational errors and argues that changes to expectations about measured fundamentals are vital. This approach studies how dispersed information is embedded into exchange rates through trading decisions. Thus the microstructure approach is not ignoring fundamentals as such, but rather focusing on the mechanism through which fundamentals influence price. Because fundamentals are not necessarily observable, a proxy is needed. This proxy is referred to as the order flow in foreign exchange microstructure.

Furthermore, this approach argues that the aggregated trading decisions reflect the market's expectations about future fundamentals and as result order flow contains information. Like the asset market approach, the demand for currencies in the micro approach emanates from the purchases and sales of assets. Nevertheless the micro approach relaxes three of the asset market approach's most important assumptions:
Information is not publicly available, market participants behave differently in a way that influences prices and trading mechanism also differ in ways that affect prices. Information is at the centre of the micro approach with order flow being the main pillar.

The assumptions that information relevant to exchange rates is publicly available and immediately included in prices, implies that order flow has no place in the macro approach. In summary, the microstructure allows for an environment where the FX market's structure, participants and mechanisms have an effect on exchange rate.

In a seminal paper, Evans and Lyons (2002a) provide evidence that order flow significantly explains movements in two major bilateral exchange rates. Further, they observe that the coefficients of determination are substantially larger than those in standard macroeconomic models of exchange rates. Subsequently, results from this landmark paper have been confirmed by numerous studies (Froot and Ramadorai, 2005; Kileen, Lyons and Moore, 2005; Payne, 2003, Marsh and O'Rourke, 2005). Aside its explanatory power, the gradual learning of information in the FX market may generate some forecasting power in order flow (Evans and Lyons, 2005a, 2006, 2007).

According to Bacchetta and van Wincoop (2006), the finding that order flow is relatively more successful than macro variables at explaining exchange rate movements points to the significance of heterogeneous expectations. Nonetheless, it is important to note that this does not imply that order flow is the underlying determinant of exchange rates. It could be that macroeconomic fundamentals are still the main drivers of exchange rates, but measures of expected fundamentals are so imprecise that an order flow proxy offers a better alternative in estimation.

In spite of the rapidly growing literature in FX microstructure for developed countries, little work has been done in emerging markets. Only a handful of FX microstructure studies have been conducted on emerging markets. To the best of our knowledge, this is the first microstructure study to be conducted in an African country.

Microstructure analysis can help policymakers to understand and improve their FX markets. According to Lyons (2001), '*Most of these currencies are not traded on a*

world-wide basis, due to lack of convertibility of one form or another. Because trading in these currencies is largely within-country, it is feasible to legislate market design in a way that is not possible in major markets. Microstructure analysis is well-suited to address questions concerning where fledging FX markets should be organised as auction markets, dealer markets, or both, as well the level of transparency that should be required'.

This, we believe, represents a gap in the FX microstructure literature which this study intends to fill. In light of the fact that most emerging FX markets are under-developed and illiquid, this study attempts to investigate whether previous microstructure results are robust in an emerging markets environment. Specifically, we examine the Ghanaian FX market through microstructure lenses.

Our unique dataset is the first of its kind in Africa and was obtained from the central bank. In Ghana there is the presence of a thriving large parallel FX market which co-exists with the official FX market. Consequently, for the first time in FX microstructure, parallel FX market is considered in terms of its relationship with the official FX market. Just like many other emerging markets, the Ghanaian central bank is a dominant player in the FX market and this has huge implications for the exchange rate determination. We apply microstructure analysis to investigate the contentious issue of FX intervention in order to ascertain the true state of affairs in the FX market.

1.2 Organisation of the Thesis

The thesis is divided into eight chapters.

Chapter 2 presents an overview of the Ghanaian economy over the period 1970 to 2007. We also highlight the structural features of the economy and assess how these features have influenced the performance of the Ghanaian economy. Subsequent analysis also includes the macroeconomic adjustment period (1980 onwards) and the effects of these adjustment polices on the macro economy. We also lay emphasis on the nature of shocks experienced by Ghana recently and the relevant policy responses. The various sectors (agriculture, industry, external, fiscal, and financial) of the economy are discussed in terms of the trends in macroeconomic indicators.

Chapter 3 deals with the literature review of the study. In this chapter we briefly discuss the role of customer order flow in FX microstructure theory, and provide some simple theoretical foundations to the equations estimated subsequently. Existing literature on exchange rates describe the exchange rate as a function of a varying set of macroeconomic fundamentals including inflation, money supplies, interest rates, productivity differentials, government debt, terms of trade and net foreign assets. However, most researchers argue that the microstructure approach to exchange rates determination should be the key to the underlying factors. We thus, provide a more comprehensive analysis of the empirical findings of other studies and try to provide the theoretical underpinnings of their study.

Chapter 4 deals with the econometric issues of the study. Here, the estimation strategy of the study is discussed in light of the time series properties of the variables used (i.e. the non-stationarity and cointegration ECM).

Chapter 5 of the study adopts the Evans and Lyons (2002a) framework to test for a link between exchange rate movements and order flow. As the paper's main focus is to uncover what empirics tell us, rather than to test any particular model of market microstructure, we do not provide here a rigorous and detailed theoretical model. We simply wish to show the intuition behind the equations that link the order flows of different customer groups to the exchange rate.

The Evans and Lyons (E&L) model consists of a hybrid of micro and macro variables. Specifically the main variables in their model are order flow and changes in the interest rate differential. This is a static model as it deals with contemporaneous relationships and may not be compatible or appropriate for the relatively inefficient Ghanaian FX market. We, however, test the data using E&L's static model, just to be consistent with the previous literature. To take into account the delayed reaction of exchange rates (due to inefficiencies), the static model is transformed into a dynamic one by including lags.

Most of the empirical analysis is conducted using OLS estimation. In each case, datasets from both crisis and stable periods are tested to allow for a comparative analysis. We observe a positive relationship between order flow and exchange rate movements during the crisis period but observe a negative relation during the relatively stable period.

The negative relationship is contrary to what one would expect and might be exhibiting early signs of negative feedback trading. In FX microstructure, it is usually assumed that expected flows are already priced into exchange rates by dealers and should not

have an effect on exchange rate movements. It is rather the unexpected (shock) flows that should move exchange rates.

Consequently, following the Payne and Love (2008), we use the Campbell-Schiller methodology to decompose order flow into its expected and unexpected components. Not surprisingly, we find that both components are significant in explaining exchange rate movements but the unexpected component is positively signed and has a relatively larger magnitude. As theory would suggest, it is the unexpected flow that matters but due to the various inefficiencies expected flow also has some significance. Of greater importance, is the issue of whether the effect of unexpected flows on exchange rates is permanent or temporary. A permanent effect is an indication that order flow is informative, while a temporary effect may imply that order flow is due to inventory management. A Wald coefficient restriction test indicates that unexpected order flow is informative and has a permanent effect on exchange rates.

The long-run relationship between order flow and exchange rates is examined. Using the Johansen cointegration methodology, we find that results are inconclusive. In the long-run the relationship between order flow and exchange rates is ambiguous and the corresponding error-correction model does not make any statistical or economic sense.

These findings could be due to the omission of certain important variables and the fact that this model is not the correct representation of the long-run dynamics of the Ghanaian FX market. This is not surprising because in our cointegration model, the dominant role of the central bank (BOG) in the FX market is completely ignored.

Chapter 6 deals with FX liquidity provision in the context of the role of BOG. To the best of our knowledge only one paper, Bjønnes et al. (2005), critically analyses the issue of liquidity provision for a whole FX market. Chapter 6 attempts to find out which group of market participants in Ghana provide liquidity overnight. It is well known that during a fixed exchange rate regime, the central bank actively supplies (buys/sell FX at given rate) liquidity. However it has been widely accepted that market making banks are the main liquidity providers in a floating exchange rate regime. In sharp contrast to this, other studies Lyons (1995), Bjønnes and Rime (2004) have shown that market making banks only supply liquidity intraday. In fact, this raises the question of who is the ultimate liquidity provider in the long-run. Arguably, Ghanaian FX liquidity provision is closely linked to the deeply controversial issue of BOG's perceived intervention on the FX market. According to Bjønnes et al. (2005), 'pull' customers are liquidity providers who are pulled to the market by returns whiles 'push' customers are liquidity demanders who initiate price changes. Using the Johansen cointegration methodology, Bjønnes et al. find that non-financial customers are the liquidity providers (pull agents) while financial customers are the liquidity demanders (push agents) for the Swedish Krona market in the long-run.

We apply this framework to the Ghanaian data, but in a slightly different way. Contrary to Bjønnes et al. (2005), our dataset consists of bank customers (except remittance bank), BOG and banks. The main aim of the paper is to investigate which of these players is providing or demanding FX liquidity. Initially, Granger causality tests indicate that BOG is the liquidity supplier whiles bank customers act as liquidity demanders in the long-run. These results are confirmed by Johansen cointegration methodology. Furthermore the previous positive relationship between order flow and

exchange rate in chapter 5, is observed in the cointegration framework between bank customers and exchange rate levels. The error-correction model indicates that the exchange rate and customer flows adjust to attain equilibrium in the long-run. Generally, the results are robust over the crisis and stable periods. The dataset for this paper commences from March 2002, when BOG initiated a series of sustained interventions. Additionally, the pre-intervention period is analysed to ascertain who acts as the liquidity provider in the absence of BOG interventions.

In trying to identify the fundamental determinants of order flow, we seek to examine its relationship with macroeconomic information and commodity prices. Ghana is predominantly an export-driven economy that depends mainly on commodity exports and it can be argued that order flow may reflect changes in the prices of these commodities.

In chapter 7, we employ monthly macroeconomic and commodity price data to test for the existence of such a relationship. Quarterly GDP data is interpolated into a monthly frequency, to enable its use in subsequent empirical analysis. Using basic Ordinary Least Squares (OLS), we observe very encouraging results that link order flow to macroeconomic information. Specifically, changes in macroeconomic fundamentals are significant in explaining monthly order flow.

Chapter 8 summarises the major findings of the study, and also highlights policy options for the management of FX in the country. A set of conclusions concerning FX transactions are drawn, as well as the limitations of the study, together with suggestions for further research.

CHAPTER TWO

AN OVERVIEW OF THE GHANAIAN ECONOMY

2.1 Introduction

This chapter seeks to examine the economic background/history of Ghana with a special focus on the macroeconomic policies that have been implemented. As a result, we also highlight the structural features of the economy and asses how these features have influenced the performance of the Ghanaian economy. Subsequent analysis also includes the macroeconomic adjustment period (1980 onwards) and the effects of these adjustment polices on the macro economy. Additionally, there is a general review of the performance of the Ghanaian economy from 1970 to 2007.

We also lay emphasis on the nature of shocks experienced by Ghana recently and the relevant policy responses. The various sectors (agriculture, industry, external, fiscal, and financial) of the economy are discussed in terms of the trends in macroeconomic indicators.

2.2 Macroeconomic performance

The Ghanaian economy can be best described as a relatively small open economy that is susceptible to developments/movements on the world market. The structural weakness of the Ghanaian economy is inherent in its dependence on the world market for its main exports, oil imports and other vital raw materials needed for domestic production. From independence in 1957 to the eighties, Ghana adopted and adhered to an import substitution strategy. Specifically locally produced goods were to be gradually substituted for imports. At the time the government allocated resources directly to vital sectors of the economy. This strategy formed part of the "socialist agenda" of the government which was enshrined in the Seven year Development Plan

(1963-1970). The main aim of this plan was to accelerate growth by stimulating a mass production of food for local consumption and pursuing an ambitious industrialisation programme.

During the 1970s, state intervention was endemic in all vital sectors of the economy. A large proportion of enterprises/corporations government owned/backed. Such organisations were found in transportation, communication, manufacturing, banking and cocoa marketing. However the state-owned enterprises (SOEs) placed a huge strain on government finances in the form of low debt repayments and inadequate dividends. Consequently the SOEs gained monopolies in the production, pricing and marketing of agricultural crops for export and local consumption. Naturally, the SOEs emerged as the main importers and exporters in the economy.

During the 1970s, state intervention meant that domestic prices were not determined by market forces. Producers of export crops were obliged to sell their produce to SOEs at prices below world market prices. Also non-traditional exporters were required to surrender their foreign exchange (FX) proceeds and had to deal with a complex system of export permits. For every shipment, exporters were required to obtain new licences. Furthermore the relevant ministries were given the power to adjust the number of consignments moving between Ghana and the rest of the world.

Systems of import licensing and strict governmental allocation of FX were implemented in order to control importers. These systems had the effect of squeezing importers, especially during times of FX scarcity (see figure 2.1 for gross foreign exchange reserves for the period 1970-2008).

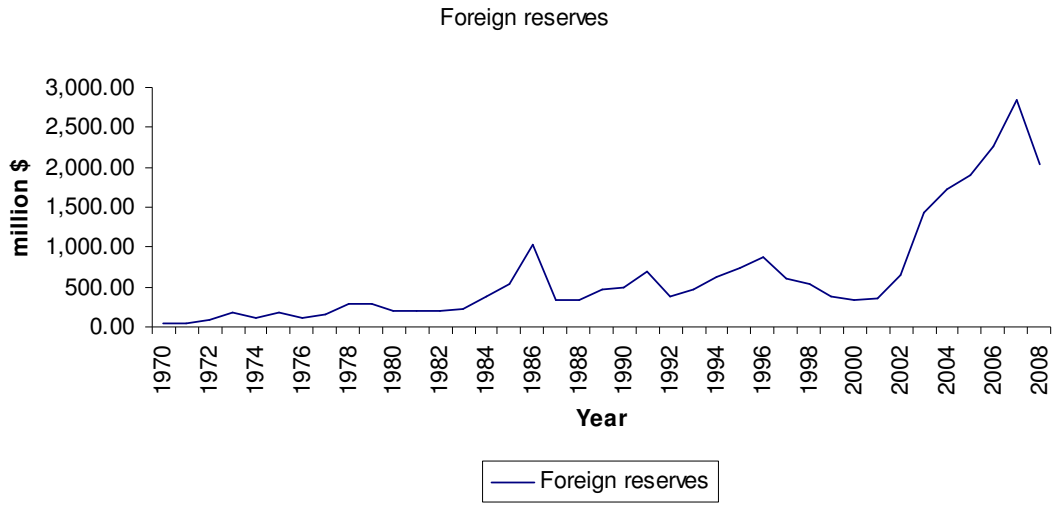


Figure 2.1

In a climate of dwindling exports and imports, these restrictive trade measures led to the economy experiencing large surpluses between 1970-1983. During this period, import-GDP ratio reduced from 18.5% to 3.6%, while export-GDP fell decreased from 20.7% to 3.6%.

The oil crisis of 1974 combined with the worsening terms of trade aggravated the economy of Ghana. Moreover falling exchange rate receipts and largely inefficient SOEs led to acute FX shortages. Industries were seriously affected by the fall in the imports of raw and intermediate materials, leaving them with no choice but to operate below capacity. In the meantime, the problem of import shortages and increasing costs had the direct effect of weakening the profitability of SOEs and an indirect effect of significantly reducing government revenue.

During the early 1980s, the continuous FX shortages led to a further decline in economic activity and fuelled uncertainty about the state of the economy. Import volumes plummeted by an annual average of 8%, while real export earnings fell by an annual average of 6.4%.

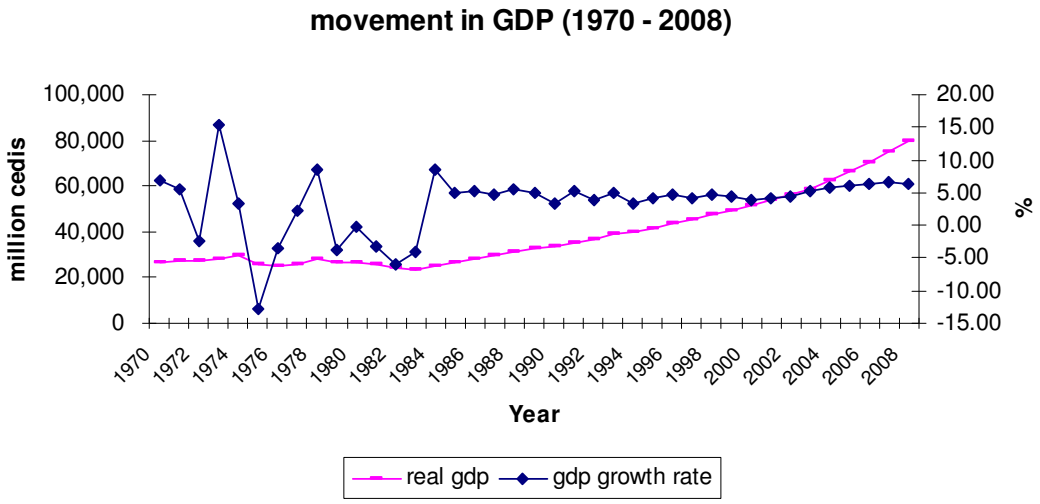


Figure 2.2

The Consumer Price Index (CPI) inflation accelerated at an annual rate of 50% and peaked at 123% in 1983. Domestic savings and investment dropped significantly. Many factors contributed to the deplorable state of the economy between 1973 and 1983. They included large budget deficits; a fixed and highly over-valued exchange rate; unsuitable monetary expansion that fuelled high inflation; imposition of price controls over a wide variety of products; abuse of import licensing system which led to more inefficiency.

Natural causes, especially in 1983, were a major contributory factor to the

.

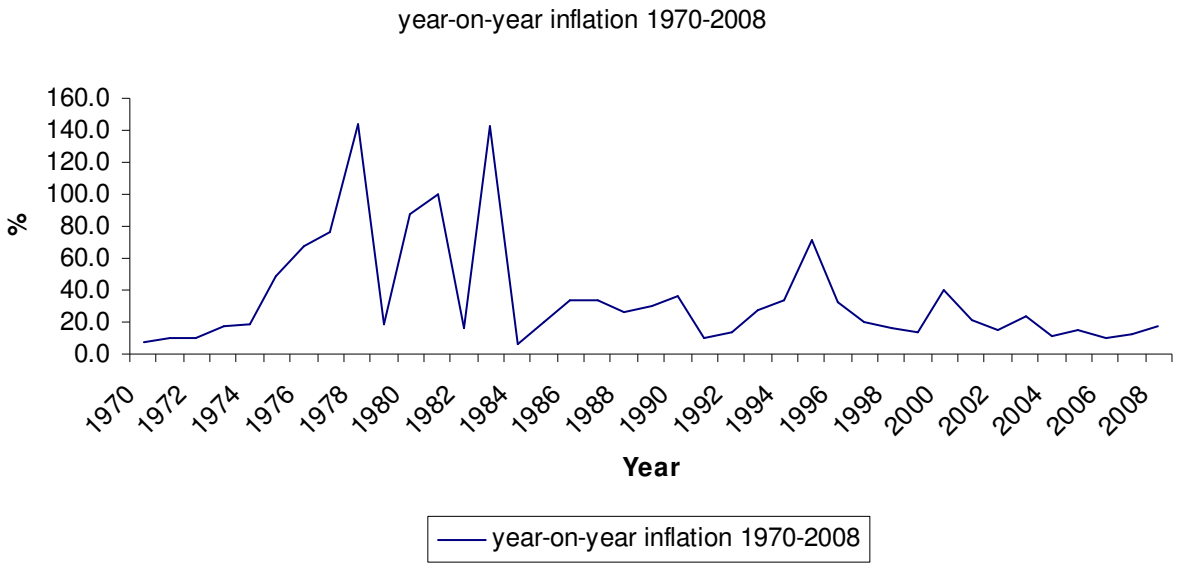


Figure 2.3

economic woes of Ghana. The very vital agricultural sector was virtually crippled with severe droughts and bushfires. Not surprisingly, the industrial sector indirectly suffered severe consequences.

In general the Ghanaian economy was characterised with numerous problems including: hyperinflation which reduced real/disposable incomes, stifled productive investment, and dented economic growth; fiscal indiscipline which eventually led to printing of money to finance the huge deficits; high unemployment rates; an extremely over-valued exchange rate which had the effect of reducing exports' competitiveness and resulted in an over-reliance on cocoa as the source of FX; decaying infrastructure due to many years of neglect; a sharp decline in the provision of public services (health, education etc) and utilities (water, electricity etc). It became obvious to government that economic reforms were imperative.

In an attempt to tackle these enormous challenges, the government launched the Economic Recovery Program (ERP) in 1983, with the assistance of the International Monetary Fund (IMF) and the World Bank. The main function of the ERP was to

significantly decrease Ghana's debts and to ameliorate its trading position in the world economy. Under the ERP, policies were aimed at restoring economic activity in the most efficient manner. These policies included: reducing inflation through strict fiscal, monetary and trade polices; boosting the flow of FX into Ghana and allocating it to vital sectors; reorganising the economic institutions; reinstating productive incentives; repairing infrastructure to improve conditions for the production and export of goods; and increasing the accessibility of vital consumer goods. The ERP was implemented in about three stages. From 1983 the government embarked on a path of slashing its expenditures while stimulating private production. Early cuts in expenditure coupled with more efficient tax collection resulted in drastic reduction in the budget deficit from 6.3% of GDP in 1982 to 0.1% in 1986. This had the effect of easing government strain on the banking system. Also export activity was increased through a succession of cedi devaluations. During the second stage, between 1987 and 1989, the government privatised most of its assets and pursued more far-reaching FX reforms in order to devalue the currency further. Consequently the parallel (parallel) FX market was almost eradicated with the opening FX bureaus in 1988. The third stage saw the government deepening monetary reforms and cutting private corporate taxes to enhance private sector growth.

Generally the ERP enhanced Ghana's international financial status due to its ability to service foreign debt and its return onto the international capital markets after an absence of two decades. Nevertheless, the ERP was heavily criticised for failing to rectify the structural problems of the Ghanaian economy. The economy still relied heavily on the export of cocoa and other agricultural commodities. Critics also accused the ERP of not being beneficial to the average Ghanaian. The ERP encountered numerous shocks. At times forecasting or averting the shocks, such as

dreadful weather conditions and oil crisis, were beyond government control. Other shocks were induced by polices that had been implemented under the ERPA set of conditionality embedded in the ERP were viewed as inappropriate. On the other hand the ERP chalked a considerable amount of success in terms of rectifying macroeconomic imbalances, liberalising the external sector and also liberalising the exchange and trade systems.

The balance of payments (BOP) recorded surpluses from 1984 to 1991. There was a remarkable improvement in per capita incomes due to real GDP growth of 4.5% per annum. Yet economic activity remained sluggish because continued high and fluctuating inflation rates deterred private savings and investment.

Sluggish implementation of structural reforms in SOEs, agricultural and financial sectors held back private investment and economic growth. Food production was virtually neglected as vast amounts of resources were diverted to cocoa rehabilitation and other export areas. Consequently many employees of SOEs were made redundant. Percentage of the total budget allocated to agriculture fell from 10% in 1983 to 3.5% in 1988. Relative to food crops, cocoa contributed less to GDP but received over 60% of recurrent agricultural expenditures due to its high export values.

In trying to deal with the social costs generated by the ERP, the government instituted a Program of Action to Mitigate the Social Costs of Adjustment (PAMSCAD). With an initial amount of US$85 million, PAMSCAD targeted the poor, artisans and small-scale miners with particular emphasis on executing labour intensive self-help projects. Through PAMSCAD another programme was introduced which aimed at improving public services especially health care, education, water supply and sanitation. Retrenched government workers also received end-of –service benefits through the program.

The beginning of the 1990s saw the Ghanaian government press on with the policies of the ERP. The World Bank continued to extend credit on condition that Ghana created a conducive environment for private sector development by reviewing and overhauling its economic and regulatory laws. In other words Ghana was to introduce deeper reforms in areas of exchange rates, economic liberalisation and deregulation.

Ghana's fragile export sector led to a situation where it reluctantly had to depend on external assistance.

During the late 1990s, Ghana faced mixed fortunes. In 1998, the budget deficit financing was transferred to deposit money banks and the public. Stringent monetary and fiscal policies led to the lowest rate of monetary growth since the beginning of the ERP in 1983. Amidst a severe energy crisis, the external sector benefited tremendously from high commodity prices on the world markets. The BOP surplus shot up from US$ 25 million in 1997 to US$ 99 million in 1998. Subsequently the exchange rates became relatively stable with the cedi depreciating by only 4% against the US dollar. The rate of inflation plunged from 15.7% in the last quarter of 1998 to 9.4% in the second half of 1999. This relative stability was seriously hampered in June 1999 when Ghana experienced a series of external shocks. Prices of Ghana's main export commodities, cocoa and gold, plummeted on the world markets while Oil prices increased sharply. To worsen the situation, bilateral and multilateral donors withheld a large portion of promised aid referring to the failure of the government to implement certain key reforms including the privatisation of SOEs. Consequently the FX reserves gradually declined and the strong demand for imports exerted huge pressure on the exchange rate. Speculation also exacerbated the situation because the end to this crisis was nowhere in sight. The cedi depreciated by more than 33% and inflation rose from 10.3% in June to 13.8% by year end.

Though real GDP grew by 3.7% in 2000, the three main sectors of the economy (agriculture, industry and services) recorded a slowdown in growth. Specifically agriculture (which contributed to 40% of GDP) registered a decrease in the growth rate from 3.9% in 1999 to 2.1% in 2000. The industrial sector also recorded a decline in growth from 4.9% in 1999 to 3.8% in 2000 while the services sector however experienced an increase from 5.0% to 5.4%. BOP deficit deteriorated from US$93.7 million to US$194.7 million. Export receipts too fell by 3.6% while imports, on the other hand, shot up by 14%. Not surprisingly, external debt increased by about US$63 million and the cedi depreciated further by 99.3%. At the same time the central bank was pursuing a tight monetary policy. Consequently, by the end of 2001 inflation had dropped to 21% from 40.5 during previous year. The cedi gained some stability as it depreciated by less than 5% compared with a depreciation rate of 49.5 in 2000. The government reduced the budget deficit by 1.4% and also decreased its domestic borrowing requirements. Furthermore the government transferred the budget deficit financing and funding of domestic debt from banks to non-bank sources. At this point Ghana's external debt stock constituted 575% of revenue in present value terms. This implied that Ghana satisfied the criteria for being eligible for Highly Indebted Poor Countries (HIPC) initiative because it had surpassed the 250% for sustainability. Ghana opted to join the HIPC initiative in 2001 and reached the decision point in 2002. It was projected that Ghana would receive nominal debt relief equivalent to 56% (or US$ 3.75 billion) of outstanding external debt stock at the end of 2000. As a result the debt burden was forecast to decline from 24% of budget revenue in 2000 to 8% by 2003. It was hoped that the implementation of HIPC would significantly lessen the burden on the economy and a positive impact on the debt and growth dynamics. More importantly HIPC would enable the government to deal with genuine obstacles to

sustainable growth including human capital, insufficient deteriorating infrastructure and weak institutions. In order to reinforce the central bank's monetary policy role, the Bank of Ghana (BOG) Act was passed at the end of 2001. The Act gave BOG operational independence and the sole responsibility of maintaining of price stability. Additionally government borrowing from BOG was not to exceed 10% its annual revenue. The Act also provided for the creation of a monetary policy committee (MPC) that would be responsible for devising monetary policy.

In 2002, BOG introduced the Prime rate. According to the BOG "it is a rate which the central bank uses to signal its monetary policy stance". Also it is "the benchmark rate used by lenders as a reference to establish the rate to be charged to borrowers". Inflation dropped from 21% to 15.2% by 2002. Though world cocoa price rose (from US$1021 in 2001 to US$1266 in 2002), the volume exported fell slightly and as a result Ghana was unable to take full advantage this situation. The sudden drop in volume was due to smuggling activities and diseases that affected the cocoa beans. Ghana also benefited from relatively higher gold prices. Favourable world prices combined with the HIPC relief narrowed the budget deficit.

Petroleum price increases led to a hike in inflation from 16% in January 2003 to 29% in February 2003. The MPC was forced to increase its prime rate to 27.5% and consequently money market rates rose during the first half of 2003. Inflation fell significantly from 30% in April to 23.6% in December 2003. The third quarter saw money market rates on a declining path induced by government's decision to reduce its funding of borrowing requirements on the auction market. As a result the 91-day treasury bill halved from 34% in June 2003 to 17% in December. Similarly interbank money rates reduced drastically from 27% in June 2003 to 15% in December and commercial bank base rates dipped from 32% to 27%. The external position improved

considerably mainly due to increased cocoa earnings and private inward remittances. Private inward remittances (transfers from NGOs, religious organisations and individuals) through banks and finance companies shot up drastically by 57.5% from US$ 1.374 billion in 2002 to US$ 2.164 billion in 2003. These favourable developments led to a significant build-up in international reserves from US$ 640 million in 2002 to US$ 1.426 billion, which represented 2.9 months of imports (as shown in figure 2.1).

Naturally the cedi/dollar exchange rate gained relative stability, depreciating by only 4.7%. In order to have an early sense of the performance of the real sector of the economy since GDP numbers are reported with a long lag, Bog developed a new economic indicator, the Composite Index of Economic Activity (CIEA). The CIEA measures activity in industry, industrial electricity consumption, domestic VAT, port activity, imports, exports, and employment contributions. For the first time, Ghana attained a sovereign credit rating. Standard and Poor's assigned a B+ rating and Fitch Rating assigned a 'B Positive Outlook'. The banking and payments systems bill was passed in 2003 to strengthen the BOG's regulatory role and deepen the financial intermediation.

Inflation dropped to 11% in December 2004 from 23.6 in December 2003. GDP growth reached record levels, rising from 5.2% in 2003 to 5.8% in 2004. This was the highest growth rate Ghana had achieved in 20 years. The trade deficit widened from US$670 million in 2003 to US$1.512 billion in 2004. This was due to a 22.9% increase in merchandise imports resulting from domestic demand for mainly capital and intermediate goods. Another contributory factor was the 45% increase in the expenditure on petroleum imports, emanating from high oil prices which rose from US$ 28 per barrel in 2003 to US$ 37 in 2004. However the overall BOP was

strengthened by the external account position. Specifically, developments in the external sector, consisting of private inward remittances and HIPC debt relief, compensated for the current account deficit. An accumulation of an extra US$300 million led to an increase in the Gross International Reserves to US$1.33 billion, equivalent to over 3.8 months of imports. Upon reaching the HIPC completion point in July 2004, Ghana's external debt stock was reduced by US$2 billion with a further US$ 2 billion cancellation over 20 years. Consequently Ghana's external debt decreased to US$6.1 billion in December 2004 from US$8.03 billion in December 2003. The cedi continued to remain relatively stable, depreciating by about 2%. The relatively favourable economic situation encouraged banks and other financial institutions to increase their exposure to the private sector against their usual practice of investing in treasury bills, thus crowding out the private sector. The government rolled out two and three year fixed and floating rate bonds. The BOG also introduced 28 and 56 day bills for open market operations. The purpose of these notes was to increase the average maturity of debt, alleviate funding pressures on debt markets and decrease the frequency with which the government has to refinance maturing debt.

At the beginning of 2005, an increase in the petroleum price hiked inflation from 11.8% in 2004 to 16.7% in March 2005. However towards the end of the year reduced to 14.8%. In line with the downward trend in inflation, the MPC reduced the prime rate from 18.5% in January to 15.5% in December 2005. As inflationary pressures eased, interest rates generally declined. Real GDP registered a growth rate of 5.8%. There was increased activity in the real sector with the exception of the agricultural sector. The agricultural sector, which contributed 40% to the GDP, recorded a decline in growth from 7.5% in 2004 to 6.5% in 2005. Growth in the industrial sector was robust to wage and crude oil shocks as it registered a higher growth from 5.1% in 204

to 5.6% in 2005. The services sector also recorded an increase in growth from 4.7% in 2004 to 5.4% in 2005. The overall budget deficit narrowed from 3.2% of GDP in 2004 to 2.4% in 2005. In order to promote the private sector as the engine of growth, the government resolved to reduce domestic debt as a percentage of GDP to tackle the crowding-out of the private sector. Consequently, public domestic debt as a percentage of GDP fell from 21.7 in 2004 to 18.3% in 2005. The stock market index was relatively bearish as it rose by only 29.8% in 2005 compared to a gain of 91.3% in 2004. The overall BOP registered a surplus of US$110 million in 2005 from a deficit of US$10.4 million, mainly due to large inflows of private and official capital into the economy. These inflows more than compensated for the current account deficit of US$ 757.6 million to register a surplus of US$104 million. Exports increased by only 1.2%, from US$2.705 billion in 2004 to US$2.737 billion. However imports increased by 22% due to a 41% increase in oil-related imports. Gross international reserves increased marginally to US$1.9 billion in 2005 from US$1.7 billion in 2004, representing a decrease in import cover from 3.8 months in 2004 to 3.5 months in 2005. The cedi remained relatively stable, depreciating by only 0.9%. The HIPC initiative impacted favourably on external debt, reducing the external debt to GDP ratio from 266.3% in 2004 to 63% in 2005.

Inflation continued to decline. It dropped from 14.8% in 2005 to 10.5% by December 2006, mainly due to relatively stable exchange rate, favourable food supply conditions and a tight monetary policy. Subdued inflation expectations led to the MPC reducing the prime rate further during 2006. Money market rates followed suit with the 91 day treasury bill rates dropping 11.77% in 2005 to 10.19% in December 2006. On average, bank base rates decreased from 24% at the start of the year to 19%. Real GDP grew from 5.9% in 2005 to 6.2% in 2006. Most of this growth was attributed to the

industrial and services sectors. Though the agricultural sector experienced higher growth from 4.1% in 2005 to 5.7% in 2006 (still below target of 6.2%), its contribution to GDP fell slightly from 36% in 2005 to 35.8% in 2006 due to the cocoa and fisheries sub-sectors. Growth in the industrial sector decreased from 7.7% in 2005 to 7.3% in 2006 but its contribution to GDP improved slightly from 25.1% in 2005 to 25.4% in 2006. The service sector surpassed its target of 6.2%, growing by 6.5%. The contribution of the services sector to GDP also improved marginally from 29.9% to 30% in 2006. In real terms, the credit extended by banks to public and private institutions increased by 27.1% in 2006 compared to 21.9% growth in 2005. The overall budget deficit shot up to 7.8% of GDP in 2006 from 2.7% of GDP in 2005. This was mainly due to lower revenues and relatively higher expenditures. Domestic revenue as a percentage of GDP dropped from 24% in 2005 to 22.3% in 2006, implying that revenue was unable to keep up with the rapid growth in the economy. Total expenditure as a percentage of GDP increased from 34.1% in 2005 to 34.9% in 2006, mainly due to the energy crisis and higher wage demands. Consequently the domestic debt to GDP ratio rose to 14.7% in 2006. Overall BOP improved from US$84.5 million in 2005 to US$415.1, representing 3.4% of GDP. Again large surpluses on the capital and financial accounts more than compensated for the increase in current account deficit. Even though exports increased, the trade balance further deteriorated. Increased import of intermediate and capital goods to assist with high level of investment activities shot imports up from US$5.35 billion in 2005 to US$6.75 billion in 2006. Consequently FX reserves registered an increase of US$371.8 million to US$2.27 billion at the end of 2006. The increase in reserves was due to higher export earnings and debt cancellation by the bilateral/multilateral agencies. Import cover, however, decreased from 3.5 months in 2005 to 3 months in 2006. Naturally,

external debt dropped sharply from US$3.98 billion in 2005 to US$2.77 billion in 2006. The cedi continued to maintain its relative stability, depreciating by only 1.1%. Real GDP grew by 6.3% in 2007. The services sector was responsible for most of this growth. It grew from 6.9% in 2006 to 8.2% in 2007. The agricultural sector recorded a decrease in growth from 5.7%in 2006 to 4.3% in 2007, due to irregular rainfall patterns and decreased activity in fisheries. Not surprisingly the industrial sector also recorded a decline in growth from 9.3% in 2006 to 7.4% in 2007 as a result of the severe energy crisis. Inflation inched up slightly from 10.5% in 2006 to 12.7% in 2007. This was mainly driven by food price increases, high petroleum prices (effect of high crude oil), and the upward adjustment of utility prices. The overall BOP registered another surplus US$413 million, representing 2.9% of GDP. As usual the relatively larger capital and financial accounts more than offset the increase in the current account. The current account deficit increased from US$1.072 billion in 2006 to US$1.884 billion in 2007 as the trade balance further deteriorated. The surplus recorded in the capital and financial accounts were from proceeds of the floatation of Ghana's US$750 million 10 year sovereign and increased foreign direct investment (FDI) in the telecommunications sector. Gross international reserves increased by US$566.9 million to US$2.84 billion in 2007, equivalent to 3.1 months of imports. The cedi depreciated by 4.8% against the dollar as a result of increased expenditure on energy-related imports and rehabilitation and construction of infrastructure. External debt increased significantly due to disbursement of proceeds of the bond and other additional disbursements from multilateral/bilateral creditors. The external debt increased by US$1.41 billion to US$3.59 billion in 2007. The budget deficit continued to widen, reaching an alarming 8.1% of GDP from 4.16% in 2006. Domestic revenue as a percentage of GDP increased from 22.3% in 2006 to 26% in

2007 while total government expenditure shot up to 40% of GDP. In real terms, the credit extended to the private sector rose by 41.6% compared to a growth rate of 28.7% in 2006. The formal adoption of an inflation targeting framework was announced by the MPC in May 2007. In July 2007, the national currency was redenominated. The main aim of the redenomination was to eliminate the deadweight burden in transactions as well as improve efficiency in the economy. With regards to the handling of the economy, it was expected that this exercise would increase efficiency in transactions. Specifically, 10,000 cedis was set to 1 Ghana cedi.

Figure 2.4

2.3 SECTORAL ANALYSIS OF GHANA

This section outlines the variations in performance and contribution to growth of the three main sectors in the Ghanaian economy during the period between 1970 to 2007 (see figure 2.5)

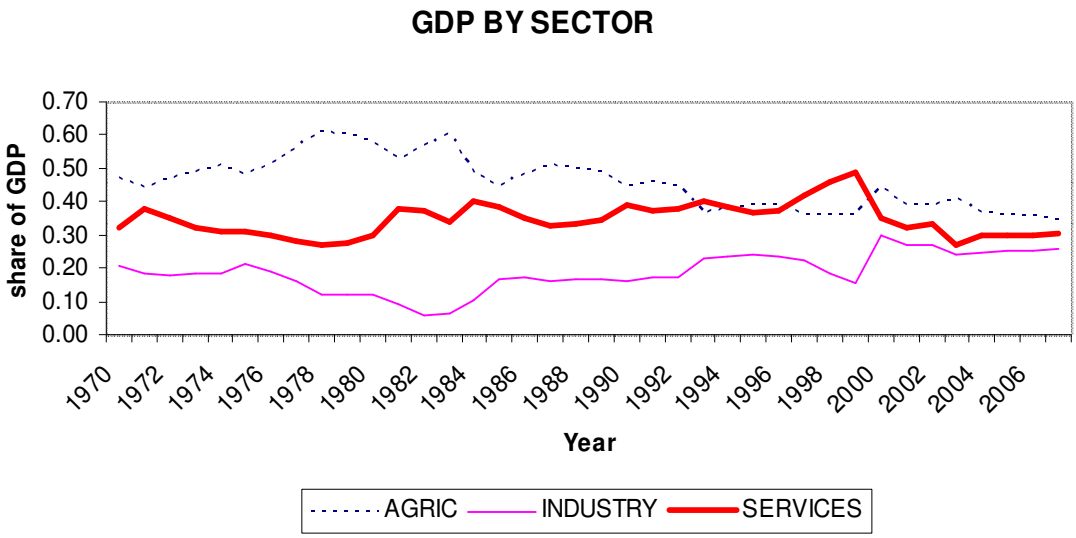


Figure 2.5

The economy of Ghana is mainly driven by the agricultural sector which accounts for about 40% of GDP. In comparison to most countries in Sub-Saharan Africa, Ghana's agricultural sector is relatively large. Cereals (mainly maize) are the main crops and account for roughly 20% of GDP. Naturally this sector heavily depends on labour, land and weather production with inadequate mechanisation. The lack of mechanisation has led to low levels of yields and farm productivity in comparison to other African countries.

The 1970s was characterised with low productivity and diminished significantly during the economic crises between 1979 and 1983. The contribution of agriculture to GDP fell sharply from 60% in the early 1970s to 53% during the economic crises. With the introduction of the ERP, production recovered slightly and continued its surge

throughout the 1980s. Starting from the mid 1980s, a gradual increase in the area under cultivation led to a slight expansion in production. However the downward trend resumed, resulting in a decrease of about 40% in 1990 to 36% in 2000.

During the 1990s, the growth rate of the agricultural sector points to it lagging behind the performance of the industrial and service sectors. Naturally this situation resulted in increased food imports and industrial raw materials. It has also exerted an upward pressure on domestic prices and reduced the volume of vital exports like cocoa.

Cocoa is the main export commodity and primary source of FX for the Ghanaian economy. FX earnings mainly come from the export of dry cocoa beans, cocoa products and other non-traditional agricultural commodities. Cocoa production is predominantly privately owned. During the 1970s, cocoa production reduced gradually and reached an all-time low of 166,000 tons in 1984, which represented less than half of the annual output in the early 1970s. This sharp fall in production was due to high taxation and inadequate incentives. The share of taxes in cocoa export revenue hovered around 40% during the 1980s and 90s. By the late 1990s, Ghana's share of the world cocoa production had dipped to only 13%. This was in sharp contrast to 1960's when Ghana was the world's leading producer of cocoa. In an attempt to revamp cocoa production, government introduced a policy which was aimed at enhancing price incentives for increased cocoa production. Specifically, cocoa farmers were paid price compensation as and when it is necessary in order to push producer prices up. Farmers viewed this price compensation scheme, which was introduced in the mid 1980s, as a 'bonus' and expected it each year. Nevertheless, dwindling world cocoa market prices combined with inefficiencies in the internal marketing under the COCOCBOD and excessive taxation of the crop have result in lower producer prices, falling yields, and disinvestment in Ghana. Cocoa prices plummeted to US$ 1094 per ton in 2000 from US$ 1434 per ton in 1999. However the price recovered and eventually shot up to US$

1949.50 in 2003 due to political tensions in neighbouring Ivory Coast, the largest producer of cocoa. Again prices dropped significantly to US$ 1586.90 in 2004 but gradually recovered to US$ 2072 in 2007. Cocoa production hovered around 300,000 tones per annum from 348,031 tonnes in 2000 to 354,775 tonnes in 2003 Due to mass cocoa spraying exercises and improved crop growing practices initiated by government, cocoa production increased by over 70% to 620,365 tonnes in 2004. Cocoa production for 2007 was estimated at 531,748 tonnes. The agricultural sector's share of GDP was 34.7%, which represented a decrease from 2006. However it still remains the dominant sector.

Industry

The industrial sector accounted for about 20% of GDP in 1970. Nevertheless, this share rapidly reduced to single digits during the economic crises until the beginning of the ERP. During this period between 1970 to 1983, the industrial sector was saddled with low plant utilisation levels. Plant utilisation levels were estimated to be less than 20% in 1982. The severe problem of declining utilisation levels was induced by the unavailability of imported inputs, thus private sector employers were forced to downsize workforce. Government, on the other hand, was obliged to do the exact opposite. The main highlight of the Structural Adjustment Program on tackling the serious macroeconomic imbalances during the 1970s and early 1980s laid the foundation for industrial recovery. Initially, the adjustment policies resulted in improvements in the plant utilisation. Between 1970 and 1983, industrial output increased gradually. Manufacturing, which accounted for 14% of GDP in 1970, contributed to 21.5 % of GDP in 1977. Yet, its share had gradually declined over time, accounting for only 9% of GDP. The manufacturing sub-sector was the slowest to recover during the adjustment period. In 1990 the average production of the manufacturing industries represented only

about 60% of the level in the mid-1970s. With the exception of cement and iron, the output in all manufacturing industries was below the 1970s levels. Estimates from the Ghana Statistical service, indicate that the capacity utilisation levels in manufacturing was only at 40% in 1990 and has relatively remained unchanged. Production in the Food processing and textile manufacturing sub-sectors is still below 1970s levels.

In comparison to other industries, cement, petroleum and metal industries have experienced grown rapidly. During the early 1990s, the privatisation of the iron industry boosted iron production from a decline of 5% in the 1970s to a six-fold increase in volume between 1990 and 1996. Sawn wood production, after experiencing strong growth during the late 1980s to the early 1990s, slowed down considerably due to a ban on log exports and new environmental legislature. Aluminium production increased gradually after the initiation of reform programs but by 1992 production was still below the 1980 levels. By 2006, total aluminium production was about 65,000 metric tonnes valued at US$ 164 million.

The second half of the 1980s saw an increase in mining sector production, accounting for 6% of GDP in 1997. However, the composition of mining output had varied over the years. In terms of volume, diamond extraction was Ghana's second largest mining industry in the 1970s, but almost collapsed in the 1980s. By 1990, the mining production had returned to its 1977 level with strong increases registered in bauxite and manganese production. In 2006 total manganese production was 1,804,155 tonnes valued at US$ 40.64 million. This growth has contributed to raising the share of the mining sector in total exports. Gold has emerged as a main FX earner for Ghana with a total production of 2,120,230 ounces valued at US$ 1.28 billion. The 2000s was characterised with a severe energy crisis which contributed to the declining growth rates in various industrial sub-sectors. In 2007, this adverse impact was somehow mitigated

by relatively high growth rates of 30% and 11% in the mining and construction sub-sectors respectively. The growth in mining sector was mainly due to the installation of emergency power plants to supplement energy supply shortages.

Growth in the construction sector, usually proxied by the growth in the production of cement, continuously declined in growth until the late 1980s. Since the early 1990s, output has grown steadily, more than doubling between 1990 and 1996. Construction has grown from 5 percent of GDP in 1975 to 9 percent of GDP in 1998. Over the year the construction sub-sector has experienced sustained growth emanating from increased road construction and other infrastructural development throughout the country. In addition, a total of 2,010,324 metric tonnes of cement were produced during the 2006 against 1,896,325 metric tonnes in 2005, thus indicating robust construction activities. The contribution of the industrial sector to GDP in 2007 was 26%, a marginal increase from 2006.

Services

The services sector is usually referred to as the tertiary sector of the economy. The development of the primary (agricultural) and secondary (industrial) sectors is expected to boost development in the services sector. Specifically, as the agricultural sector advances and industrialisation overshadows it in significance, the services sector would eventually emerge as the largest contributor to GDP and economic development. The services sector has a strategic role of inducing economic growth in the economy by facilitating the efficient functioning of product and factor markets. Despite its importance the services sector has been somehow neglected by policy makers, who have continued to place a larger emphasis on agriculture and industry. The proposal of the USA to include services in GATT negotiations in 1982 has gone a long way in stimulating interest in the services sector in sub-Saharan countries like Ghana.

In the national accounts of Ghana, the services sector is organised into six main categories: (i) finance, insurance, real estate and business services; (ii) wholesale, retail trade, restaurants and hotels; (iii) transport, storage and communications; (iv) government services; (v) producers of private non-profit services; (vi) community, social and personal services. A good transport system improves division of labour, and lowers the retail prices of food and other domestically produced goods. Transportation system plays a role in determining a country's competitiveness on the world markets. Basic communication facilities include the telephone and mobile phone networks, internet, telegraph, and postal services. Communication services improve the running of the product and factor markets by efficiently connecting buyers and seller. Telecommunications advancements have allowed consumers and service providers to trade efficiently without significant personal contact. Wholesale, retail trade, restaurants and hotels form the largest category of the services sector. This category includes a majority of local entrepreneurs with government participation at a minimum. Finance, insurance, real estate and business services are vital in the mobilisation of domestic savings for investment in human and physical capital. The growth and expansion of other sectors of the economy depend on this category. Nevertheless this category of the services sector remained relatively under-developed before the start of the adjustment program. The heavy presence of the SOEs in this category led to increased inefficiency and under-performance especially in the banking, insurance and estate businesses. Government services consist of sectors of the economy which provide social services like health, education and housing. Government is also heavily involved providing community and social welfare services. Producers of private non-profit services, referred to as non-governmental organisations (NGOs), provide assistance to poor and underprivileged communities. The Ghanaian service sector contracted considerably during the pre-ERP period. According to estimates by the Ghana Statistical service, the

share of services in terms of value added dropped considerably from the mid 1970s to the early 1980s. After the inception of the ERP, the services sector has been transformed significantly. This sector has been expanding moderately since 1984. Since 1985 the contribution of the service sector to GDP has averaged 40% per annum. With respect to the diminishing contribution of agriculture to GDP since the early 1980s, the services sector can be described as a more vibrant sector. Tourism, though in its early years, is emerging as an important service sector which is rapidly developing. Over the years, the tourism sector has proved beyond reasonable doubt that it has the potential to attract private sector investment, offer employment opportunities and support export diversification. FX earning from tourism has increased at an average of 30 per annum since 1995, and it employs over 500,000 people. In 2005, Ghana earned about US$800 million from the tourism sector. This figure represented expenditures and receipts from about 400,000 tourists with average spending of US$1950 per tourist.

Other components of GDP

This section examines the expenditure composition of GDP.

Aggregate capital formation (Gross investment)

Investment is vital in the determination of economic growth. Investment leads to the adoption of new technology, creation of employment, increases in income and the improvement in people's living conditions. If investment is channelled efficiently to the relevant projects, it may contribute positively to poverty alleviation. Yet, successive governments have maintained the hostile attitude towards investment, mainly private investment, in Ghana. Immediately after independence in 1957, the government implemented an industrialisation strategy through a direct state-owned concept to promote growth through rapid industrialisation, and to encourage the mass production of food for local consumption. At the time, President Kwame Nkrumah opposed private investment because of the potential threat to his political ambition posed by wealthy

entrepreneurs (Killick 1978). This was evident in his declaration that he favoured the creation of Ghanaian co-operatives rather than empowering Ghanaians to start private business enterprises.

Notwithstanding this observation, in 1963, a Capital Investment Act (172) was passed, which offered a variety of concessions to potential investors, though accompanied by very harsh provisions. Between 1966 and 1972, various governments vigorously pursued more open policies and encouraged private investment. These governments sought to arrange foreign inflows in terms of long-term public and private capital, and introduced import liberalisation into Ghana (Leith, 1974). Yet, not much was done to alter the law on state ownership in economic activities. According to Killick (1978), 43 out of 53 enterprises that operated in 1971 were state-owned.

Between 1972 and 1978, a succession of military interventions occurred that transformed the economy into a strong command system. Consequently state intervention in economic activities deepened. In 1973, an Investment Decree (NRCD 141) was enacted, followed by the Investment Policy Decree NRCD 329 of 1975, both of which promote local and foreign investment. In 1979, a new military coup brought in the Armed Forces Revolutionary Council (AFRC), with the view to embarking on "some house cleaning" exercises. The new military council "denounced neo-colonialism prevailing in the country as the root causes of the economic problems". Consequently, it regarded a revolution based on the mobilisation of internal and external resources to finance productive investments as the means by which the foundations of a self-reliant economy could be laid (Sarpong 1993). After a few months of military rule, the economy was returned to a democratic state under President Liman. Liman's government was later ousted by the leader of the previous military government. Initially, private entrepreneurs were criticised as being corrupt, and for this reason, assets of the majority of investors were confiscated by the state. Subsequently, the Ghana Investment Code (Act 437) was

introduced in 1981, which among other things, sought to centralise investment promotion activities at the Capital Investment Board, and consolidate all investment legislation. Ghanaians were surprised at this new initiative launched by the same government who had earlier made attacks on private investors in Ghana. In 1985, an Investment Code (PNDCL 116) was formulated, which led to the establishment of the Ghana Investment Centre, whose main function was to serve as the Centre of investment activities in the country. The investment code offered several incentive packages for would-be investors, for instance, incentives in the area of accelerated depreciation allowances, exemption from import duties on machinery and equipment, tax holidays, and arrangements for repatriation of profits.

Another issue of importance was the ratification of the convention establishing the Multilateral Investment Guarantee Agency (MIGA) of the World Bank. One of the prominent aims of MIGA was to encourage equity investment and other forms of direct foreign investment in Ghana, "by reducing non-commercial risks" (The World Bank, 1987). Subsequently, the Ghana Investment Centre (GIPC) was set up under the GIPC Act of 1994, the aim of which was to promote and encourage private investment. Among its activities was the revision of the 1985 Investment Code, to enable the country to attract the much needed investments in support of its accelerated economic growth policies.

Data on gross domestic investment in Ghana is categorised into public investment (including government and public enterprises) and private investment. Gross domestic investment (GDI) is used in this research as an acronym for gross fixed capital formation in the data series. GDI as a percentage of GDP reduced from a peak of 16% in both 1970 and 1973, to only 4% in 1981-1983. The gradual decline in GDI cannot be easily attributed to a particular component (either public or private), since both fluctuated during the period between 1970 and 1983. The long-lasting economic decline,

restrictions in credit and FX markets, combined with the risks faced by investors, resulted in the worsening of the problem. GDI increased from 6% of GDP in 1984, to 11% of GDP in 1990, before falling to around 8% of GDP in 1991. It rose again to peak at 18% in 1997 before falling again to around 8% of GDP thereafter. During the period 1988 to 1995, investment activities in Ghana focused on rehabilitation and expansion rather than on new investment. The trends in investment in Ghana are similar to the overall figures in Sub-Saharan Africa. During the early 1980s when Ghana's investment drive had reached its lowest level, private and public investment as proportions of GDP in Sub-Saharan Africa also recorded low ratios.

Between 1970 and 1975, public investment averaged 5.2% of GDP, moving in the opposite direction from that of private investment. Public investment dropped from a peak of 12% of GDP in 1976 to its lowest level of 1% of GDP in 1981 and 1982. There were marginal increases to about 3% of GDP from 1985 to 1991 and also from 1993 to 1994. It increased gradually to about 6% in 2000. It must be noted that at the time of a sharp decline in public investment between 1977 and 1983, the economy of Ghana experienced a severe recession accompanied by excessive rates of inflation and high unemployment amidst high over-valuation of the exchange rate. The government was unable to undertake any development projects, as the state owned industries became a burden on the state.

Private investment was about 10% of GDP 1970 to 1971, but dropped to 3% of GDP in 1972, mainly because of the military coup, and was around 9% in 1974. Investment then declined to approximately 5% in 1978, reaching its lowest level of 2% of GDP in 1982. After 1983, there was a steady increase in the private investment ratio to a peak of 8% in 1990, before falling again to 4% of GDP in 1994-1995. Thereafter it fluctuated to reach a stable 5% of GDP in 2000. The recovery of private investment may have been encouraged by the improvements in exchange rate liberalisation, elimination of trade

barriers such as controls, exchange controls, export and import permits, surrender of export receipts, as well as the improvements in roads and transportation networks. The subsequently flat level could be explained by the lack of adequate investible capital. The main driver of growth in 2005 appears to have been the increase in investment, both private and public, with road construction accounting for most of the projected 9 percent real increase in public investment. While private investment matched the increase in public investment, suggesting that private investment have been able to respond to the opportunities provided by the economic expansion, it appears that there is still scope for faster growth through an increase in investment efficiency. At Ghana's current investment to GDP ratio, almost 30 percent, if the efficiency of investment were at levels comparable to other developing countries, the country could be growing at an additional 2 to 3 percentage points per year.

2.4 Main Characteristics of the Ghanaian FX market

Between January to August 2007, average daily market turnover in the Ghanaian FX market was approximately $38m ($29m without oil imports). The domestic currency is called the CEDI. It is primarily a spot market where FX trades involve the exchange of domestic currency for foreign currencies for settlement in two days. The forward FX market is non-existent due to the absence of a yield curve on which to base forward prices. The central bank is the main supplier of FX with its main source being export receipts, donor inflows and taxes and royalties paid in foreign currency.

Unlike the major currencies (with liquid markets) that are traded worldwide, a small currency like the CEDI is only traded onshore in Ghana. Central bank regulations prohibit the operation of offshore trading of the CEDI and it has the power to impose restrictions on its import and export. The US dollar is the most traded foreign currency in Ghana and subsequently plays the role of a vehicle currency in cross currency

transactions. For example the purchase of Indian rupees with CEDIS is performed by first purchasing US dollars with CEDIS and then using the US dollars to purchase the Indian rupees. In other words, it is easier to find agents who are willing to exchange CEDIS and rupees for US dollars than finding one willing to exchange CEDIS for rupees. This is simply because US dollar market is more liquid with lower transaction costs.

There is a high degree of concentration in the Ghanaian FX market. Out of the 17 banks the top 5 control 80% of the FX transactions. There are numerous foreign exchange bureaus that compete with the banks but they account for small portion of the foreign exchange market. In comparison to customer level transactions, the FX interbank market is relatively small.

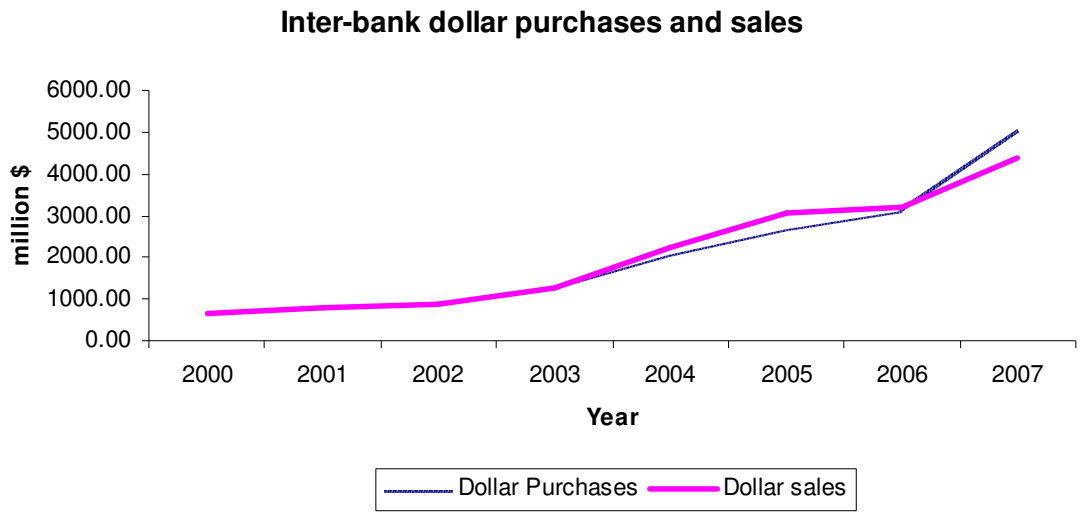


Figure 2.6

2.4.1 Foreign Exchange Bureaus in the Ghanaian FX market

In light of the fact that FX bureaus rates have been used as a proxy for parallel market rates, it is imperative that we gain a deeper insight into their activities.

Brief History of FX Bureaus

In 1981, smuggling and illegal FX operations had become so widespread that the parallel market rate was 9.6 times higher than the official rate. Around this period transactions in the parallel economy was accounted for about a third of Ghana's GDP. By 1986, the government was not directly involved in exchange rate determination. It introduced a system where the exchange rate was determined at periodic currency auctions. These currency auctions were under the influence of market forces and consisted of a two-tier exchange rate system, one rate for essentials and another for non-essentials. By 1987, the two auctions had merged. Most of the foreign exchange inflows were allocated through the auctions. In an attempt to combat and eradicate parallel market operations, private foreign-exchange bureaus (FX bureaus) were allowed to trade in foreign currency. In July 1989 there were 148 FX bureaus operating all over Ghana. Eventually the huge gap between the auction rate and FX bureau rate had narrowed drastically. Specifically the gap reduced from 29% in 1988 to approx. 6% in 1991. In 1992, the auction system was abandoned. FX bureaus and other purchasers of foreign currency were referred to the central bank, which used the market-determined exchange rate. Gradually Ghana moved towards a market-determined exchange rate and lowered tariffs in order to attract more trade.

2.5 The Market Microstructure of the Ghanaian FX market

There is only one official FX market where all legally permitted FX transactions take place. However there exists a very active parallel (parallel) where illegal but tolerated transactions take place. The existence of the parallel market is largely due to direct and indirect intervention in the FX market. "When access to the official foreign exchange market is limited and there are various foreign exchange restrictions on international transactions of goods, services and assets, an excess demand develops for foreign currency at the official rate, which encourages some of the supply of foreign currency to be sold illegally, at a market price higher than the official rate." (Phylaktis 1997)

The relatively low interbank activity could imply that the central bank may have accurate measures of order flow in the market. Specifically, in order to have an idea of exchange rate pressures, order flow can be deduced from the transactions between banks and their customers because it is the customers who initiate the transactions at exchange rates quoted by the banks. Even if the interbank market turnover were to increase in the future, the central bank could still obtain an accurate measure of order flow due to its strict reporting requirements.

The Ghanaian FX market is pure dealer market. Dealers usually provide liquidity to the market by absorbing order flow imbalances. This is achieved through a mixture of exchange rate adjustment and inventory management. Specifically dealers set two-way exchange rates at which customers will buy and sell FX, they absorb any excess demand or supply and then adjust exchange rates to manage their net open FX positions. Apart from providing liquidity, net open positions allow dealers to speculate against the CEDI by building position before expected currency depreciation takes place.

There are 17 active dealer banks in the foreign exchange market. The top five banks are the main market makers and play a vital role in the determination of the exchange rate. The top five account for approximately 82.3% of total volume of transactions on the FX

market[1]. They quote two-way exchange rates at which they are willing to trade with each other. The bid-ask spread reflects the level of competition among market makers and the exchange rate risk associated with possible exchange rate movements. Unlike other emerging FX markets, limits are not imposed by the central bank on net open positions. Rather the central bank has opted for monitoring the foreign exchange positions, thus increasing the scope for market making.

In communicating and trading with each other, dealers agree to trades in telephone conversation which are later confirmed by fax or telex. There are no electronic trading platforms (like Reuters spot dealing systems) that allow for bilateral conversations and dealing.

Only licensed banks and foreign exchange bureaus are allowed to perform FX intermediation. In Ghana, all the banks (both domestic and foreign-owned) are permitted to deal in FX. The licensing of intermediaries makes it easier for the central bank to enforce its regulations concerning the use and exchange of foreign currency. For example, a customer will have to provide the proper documentation relating to the underlying economic transaction that is generating the demand for foreign currency. It is regulations like these that make the parallel market a suitable alternative.

The heavy involvement of the central bank in the FX market limits the scope for price discovery. This is because the central bank has a superior information advantage over the other banks due to its ability to obtain private information from the main market makers. From 2002 to present there is evidence of massive central bank intervention on the FX market. The central bank absorbs innovations in the order flow at existing exchange rates, usually with the aim of reducing exchange rate volatility. The central bank refers to these actions as 'balance of payment support'. The exchange rate is still

[1] June-September 2007 Quarterly Bank of Ghana Report

determined by market forces but with the central bank absorbing part of the excess demand or supply.

The high degree of concentration already mentioned above could also lead to higher transparency. Each of the dealers from the top 5 banks observe a significant proportion of the market and maybe have a rough idea of the trading flow that they are not involved with. In general the central bank does not disclose information obtained from banks' reporting requirements because of the proprietary nature. In Ghana, banks are required to report each foreign exchange transaction at their respective exchange rates.

An FX transaction is settled only when the bank account of the seller is irreversibly credited and that of the buyer is debited. This occurs at central bank accounts where banks make deposits to meet reserve requirements. The foreign currency leg of FX transactions is usually settled abroad through correspondent banks. In particular the debiting and crediting of FX occurs in nostro accounts opened by domestic banks abroad. At present most banks in Ghana, use SWIFT, a worldwide interbank telecommunications network, as the main system for conveying messages with international payment instructions and confirmations of FX transactions. For example a bank in Ghana may send a SWIFT message to its correspondent bank in London instructing it to transfer US dollars from its nostro account into the nostro account of the beneficiary. The corresponding bank in London then makes the necessary transfers to settle the transaction.

2.5.1 Activities of FX bureaus

On a typical day, the daily turnover of FX bureau operators situated in the city centre ranges from $10-$20k. However this depends on seasonal factors with peak flows being observed during the last quarter of the year, when retailers (importers) prepare for the Christmas shopping. Peak flows are also associated with Muslims' annual Hajj trip to Saudi Arabia. The USD accounts for about 2/3 of all FX transactions. Operators

attributed this trend to the global dominance of the USD, its use as a vehicle currency and the lack of confidence in the domestic currency. Presently, their main source of FX is mainly the general public. The central bank ceased the supply of FX to the bureaus around 2000/2001. This move seriously affected the profitability of the bureaus because CB flows represented a cheap source of funding and fierce competition developed between bureaus.

FX bureaus rarely engage in FX transactions with banks. Their relationship can be described as a typical bank-customer relationship where bureaus operate FX deposit account with banks. Nevertheless they share a special relationship where bureaus use bank rates as a guide and banks call bureaus on a daily basis to check their rates.

On the average bureaus quote 'higher' rates than the banks. The difference between bank rate and bureau rates is mainly due to the relative flexibility of the bureaus. Unlike the banks, bureaus can adjust their rates about 3-4 times daily in response to market signals. Depending on the season, the parallel market (FX bureau market) is relatively more volatile. On the other hand banks rates rarely change during the day. Market signals include customer flows, central bank actions, actions of other bureaus etc. As and when the bureaus receive market signals, they evaluate and process this information before fixing prices accordingly.

2.5.2 Illegal Activities of FX Bureaus

FX bureaus are regulated by the central bank. This consists of the submission of monthly returns and financial accounts. Bureaus' licences to trade FX are renewed annually to ensure strict adherence to rules and regulations. Additionally bureaus are subjected to random spot checks where for example officials check whether cash tally with receipts. Despite efforts by the CB to closely monitor the activities of bureaus, sizeable portions still engage in illegal activities. These illegal activities mainly consist of non-issuance of receipts for FX transactions and illegal remittances. When receipts

are not issued, this implies that bureaus do not account for sizable portion of their transactions. Thus bureaus' transaction will be understated and may not be a true reflection of the actual situation on the market. More importantly this illegal practice allows bureaus to charge arbitrary rates.

Also the central bank regulation prohibits bureaus from providing money remittances service. Yet some bureaus engage in these illegal money remittances. Ghanaian bureaus have representative/agents in London who receive remittances on their behalf. Consequently the bureaus in Ghana search for scarce FX on the market to pay the recipients. This is contrary to the normal procedure where it is rather the cedi-equivalent of the remittance that is paid to recipients.

Aside the banks, the FX bureaux and the financial services companies for remittances constituting the FX market, there is the usual unofficial parallel FX market made up of illegal FX dealers who operate from unauthorized locations. According to the central bank, their operations constitute less than 5 percent of the FX market turnover.

2.5.3 External Trade and Parallel Foreign Exchange Market Premium

The Parallel market exchange rate premium measures restrictions on the availability of foreign currency, which are necessarily imposed in regimes with multiple exchange rates and severely misaligned official rates (IMF, 2000). Reasons for the sources of this premium are not hard to find. In the 1970s and most of the 1980s, administrative controls were used to allocate foreign exchange. This may have contributed to the surfacing of an active parallel foreign exchange market in Ghana. During the 1970s, the parallel FX market premium was persistently large, reducing considerably in the early 1990s as the restrictions on foreign currency transactions were abolished. This was due to the adoption of a flexible exchange rate policy, which allowed market forces to determine the value of the Ghanaian Cedi.

In the late 1960s, the collapse of international cocoa prices forced the government to devalue the currency in December 1971 to reduce the domestic effects of the deterioration in the terms of trade (Aryeetey et al., 2000). The toppling of the government in 1972 was followed by a revaluation of the cedi in stages and then was eventually pegged at ¢1.15 to the US dollar in March 1973 (Roe and Schneider, 1992). During the remainder of the decade, the authorities were reluctant to devalue the cedi when faced with the excessive balance of payment deficits (Dordunoo, 1997). Instead, they preferred to impose ad hoc restrictions on trade and FX transactions. The 1973 parity was maintained until June 1978, when the cedi was again devalued to ¢2.75 to the US dollar. It remained relatively unchanged until April 1983, when it was devalued to ¢9.79 per US dollar as a result the ERP (IMF, 2000)

In an effort to significantly reduce parallel market operations, the Ghanaian authorities allowed FX bureaux to operate in February 1988. Naturally, this move led to the absorption of the parallel market into the redefined legal structure. However, this resulted in a dual exchange rate system with two different spot FX markets and two exchange rates: a bureau rate and auction rate. Additionally an FX inter-bank market was established in March 1992, to enable domestic banks to trade in FX amongst themselves. With FX now determined by market mechanisms, restrictions gradually declined. In October 1986, reforms of the exchange rate system were combined with the removal of import licensing, rationalisation of import tariffs, and the removal of all restrictions on payments and transfers for current international transactions. Even with these reforms, trade within the FX market was limited in the 1990s, with large proportion of transactions taking place between the Bank of Ghana and the commercial banks, rather than amongst the commercial banks. The Bank of Ghana quoted an exchange rate that was equivalent to the average of indicative rates quoted by the commercial banks and thus did not reflect the actual rates for market transactions. A

more serious problem was the suspicion that the Bank of Ghana was using administrative pressure and moral persuasion to maintain the currency at an overvalued level. This would enable Ghana to support her external obligations and imports while controlling inflation. In 1999, Ghana suffered a severe terms of trade shock, with the fall in cocoa and gold prices and the increase in the crude oil prices. As a result international reserves dropped to very low levels and the cedi had depreciated by over 50% by the end of the year. By the end of 2000, the parallel market premium had become almost negligible. Specifically, the official rates almost equalled their parallel market rates, excluding small transaction costs. Between 2002 and 2007, the parallel exchange rate premium on the average fluctuated between 2% to 4%.

Since the introduction of economic liberalisation, Ghana's trade balance has been in deficit compared with surpluses in the previous years of the control regime. Despite large increases export volumes, declining terms of trade and a substantial increase in externally funded imports to increase industrial production have led to a massive deficit. The current account has recorded deficits throughout the period between 1983 and 2007. The practice of financing persistent current account deficits by borrowing abroad led the mounting external debt of Ghana.

Ghana's foreign currency reserves increased from US$36.6 million in 1970 to US$207 million in 1982, and then increased further to US$878 million in 1996. In 2007, reserves stood at US$2.84 billion. This huge accumulation was mainly due to massive foreign capital inflows, increased remittances by Ghanaians resident abroad, cancellation of debt under the HIPC initiative and from proceeds of Ghana's first Sovereign bond. Recently the cedi has been allowed to depreciate freely but it has also been argued that there has been a deliberate attempt by the Bank of Ghana to maintain a stable exchange rate by intervening on the FX market. Arguably, a real appreciation in the cedi-dollar exchange

rates could lead to a decline in exports, which would counter the export promotion drive of Ghana.

2.6 Fiscal Policy

This subsection examines how the Ghanaian government obtains its revenue and allocates its expenditure. It also examines the associated impact on economic development and growth. Since 1983, fiscal discipline has been the essential element in the government's attempt to achieve and sustain macroeconomic stability. In the Ghanaian context, fiscal discipline refers to the ability to keep expenditures within available resources. Available resources comprise government revenue plus foreign grants. We analyse the trend in performance of government's revenue collection over the period 1970 to 2007.

Invariably, the tax revenues to GDP measure the success in raising revenues through non-inflationary means. Tax revenues, as a ratio of GDP, signals the government's reliance on taxes as opposed to debt accumulation, money creation, or transfers from public enterprises, as a way of financing its expenditures (Tanzi and Zee, 1996). Tanzi and Lee claim that countries whose tax revenues are usually below 10% of GDP are more likely to run into financial difficulties. In Ghana, tax collection is administered by two main agencies: the Internal Revenue Service (IRS), with responsibility for direct taxes; and the Customs, Excise and Preventive Service (CEPS), with responsibility for collecting indirect taxes (including taxes on petroleum products) and all import related tariffs. Table illustrates a detailed breakdown of sources of government revenue over the period 1970 to 2007. In 1970, total revenue as proportion of GDP was estimated at 25%. However, this ratio had fallen sharply to 14% in 1972. This situation was temporarily reversed in subsequent years but dropped to 6% of GDP between 1978 and 1980, and to 5% of GDP between 1983 and 1983. The movement in total revenue has

mirrored the movement in tax revenue, since non-tax revenue has remained well below 10% of GDP from 1970 to 2007. Nevertheless, the downward trend of total revenue as a percentage of GDP recovered following the initiation of the ERP in 1983. Total revenue increased to 23% of GDP in 1994-1995, but again, embarked on a downward trend from 1996 to 2000, estimated at about 20% of GDP in 2000. This ratio recovered again, ranging from 30% in 2004 to 32.1% in 2007. Total direct tax revenue has generally remained below 5% of GDP annually but has hovered around 6% of GDP between 2004 and 2007. Total indirect tax revenue has ranged between 2% of GDP in 1982 to 19% in 1970 but now stands at 9.35% in 2007.

The Ghanaian government acknowledges that revenue enhancement is a key element of fiscal sustainability. Value added tax (VAT) was introduced in March 1995 in order to increase the tax base to increase revenue (IMF, 1995). VAT replaced the domestic and sales tax, and was applied to goods and services at the retail level. Apart from replacing the sales tax regime, VAT was intended to bring about a shift from income to expenditure related taxation (ISSER, 1997). These changes improved the efficiency of tax collection and helped to broaden the indirect tax base (World bank, 1997). Unfortunately, the introduction of VAT coincided with the poor harvest of local foodstuffs. Consequently civil servants embarked on a strike over VAT, forcing the government to reluctantly withdraw the tax and return to the previous sales tax rate of 15%. Furthermore, the VAT secretariat was faced with problems of some traders applying the rate of 17.5% numerous times to times to the same goods and services. This was mainly due to inadequate public education on the implementation of the new tax system (CEPA, 1996). Non-registered traders also took advantage and applied the VAT rate to their goods. Transport fares, which had already increased to take account of a 20% rise in petroleum prices, were further adjust upwards for VAT. These miscalculations, combined with the simultaneous acute shortage of foodstuffs, led to

food price increases. Aryeetey et al. (2000) argued that the fiscal crises in Ghana since the introduction of the ERP were primarily driven by expenditure over-runs rather than by the government's inability to meet revenue targets. Yet, other experts have argued that the revenue collections could have improved significantly. Specifically the problems of inadequate capacity to collect taxes efficiently and effectively combined with rampant corruption impacted negatively on revenue collection.

Throughout the period between 1970 and 1983, the Ghanaian government's attempt at accelerating economic growth caused excessive government spending. As a result, the growth rate of expenditures outpaced that of revenues. The major driving force behind the government's excessive expenditure has been the ever-increasing recurrent account, especially for wages and salaries. The huge recurrent expenditure was mainly due to government's role as the largest formal sector employer. A survey by the Ministry of Industries, Science and Technology put all plant utilisation rates at less than 20%. Since government owned most of these plants, this places an extra burden on the national budget in terms of wages and salaries. As the small private sector laid off workers due to idleness, the SOEs continued expanding their workforce amidst falling capacities levels (IMF, 2000). During the same period, there was little evidence of an effective outcome of government's activities.

Fiscal imbalances started developing in 1971. Between 1970 and 1980, total government expenditure constituted an average of 21.4% of GDP. We further observe that the gross fiscal deficit of the government, which measures the difference between revenues and total expenditure, has been running high since the early 1970s. A detailed breakdown of the expenditure pattern of the central government is shown in table . From -0.44% of GDP in 1971, fiscal deficits became -8% of GDP in 1974. It then plummeted to -15% of GDP in 1977 and 1978. In 1983, the reforms led to a partial improvement in the economy. Hence, the budget deficits improved from a deficit of

around 3% of GDP to one of 2.2% of GDP in 1985, registering a modest surplus of about 0.05% of GDP in 1986, and improving steadily thereafter to approximately 2% of GDP in 1991. Sowa (1994) argued that fiscal discipline resulted from drastic cost-savings and cost recovery measures on the part of the general government sector, including the de-subsidisation and de-hiking of expenditure on education, health, and agriculture, as well as retrenchment of public servants.

In 1992, fiscal imbalances re-emerged as a consequence of large salary awards in the public sector (Bank of Ghana, 1997). In the transition to multiparty democracy, the government, concerned about the support of public servants, granted substantial wage increases amounting to 80% of the total nominal payroll. Almost all other institutions in the countries similarly increased their staff remuneration. By 1997, government expenditure as a percentage of GDP had shot up to 34%, but dropped thereafter to 23% of GDP in 2000. By 2006 domestic revenue as share of GDP stood at 26% while total expenditure as a share of GDP was 40.1%.

It seemed like the goal of expenditure reduction by the government appeared to be elusive. The persistent budget deficits have led to increased donor assistance to help finance government deficits. As a consequence, while the overall trend has shown improved fiscal consolidation since the inception of the reforms, operational and structural weakness have impeded a sustained improvement in the public finances, and domestic debt has continued to rise.

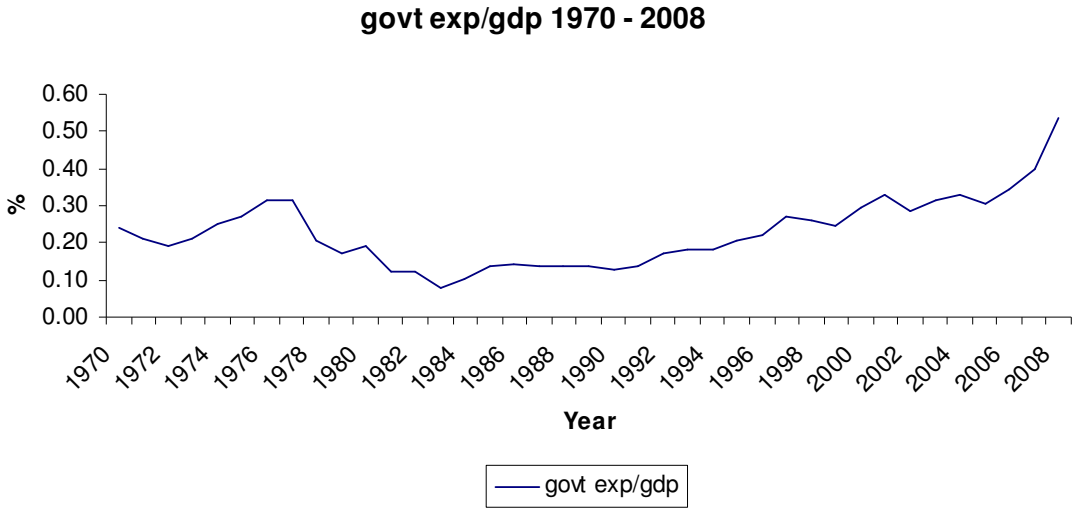


Figure 2.7

2.6.1 Government Debt

International financial institutions, especially the World bank, have been the main source of capital inflows into Ghana. These resources have been used mainly to finance public sector projects, but provided as balance of payment support. As result Ghana is heavily indebted to these organisations, including the IMF. Ghana's total external debt stock stood at US$431 million in 1970 and shot up to US$797 million in 1977. By 1993, the total external debt stock had reached US$4.68 billion, representing 75% of GDP. This continued to increase further till it reached US$6.04 billion in 2000, representing 69% of GDP. By 2004, the external debt stock had risen to US$6.45 billion, representing 73% of GDP. However in 2006, the external debt stock dropped drastically to US$2.18 billion, accounting for a relatively smaller 17.5% of GDP. This was mainly due to a debt cancellation of about US$3.7 billion as a consequence of Ghana joining the HIPC initiative. However the external debt increased again to US$3.59 billion in 2007 due to the disbursement of proceeds from the 10 year Eurobond and other additional disbursements from bilateral and multilateral creditors. The ratio of total debt stock to exports rose from 0.68:1 in 1970 to 4.80:1 in 1983. Afterwards, it fell gradually, reaching 3.18:1 by 2000 and dropping considerably to 0.86:1 in 2007. In 2000, the new

government embarked on a programme to reduce domestic debt in relation to GDP to enable the private sector access credit and stimulate the growth process. Consequently the domestic debt to GDP ratio dropped significantly from 29.12 in 2002 to 14.7% in 2006. However this ratio increased to 18% in 2007 mainly as a result of energy related expenditures and infrastructural development. Government's persistent fiscal deficits have been financed mainly through domestic and foreign sources, with the Bank of Ghana providing the largest share. Islam and Wetzel (1994), and Dordunoo (1993) have attributed the high inflationary rates in the 1970s to the Bank of Ghana's financing of deficits during that period. As already mentioned, fiscal discipline has been a primary element of Ghana's efforts at achieving macroeconomic stability since 1983. Though high level of donor inflows has partly mitigated this problem, a more sustained fiscal balance will depend on the government's efforts to raise domestic revenue.

2.7 Monetary Policy

We now examine money supply and its contribution to high inflation rates in Ghana. The key aim of monetary policy in Ghana has been to achieve and maintain low, stable inflation, and ensure a relatively stable exchange rate. This is the result of government's acknowledgement of how a low inflationary environment will be conducive to economic growth and hence, poverty reduction by encouraging long-term investment and attracting foreign direct investment. Additionally, low inflation preserves the real income of the population and helps maintain living standards.

A critical assessment of the data shows that the expansion of the monetary system was engineered largely through government borrowing from the Bank of Ghana. Roe and Schneider (1992) observed that cocoa financing was second to government borrowing, in terms of total money supply in Ghana. Broad money supply continued to grow throughout the period 1970 to 1978. The growth in M2 over the post-ERP period has

followed a pattern similar to that of the pre-ERP era. Even though money creation has been mitigated by the growth in the foreign asset component (Sowa, 1994), the rate of growth appears to be responding to the changing growth rates of government spending. Growth of broad money increased from 10% in 1971 to 34% in 1972, before dropping to around 17% in 1973, and rising once more to a peak of 74% in 1975. After that, the growth rate of money supply fell to around -6% in 1977, shooting up to 54% in 1978. Since then the rate of growth of broad money has followed a chequered pattern. Although the growth of broad money appears to have been controlled during the reform era, expansion of broad money could not be kept below 15% per annum.

The acceleration in money supply was mainly due to increases in both the net foreign assets and net domestic assets of the banking system. However, the rate of expansion in money supply decreased, as a result of tight monetary policy pursued by the BOG. The net foreign assets of the BOG, on the other hand, fell considerably during the early 1970s to mid-1980s, improving marginally between 1994 and 1999, before falling further in 2000. This pattern was due to the scarcity of FX inflows in the face of mounting debt. The net domestic assets of the banking system increased steadily throughout the period 1970 to 2000, reflecting exceptionally strong domestic credit growth during the period. In 2002, broad money including foreign currency deposits (M2+) increased drastically to 50% mainly due a 190.6% growth in net foreign assets and a 26.3% growth in net domestic assets. This resulted from a surge in the foreign exchange reserves. Afterwards, there was a general slowdown in the growth of the monetary aggregates with the rate of growth of M2+ decreasing to a rate of 14.3% in 2005. Nevertheless, the rate of growth of M2+ shot up to 38.8% in 2006. This increase was attributed to strong growth in net foreign assets (39.5%), resulting from strong cocoa export receipts and relief granted under the multilateral debt relief initiative. The increase in net domestic assets (38.1%) was due to increases in banking system net claims on private sector

(42.2%), public sector (31.5%) and government (11.3%). Continued strong increases in both net domestic assets and net foreign assets of the banking system resulted in M2+ growth of 36.3% in 2007.

In the past, the BOG used indirect instruments for monetary policy. Specifically the BOG issued Treasury Bills (T-Bills) to control liquidity in the economy and meet government's borrowing requirements. Since the commercial banks were the major buyers of the t-bills, this contributed to a crowding-out of private investment. However, recent experience suggests that the TB sales alone are inadequate in responding to the more complex monetary policy requirements of a liberalised financial system. To enable a quick response to current market conditions, the Bank of Ghana introduced the use of repurchase agreements with commercial banks. In 2002, the Bank of Ghana prime rate was introduced. According to BOG, the prime rate is to be "used as an anchor for money market rates and to signal the bank's assessment of inflationary pressures and monetary policy stance".

Effective liquidity management using open market operations depends very much on the level of capital development in the country. Clearly, capital markets are very important in the mobilisation of investment capital. Despite having been operational for a number of years, the capital market in Ghana is still very shallow. A majority of Ghanaian firms are generally small and uncompetitive. Furthermore, they have huge tax arrears which make them unwilling to disclose information required by the Capital market Board.

Interest rats have barely responded to changes in the macroeconomic environment over the period 1970 to 2000. Between 1970 and 1986, interest rates were controlled by the Central Bank. This policy was labelled "financial repression" by Shaw (1973). Bhagwati (1978) detailed the web of physical and quantitative controls common in many developing countries, examining the economic consequences of such controls. Particular emphasis was on the ineffectiveness of this monetary policy during the pre-ERP period.

In fact, real interest rates were largely negative, due to the high rates of domestic inflation prevalent in Ghana at the time. However, after the commencement of the financial liberalisation programme, management of interest rates were liberalised. Consequently, the rate rose gradually peaking at around 35 per annum in 1998, and ranging between 30-40% over the period 1999-2000. Afterwards, interest rates gradually decreased, reflecting a relative improvement in macroeconomic fundamentals. In 2002, the prime rate was set at 24.5% with the inter-bank rates ranging from 21.7% to 26.6%. The range in rates usually reflects liquidity conditions related to injection of money for cocoa purchases and Christmas spending. In Ghana, a majority of government instruments sold were 91-day t-bills, as investors preferred short-term assets. The 91-day t-bill rate stood at 26.6%. By 2006, the prime rate had been reduced to 12.5% with the t-bill rate dropping to 10.19%. Commercial bank base rates had also reduced from 32% in 2002 to 19% in 2006. However, interest rose marginally as inflationary pressures increased in 2007. The prime rate was increased to 13.5% whiles the t-bill rate rose slightly to 10.60%. Bank base rates also rose to 23.8%.

At present the BOG continues to use its open market operations, reverse repurchase agreements and prime rate to achieve price and exchange rate stability.

2.7.1 Inflation

Since 1970, the Ghanaian economy has been saddled with relatively high rates of inflation. According to various studies, the control of inflation by developing countries like Ghana has represented a major macroeconomic adjustment process, usually highly valued by the policy makers. The government's heavy intervention in the economy through the use of price controls to curb inflation, of distributive controls to counter scarcities of goods and services, and of import controls to counter BOP deficits, as well as the enhanced role of SOEs during the pre-ERP ERS, discouraged production, saving and investment. In spite of these controls, consumer price inflation increased gradually

from 3% in 1970 to 121% in 1977 (table). In 1983, prices soared further to reach a peak inflation rate of 123%. Even though the rate has dropped considerably since the start of the ERP, it has begun to rise once again throughout the liberalisation. Indeed, high government spending, accompanied by money printing, would have been advantageous if they had been associated with increases in real output (Sowah, 1994). According to the Economic survey of the Ghana Statistical Service (1981), the main sources of government deficits registered during the period 1970-1981 were mainly due to the losses incurred by the SOEs.

However, it is important to note that the main objectives of the reforms was to reduce inflation and ensure increased growth at an accelerated pace. Annual growth has remained positive, averaging about 4.2% throughout the reforms period (table). High inflation rates in Ghana have always been accompanied by high growth rates in broad money throughout the period. By contrast, high GDP growth rates have not necessarily been accompanied by substantial increases in money supply.

2.8 Financial Sector

The first commercial banks set up in Ghana at the beginning of the twentieth century still operate today: Barclays Bank of Ghana and Standard Chartered Bank. Under colonial rule, their main business was trade finance and primarily served the expatriate community. In 1953, the first indigenous commercial bank, now called Ghana Commercial Bank (GCB) opened to provide credit services to the local population. Following independence in 1957, the Bank of Ghana was established to serve as a central bank and to take over some of the functions previously carried out by the West African Currency Board. From 1957 to 1983, the government followed a policy of intervention in economic activity and held a controlling interest in all commercial banks. Three state banks were established during this period: the National Investment bank (NIB), the Agricultural Development Bank (ADB), and the Bank for Housing and

Construction (BHC). After the launch of the Economic Recovery Program in 1983, financial sector reforms were initiated allowing private commercial banks to operate.

In the 1980s, after decades of state management, Ghana's banking system was in distress. Banks suffered from the effects of undue political influence, weak management, inadequate capital, poor internal controls, and obsolete information and accounting systems. Moreover, they held substantial portfolios of non-performing loans, insufficient provisions against losses, and were often overexposed to a few clients, in particular other state enterprises. At the end of 1989, the banking system was close to a crisis, as non-performing loans reached 41 percent of total credit. Faced with this situation, the government adopted a reform program with the objective of restructuring the banking system while enhancing its competitiveness and efficiency. A new banking law was enacted that year that laid out the basic regulatory framework for the banking system: minimum capital requirements, adequacy ratios, prudential lending ratios, exposure limits, and accounting and auditing regulations. The supervisory activities of the Bank of Ghana were also strengthened, and banks were required to submit accounts for off-site monitoring. Annual on-site inspections, as well as off-site surveillance, were conducted to verify compliance with regulations.

During 1990 and 1991, most non-performing loans on the banks' balance sheets were swapped for government guaranteed interest-bearing bonds issued by the Bank of Ghana or offset against liabilities to the government or the Central Bank. A total of C62 billion in non-performing loans was removed from banks' portfolios, of which C47 billion was replaced with bonds paying 7, 9, and 15 percent annual interest at two- to five-year maturities. These bonds have since been rolled over. A Non-Performing Assets Recovery Trust (NPART) was formed in 1990. Its performance as evaluated in 1990 was very

impressive: C13 billion was recovered out of a total of C18 billion outstanding. However, this assessment did not take into account years of high inflation, which meant the amounts eventually collected represented much smaller amount in real terms.

In February 1992, the government announced a strategy to divest its share in the commercial banks. The divestiture was intended to increase competition and efficiency in the banking system. The program made early progress but eventually stalled. The Social Security Bank and the National Savings and Credit Bank were restructured and merged; 21 percent of the merged bank's shares were divested through a public offer in March 1995 and 40 percent were sold to strategic investor.

In February 1996, 30 percent of the shares of GCB, the largest state bank targeted for divestiture, were floated. After the initial offer was over-subscribed, the government decided to increase the public offer to 42 percent while looking for strategic investor for 40 percent. Substantial delays were encountered in the negotiations with the strategic investor, partly because in 1997 the UK supervisory authorities objected to the proposed ownership transfer of the London branch of GCB. Instead, the London branch was converted into an independent bank, the Ghana International Bank.

As at the end of 1999, the banking system in Ghana consisted of seventeen main banks: nine commercial banks, four development banks, and four merchant banks. Altogether, they account for about 90 percent of deposits in the banking system. The financial sector also includes 107 rural banks and several non-bank institutions including four brokerage companies, two discount houses, seven savings and loans institutions, the Social Security and National Insurance Trust, and some other minor financial institutions. In January 2000, two more commercial banks were licensed to operate, and two more state-owned banks, both of them development banks, were liquidated.

Ghana's banking penetration ratio is relatively high for Sub-Sahara Africa. On average, Ghana has a bank branch for every 54,000 persons. The Greater Accra region has an average of one branch per 15,000 but the density in the north is much lower, with only one branch for every 85,000 persons. About half of the banks have branches in the interior of the country, but GCB owns about half of all local branches and is represented in all regions of the country.

Although the number of financial institutions in Ghana is high, and has grown considerably since the early 1990s, financial intermediation remains relatively modest. In 1997, the ratio of M2 to GDP was 17% excluding foreign currency deposits. The ratio including foreign currency deposits was 23.5%. This is not too different from other countries in Sub-Sahara Africa, but only about 30% of the level in most industrial countries. This ratio changed only marginally between 1980 and 1999, showing little progress toward financial deepening. Holdings of currency are relatively high in Ghana at about 6% of GDP, but remain virtually unchanged since 1990. After growing sluggishly during most of the 1990s, credit to the private sector as a share of GDP increased rapidly in 1998 and 1999 to reach 14 percent or three times its level at the beginning of the reforms. However, actual levels remain well below the average for Sub-Sahara Africa. The M1/M2 ratio has not shown any appreciable decline in the last decade, a development characteristic of note in a country prone to inflation (see figure 8). Ghana seems to be moving towards increasing the depth of its financial system, albeit at a slow pace.

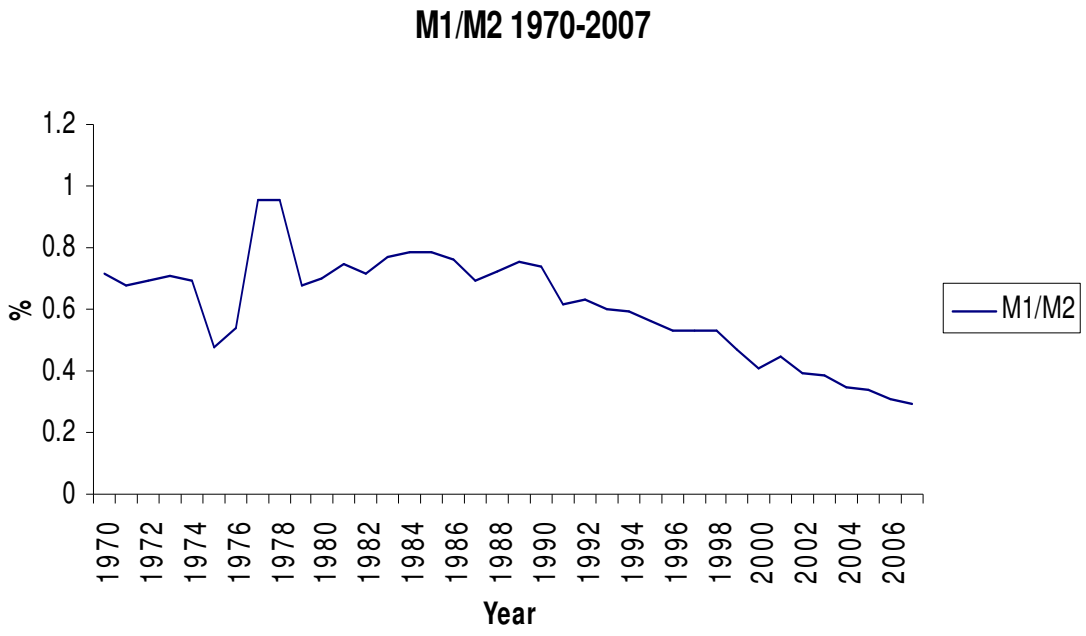


Figure 2.8

Financial activity remains concentrated in a small number of core banks, although changes from the late 1980s are most visible in this area. The potential for competition is well above the average for Sub-Sahara Africa as none of the five largest banks is excessively dominant.

Interest rates have scarcely responded to changes in the macroeconomic environment. In 1995, the average yearly inflation rate was 50%, yet lending rates were about 40% and savings rates barely reached 30 percent, both negative in real terms. In 1998, inflation more than halved, but lending rates remained at around 30-40%. The presence of state owned banks with large shares of non-performing loans might be one reason for this behaviour. In general, demand deposits, which represent 33% of total deposits, yield little or no interest. This implies that in the event of a downward adjustment in the interest rate received on credits, banks would not be able to adjust the interest rate paid on deposits. Thus, their cost of funds would be mainly unaffected. Their cost structures suggest that declines in interest rates are likely to reduce bank spreads, possibly to levels

that would make the banks unprofitable. Finally, interest rates did start to decline in response to the lower inflation numbers in the last quarter of 1998, although real interest rates remained high throughout 1999. However, at the end of the year rates were increased once again as a result of the rapid depreciation of the currency.

Another feature of the banking system is its high dollarization: 34 percent of total assets and 29 percent of deposits were denominated in foreign currency as of December 1999. For borrowers the main attraction of foreign currency credits is the interest rates, which are much lower than on domestic currency loans. In December 1999, interest rates on foreign currency loans were 27-34% points lower than domestic currency loans. The dollarization of the banking system in Ghana has led the supervisory authorities to closely monitor the foreign exchange exposure of individual banks to ensure they are not taking excessive risks. New foreign exchange exposure limits were implemented in 1999, but the net open positions of many of the Ghanaian banks (calculated as the ratio of the difference between assets and liabilities denominated in foreign currency to shareholder funds) have remained high. The net open position of the consolidated banking system at the end of 1999 was about 40 percent of shareholder funds. Indeed, public sector and merchant banks continue to have very high exposure ratios - some above the regulatory limits. Therefore, the banking system in Ghana is highly vulnerable to exchange rate movements that could result in large losses in relation to shareholder funds.


Interest rates
60.00
50.00
40.00
30.00
20.00
10.00
0.00
%
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
Year
Interest rates

Figure 2.9

2.9 Conclusion

The reforms program in Ghana has a long way to go because it has yet to accelerate growth, stimulate investment and domestic savings and create the basis for a sustained growth process which can lead to greater self-reliance in terms of reduced borrowing and substantial reduction in mass poverty. There has been a sizable fiscal adjustment since 1983, but the successes of the reforms depends crucially on the role of the state in creating realistically optimistic expectations through the credibility of the policy makers and through State's role in promoting investment in infrastructure such as power, transport, communications, etc. A sizable portion of the adjustment has come from a reduction in domestic investment, which has to be stepped up in order to attain long term growth. It is also worth mentioning that though some successes have been attained in the reform program, the two crucial parameters of the economic situation, namely, the inflation and adverse BOP position have remained still serious.

Table 2.1

ECONOMIC INDICATORS 2000-2007

	1999	2000	2001	2002	2003	2004	2005	2006	2007
Real GDP Growth	4.40	3.70	4.20	4.50	5.20	5.80	5.80	6.20	6.30
Inflation (%)									
Year-on-Year	13.80	40.50	21.30	15.20	23.60	11.80	14.80	10.50	12.70
Annual average	12.40	25.20	32.90	14.80	26.70	12.60	15.20	10.90	10.70
Exchange Rate (End Period)									
₵ per US$	3,535.10	7,047.70	7,321.90	8,438.80	8,852.30	9,051.30	9,130.82	9,235.30	9,704.00
₵ per UK$	5,715.50	10,189.90	10,596.70	13,305.20	15,296.00	17,411.50	15,673.30	18,102.70	19,511.00
₵ per EURO	3,577.30	6,343.50	6,500.50	8,511.60	10,986.30	12,309.00	10,814.97	12,144.50	14,398.00
Growth (year-on-year,%)									
Reserve Money	35.80	52.60	31.30	42.60	33.40	18.80	11.20	30.80	30.60
Broad Money (M2+)	23.90	46.50	41.40	50.00	37.80	26.00	14.10	38.80	36.30
Broad Money (M2)	24.80	33.40	48.40	50.00	40.50	26.60	13.80	39.40	43.50
External Sector									
Exports of goods and services (US$'m)	2,473.10	2,440.60	2,398.80	2,570.10	3,192.40	3,486.90	4,211.20	3,735.10	4,194.70
Imports of goods and services (US$'m)	3,925.90	3,350.20	3,574.50	3,327.90	4,132.60	5,355.70	6,295.40	6,523.60	8,073.60
Current account Balance (US$'m)	-964.60	-386.50	-324.60	-31.90	302.30	-151.20	-382.20	-555.90	-1,884.70
Overall Balance of Payments (US$'m)	-90.70	-116.80	8.60	39.80	558.30	-123.40	110.00	415.10	413.10

Reserves (end of period, in US$m)	420.10	233.40	364.80	640.40	1,425.60	1,732.40	1,894.90	2,266.70	2,836.70
Reserves(in months of imports)	1.20	0.80	1.20	2.20	3.90	3.80	3.50	3.00	3.10
External Debt (US$'m)	5,960.00	6,062.00	6,376.80	6,131.30	7,548.90	6,447.90	6,347.80	2,177.20	3,586.70
Interest Rates (End Period,%)									
Banking of Ghana Prime Lending Rate	N/A	N/A	N/A	24.50	21.50	18.50	15.50	12.50	13.50
91-days Treasury Bills	31.50	42.00	28.90	26.60	18.70	17.10	11.45	10.70	10.60
182-days Treasury Bills	26.00	42.40	28.90	27.20	20.30	17.90	12.78	10.70	10.70
1-year Treasury Notes	22.30	31.00	29.90	27.70	20.50	17.90	16.50	13.50	12.30
Nominal GDP (in billions cedis)	20,580.00	27,153.00	38,071.00	48,862.00	66,158.00	79,803.70	97,260.60	114,903.20	139,767.00
Commodity Prices									
Cocoa (US$/tonne)	1,434.00	1,094.00	1,021.00	1,260.00	1,949.50	1,586.90	1,524.69	1,719.85	2,072.00
Gold(US$/fine ounce)	278.70	280.40	271.60	309.50	364.50	409.90	445.28	628.90	807.20
Oil (US$/barrel)	18.60	28.40	25.00	25.00	28.40	37.80	55.44	62.50	91.90
Oil Imports (US$M)		641.8	562.9	507.8	562.9	775.0	1,127.5	1,646.2	2,049.4
Inter-bank FX Purchases (US$M)		677.90	824.20	931.20	1270.20	2071.70	2668.50	3105.70	5028.90
Inter-bank FX Sales (US$M)		636.00	792.60	896.70	1269.60	2236.20	3048.30	3193.20	4360.20
Net Claims on Government (bn cedis)									
Government Budget (% of GDP)									
Total Revenue	16.52	17.70	18.10	18.00	20.80	23.80	23.80	22.30	26.00
Grants	1.47	2.10	6.90	3.10	4.70	6.20	5.20	5.50	6.10
Total Expenditure	24.12	27.70	32.10	26.10	29.00	32.90	30.70	33.80	40.10
Overall Balance (including Grants)	-6.51	-9.70	-9.00	-6.80	-4.50	-3.20	-2.30	-7.80	-8.10
Domestic primary balance	2.31	2.60	3.80	2.00	2.20	0.70	3.40	-4.80	-6.20

CHAPTER THREE

3.0 LITERATURE REVIEW

3.1 Macroeconomic Models of exchange rate determination

Empirical literature on exchange rates modelling define bilateral exchange rate as the relative price of the monies in context of a two-country framework. Many of these models have described the exchange rate as a function of a varying set of macroeconomic fundamentals including inflation, money supplies, interest rates, productivity differentials, government debt, terms of trade and net foreign assets.

Models of exchange rate determination with their underlying macroeconomic variables have failed to explain and forecast exchange rate movements. Groundbreaking work by Meese and Rogoff (1983) shows that none of the existing models are able to consistently outperform a naïve random walk at short-to-medium term horizons even though actual future values of explanatory variables are used. This analysis is well documented in Obstfeld and Rogoff (2000) who coin the term 'exchange rate disconnect puzzle', to refer to the relatively weak link between exchange rates and macroeconomic variables.

Invariably, Obstfeld and Rogoff (2000) argue that at horizons less than two years exchange rate determination remains a puzzle. According to these researchers, the Meese and Rogoff analysis at short horizons has never been convincingly overturned or explained. They argue that the puzzle has exerted a pessimistic effect on the field of empirical exchange rate modelling in particular and international finance in general. They believe that no model, based on such standard fundamentals like money supply, real income, interest rates, inflation rates, and current account balances can ever succeed in explaining or predicting a high percentage of the variation in the exchange rate, at short- or medium-term frequencies.

3.2 The Microstructure approach to exchange rate determination

Foreign exchange microstructure research has been motivated by the need to understand exchange rate dynamics at short horizons.[3] The dominant exchange rate models of the recent decades take a macro perspective and come from the macro modelling tradition and have some relative value at long horizons. The search to find a new framework to explain short-run exchange rate dynamics has led to the microstructure approach to exchange rates, which takes into account the currency trading process. These micro-based models set out to model the structure of the foreign exchange market in a more realistic manner. In this setting, information is dispersed and heterogeneous agents have different information sets. The trading process itself is not transparent and agents may have access to private information about fundamentals or non-fundamental variables that can be exploited in the short-run. Consequently the transactions of better-informed agents may have a larger effect on exchange rates than those of uninformed agents. Thus, the microstructure approach not only recognises private information as being important for exchange rate determination but also takes into account how differences between agents and trading mechanisms affect exchange rates. (see Evans and Lyons, 2002a). This is in contrast to macro models, which assume that all relevant information is commonly known and all participants are the same.[4]

[3] For a survey of the theoretical and empirical literature see Osler (2008).

[4] Earlier works on FX microstructure have used surveys of FX market participants to support strong heterogeneity of expectations and an increasing diffusion of expectations.

3.2.1 Order Flow Concept

Thus, one of the most important explanatory variables in the microstructure approach to exchange rates is order flow. Order flow, as defined by Evans and Lyons (2002a) refers to "net of buyer-initiated and seller initiated orders; it is a measure of net buying pressure." Order flow consists of 'signed' transaction volumes. When a participant initiates a transaction by selling the base currency in exchange for foreign currency, the order has a negative sign. On the contrary, if participants buy foreign currency in exchange for base currency, the order has a positive sign.

By observing order flow, a participant might be able to have an idea of the sort of information others may hold. For example, if an initiator's expectation is that the base currency will fall, this may lead to a sale of the base currency in exchange for the foreign currency. This order flow will, thus, provide vital information to other participants and might result in the strengthening of the foreign currency. Order flow is viewed as a transmission mechanism through which information is transmitted to price. The extent to which order flow is informative depends on the factors that cause it. It is most informative when it transmits private information about macroeconomic fundamentals that is scattered among agents. By aggregating information in this way, order flow establishes a connection between macroeconomic fundamentals and exchange rate movements. On the other hand, order flow is less informative when it is as a result of inventory control activities in reaction to liquidity shocks. Nevertheless, the importance of order flow in exchange rate determination does not mean that it is the underlying cause of exchange rate movements. Rather it is a proximate cause with information being the underlying cause. The problem lies in identifying what information determines order flow.

3.2.2 Hot potato trading and the information content of order flow

In an attempt to address the question, Lyons (1997) present a simultaneous trade model of spot FX that captures the actual dynamics and structure of the FX market. This model takes into account inter-dealer trading and customer order flow as a source of private information and the risk aversion of dealers. These features sharply contrast with those of previous trading models. Because trading is simultaneous, dealers cannot condition their trades on other dealers' trades. This leads to shocks to dealers' inventories, resulting in unwanted positions. The risk aversion of dealers makes these imbalances less attractive. This sparks off what is referred to as hot potato trading. It describes the passing of unwanted positions amongst dealers for the purposes of risk management. The private information observed by dealers through order flow allows them to take speculative positions. Hot potato trading introduces noise into order flow because it reduces the information content of inter-dealer trades. Consequently this affects price because it is the inter-dealer trades that determine prices. The two contrasting roles of the dealer, one as an information intermediary and the other as a speculator, will make price less informative.

Additionally, Lyons (1995) identify the asymmetric-information and inventory-control as the main channels through which order flow influences price. The inventory-control path involves manipulating the prices to control the inventory caused by order flow whilst the asymmetric information path involves changing the prices to account for private information reflected in the order flow. Lyons tests for the significance of both approaches using one week trading data obtained from a large dealer in the USD/DM market. This dealer trades an average of $1bn daily. The paper adopts a Bayesian model of pricing behaviour which is an extension of the Mandhavan-Smidt model. The model incorporates the role of inventory-control and asymmetric-information thus

capturing the nature and dynamics of the FX market. For example, the FX market is decentralised with multiple dealers and the ability of a dealer to shift inventory at other dealers' prices. Model estimation reveals that both asymmetric-information and inventory-control variables are significant and correctly signed.

3.2.3 Order flow's explanatory power

Evans and Lyons (2002a) use inter-dealer data from Reuters Dealing 2000-1 to analyse the contemporaneous relationship between order flow and exchange rate movements. The FX markets under consideration are the DM/USD and JPY/USD. They propose a transaction frequency model called the 'portfolio shifts model' which focuses on the information content of order flow. It is a hybrid model which combines both micro and macro variables. A unique feature of the model is that it allows the use of daily frequency data. According to this model daily exchange rate movements depend on signed order flow and changes in the interest differential. Therefore the equation to be estimated,

$$\Delta S_t = \beta x_t + \alpha \Delta(i_t^* - i_t) \qquad (3.1)$$

Where ΔS_t is the change in the log spot exchange rate from the end of day $t-1$ to the end of day t, x_t represents the inter-dealer order flow from the end of day $t-1$ to the end of day t and $\Delta(i_t^* - i_t)$ is the change in the nominal interest differential where i is the nominal dollar interest rate and i^* is the nominal non-dollar interest rate.

The change in interest differential is preferred to other macro determinants because its data is available at a daily frequency and it is usually the main variable in exchange rate determination models. We should expect a positively signed interest differential. Under the model's null hypothesis, causality runs strictly from order flow to price. The order flow coefficient is significant and positively (correctly) signed for both equations. This

means that net dollar purchases leads to an increase in DM and JPY prices of dollars. The model explains about 64% and 46% of movements in the DM/USD and YEN/USD respectively. More specifically these exchange rate movements are mainly due to order flow, while changes in interest rates account for very little. The paper concludes that a net order flow of $1bn leads the USD to appreciate by 0.5%.

The dataset covers the period between May 1st and August 31st 1996. It includes the quantity of buy and sell orders and the exchange rates at which they are transacted. However the transaction size and counterparty identity are not included. Because of the strict causality running from order flow to price, the model does not allow for the case where exchange rate movements could cause order flow (feedback effects). In the presence of feedback effects, the coefficient estimate of order flow is biased and the results from the model could be misleading.

3.2.4 Evans and Lyons Model

Evans and Lyons (2002a) develop a model with three trading rounds each day. In the first round, dealers trade with their customers. The second round involves inter-dealer trading to enable dealers share the resulting inventory risk from the first round. During the third round dealers trade again with their customers to share inventory risk more broadly.

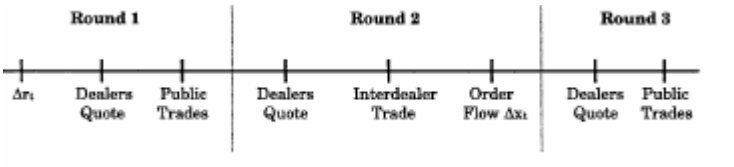


Figure 3.1- Evans and Lyons 2002 model

They consider a pure exchange economy with T trading periods and two assets, one riskless and one risky. The $T+1$ payoff on the risky foreign exchange asset is given by R, which constitutes a series of increments:

$$R = \sum_{t=1}^{T+1} \Delta r_t \tag{3.2}$$

The Δr_t increments represent the innovations in public macroeconomic information. Before quoting in round 1, dealers receive public macro information based on which they simultaneously and independently quote scalar prices to their customers at which buy and sell orders will be executed. The price of dealer i on day t during round 1 is given by P_{it}^1. After quoting in round 1, each dealer receives market orders $\sum_{i=1}^{N} C_{i1}$ from his/her own customer. Each dealer's customer order cannot be observed by other dealers. Consequently, they are regarded as "private information".

In round 2, each dealer simultaneously and independently quotes a scalar price to other dealers at which buy and sell orders will be executed. These quotes can be observed by all dealers. Dealers do not want to reveal their private information ($P_{i2} = P_2$) so they simultaneously and independently trade on other dealers' quotes in order to share inventory risk and speculate on their private information from round 1 customer trades. The net inter-dealer trades initiated by dealer i and is proportional to customer order in round 1 is denoted by T_{i2}. At the close of round 2, all dealers observe the net inter-dealer order flow from that period:

$$\Delta x_t = \sum_{i=1}^{N} T_{i2} \tag{3.3}$$

In round 3, dealers use information from net inter-dealer order flow in round 2 to simultaneously and independently quote scalar prices at which customers are willing to absorb all dealer imbalances. In order to set the round 3 quote, dealer need to have an idea of the total flow the customers need to absorb by observing Δx and also need to

know the customers' risk-bearing capacity. For example, if dealers on the average are short in dollars, they must increase the price for dollars to induce customers to sell dollars. Round 3 price is

$$P_{i3} = P_3 = P_2 + \beta x \tag{3.4}$$

Where β is constant depending on the customers' demand and the dealers' trading strategy.

If customers who buy (dollars) orders exceed sell orders in round 1, the total inter-dealer order flow observed at the end of round two will be positive because dealers will attempt to buy back dollars. Since dealers dispose of all their inventory in round 3, this implies that total customer order flow in round 1 and 3 must be of similar size but with opposite sign. Thus

$$c_1 = \frac{1}{\gamma}\Delta x = -c_3 \tag{3.5}$$

3.2.5 Possible feedback effects of exchange rate movements on order flow

Unlike Evans and Lyons (2002a), Payne (2003) takes into account the possibility of feedback trading rules by applying a simple VAR methodology introduced in Hasbrouck (1991). This linear VAR model consists of trades and quote revisions. The dataset covers all inter-dealer trades transacted through the Reuters Dealing 2000-2 system in the spot USD/DEM market over the week spanning October 6th to October 10th 1997. The paper analyses the impact of order flow on quotes and whether this relationship is affected by the level of market activity. According to the paper, the information conveyed by inter-dealer traders is what induces the permanent effect on quotes. It does not matter whether information is about future fundamentals or future risk premia.

Consequently Payne attempts to test for this permanent price effect by applying a bivariate VAR model for quote revisions and signed trades as shown below:

$$r_t = \sum_{i=1}^{P} \alpha_i r_{t-i} + \sum_{i=0}^{P} \beta_i x_{t-i} + \varepsilon_{1t} \tag{3.6}$$

$$x_t = \sum_{i=1}^{P} \gamma_i r_{t-i} + \sum_{i=1}^{P} \delta_i x_{t-i} + \varepsilon_{2t} \tag{3.7}$$

Where r_t is the return on foreign currency and x_t is a vector containing trades information.

The innovation terms, ε_{1t} and ε_{2t}, are assumed to be uncorrelated. ε_{1t} refers to quote revisions brought about by the arrival of public information. ε_{2t} corresponds to unpredictable trading activity, probably related to private information. Payne obtains impulse-response functions linked to news releases and trade innovations. Thus the long-run response of exchange rates to trade innovations can be regarded as a measure of the information content of order flow.

Payne also uses Variance decomposition analysis to distinguish the component of total volatility of exchange rate which is attributable to public information from that which is due to trade innovations. The results show that about 40% of exchange rate variability is due to unpredictable trading activity. Notwithstanding this relatively high percentage variation, he argues that order flow still has significant (both statistically and economically) impact on exchange rates. Also during period of high volume and liquidity, intense competition between agents results in a reduced impact of trades on price. Even when feedback trading is taken into account, order flow continues to be the fundamental determinant of exchange rate movements.

Danielsson and Love (2004) also examine the issue of feedback trading. Their paper looks at contemporaneous feedback trading and its effect on the informativeness of order flow. Contemporaneous feedback trading occurs when order flow at date t depends on date t asset return. They note that previous VAR models have allowed for some sort of feedback trading but not contemporaneous feedback. The VAR specification differs from that of Payne 2003 in the sense that order flow is allowed to depend on current exchange rate returns. Instrumental variables are used estimate the VAR on brokered inter-dealer data for the spot USD/EUR. Like Payne 2003, impulse response functions of spot rates to trade innovations which take into account contemporaneous feedback trading are obtained. The main findings indicate that when contemporaneous feedback trading is allowed, the impact of order flow shock is larger compared to the previous case.

3.2.6 Order Flow, fundamentals and exchange rate determination

Using data from State Street Corporation, Froot and Ramadorai (2005) attempt to investigate how institution-investor flow might affect currency values. The dataset spans 7 years and includes 19 currencies. This is after removing fixed or pegged currencies and rarely traded currencies. Specifically they examine the relationship between order flow, exchange rate returns and fundamentals. Froot and Ramadorai present three different ways in which flows could cause movements in exchange rates. The "strong flow-centric" view states that flows convey private information about fundamentals and thus induces a permanent effect on exchange rates. This view is in line with Evans and Lyons (2002a). The "weak flow-centric" view also states that flows rather convey private information about deviations from fundamentals and thus induces only transitory effects on exchange rates. However with the "fundamentals-only view", flows are not connected to exchange rates. Fundamentals are the only determinants of exchange rates.

Initially, Froot and Ramadorai replicate the Evans and Lyons (2002) methodology by estimating the following equation:

$$r_{t+1,j}(p) = \alpha + \beta_{z,j} z_{t,j}(p) + \varepsilon_{t,j} \quad (3.8)$$

where $r_{t+1,j}(p)$ is the p-period cumulative return on currency j against a basket of major currencies, $z_{t,j}(p)$ represents the corresponding cumulative for the signed order flow size. They find a strong positive correlation of about 30% between flows and returns. At longer horizons of about 1 or 2 months, the correlation peaks at 45% and then gradually falls (until it becomes negative) as the horizon continues to increase. This substantial initial increase is due to non-contemporaneous correlation. Effects of flows appear to be transitory. Consequently, they infer that the positive correlation between order flow and exchange rate over short horizons is not linked to fundamentals but is the result of trend chasing activity of some investors.

To validate their inference, Froot and Ramadorai use a combination of Campbell-Shiller decomposition and VAR model to separate unexpected currency returns into permanent and transitory components. The decomposition allows for the analysis of how changes in flows and fundamentals interact with exchange rates. The main focus of their analysis is the impulse-response function associated with the VAR. These impulse response-functions allow them to calculate the short and long-run covariances between order flow and returns. They find that contemporaneous covariance between order flow and exchange rate return is positive. They also find that the covariance between current order flow and short-term future exchange rate returns is also positive. This means that order flow is able to positively predict short-term movements in exchange rates. On the other hand, this positive relationship turns negative over the long-term. Additionally the covariance between short-term future cumulative innovations in order flow and current exchange rate returns is positive. This could be as a result of some investors using

positive feedback trading rules over the short-term. The negative covariance between long-term future cumulative innovations in order flow and current exchange rate returns could be the result of negative feedback trading. In general, it seems investors use positive feedback trading rules to build up their speculative positions in the short-run and eventually offload these position using negative feedback trading rules in the long-term.

Furthermore current exchange rate returns are positively correlated with short-term future changes in interest rates and current order flow is positively correlated with short-term future changes in interest rates. According to Vitale (2006), this could imply that order flow is at least linked to fundamentals in the short-term.

Breedon and Vitale (2004) use six months of inter-dealer flows from EBS and Reuters to investigate whether the impact of order flow on exchange rates is due to information effects or liquidity effects. In view of the fact that it is difficult to untie these two effects, the paper adopts the Bacchetta and Wincoop (2006) framework. This framework is modified by making a few assumptions that take into account private information through customer order flow. They point out that the persistent effects of order flow on exchange rates can also be induced by liquidity effects. This is contrary to the common view in microstructure that the persistent effects of order flow on exchange rates are induced by only information effects. Using GMM techniques, they find that the high explanatory power attributed to order flow is due to liquidity effects. Specifically the impact of order flow on exchange rates is not due to aggregation of private dispersed information but rather due to FX dealers risk aversion. FX dealers are only willing to hold unwanted inventory if they are adequately compensated for bearing the risk

Also, the type of FX transactions used by Froot and Ramadorai cover only a portion of customer transactions in the FX market and does not cover all the information content in order flow. Numerous studies including Marsh and O'Rourke (2005), Carpenter and

Wang (2007), Mende and Menkhoff (2003) and Evans and Lyons (2003b, 2005a) have examined the information content of disaggregated order flow in FX market.

Marsh and O'Rourke use daily customer order flow of Royal Bank of Scotland between June 2004 and August 2004, to distinguish between the explanations for the strong positive correlations between spot exchange rates and order flow. In previous literature, private information, liquidity effects and feedback trading are the main suggestions that have been used to explain this strong correlation. The order flow data is split into various customer groups. This allows for a detailed comparison of information content of order flow between the different customer categories. The exchange rate is regressed on disaggregated order flows and thus relaxes the constraint that the effect of order flow on exchange rate are equal for all customer groups.

$$\Delta S_t = \beta_0 + \beta_1 x_t^{Corp} + \beta_2 x_t^{Unlev} + \beta_3 x_t^{Lev} + \beta_4 x_t^{Other} + u_t \qquad (3.9)$$

where x_t^{Corp} represents Non-financial corporate flows, x_t^{Unlev} represents un-leveraged financial flows, x_t^{Lev} represents the leveraged financial flows and x_t^{Other} represents other financial flows.

The results indicate that financial customers order flow is positively correlated with exchange rate movements whilst non-financial customer order flow is negatively correlated. They interpret these results as meaning that financial customer flows contain price relevant information with non-financial customers following negative feedback trading rules. The different impacts of order flow effectively discount any liquidity effects. Also they find that the probability of informed trading (PIN) is relatively higher for financial customers. This is not surprising since financial customers are more aggressive in the FX market and have a better access to price relevant signals. Non-financials, on the other hand, exploit short-term movements in spot rates to conduct their transactions for purely non-speculative reasons. Furthermore, Marsh and O'Rourke find

that order flow in one currency market could affect spot rate movements in another market. The previous result that liquidity effects are not the main reasons for the strong correlations is reinforced by the presence of cross-market flow effects.

Other studies have looked at the issue of heterogonous sample. Carpenter and Wang (2007) also report similar results. Using tick-by-tick customer data from a large Australian, they investigate the price impact from different participants in the FX market. They find that non-bank financial customer flows have a large impact on dealer pricing whilst corporate order flows have the least impact.

Employing Citibank data spanning 6.5 years, Evans and Lyons (2005a) argue that order flow of the different customer segments behave differently and the information content of their respective order flows is dollar for dollar also different.

Wei and Kim (1997) find that though the currency positions of large market participants are positively correlated with exchange rate volatility, they are not able to forecast future exchange rate movements and may be trading on noise rather than on private information. Bjonnes and Rime (2001) show that customer trading has a relatively larger price effect than inter-bank trading.

However, it should be noted that data for these studies have been obtained from single banks and as a result their customer order flow may not be a good representation of market-wide order flow.

3.2.7 Heterogeneous Information, Order flow and Exchange rates

Bacchetta and van Wincoop (2006) introduce information heterogeneity into a standard model of exchange rate determination. If risk-averse traders have heterogeneous beliefs and expectations about future macroeconomic fundamentals and observe imperfectly correlated fundamental signals, portfolio shifts will result in a permanent and significant effect on exchange rates. The paper proposes a noisy rational expectations model where investors have private information and the auction market is order-driven. In the short-run, rational confusion is responsible for the failure of fundamentals to explain exchange rate movements. This is because investors are unsure whether exchange rate movements are as a result of changes in private information about future fundamentals or hedged trades. This confusion leads to a magnified effect of unobserved hedge trades in exchange rates.

In a heterogeneous information setting, these hedge trades are a source of volatility. However in a homogenous setting they have no such effect. In the long-run, rational confusion slowly wears out as investors gain access to more information about future fundamentals. The effect of unobserved trades on exchange rates eventually diminishes. This implies that the effect of private signals on future fundamentals will have a relatively larger effect on exchange rate movements. In the long-run, exchange rate and cumulative order flow are closely connected when the fundamental has a permanent component. Because private information about permanent future fundamental changes is conveyed to the market through order flow, order flow has a permanent effect on exchange rates.

3.2.8 Order Flow in Emerging Markets

While most order flow studies have focused on developed economies, only a couple of studies have examined order flow in emerging economies. One of those studies is Wu (2007) which studies the behaviour of order flow and its influence on the exchange rate dynamics in Brazil. The dataset used consists of daily customer transactions spanning a period of 4years, from July 1999 to June 2003, and represents 100% of the official Brazilian market. Customers are further divided into three sub-categories: commercial customers, financial customers and central bank.

Wu's model is similar to that of previous microstructure models but with two key changes. First, Wu favours a general equilibrium model where customers' demand for FX is induced by macro fundamentals, including contemporaneous changes in the exchange rate. Secondly, unlike Evans and Lyons model, FX dealers do not have to close with zero net positions at the end of each trading day. These dealers may decide to provide extra liquidity in the case where there is an imbalance between customer buy and sell orders. They will only do this if they believe it is optimal to do so.

The model also allows for a two-way relationship between customer order flow and exchange rates. The first relationship refers to the situation where an exchange rate appreciation makes foreign goods and assets cheaper and induces an increased demand for FX by customers.

The second relationship is as a result of the portfolio balance effect. FX dealers charge a risk premium for providing extra liquidity and the corresponding price change causes the exchange rate to depreciate. This suggests an endogenous relationship between customer order flow and exchange rates.

The presence of endogeniety is first tested using a bivariate Granger causality test between exchange rate and the different types of order flow. The null hypothesis that exchange rates do not granger cause order flow is rejected for all the 3 order flow variables. Further evidence of endogeneity is provided by running a simple OLS regression, similar to that of Evans and Lyons (2002a), where the dependent variable is the change in the log of exchange rate and the regressor is the total customer order flow. Not surprisingly, the purchase of FX drives up the exchange rate..

Consequently Wu employs a Structural VAR approach to identify this endogenous relationship between exchange rates and order flow.

The underlying assumption is that financial flow and commercial flow do not influence each other contemporaneously but this does not imply that they are uncorrelated at a daily frequency.

Estimations from the VAR relationship indicate that dealers need to increase the domestic price of the dollar by approximately 2.7% in order to meet a customer flow of US$1bn. Also a 1% depreciation rate reduces commercial flow by US$ 46m and the financial flow by US$111m.

Gereben, Gyomai and Kiss M. (2005) examine the role of customer order flow in the Hungarian forint (EUR/HUF) market. Their study is mainly based on the Evans and Lyons (2002a) framework. Not only do they test whether customer order flow aids in explaining exchange rate, they also identify the roles played by different customer types. They also examine whether customer order flow can forecast future exchange rate movements. The dataset employed consists of 4 years of daily customer order flow obtained from the central bank of Hungary. Customer order flow data is further divided into domestic (non-market making) banks, domestic non-banks, the central bank, foreign

banks and foreign non-banks. Using maximum likelihood approach, they estimate a generic model at a daily frequency where all the different order flow variables are included,

$$\Delta S_t = \alpha_0 + \sum_i \alpha_i x_t^i + \varepsilon_t \ , i = \{fb, fo, db, do, cb\} \tag{3.10}$$

Where ΔS_t is the change in the log of exchange rate and x_t^i are the various components of customer order flow, specifically foreign banks order flow (x_t^{fb}), foreign non-bank customer flow (x_t^{fo}), domestic non-market making banks (x_t^{db}), domestic non-bank customer flow (x_t^{do}), and the central bank (x_t^{CB}).

The results indicate that the estimated coefficients of the foreign banks', foreign non-banks' and central bank's order flow are negative and significant. This implies that purchases of domestic currency by these customers cause an appreciation in the Hungarian currency relative to the Euro. However the coefficients of the domestic bank and non-banks were not significant.

In view of the above, the researchers adopt Bjonnes, Rimes and Solheim (2005) alternative to the Evans and Lyons (2002a) framework and distinguished between "push" and "pull" customers by running two separate regressions for the two subgroups. Push-customers instigate price rises or falls through their buying and selling and as result their transactions are positively correlated with price movements. These transactions are understood to convey private information.

Pull-customers, on the other hand, are attracted to prices which they find suitable and their transactions are negatively correlated to price movements. They are assumed to provide liquidity to the market.

The above equation is estimated for the two groups. For the push-equation, the coefficients of foreign and central bank flows are significant and positive, implying that

that order flow from foreign customers and central bank are the main drivers of exchange rate variations. For the pull- equation, the coefficients of domestic flows become highly significant and positive. This means that the purchase of domestic currency by domestic customers causes the Hungarian forint to depreciate. In other words, domestic customers act as pull-customers and supply liquidity to the FX market whilst foreign customers and central bank play the role of push-customers. These results are, however, contrary to studies like Marsh et al. (2004), who find that in determining the sign of order flows', it is the difference between financial and non-financial customers that matters rather than the difference between domestic and foreign customers.

Indeed, this research has been criticised by other renowned economists. The reason being the dataset did not differentiate between financial and non-financial flows. Another legitimate excuse could be that Hungary which is an emerging economy is heavily reliant on foreign inflows and as a result a large portion of its macro fundamentals are dependent on external factors. Therefore it could be argued that foreign customer flow may convey more private information about future fundamentals than that domestic customer flows.

3.2.9 Order Flow and FX Liquidity Provision

Using data from the Swedish Krona market, Bjønnes et al. (2005) attempt to identify the long-run liquidity providers. Their data spans 6 years and is split into 4 main categories namely: market-making banks, non-financial customers, financial customers and central bank.

Their analysis was based on the Evans and Lyons (2002a) model. Bjønnes et al. (2005) tag round one customers as 'active' and round three customers as 'passive',

terminologies first used by Sager and Taylor (2006). 'Push' customers are usually the 'active' party in trades and initiate price movements through their buy/sell transactions. Net flows of 'push' customers will be positively correlated with exchange rate movements. 'Pull' customers, on the other hand, are usually 'passive' in trades and are drawn into the market by attractive prices which are beneficial to themselves. Net flows of pull customers are negatively correlated with exchange rate movements. Thus push customers demand liquidity while pull customers provide liquidity.

Using Granger causality and Cointegration tests, Bjønnes et al. (2005) find that financial customers demand liquidity whiles non-financial customers supply liquidity in the long-run. In other words, financial customers 'push' the market whiles non-financial customers are 'pulled' by the market.

A study by King, Sarno and Sojli (2010) examine the macroeconomic determinants of the Canadian dollar/US dollar (CAD), using a unique dataset consisting 11 years of disaggregated order flow based on spot transactions reported by Canadian-based dealers. The study argues that Canada is an open economy that has strong trade relations with the US economy which is the destination of 80% of its exports. So far as the FX microstructure approach is concerned, the study rests heavily on the seminal paper by Evans and Lyons (2002a) which dwells on a partial equilibrium model that links order flow to contemporaneous changes in the exchange rate. Additionally, the study draws motivation from Evans and Lyons (2005a) which argues that order flow captures changes in expectations for macroeconomic fundamentals and responds to changes in commodity prices. King, Sarno and Sojli (2010) confirm that order flow respond to changes in commodity futures especially gold and aluminium prices. Besides, adding order flow to regressions on exchange rate returns that include commodity variables and interest rate expectations significantly improves that the fit of the model.

King, Sarno and Sojli (2010) use the present value formulation[5] of exchange rate modelling, which highlights the role of order flow as a proxy for aggregating heterogeneous beliefs on macroeconomic information. Results from the study indicate that over 25% of the available macroeconomic news can explain fluctuation in order flow.

In another study, Evans and Lyons (2008) investigated the response of order flow to macroeconomic news and find that when investors are well informed about macroeconomic developments preceding the announcement, any possible macroeconomic surprise that could generate erratic movements in exchange rates could be mitigated. Rime, Sarno and Sojli (2010), on the other hand, posit that order flow should reflect changes in expectations with respect to current economic conditions. Chen, Rogoff and Rossi (2008) also establish a direct link between exchange rate of commodity exporting countries and commodity prices. This link is further corroborated by King, Sarno and Sojli (2010).

This thesis intends to build on existing FX microstructure literature in three key chapters. In chapter 5, we apply equation 3.9 to Ghana taking into account the peculiar nature of the Ghanaian FX market. The Evans and Lyons (2002a) model will form the basis for this chapter. Chapter 6 applies the Bjønnes et al. (2005) framework to identify the liquidity providers in the FX market. Unlike Bjønnes et al. (2005) who divide their data set into financial and non-financial customers, we divide our dataset into bank customers and central bank. This approach is to enhance the study and to enable us to identify the long-run liquidity providers in FX market.

Finally, chapter 7 is essentially an application of King, Sarno and Sojli (2010) which investigated the macroeconomic determinants of order flow for Canadian dollar.

CHAPTER FOUR

4.0 METHODOLOGY-Choice of Estimation Technique

4.1 Introduction

Traditionally, econometric modelling consists of three phases: specification, estimation and validation. This chapter discusses the estimation and validation approaches adopted for the study. The rest of the chapter has been organised as follows. Section 4.2 deals with the techniques used to investigate the time series characteristics of all the series used in the model. This has been done in order to avoid the problem of spurious regression that exists among microstructure and macroeconomic time series variables. Investigations are carried out to ascertain the order of integration of each variable in the model, which will establish the degree of non-stationarity and the number of times the variable should be differenced to attain stationarity. Issues involved in the testing for cointegration and estimation of error-correction models (ECM) are considered in Sections 4.4, with emphasis on the Johansen's Multivariate approach - the main approach used for this study. The Johansen Multivariate approach examines the possibility of more than one cointegration relationship. Section 4.5 treats other alternative approaches to ideal estimation, and discuses the problems inherent in each, while the approaches used to determine the adequacy of the estimated model are also treated in Section 4.6.

4.2 Times Series Characteristics of the data

Collecting data for the research of this kind requires the utilisation of a variety of sources, which for this research; include the Bank of Ghana for financial data, and the Statistical Service of Ghana for real data. A detailed description of the variables and their

sources are presented in Appendix 1. In this section, an investigation is carried out to determine the time series characteristics of all the series used in the model. This was done in order to avoid the spurious regression problem, by ensuring the existence of a meaningful economic relationship. The investigation was therefore, designed to ascertain the order of integration of each variable in the model, that is, the number of times the variable should be differenced to induce stationarity.

Econometric theory has shown that the validity of traditional econometric analysis is dependent upon the assumption of stationarity. It is widely acknowledged that the vast majority of macroeconomic variables are non-stationary, and when such variables are included in a regression, they are likely to cause a spurious regression problem. In other words, the high correlation found among those variables may not represent the true economic relationship, but simply common trends in the variables. For this reason, until the 1980s, it was assumed that individual time series must be made stationary by pre-filtering data, using seasonal adjustment, difference or elimination of deterministic trends. One drawback of the procedure for differencing was that it could result in a loss of valuable long-run information in the data.

Subsequent studies have adopted many approaches to testing for the presence of a unit root, among which the Augmented Dickey is-Fuller (ADF) approach, popular among researchers because of its simplicity. This test estimates

$$\Delta yt = \mu + \alpha t + \sum_{j=1}^{p^*} \delta_j \Delta y_{t-j} + u_t + \phi y_{t-1} \qquad u_t \sim IID(0, \sigma^2) \qquad (4.1)$$

With the null $H_0: \rho \geq 1$ against the alternative $H_1: \rho < 1$.

In this approach, the lag length is usually set to avoid autocorrelation in Δy_t. The critical values of the asymptotic distributions of these t-statistics are tabulated in Dickey and Fuller (1981) and MacKinnon (1991). In addition, the limiting distributions of these

researchers are derived on the assumptions that the error terms are iid. $(0, \sigma^2)$, but are also valid in the presence of some heterogeneity in the innovation process. If the errors are serially correlated, the statistics have to be modified. The simplest approach is to use equation (4.1),i.e. the Augmented Dickey-Fuller tests, to add as many lags of the dependent variable as necessary to ensure that the residuals of the regression appear to be white noise.

An alternative approach to test for the existence of unit root is that suggested by Phillips (1987), and extended by Perron (1988) and Phillips-Perron (1988). These researchers showed that if a series was stationary around a deterministic time trend that had undergone a permanent shift sometime during the period under consideration, then failure to take account of this change in the slope would be mistake by the usual ADF unit root test as a persistent innovation to a stochastic trend, they recommend a non-parametric correction to the underlying t-test statistics to be undertaken to account for any autocorrelation that would emerge if the data-generating process was not AR(1).
Other tests, such as Sargan-Bhargava (1983) cointegration regression Durbin-Watson tests, based on the usual Durbin Watson statistic, are applicable on the level of each emerging variable and are defined as:

$$CRDW = \frac{\sum (y_t - y_{t-1})^2}{\sum (y_t - \overline{y_t})^2} \qquad (4.2)$$

where $\overline{y_t}$ stands for the arithmetic mean of y_t.

Following these tests, the Ogaki (1992), and Kwiatkowski, Phillips Schmidt and Shin (1992) (KPSS) tests for stationarity also emerged.

Since the ADF has remained the most popular approach, this study has used them in testing for the order of integration of the series.

The next section discusses the Johansen approach to model estimation, adopted in the present study for the estimation of the equations in the model.

4.3 The Johansen Methodology

The Johansen and Juselius (1992) technique was developed to address the main problems inherent in the use of the Engle and Granger technique. It was known that using a single equation representation simply implied the assumption that all the explanatory variables were exogenous, which may not be the case. Moreover, if there were more than two variables in a model, there could be more than one cointegration relationship, possibly rendering traditional estimation techniques inappropriate. In this regard, it became common practice not to begin by using a single-equation model, but rather by adopting a more general simultaneous equation formulation, in which each variable was modelled in terms of lagged values of all the other variables.

In order to corroborate the rank results of the EG methodology, this study uses the Johansen and Juselius (1992) approach to show that the existing CI is, in fact, unique. This is particularly useful because when one assumes there to be one CI when, in fact, there are more, leads to inefficiency. Appropriate lags are added to ensure that the error terms are all distributed white noise.

The Johansen approach starts by defining an unrestricted vector auto regression (VAR) of Z_t of n potentially endogenous variables that involve up to k-lags, which the data generating process states as:

$$Z_t = A_1 Z_{t-1} + \ldots\ldots\ldots + A_k Z_{t-k} + \mu_t \qquad \mu_t \sim IID(0, \Sigma) \qquad (4.5)$$

where Z_t is (n x 1) and each if the A_i is an (n x n) matrix of parameters.

We can reformulate equation (3.5) into VECM of form

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + ... + \Gamma_{k-1} \Delta Z_{t-k+1} + \prod Z_{t-k} + u_t \qquad (4.6)$$

Where $\Gamma_i = -(I - A_1 - ..... - A_i)$ and $(i = 1,....., k-1)$. Also $\prod = -(I - A_1 - ...A_k)$.

Through this formulation, the system then contains information on both the short-run and long-run adjustment to changes in Z_t through the estimates of $\hat{\Gamma}$ and $\hat{\prod}$ respectively. It is also shown that $\prod = \alpha\beta'$, where α represents the speed of adjustment to disequilibrium and is a matrix of long-run coefficients, such that the term $\beta' Z_{t-k}$ which was embedded in equation (4.6) represents up to (n-1) cointegration relationships in this multivariate model, assuming that Z_t is a vector of nonstationary I(1) variables. This also implies that $\prod Z_{t-k}$ contains the stationary long-run error correction relations, and should be stationary, in order for u_t to be "white noise". This occurs when $\prod = \alpha\beta'$ has reduced rank, implying that there are r ≤ (n – 1) cointegration vectors present in β. In this case, testing for cointegration implies the finding of the number of linearly independent columns in $\prod$, which is also equivalent to testing that the last (n-1) columns of α are insignificantly small. It is shown that if $\prod$ has full rank, then the variables in Z_t are $I(0)$, while if the rank of $\prod$ is zero, then there are no cointegration relationships. More usually, $\prod$ has a reduced rank, in which case there are r<(n-r) cointegration vectors present.

Johansen's maximum likelihood approach to determine the number of cointegration vectors amount to a reduced rank regression which provides n eigenvalues. The Johansen maximum eigenvalue test statistics used for carrying out this operation are defined as – T (1- μ_j) derived from the minimisation of the product of the concentrated likelihood of the function, the significance of the largest λ_r is the so-called maximum eigenvalue or λ - max statistic, given by:

$$\lambda_{max} = - T \log (1 - \lambda_{r+1}) \qquad r = 0,1,2\ldots\ldots\ldots n-1. \qquad (4.7)$$

This demonstrates that there are r- CI vectors against the alternative that r +1. another test if significance us called trace. This is estimated by

$$\lambda_{\text{trace}} = -2\log(Q)$$

$$= -T\sum_{i=r+1}^{n}\log(1-\lambda_i) \qquad r=0,1,....n-2,n-1 \qquad (4.8)$$

where Q = $\frac{\text{Restricted maximum likelihood}}{\text{Unrestricted maximum likelihood}}$

These approaches demonstrate that if the researcher faces a small sample problem, then there is the likelihood of problems with regard to power and size properties when using the asymptotic critical values. In this respect, **Lutkepohl *et al.* (2001)** examined both the race and –max tests, concluding that the former had power size properties, while the latter suffered from loss of power.

4.4 Statistical Diagnostics

In this study, particular emphasis is placed on the reliability of the complete model and statistical appropriateness of the individual equations, tested through a series of diagnostic checks. First, to ensure that the estimated parameters had a statistically desirable property, and second that there existed a meaningful and interpretable economic relationship among the endogenous variables, residuals were checked for normal, independent and identical distribution (white noise- CHECK). The model was also checked for possible mis-specification. The reported diagnostic statistics included adjusted R^2 , which is a measure of the goodness of fit of the model (i.e. the percentage of the total variation in the dependent variable explained by the independent variables). Additionally, an F-test, in which all the right hand side explanatory variables except the constant are checked to have zero parameter coefficients; the standard deviation of the regression; the Durbin Watson (DW) test for the first order auto-correlation up to the k – th, ($k \geq 1$) (which is strictly not valid when the model has a lagged dependent variable);

a Breusch-Godfrey Lagrange Multiplier (LM) test for serial correlation up to the k-th lag, obtained by regression, the DW statistic would be biased towards 2, resulting in too frequent acceptance of the null hypothesis of no AR(1) errors. Durbin developed an alternative test, Durbin's *h*-statistic, defined as

$$h = r_1 \sqrt{\frac{T}{1 - T\hat{V}}} \qquad (4.9)$$

Where $r_1 = 1 - ½$ DW, $\hat{V}$ was the estimated variance of the coefficient of the lagged dependent variable, and T was the number of observations. This statistic was known to be asymptotically standard normally distributed under the null hypothesis of no serial correlation. Other tests employed were an autoregressive conditional heteroscedastic (ARCH) test, obtained by regressing the squared residuals from the model on their lags and a constant; White's heteroscedasticity/ functional mis-specification test, based on auxiliary regression of the squared residuals on all squares and cross products of the original regressors; Ramsey's RESER general test of mis-specification test, obtained by adding powers of the fitted values from the values from the model to the original regression equation; and the Jarque-Bera test for normality.

4.5 DATA

4.5.1 Exchange Rate and Interest Rate Data

The Central Bank of Ghana is the main source of data on the spot foreign exchange market. The data set includes both the daily official and parallel (parallel market) cedi/dollar rates between **3rd January 2000 and 29th December 2007.** With the exception of the parallel market, foreign exchange trading takes place during normal banking hours (9am to 4/5pm). These transaction quotes represent the mid-rate between the bids and ask quotes at the close of each day. In this study transaction rates are used rather than indicative rates because they provide a better picture of price dynamics in the foreign exchange market. Indicative quotes are usually provided to attract customers and usually differ from the transaction quotes.

For an emerging market like Ghana, it would be unwise to disregard the thriving parallel market for exchange rates. The Ghanaian Central bank acknowledges this fact and therefore incorporates parallel market exchange rates in its analysis and decision making. The FX bureau rate (proxy for parallel market rate) is the average of the individual FX bureau rates. The bank rates (official rates) comprise the indicative and transaction rates. The indicative rate (average opening rates) is the average of all individual banks' indicative rates. Typically, the indicative rates are advertised in banking halls of all banks, and are normally used for all FX transactions, including money remittances. However the transaction rate is a weighted average of the rates charged for the banks' various FX transactions. The volumes are used as the weights.

The central bank requires all banks in the country to submit daily returns on their respective FX market purchases and sales and their related dealing or transaction rates. It derives its USDGH₵ currency pair rates from the market weighted position, and uses

these rates against the international cross rates to derive the domestic currencies equivalent of other foreign currencies.

These two rates are both referred to as the interbank rates. The transaction rate charged by a particular bank will depend on the availability of FX at that point in time.

FX bureau data is collected by the central bank daily. FX bureaus do not observe any customer order flow on the FX market. The dependent variable, the daily log change in exchange rate, is constructed by taking the logarithmic difference of the exchange rate series.

The interest rate differential is the difference between the Ghana daily three-month Treasury bill rate and the US daily three-month Treasury bill rate, expressed on an annual basis. The Ghanaian rates were collected from the central bank of Ghana while the US data was obtained from the Federal Reserve website.

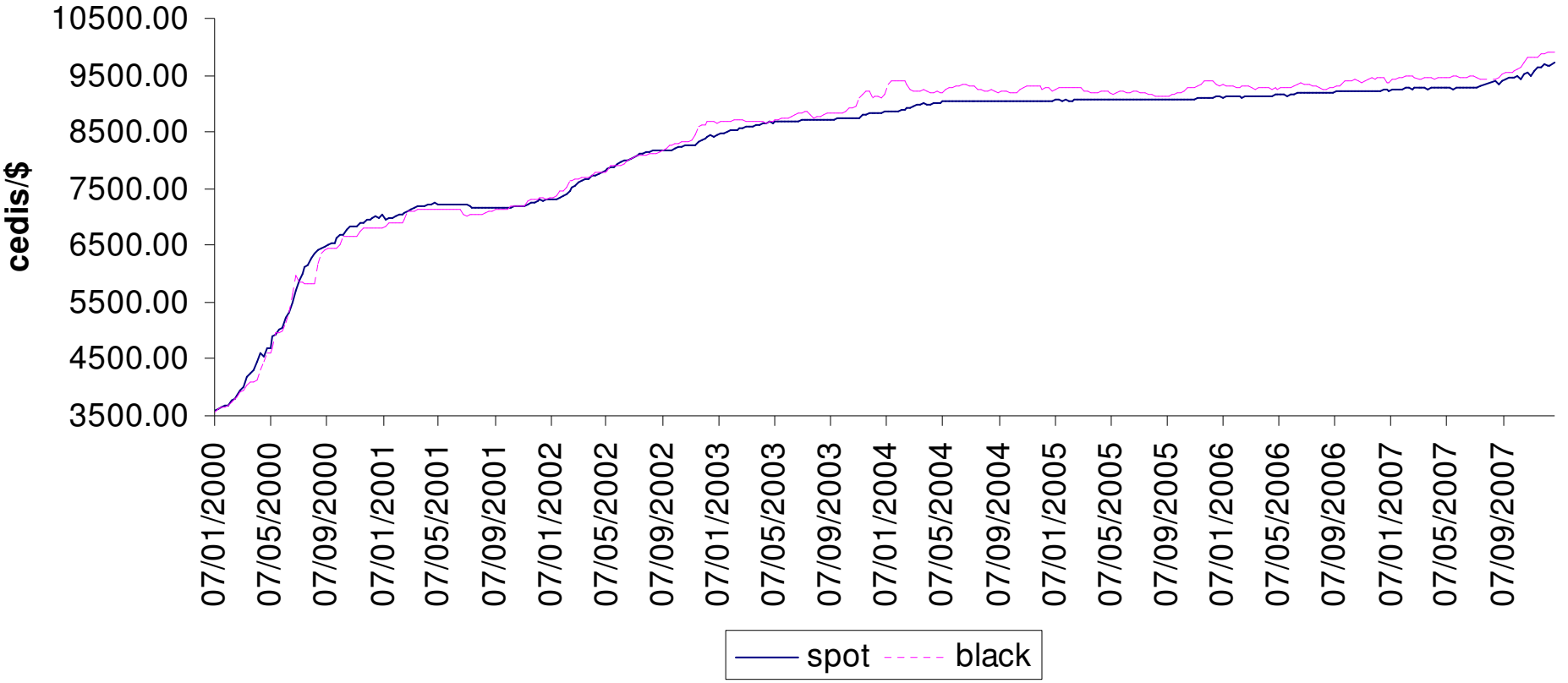
The data sample is diverse in the sense that it contains a period of relative stability and a period of turbulence. Therefore the sample is divided into two sub samples. The first sub sample represents the crisis period spanning the whole of the year 2000. In 2000 Ghana suffered a severe terms of trade loss due to falling cocoa exports and increasing prices on imported petrol. The situation was worsened with a shortfall in divestiture receipts and donor inflows. During this crisis period, consumer price inflation (CPI) shot up to 42% and the Ghanaian currency (CEDI) depreciated by over 50% (figure 4.2).

The second sub sample represents the relatively stable period spanning 2002-2007. By 2002 the prices of Ghana's main export, cocoa and gold, had recovered slightly and the authorities were able to stabilise the main macroeconomic indicators. Equally important in 2002 was the resumption of intervention activity on the FX market by the central bank. By the end of 2001 CPI stood at 21% and the CEDI depreciated by only 3.5%

(figure 4.3). This was the result of tight monetary and fiscal policies. These developments contributed to the restoration of business confidence in Ghana. Data analysis will show that the exchange rate behaves differently during these two periods.

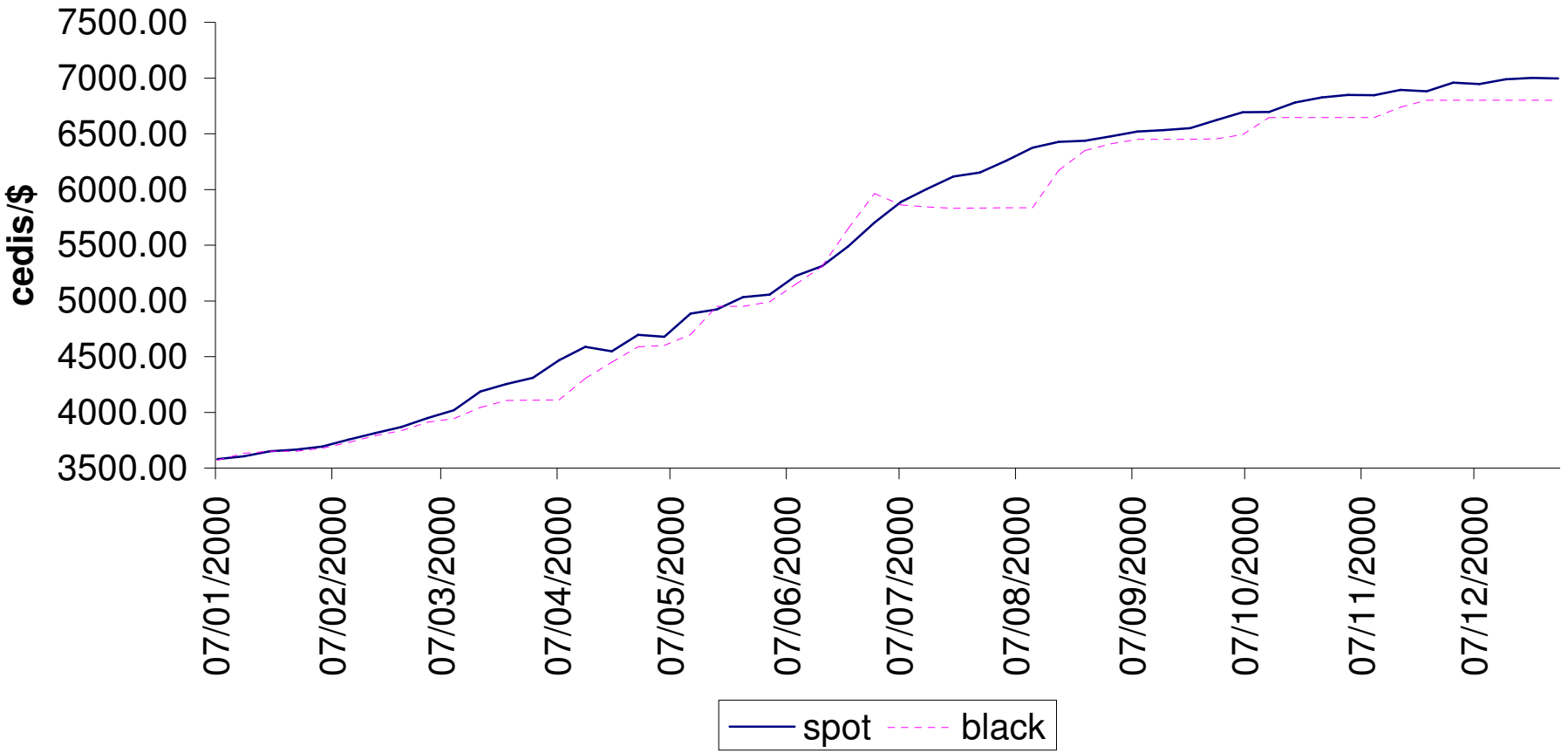
Although the original data is at a daily frequency, preliminary regressions indicate that daily data is noisy. Consequently we aggregate the data into weekly frequency in an attempt to solve the problem. It is also interesting to note that intervention activity coincided with the relative stability of the official exchange rate.

Figure 4.1 weekly spot Exchange rates for the whole sample period



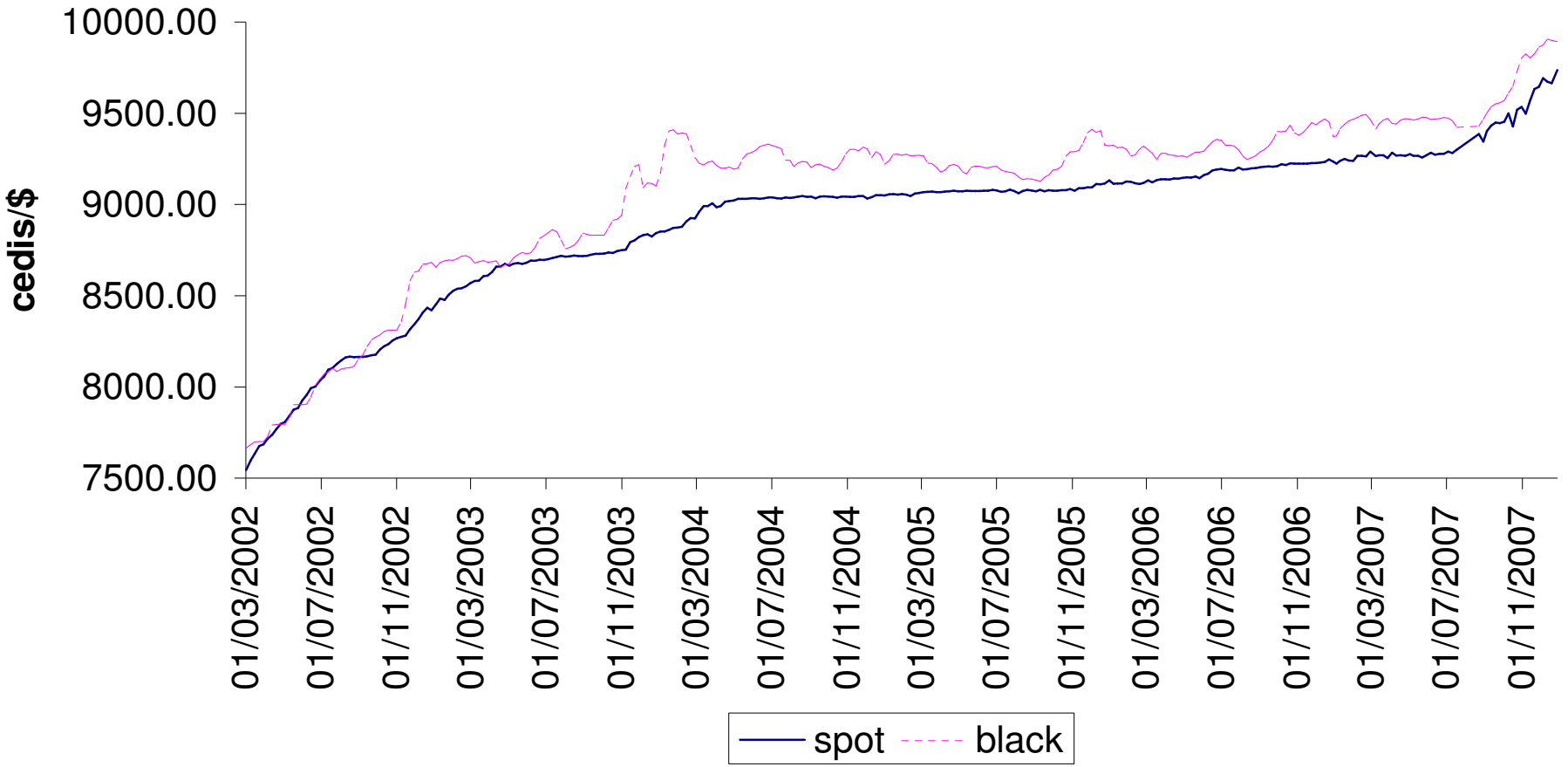
Source: Bank of Ghana (Central Bank of Ghana).Trading occurs during normal banking hours, 9am to 4pm, except for the parallel market. The daily spot exchange rates represent the transaction rates of the market-making commercial banks. The daily FX bureau transaction rates are used as proxies for the parallel market rates.

Figure 4.2 weekly spot Exchange rates during crisis period



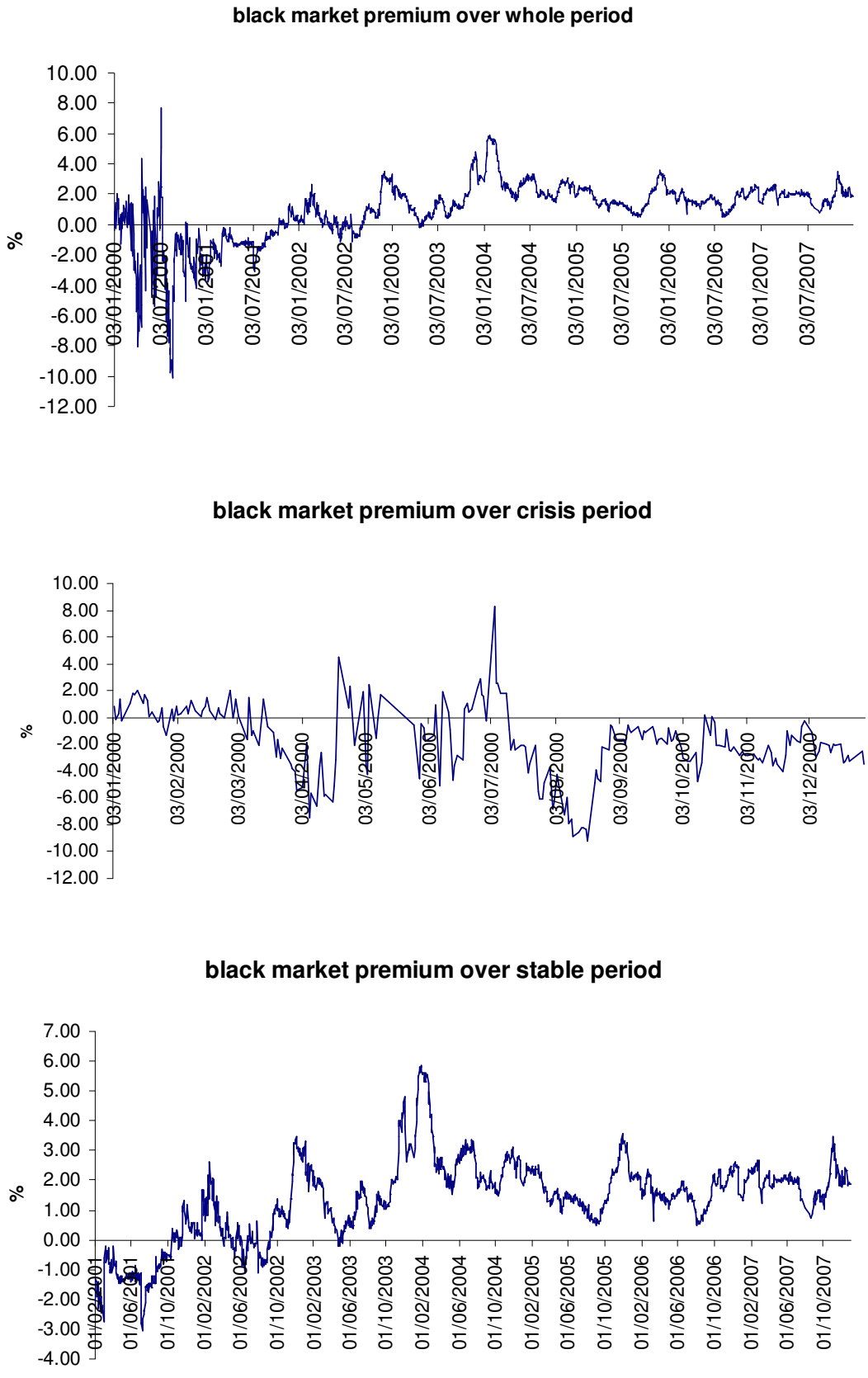
Source: Bank of Ghana (Central Bank of Ghana). During 2000, the cedi depreciated by about 50% due to external shocks. Generally we observe a negative parallel market premium (Parallel market exchange rate minus Official rate) during this period.

Figure 4.3 weekly spot Exchange rates during stable period



Source: Bank of Ghana (Central Bank of Ghana).The cedi remained relatively stable, depreciating by about 20% over six years (2001-2007). Generally we observe a positive parallel market premium (Parallel market exchange rate minus Official rate) during this period.

Figure 4.4 Parallel Market Premiums



The parallel market premium is defined as the spread between the parallel market rate and the official rate. Generally there was a parallel market discount for most of the crisis period. There was an uncharacteristically huge hike in the premium during the middle of 2000.

The crisis period was characterised with spiralling inflation and rapid deprecation of the cedi. During 2000, the cedi depreciated by about 50% against the US dollar (figure 4.2). This situation could be attributed to falling prices of Ghana's major exports commodities (main foreign exchange earners) namely cocoa, gold and timber. The average price per tonne of cocoa plummeted from around $1400 in 1999 to $1000 in 2000. The average price per ounce of gold also fell from pre-crisis levels of $400 to $250 in 2000. The price of timber followed the same pattern, falling from $400 to $350. To further exacerbate this situation, the price of imported crude oil which previously hovered around $10 per barrel, soared to $34 by mid 2000. Official donor inflows, which hitherto, had been supporting the economy, were withheld in 2000. The expected figure was around $200million.

Against all these challenges, Ghana had to pay about $200million every month towards foreign debt obligation by drawing on the already depleting foreign exchange reserves. This created an acute shortage of foreign currency (mainly dollars) as demand for dollars far outstripped their supply. In light of the fact that the nation is heavily dependent on imports, the scarcity of FX fuelled inflationary pressures. Low business confidence and political uncertainty over the outcome of the December 2000 presidential elections led to massive capital outflows around the middle of 2000. At this point, the relative scarcity of FX allowed the parallel market agents to demand huge premiums. This could have contributed to the huge spike in the premium during July 2000 (figure 4.4.)

On the other hand the stable period was characterised with a positive premium starting from 2002. It is interesting to note that also in 2002, the central bank embarked on a program of sustained FX interventions which is still on-going. This was made possible due to the country's replenished FX reserves resulting from a recovery in commodity prices, a fall in crude oil prices and the resumption in foreign donor inflows. At start of 2004, there is another big hike in the premium due to political uncertainty over the outcome of the December 2004 elections.

Table 4.1: Unit Root test on Parallel market Premium

	Crisis Period	Stable period
ADF, P-value	**0.0454**	**0.0041**

To have an idea of the long-run relationship between the official and parallel exchange rates, we test for stationarity using the augmented Dickey-Fuller (ADF) test. The null hypothesis of a unit root is rejected in favour of the stationarity alternative for both periods. This is an indication that the parallel market premium is stationary for both periods. In other words, the official and parallel rates move in tandem in the long-run.

Table 4.2: Descriptive statistics for changes in exchange rates for whole period

	Changes in spot	Changes in parallel
Mean	0.2428	0.2474
Median	0.0638	0.0631
Maximum	4.3725	6.2064
Minimum	-0.8962	-1.7375
Std. Dev.	0.6225	0.7977
Observations	412	412

Descriptive statistics for weekly changes in log of exchange rates calculated over the period January 2000 to December 2007

Table 4.3: Descriptive statistics for changes in exchange rates for crisis period

	Changes in spot	Changes in parallel
Mean	1.3130	1.2634
Median	1.0953	0.6221
Maximum	4.3725	6.2064
Minimum	-0.8847	-1.7375
Std. Dev.	1.2429	1.7591
Observations	51	51

Descriptive statistics for weekly changes in log of exchange rates calculated over the period January 2000 to December 2000

Table 4.4: Descriptive statistics for changes in exchange rates for stable period

	Changes in spot	Changes in parallel
Mean	0.0850	0.0851
Median	0.0407	0.0641
Maximum	0.9732	1.6969
Minimum	-0.7421	-1.3977
Std. Dev.	0.1894	0.3303
Observations	300	300

Descriptive statistics for weekly changes in log of exchange rates calculated over the period March 2002 to December 2007

The descriptive statistics indicate that the exchange rates are very volatile during the crisis period but are relatively stable during the stable period. The standard deviations are abnormally high during the crisis period compared to that of the stable period. In order to give an idea of scale, we compare these movements to that of a larger and more liquid market like the euro-dollar. Specifically we compare the movements of the CEDI/USD to the EUR/USD over the crisis and stable period.

Table 4.5: Descriptive statistics for euro-dollar movements during the Ghanaian crisis and stable periods

	Crisis period	stable period
Mean	-0.000319	0.000253
Median	-0.000492	0.000322
Maximum	0.042041	0.02521
Minimum	-0.02252	-0.021333
Std. Dev.	0.008665	0.005724
Observations	254	1767

In comparison to the CEDI/USD movements, the EUR/USD has enjoyed extreme stability. The relative stability experienced by the Ghanaian CEDI would be equivalent to a currency crisis for the Euro. (Fig 4.3)

Table 4.6: Autocorrelation Function for changes in official exchange rate for crisis period

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
**|. |	**|. |	1	-0.299	-0.299	21.558	0.000
**|. |	***|. |	2	-0.224	-0.344	33.658	0.000
.|** |	.|. |	3	0.238	0.057	47.455	0.000
*|. |	*|. |	4	-0.128	-0.114	51.429	0.000
.|. |	.|. |	5	-0.031	-0.031	51.66	0.000
.|* |	.|. |	6	0.074	-0.027	52.993	0.000
*|. |	*|. |	7	-0.119	-0.11	56.48	0.000
.|* |	.|. |	8	0.098	0.041	58.843	0.000
.|* |	.|* |	9	0.116	0.129	62.204	0.000
*|. |	.|. |	10	-0.177	-0.038	70.088	0.000

Table 4.7: Autocorrelation Function for changes in parallel exchange rate for crisis period

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	-0.035	-0.035	0.2888	0.591
.|. |	.|. |	2	-0.054	-0.055	0.9865	0.611
.|. |	*|. |	3	-0.057	-0.061	1.7661	0.622
.|* |	.|* |	4	0.103	0.097	4.3785	0.357
.|* |	.|* |	5	0.117	0.12	7.7131	0.173
.|. |	.|. |	6	-0.017	0	7.7827	0.254
.|. |	.|. |	7	-0.016	0.006	7.8462	0.346
.|. |	*|. |	8	-0.057	-0.058	8.6492	0.373
.|. |	.|. |	9	0.043	0.013	9.1168	0.427
.|* |	.|* |	10	0.131	0.119	13.389	0.203

Table 4.8: Autocorrelation Function for changes in official exchange rate for stable period

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
***| |	***| |	1	-0.448	-0.448	295.17	0.000
| |	**| |	2	0.008	-0.241	295.26	0.000
| |	*| |	3	0.049	-0.072	298.86	0.000
*| |	*| |	4	-0.063	-0.087	304.71	0.000
|* |	|* |	5	0.129	0.093	329.08	0.000
*| |	| |	6	-0.085	0.022	339.8	0.000
|* |	|* |	7	0.098	0.124	353.91	0.000
| |	|* |	8	-0.023	0.091	354.66	0.000
| |	| |	9	-0.008	0.064	354.74	0.000
|* |	|* |	10	0.082	0.119	364.67	0.000

Table 4.9: Autocorrelation Function for changes in parallel exchange rate for stable period

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
|* |	|* |	1	0.105	0.105	16.224	0.000
|* |	|* |	2	0.164	0.155	55.883	0.000
|* |	|* |	3	0.094	0.066	68.938	0.000
|* |	| |	4	0.08	0.043	78.343	0.000
|* |	| |	5	0.067	0.034	84.915	0.000
| |	| |	6	0.04	0.008	87.247	0.000
| |	| |	7	0.001	-0.027	87.25	0.000
| |	| |	8	0.033	0.019	88.889	0.000
| |	| |	9	-0.012	-0.021	89.086	0.000
| |	| |	10	-0.01	-0.018	89.241	0.000

With the exception of parallel market rate changes during the crisis period, exchange rate changes are generally serially correlated. All the autocorrelation and partial autocorrelation coefficients are statistically significant. This could be evidence of huge inefficiencies in an under-developed and illiquid market. This issue will be addressed when considering our modelling strategy in subsequent chapters.

4.5.2 Order Flow Data

Most banks consider their customer trades to be highly confidential and are usually reluctant to release such data to the public. In Ghana, it is a regulatory requirement for all market making banks (both Ghanaian and foreign) to report all their daily foreign exchange transactions to the central bank. These commercial banks register every single foreign exchange trade (purchase and sale) with their customers at respective transaction rates. For spot FX, commercial banks have a more natural customer base than investment banks (Lyons 2001). This study will examine the cedi/US dollar market covering a period of seven years (January 2000 to December 2007). The dataset will cover the five largest banks (market-makers) in the foreign exchange market, who account for over 80% of the transactions. This leads to a high degree of transparency because an individual big bank observes a substantial portion of the market and may

have an idea of order flow in the other big banks. The banks are ranked in terms of net interest income, deposits, profits etc (Table 4.10). They are Barclays Bank (BBG), Standard Chartered (SCB), Social Security Bank (SSB), Agricultural Development Bank (ADB) and Ghana Commercial Bank (GCB). They form the 1st quartile of the banking industry. As of 2007, there were 17 active dealer banks in the foreign exchange market.

Table 4.10: Industry statistics of top five banks

BANKS	Net Interest income	Profit Ranking	Share of deposits	Number of branches
GCB	15.90%	3	17.89%	131
BBG	14.00%	1	15.44%	32
SCB	12.40%	2	13.33%	18
ADB	8.00%	7	6.80%	48
SSB	14.10%	4	6.67%	36

Source: PriceWaterHouseCoopers Ghana Banking Survey 2006. Findings of annual Survey of the Ghanaian banking industry. The survey focuses on the last 5 years beginning 2000 and includes 20 banks.

A brief background and structure of these banks will help in the interpretation of the subsequent results.

SCB & BBG were the first banks to be set up in Ghana at the beginning of the 20th century. Their main line of business was trade finance and they mainly served the expatriate community. This trend has continued with a majority of their customers being multinationals and large and medium-scaled enterprises.

GCB was the first indigenous bank to be set up in 1953. Its main objective was to extend credit to the local population. GCB owns about 50% of all branches in Ghana. Its customer base is well diversified with customers ranging from state enterprises to private individuals. It is the largest bank in Ghana in terms of deposits and assets.

ADB was a development bank established in 1965 to cater for the needs of the agricultural sector. It has a vital role since the agricultural sector is still the largest contributor to the GDP. Until 2005 it was the sole agent for Western Union money transfer. As a result remittances account for about 90% of its foreign flows. Customer base consists of mainly small to medium scaled enterprises and privates individuals.

SSB is the smallest bank in the 1st quartile. It was set up by the social security and national insurance trust in 1977. Societe Generale, the French Bank, acquired controlling interest in the bank in March 2003.

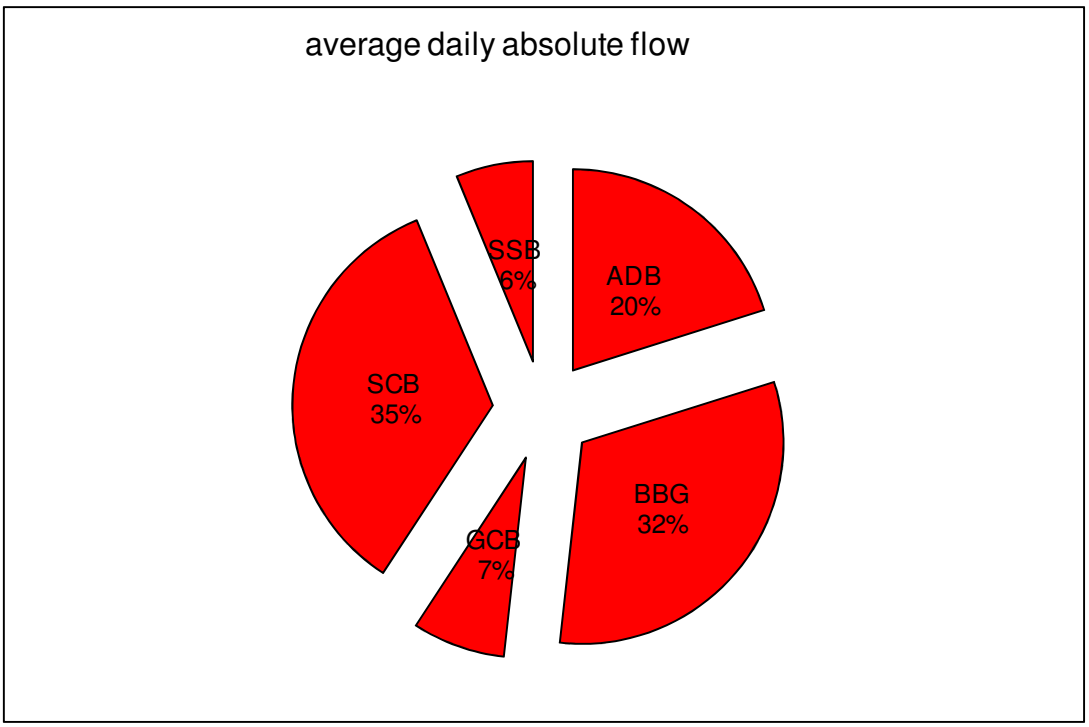
This data set provides us with a relatively complete picture of the cedi/dollar market. This is similar to the datasets of Rime (2000) and Bjønnes, Rime and Solheim (2004) which account for about 90% of the Norwegian and Swedish markets respectively. The trades are aggregated over each day for each bank and for the total of the five banks. Daily order flow is calculated by taking the difference between the number of buyer initiated trades and the number of seller initiated trades. A positive order flow denotes net dollar purchases.

In order to determine the sign of the trades we make the widely used assumption that trades between banks and customers are initiated from the customer side. This assumption is based on the fact that trading between banks and their customers is likely to occur when customers demand this service and therefore become initiators. Banks act as the middlemen between the interbank market and the customers. Customers place orders with their banks and then the banks trade with each other on the interbank market. The resulting order flow is what aggregates information into prices.

Unfortunately, this data set does not allow us to distinguish between the various customer groups. Generally the big commercial banks experience large customer order flows due to the nature of their customer base. Their customers are usually large non-banking firms (big corporations and multinationals).

Some earlier studies like Marsh and O'Rourke (2005), Bjønnes et al (2005) and Mende and Menkhoff (2003) have been able to split non-bank customer categories into financial and non-financial customers to enable them analyse the impact of these different order flows. Nevertheless this dataset is unique in so many ways. To the best of our knowledge this is the most complete data set for an African country. In calculating order flow, Evan and Lyons (2002a) used the quantity of buyer and seller initiated trades whiles this study uses the actual transaction volumes. It seems that actual transactions of customers provide a better measure of the underlying sources of demand and supply for foreign exchange in the economy (Lyons 2001). Our dataset gives a more complete picture of the FX market than studies like Evans and Lyons (2002a), Froot and Ramadorai (2005), Marsh and O'Rourke (2005) who use data for just for a single market-maker. The data set for this study makes use of transaction volumes covering almost the whole Ghanaian foreign exchange market and as a result most of the significant trades. The longer time span also allows for a more precise estimation of the impact of daily order flow on weekly exchange rate movements.

Figure 4.5: Average daily absolute flows. This pie chart illustrates each bank's share of the daily volumes traded. It is obvious that the FX market is dominated by two main foreign banks (Standard Chartered Bank & Barclays bank). The relatively high figure of 20% for ADB, a local bank, could be as a result of its Western Union remittance flows.



Absolute flow gives an indication of the actual value of transactions disregarding whether transactions are purchases or sales. From table 4.11 and figure 4.5 it is obvious that the two foreign banks (Barclays & Standard chartered) are by far the biggest players in the Ghanaian foreign exchange market. This could mean that they have superior information with regards to exchange rate movements. This is not surprising because they mainly serve the expatriate community in Ghana. The relatively high value of transactions recorded by ADB could be misleading because its main source of foreign exchange is their remittance flows. The two other local banks (GCB & SSB) control a significantly small portion of the foreign exchange market. According to the central bank, during the 3rd quarter of 2007, one bank dominated the FX market with 23.2% of total volume of transactions whiles the other four banks accounted for 59.1%.

Table 4.11: Descriptive statistics of weekly order flow

	ADB	BBG	GCB	SCB	SSB
Mean	-1.07	1.31	1.43	1.64	1.02
Median	-1.20	1.08	-0.01	1.09	-0.15
Maximum	21.91	19.38	27.10	18.55	9.75
Minimum	-9.62	-14.62	-2.90	-6.48	-0.99
Std. Dev.	2.43	2.80	3.32	2.92	2.03
Observations	413	413	413	413	413

Source: Central Bank of Ghana. Weekly spot trading from January 2000 to December 2007. All numbers in million USD. Positive order flow indicates that customers are net buyers of dollars and negative flow indicates that they are net sellers of dollars

Table 4.12: Correlations between individual banks flows for the whole period

	ADB	BBG	GCB	SCB	SSB
ADB	1.00	-0.02	-0.06	-0.11	-0.07
BBG	-0.02	1.00	-0.04	0.08	0.13
GCB	-0.06	-0.04	1.00	0.18	0.43
SCB	-0.11	0.08	0.18	1.00	0.18
SSB	-0.07	0.13	0.43	0.18	1.00

Table 4.13: Correlations between individual banks flows for the crisis period

	ADB	BBG	GCB	SCB	SSB
ADB	1.00	0.00	0.21	0.36	-0.09
BBG	0.00	1.00	-0.08	0.10	0.04
GCB	0.21	-0.08	1.00	0.39	0.03
SCB	0.36	0.10	0.39	1.00	-0.21
SSB	-0.09	0.04	0.03	-0.21	1.00

Table 4.14: Correlations between individual banks flows for the stable period

	ADB	BBG	GCB	SCB	SSB
ADB	1.00	0.01	-0.05	-0.11	-0.06
BBG	0.01	1.00	-0.08	0.05	0.09
GCB	-0.05	-0.08	1.00	0.14	0.38
SCB	-0.11	0.05	0.14	1.00	0.14
SSB	-0.06	0.09	0.38	0.14	1.00

Normally one would expect the flows of the individual banks to be somehow correlated. Rather surprisingly, the individual bank flows are almost uncorrelated. This reflects the differences in customer types. The flows of GCB and SSB, the two banks that serve significant portion of the indigenous Ghanaian community, are relatively highly correlated.

Figure 4.6: This graph presents the weekly customer order flow calculated from January 2000 to December 2007. There seems to be an increase in customer trading activity from 2002 onwards.

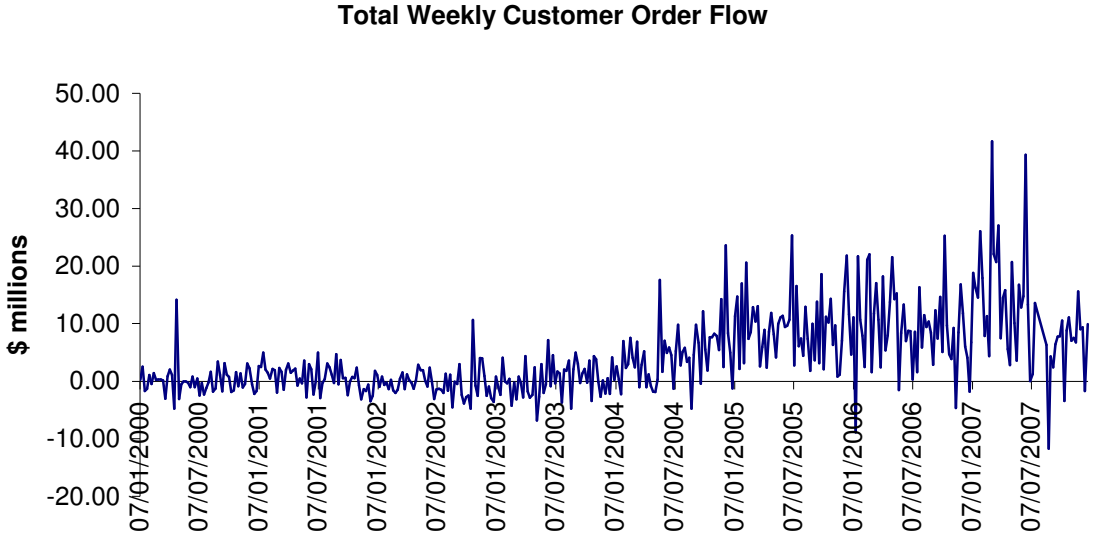


Figure 4.7: This graph presents the cumulative customer order flow calculated from January 2000 to December 2007. This provides evidence that customers have remained net buyers of dollars over the whole period. There seems to be an increase in customer trading activity from 2002 onwards.

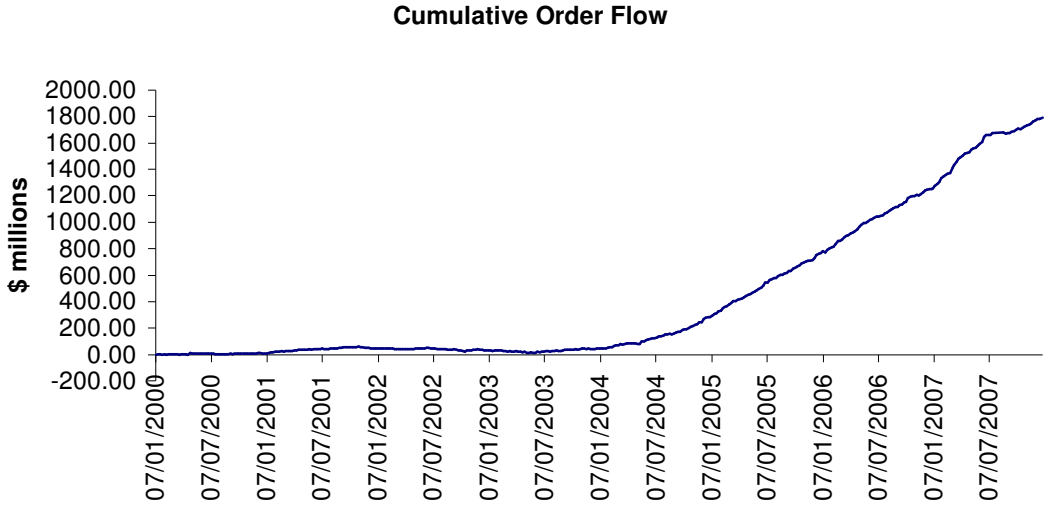


Figure 4.6 shows the daily order flow for the five banks over the whole sample period. In this case order flow is from the point of view of the customer. Therefore a positive order flow means customers are buying dollars and selling cedis contemporaneously. Figure 4.7 shows the cumulative net order flow for the whole period.

From the two graphs it is obvious that transaction activity increased dramatically from mid 2002 onwards. The direction of this activity was towards the purchase of dollars, evident in the positive order flow. Generally order flow has remained positive for the whole period. This is not a surprising feature since in Ghana, a large proportion of the customers of these top banks maintain a high proportion of their deposits in foreign currency. They view the dollar as a 'safe haven'. This could be attributed to positive real interest rates, the continued lack of confidence in the sustainability of the appropriate economic policies and the heavy dependence of Ghanaian economy on imports.

The only exception was ADB as it exhibited negative order flow throughout the period. For several years ADB was the main agent for Western Union Money transfer in Ghana. The beneficiaries received the cedi-equivalent of the remittances. This was equivalent to them selling dollars and buying cedis, hence the negative order flow. Another significant development was the cancellation of Ghana's debt by the Paris club of donors in 2001 as a result of adopting the highly indebted poor country (HIPC) initiative. Non payment of debt coupled with the revival of cocoa and gold prices increased the foreign exchange reserves of Ghana.

4.5.3 Central Bank Flow data

In the discharge of its activities, BOG has created a permanent window to buy and sell Foreign Exchange (FX). It thus, sells FX for the following purposes;

(a) To commercial banks to enable them cover oil import bills and sometimes for BOP support (i.e. non-oil FX sales).

(b) To the Government to cover debt repayments, important imports, and other required service payments.

Despite the fact that the market operates independent of the BOG, it is incumbent on the Bank to keep foreign exchange reserves accounts for all commercial banks as a statutory requirement. Consequently, all multi-donor, bilateral and agency donor inflows are channelled through the Bank. In addition, about ninety-eight percent (98%) of export proceeds from cocoa plus 20% to 40% portion of Gold export proceeds are also channelled through the BOG.

The amount of FX the BOG sells to the market to cover oil payments or to provide 'BOP support' is not pre-announced. Moreover, the BOG sells FX at rates derived from the

interbank market. Most bank treasurers argue that on average the rates at which BOG sold FX to banks were below market rates. They are of the view that the intention of BOG is to slow down the rate of depreciation of the exchange rate.

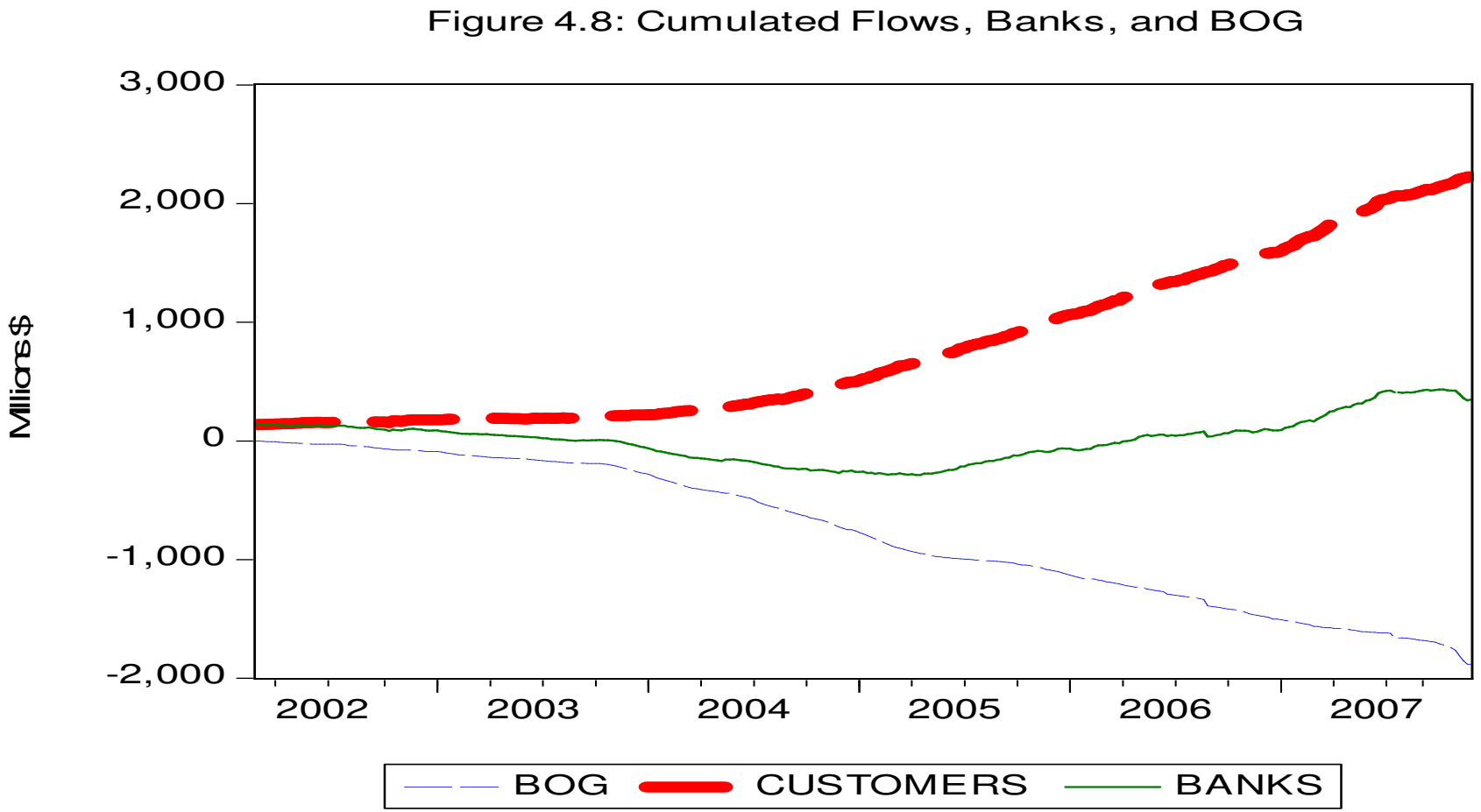
On the contrary, BOG states that it does not buy FX from or sell to the market for the purpose of intervening but as a result of regulatory requirement (e.g. surrender amounts), or payment for oil to the country or for 'BOP support'. Accordingly, the BOG's support to the market to cover oil import bills and BOP is always accounted for in its annual cash flow programme. Implicitly, the BOG's entry into the market is not to smoothen out the market in terms of volatility but to cover a programmed need or payment.
Clearly, as shown in Figure 4.8, the negative order flow exhibited by BOG could be due to the frequent provision of FX to be supplied to banks. This data is categorized as 'non-oil FX sales to banks' in the records of the Central Bank.

On a normal day, banks usually approach the central bank and submit FX buy orders (resulting from customer orders). The BOG supplies the required FX to the needy banks as and when the requests are made. By so doing, BOG appears to be rationing its FX supplies to the needy commercial banks.

The records show that for each order submitted by a bank, BOG supplies only about 40-50% of the required volume. During crisis times, BOG is able to meet only about 10% of the required volume. However, data on volumes sold are not made available to the market, they are highly confidential. Banks only have an idea of their own volumes. BOG provides aggregate volume information (e.g. quarterly data, yearly etc) with a significant lag at monthly frequencies. We were, however, able to assemble the weekly data through special arrangements at BOG. In light of the fact that the remittance bank

and BOG are both net-sellers of dollars, we combine their flows into one group (BOG) in subsequent analysis.

All the macroeconomic dataset used for the study (i.e. GDP, M2 money, consumer prices, exports/imports, gross reserves, interest rates) were obtained from various publications of BOG.



The graph (Fig 4.8) illustrates the dominant role of BOG in the FX market and raises the issue of the impact of its actions on exchange rate movements. Customer order flow is almost a mirror image of the BOG flow. As already mentioned, the BOG pursues a one-sided policy of selling FX to banks that make requests. It could therefore be inferred that the banks merely act as 'middlemen' between BOG and the bank customers.

CHAPTER FIVE

ORDER FLOW AND EXCHANGE RATE DYNAMICS IN GHANA

5.1 Introduction

Exchange rate may be regarded as an open economy's most important price. It has a direct effect on most macroeconomic variables such as imports, exports, wages and inflation. The exchange rate has a direct bearing on consumer prices, both through increases in import prices of final goods (the direct channel), and through the price of imported intermediate inputs (the indirect channel): this is known as exchange rate pass-through.

Undoubtedly, exchange rate instability can cause havoc to both the real economy and the inflation rate. Thus, there can be no macroeconomic stability (of inflation and/or real GDP) without exchange rate stability.

In the light of the importance of the exchange rate for the macro economy, it is noticeable that traditional macroeconomic models fail to explain exchange rate behaviour in the short run. In other words, most macroeconomic approaches to exchange rates, e.g. Meese and Rogoff (1983) suggest empirical failures.

Existing literature seem to suggest that after the collapse of the Bretton Woods system and the move to generalized floating among the major currencies, it became clear that large movements in exchange rates were occurring far more frequently than many flexible rate advocates had expected. Indeed the rates fluctuated widely in unanticipated directions and magnitudes. These swings affected interest rate movements as the monetary authorities tried to influence exchange rates through movements in interest rates.

Consequently, the microstructure approach to exchange rate determination has attempted to understand the systems inducing these large deviations from macroeconomic fundamentals which have characterised exchange rate movements. The microstructure approach has tried to tackle these empirical failures by looking at issues "such as transmission of information between market participants, the behaviour of market agents,

the relationship between information flows, the importance of order flow, the heterogeneity of agents' expectations and the implications of such heterogeneity for trading volume and exchange rate volatility" Sarno and Taylor (2002). Earlier works on FX microstructure have used surveys of FX market participants to support strong heterogeneity of expectations and an increasing diffusion of expectations.

Indeed, it is argued that exchange rates are determined by market participants' expectations of future exchange rates. Furthermore, these expectations are based on information available at any point in time. In other words, if for example, a significant amount of people expect the British pound to appreciate, due to the information they have, demand for the British pound will rise, resulting in a corresponding increase in the price of the British pound. Market participants are also influenced by risk. When an asset is viewed as risky, one might be willing to pay less for holding it. With the persistent volatility of these factors, firms that are exposed to the impact of exchange rate could be largely affected by these unanticipated movements and could cause very large gains or losses if the risks remain unmanaged. Nevertheless, the difficulty in explaining changes in exchange rates arises because neither expectations, nor information (which forms the basis of expectations), nor market participants' assessment of risk can be observed. More so all these factors vary over time.

One of the most important explanatory variables in FX microstructure is order flow. In the landmark paper of Evans and Lyons (2002a), "order flow is defined as the net of buyer-initiated and seller-initiated orders: it is measure of net buying pressure". Even though order flow has high explanatory power in explaining, it does not imply that it is the underlying cause. Macroeconomic fundamentals could still be the underlying causes but the manner in which they have been measured could be inaccurate, making the order flow proxy a better candidate for estimation (Sarno and Taylor 2002). Hence order flow is a proximate cause. Order flow is considered to be informative when it conveys private

information about future fundamentals and less informative when it results from liquidity shocks.

All African financial markets are relatively under-researched but often that is because the data is unavailable for long periods. Applying the exchange rate models to African rates is not very appealing. Two ways ahead would be to either use very sophisticated econometrics (which also runs the risk of still not working because the data is poor) or trying the only successful thing we have at the moment - customer order flows.

This study tries to explain the behaviour of the exchange rate in an emerging market, namely Ghana, based on the recent microstructure framework of foreign exchange markets. This is one of the very few studies to apply such a framework to an emerging market. To the best of our knowledge, with the exception of Brazil and Hungary[6], no known studies have been done in emerging markets. One key premise of the microstructure approach is the explanatory role of the order flow in the behaviour of the exchange rate. The study uses a unique database, which covers 80% of the customer order flow of the Ghanaian FX market.[7] This is in contrast to previous studies, such as Evans and Lyons (2002a), Mende and Menkhoff (2003) and Marsh and O'Rourke (2005) that use data for a single market-maker and often for a short period of time. In addition, the longer time span also allows for a more precise estimation of the impact of daily order flow on weekly exchange rate movements. Furthermore, the study takes into account a unique feature of the majority of emerging markets, namely the existence of a parallel market for FX. Thus, we consider the interaction of the parallel market and order flow, and parallel market and official market, in addition to the interaction between the official rate and order flow. Thus, the parallel market could an additional channel for disseminating public and/or private information.

[6] Wu (2007) for Brazil and Aron Gereben, Gyorgy Gyomai and Norbert Kiss M (2006) for Hungary

[7] The data were provided through contacts at the Central Bank of Ghana

The paper makes two main contributions to the literature. First, it modifies the model to take account of a unique feature of the majority of emerging markets, namely the existence of a parallel market for FX. Secondly, it uses a unique database covering almost the complete Ghanaian market, and for a long time span compared to previous studies, which use data for a single market-maker and for a short period of time. The study confirms the contemporaneous relationship (between flows and exchange rates) suggested by previous literature (Evans and Lyons (2002a) but it also finds a lagged interaction between order flow and exchange rates, which could be due to the delays in the price transmission, which are associated with inefficiencies. Order flow impacts on exchange rates through the official market, while its impact on the parallel market is only temporary. Additionally, the study confirms the connection between the price impact of the order flow and the degree of liquidity in the FX market.

5.2 Econometric Analysis

We start our analysis with the static framework proposed by Evans and Lyons (2002a). Nevertheless it is unlikely that this static model will be successful at capturing the dynamics of a largely inefficient, under-developed and illiquid FX market. As we will discuss in the next section, this specification has problems. Specifically it assumes a static framework and ignores the relationship between official and parallel markets. However, we do this to be consistent with previous literature (like Evans & Lyons 2002a) and as a starting point in the analysis. Our dynamic model takes into account these inefficiencies by including lags of exchanges rates, order flow and interest differential. Furthermore we use an enriched version of the Love and Payne (2008) VAR framework to decompose order flow into its expected and unexpected components and find out which of these components account for movements in the exchange rates. In light of the long-run relationship between official and parallel rates, we include a lagged parallel market premium variable. Finally we investigate whether the effects of flows on exchange rates are temporary or permanent. Accordingly we test for the significance of the aggregated effect of flows by conducting Wald coefficient restrictions tests.

5.2.1 Generic Model

In this section we use basic Ordinary Least Squares (OLS) to examine the relationship between customer order flow and exchange rates. In Ghana, we observe two exchange rates, official and parallel market rates, and so we will separately examine the relationship between order flow and these two exchange rates. In Ghana, the parallel market rate is usually regarded as the 'true'exchange rate in the economy. For our regression analysis we estimate using the Evans & Lyons (2002a) generic order flow model. This static model can be represented by an equation of the form:

$$\Delta S_t = \alpha_0 + \beta \Delta X_t + \gamma \Delta r_t + \varepsilon_t \qquad (5.1)$$

Where ΔS_t is the daily change in the log exchange rate (Ghanaian cedi/US dollar) and X_t is the total customer order flow from the top five Ghanaian commercial banks. Δr_t represents the change in the nominal interest rate differential, $\Delta(i - i^*)$ where i is the daily nominal Ghanaian three-month treasury bill (t-bill) rate and i^* is the daily nominal US three-month t-bill rate. Customer Order flow is measured in million US dollars. When β, the coefficient of order flow, is positive (correctly signed) and significant we say that the purchase of dollars by customers results in a depreciation of the cedi/dollar exchange rate. This refers to the null hypothesis of the order flow concept.

Hypothesis: The null hypothesis states that information from order flow causes exchange rate changes.

An increase in the exchange rate corresponds to depreciation and vice versa. To correct for serially correlated and heterscedastic errors, we need to use appropriately modified standard error estimates. We apply the Newey-West procedure which results in standard errors that are consistent in the presence of both heteroscedasticity and serial correlation.

Table 5.1 generic model 1: Regressing weekly change in log exchange rates (both official & parallel market) on total order flow and change in interest differential over the whole sample period: spanning 3rd January 2000 to 29th December 2007: $\Delta S_t = \alpha_0 + \beta \Delta X_t + \gamma \Delta r_t + \varepsilon_t$

	Official Exchange rate	Parallel market rate
Δx_t	-1.548 (-3.085)	-1.727 (-3.354)
Δr_t	0.249 (1.576)	0.308 (1.244)
R^2	0.076	0.061
	Diagnostics	
Serial correlation	0.00	0.000
heteroscedaticity	0.001	0.000

T-values are in parenthesis. Standard error estimates are corrected for serial correlation and heteroscedasticity using the Newey-West HAC correction. All equations are estimated using basic OLS. We scale the order flow by multiplying by 100.

Table 5.1, above, reports the estimates of the generic model. This model is estimated using basic OLS. The dependent variable is the daily log change in cedi/dollar exchange rate. The t-statistics are in parentheses. The regressor ΔX_t is the daily net customer order flow. The regressor (Δr) represents the change in the interest rate differential. The sample spans eight years (January 2000 to December 2007).

Customer order flows are significant in this generic static model. In other words, customer order flows are able to explain contemporaneous movements in the exchange rate. Nevertheless, order flow variables are negatively signed, contrary to what is expected. Thus over the whole period, customer trades may not convey any incremental information relevant to exchange rates. These negative results could emanate from the heterogeneity of our data sample and/or the static nature of our model. As already discussed we tackle heterogeneity by dividing the sample into sub samples. The first sub sample represents the crisis period spanning January 2000 to December 2000 when the exchange rate depreciated by almost 50%. The second sub sample corresponds to the relatively stable period spanning March 2002 (when central bank resumed intervention) to December 2007. We believe that these different sub samples may have an effect on the relationship between order flow and exchange rates. The generic model is estimated for the different sub samples.

Table 5.2 generic model 2: Regressing weekly change in log exchange rates (both official & parallel market) on total order flow and change in interest differential over the crisis period spanning 3rd January 2000 to 29th December 2000: $\Delta S_t = \alpha_0 + \beta \Delta X_t + \gamma \Delta r_t + \varepsilon_t$

	Official Exchange rate	Parallel market rate
Δx_t	1.259 (2.456)	0.494 (0.741)
Δr_t	0.538 (4.325)	0.900 (3.000)
R^2	0.146	0.138
	Diagnostics	
Serial correlation	0.010	0.149
heteroscedaticity	0.902	0.789

T-values are in parenthesis. Standard error estimates are corrected for serial correlation and heteroscedasticity using the Newey-West HAC correction. All equations are estimated using basic OLS. We scale the order flow coefficient by multiplying by 10.

For the crisis period (table 5.2), the order flow variable is positively signed and significant in explaining movements in the official exchange rate. This means that a net purchase of dollars by customers is associated with a depreciation of the Ghanaian cedi. The interest differential is also positively signed and significant as expected. When the dependent variable is the change in the parallel market rate, order flow is not significant. In other words, flows have no explanatory power in the parallel market during the crisis period. The interest differential is however highly significant and correctly signed.

Table 5.3 generic model 2: Regressing weekly change in log exchange rates (both official & parallel market) on total order flow and change in interest differential over the stable period spanning March 2002 to 29th December 2007 : $\Delta S_t = \alpha_0 + \beta \Delta X_t + \gamma \Delta r_t + \varepsilon_t$

	Official Exchange rate	Parallel market rate
Δx_t	-3.965 (-2.364)	-3.471 (-1.506)
Δr_t	-0.004 (-2.364)	0.001 (0.013)
R^2	0.003	-0.001
	Diagnostics	
Serial correlation	0.062	0.000
heteroscedaticity	0.298	0.162

T-values are in parenthesis. Standard error estimates are corrected for serial correlation and heteroscedasticity using the Newey-West HAC correction. All equations are estimated using basic OLS. We scale the order flow coefficient by multiplying by 10^3.

During the stable period (table 5.3), both order flow are highly significant but negatively signed with the official exchange rate as the dependent variable. In the parallel market rate order flow is only significant at 10% significance level and negatively signed. The interest differential is insignificant.

5.2.2 Dynamic Model

This static model allows for only a contemporaneous relationship between customer order flows and exchange rates where changes in the net flows cause an instant change to the exchange rate. In general, the change in an explanatory variable will not immediately have an effect on the dependent variable during that same period but rather with a lag over

several time periods. However as we witnessed earlier, the autocorrelation present in the exchange rates is an indication of inefficiencies in the Ghanaian FX market (tables 4.6-4.9). For that reason a static model may not be able to fully capture the dynamics of the Ghanaian foreign exchange (FX) market When customer trades are executed, there may be some delays (due to various reasons) in the time it takes for the information conveyed by trades to be embedded in exchange rate. The dynamic model includes lagged values of both the explanatory and dependent variables which would allow us to capture the dynamic structure in the exchange rates. By including lags, we are taking into account the fact that changes in order flow and interest rate differential will not affect the exchange rate immediately but rather with a lag over several time periods. The transformation of a static model into a dynamic model may help in reducing or even removing the serial correlation present in the residuals. Initially we ignore parallel market rates and premiums, which are later included in the decomposition of flows into expected and unexpected components.

The dynamic model is represented by the equation of the form:

$$\Delta S_t = \alpha_0 + \beta \Delta X_t + \sum_{i=1}^{4} \mu \Delta X_{t-i} + \sum_{i=1}^{4} \gamma \Delta S_{t-i} + \sum_{0}^{4} \lambda \Delta r_{t-i} + \varepsilon_t \qquad (5.2)$$

We choose a maximum lag length of 4 which is the equivalent of 4 trading weeks. This takes into account the inefficiencies in the FX market which could result in lagged interactions between the variables. Akaike Information criterion (AIC) is used to determine the appropriate lag length for the variables in this dynamic equation.

We use the general to specific modelling approach. We start with a model containing 4 lags of changes in exchange rate and total order flow.

Table 5.4 Dynamic model 1: Regressing weekly change in log official exchange rates on its own lags and lags of total order flow and change in interest differential over the crisis period spanning 3rd January 2000 to 29th December 2000: $\Delta S_t = \alpha_0 + \beta \Delta X_t + \sum_{i=1}^{4} \mu \Delta X_{t-i} + \sum_{i=1}^{4} \gamma \Delta S_{t-i} + \sum_{0}^{4} \lambda \Delta r_{t-i} + \varepsilon_t$

	Official Exchange rate
Δx_t	1.585 (4.046)
Δs_{t-2}	-0411 (-3.020)
Δr_t	0.289 (3.078)
Δr_{t-1}	0.371 (2.544)
R^2	0.399
Diagnostics	
serial	0.026
heteroscedasticity	0.384

T-values are in parenthesis. Standard error estimates are corrected for serial correlation and heteroscedasticity using the Newey-West HAC correction. All equations are estimated using basic OLS. We scale the order flow coefficient by multiplying by 10.

During the crisis period (table 5.4), changes in the official exchange rate depend on current order flow, lagged changes in interest differential and exchange rates. The order flow variable is correctly signed and is the most significant variable in the regression. In other words, a net purchase of dollars will result/associated with depreciation in the official exchange rate. A purchase of $1m will result in 0.15% depreciation in the exchange rate. Interest differential are also correctly signed and significant. The R-squared is relatively high at 0.399.

Table 5.5 Dynamic model 2: Regressing weekly change in log official exchange rates on its own lags and lags of total order flow and change in interest differential over the stable period spanning 1st March 2002 to 29th December 2007: $\Delta S_t = \alpha_0 + \beta \Delta X_t + \sum_{i=1}^{4} \mu \Delta X_{t-i} + \sum_{i=1}^{4} \gamma \Delta S_{t-i} + \sum_{0}^{4} \lambda \Delta r_{t-i} + \varepsilon_t$

	Official Exchange rate
Δx_{t-2}	-2.310 (-2.169)
Δs_{t-1}	-0.205 (-1.705)
Δs_{t-2}	0.122 (2.329)
Δs_{t-3}	0.462 (6.014)
Δs_{t-4}	0.153 (1.755)
Δr_{t-1}	0.040 (2.193)
Δr_{t-3}	-0.027 (-1.621)
R^2	0.266
Diagnostics	
serial	0.316
heteroscedasticity	0.000

T-values are in parenthesis. Standard error estimates are corrected for serial correlation and heteroscedasticity using the Newey-West HAC correction. All equations are estimated using basic OLS. We scale the order flow coefficients by multiplying by 10^3.

During the stable period table (5.5), changes in the official exchange rate depend on lagged total order flow. Changes in the official exchange rate also depend on their past values. This could be evidence that FX traders following negative feedback trading rules. Subsequent tests will confirm whether or not there is negative feedback trading. Specifically, negatively signed and highly significant lagged exchange rate variables in the order flow VAR would confirm the presence of negative feedback trading.

5.2.3 Expected and Unexpected Order flows

We need to find out whether the explanatory power of order flow comes from its expected, unexpected component or both. In the Evans and Lyons (2002a) model, all order flow is unexpected because it is assumed that the expected component should already be priced into the exchange rate. Evans and Lyons find that order flow's explanatory power comes from the unexpected component. However, it is possible that explanatory power comes from both the expected and unexpected components. In this case, whilst unexpected order flow measures price discovery in the FX market, expected flow would be an indication of inefficiencies in the FX market. When order flow is unexpected, it should carry more informational content. By employing an 'enriched' version of the Love and Payne (2008) VAR framework, we decompose order flow into expected and unexpected components and determine which component accounts for movements in the official and parallel exchange rates. We say 'enriched' in the sense that, though we drop the news variable, we include lagged changes in the parallel market rate, lagged changes in the interest differential and lagged parallel market premium.

$$\begin{bmatrix} \Delta s_t \\ \Delta x_t \end{bmatrix} = \alpha_0 + \begin{bmatrix} \beta \\ 0 \end{bmatrix} \Delta x_t + \sum_{i=1}^{4} \Gamma_i \begin{bmatrix} \Delta s_{t-i} \\ \Delta x_{t-i} \end{bmatrix} + \sum_{j=1}^{4} \alpha \Delta B_{t-j} + \sum_{j=1}^{4} \eta \Delta r_{t-i} + \Delta P_{t-1} + \varepsilon_t \qquad (5.3)$$

Where ΔS_t is the log change in official exchange rate, ΔX_t is the net order flow, ΔB_t is the log change in the parallel market rate, Δr_t is the change in the interest differential and ΔP_{t-1} is the lagged parallel market premium.

The VAR equations are estimated individually using basic OLS. We decompose contemporaneous order flow into its expected and unexpected components by running an order flow regression. We store the fitted values as expected flows and the residuals as unexpected (shock) flows. We then substitute the flow variables in the exchange rate equation and run the regression. This is done for both the official and parallel market exchange rates. Specifically one equation has changes in the official exchange rate as the

dependent variable whilst the other has changes in the parallel market rate as the dependent variable.

We adopt the general to specific modelling approach. Specifically we start with an extremely general model, which is over-parameterised, then we reduce it to the most parsimonious model by testing various coefficient restrictions. As previously explained we start with a maximum lag length of 4. AIC is used to determine the appropriate lag length for the variables in this dynamic equation.

Table 5.6: Order Flow VAR for crisis period. Order flow is regressed on its own lags, lagged exchange rate changes, lagged parallel exchange rate changes and lagged interest differential: $\Delta x_t = \alpha_0 + \sum_{i=1}^{4} \beta_i \Delta x_{t-i} + \sum_{i=1}^{4} \gamma_i \Delta s_{t-i} + \sum_{i=1}^{4} \delta_i B_{t-i} + \sum_{i=1}^{4} \sigma_i \Delta r_{t-i} + \Delta P_{t-1} + \mu_t$

	Coefficients
Δx_{t-1}	-3.885 (-3.180)
Δx_{t-2}	-2.801 (-3.233)
Δs_{t-1}	-0.593 (-2.011)
ΔB_{t-2}	0.681 (2.207)
ΔB_{t-3}	-0.159 (2.262)
Δr_{t-1}	-0.860 (-3.451)
Δr_{t-4}	-0.477 (-3.478)
R^2	0.376
Diagnostics	
serial	0.861
heteroscedasticity	0.024

T-values are in parenthesis. Standard error estimates are corrected for serial correlation and heteroscedasticity using the Newey-West HAC correction. All equations are estimated using basic OLS. We scale the order flow coefficients by multiplying by 10.

Table 5.7: Expected and unexpected order flows for crisis period. Changes in the **official exchange rate** are regressed on its own lags, current and lagged expected and unexpected order flows, lagged parallel exchange rate changes, lagged interest differential:

$$\Delta s_t = \alpha_0 + \sum_{i=0}^{4} \beta_i \Delta EF_t + \sum_{i=0}^{4} \tau_i \Delta UF_{t-i} + \sum_{i=1}^{4} \gamma \Delta s_{t-i} + \sum_{i=1}^{4} \delta_i B_{t-i} + \sum_{i=1}^{4} \sigma_i \Delta r_{t-i} + \Delta P_{t-1} + \mu_t$$

	Coefficients
ΔEF_t	2.854 (4.121)
ΔEF_{t-3}	-1.748 (-3.641)
ΔUF_t	2.367 (4.059)
ΔUF_{t-2}	1.379 (1.836)
Δr_{t-1}	0.838 (4.424)
Δr_{t-3}	-0.469 (-4.001)
Δs_{t-1}	0.202 (2.693)
Δs_{t-2}	0.363 (3.252)
ΔB_{t-2}	-0.201 (-2.587)
ΔB_{t-3}	0.354 (4.319)
R^2	0.542
Diagnostics	
Serial correlation	0.227
heteroscedasticity	0.997

T-values are in parenthesis. Standard error estimates are corrected for serial correlation and heteroscedasticity using the Newey-West HAC correction. All equations are estimated using basic OLS. We scale the order flow coefficients by multiplying by 10.

Current and lagged flows (expected and unexpected) contribute to movements in the official exchange rate (table 5.7). Specifically, the aggregate impact of unexpected flows is larger and positive, as expected. This means that an increase in the unexpected flow (net purchase of dollars) results in a depreciation of the domestic currency. Additionally lagged changes in interest differential, official rate and parallel market rate are also significant in explaining official exchange rate returns. The flow variables are relatively more significant in comparison to the other variables. The lagged parallel market premium, however, is not significant. The R-squared is relatively high at 0.542.

Table 5.8: Expected and unexpected order flows for crisis period. Changes in the **Parallel market exchange rate** are regressed on its own lags, current and lagged expected and unexpected order flows, lagged official exchange rate changes, lagged interest differential and lagged change in parallel market premium.

$$\Delta B_t = \alpha_0 + \sum_{i=0}^{4} \beta_i \Delta EF_t + \sum_{i=0}^{4} \tau_i \Delta UF_{t-i} + \sum_{i=1}^{4} \gamma \Delta s_{t-i} + \sum_{i=1}^{4} \delta_i B_{t-i} + \sum_{i=1}^{4} \sigma_i \Delta r_{t-i} + \Delta P_{t-1} + \mu_t$$

	Coefficients
ΔEF_{t-2}	1.793 (2.149)
ΔEF_{t-3}	2.537(1.849)
ΔUF_{t-2}	1.779 (1.958)
Δs_{t-1}	0.331 (2.535)
ΔB_{t-1}	0.426 (3.305)
ΔP_{t-1}	-0.300 (-3.282)
R^2	0.303
Diagnostics	
Serial correlation	0.979
heteroscedasticity	0.059

T-values are in parenthesis. Standard error estimates are corrected for serial correlation and heteroscedasticity using the Newey-West HAC correction. All equations are estimated using basic OLS. We scale the order flow coefficients by multiplying by 10.

Lagged flows (expected and unexpected) are significant in explaining movements in parallel market rate (table 5.8). Their overall signs are positive but expected flows have a larger aggregate impact than unexpected flows. Though lagged changes in official and parallel rates are significant, we also observe that the lagged parallel market premium is highly significant. The adjusted R-squared is 0.303

Table 5.9: Order Flow VAR for stable period. Order flow is regressed on its own lags, lagged exchange rate changes, lagged parallel exchange rate changes, lagged interest differential

$$\Delta x_t = \alpha_0 + \sum_{i=1}^{4} \beta_i \Delta x_{t-i} + \sum_{i=1}^{4} \gamma_i \Delta s_{t-i} + \sum_{i=1}^{4} \delta_i B_{t-i} + \sum_{i=1}^{4} \sigma_i \Delta r_{t-i} + \Delta P_{t-1} + \mu_t$$

	Coefficients
Δx_{t-1}	1.361 (2.243)
Δx_{t-2}	1.824 (2.878)
Δx_{t-3}	1.521 (2.605)
Δx_{t-4}	1.706 (2.627)
Δs_{t-1}	-0.501 (-1.942)
Δs_{t-2}	-0.396 (-2.086)
R^2	0.296
Diagnostics	
serial	0.102
heteroscedasticity	0.074

T-values are in parenthesis. Standard error estimates are corrected for serial correlation and heteroscedasticity using the Newey-West HAC correction. All equations are estimated using basic OLS. We scale the order flow coefficients by multiplying by 100.

Table 5.10: Expected and unexpected order flows for stable period. Changes in the **official exchange rate** are regressed on its own lags, current and lagged expected and unexpected order flows, lagged parallel exchange rate changes, lagged interest differential

$$\Delta s_t = \alpha_0 + \sum_{i=0}^{4} \beta_i \Delta EF_t + \sum_{i=0}^{4} \tau_i \Delta UF_{t-i} + \sum_{i=1}^{4} \gamma \Delta s_{t-i} + \sum_{i=1}^{4} \delta_i B_{t-i} + \sum_{i=1}^{4} \sigma_i \Delta r_{t-i} + \Delta P_{t-1} + \mu_t$$

	Coefficients
ΔEF_t	-10.650 (-9.289)
ΔEF_{t-1}	5.134 (5.985)
ΔEF_{t-2}	4.914 (5.418)
ΔEF_{t-3}	-1.411 (-2.874)
ΔUF_{t-1}	1.480 (7.150)
ΔUF_{t-2}	1.458 (7.938)
ΔUF_{t-3}	0.358 (2.264)
Δs_{t-1}	-0.369 (-4.755)
Δs_{t-2}	0.397 (9.188)
Δs_{t-3}	0.266 (4.201)
ΔB_{t-2}	-0.048 (2.924)
Δr_{t-2}	0.036 (3.034)
Δr_{t-3}	-0.033 (-3.121)
R^2	0.697
Diagnostics	
Serial correlation	0.000
heteroscedasticity	0.000

T-values are in parenthesis. Standard error estimates are corrected for serial correlation and heteroscedasticity using the Newey-West HAC correction. All equations are estimated using basic OLS. We scale the order flow coefficients by multiplying by 100.

Table 5.11: Expected and unexpected order flows for stable period. Changes in the **parallel market exchange rate** are regressed on its own lags, current and lagged expected and unexpected order flows, lagged official exchange rate changes and lagged interest differential

$$\Delta B_t = \alpha_0 + \sum_{i=0}^{4} \beta_i \Delta EF_t + \sum_{i=0}^{4} \tau_i \Delta UF_{t-i} + \sum_{i=1}^{4} \gamma \Delta s_{t-i} + \sum_{i=1}^{4} \delta_i B_{t-i} + \sum_{i=1}^{4} \sigma_i \Delta r_{t-i} + \Delta P_{t-1} + \mu_t$$

	Coefficients
ΔEF_{t-2}	1.828 (1.700)
ΔEF_{t-3}	-2.513 (-2.361)
ΔUF_{t-1}	0.453 (2.006)
ΔUF_{t-3}	-0.591 (-2.119)
ΔB_{t-1}	0.471 (6.142)
ΔB_{t-2}	-0.099 (-1.709)
ΔP_{t-1}	-0.059 (-3.119)
R^2	0.246
Diagnostics	
Serial correlation	0.386
heteroscedasticity	0.029

T-values are in parenthesis. Standard error estimates are corrected for serial correlation and heteroscedasticity using the Newey-West HAC correction. All equations are estimated using basic OLS. We scale the order flow coefficients by multiplying by 100.

In general, both expected and unexpected components (current and/or lagged) of order flow are significant in explaining movements in the exchange rates (tables 5.10 & 5.11). Specifically, during the crisis period, expected and unexpected flows have an instantaneous and lagged effect on the official exchange rate. However they both have only lagged effects on the parallel market exchange rate.

During the stable period, expected and unexpected flows again have only lagged effects on official and parallel market rates. Additionally we observe positive momentum trading in customer flows. This is evident in the consistent positive sign of order flow coefficients in the order flow VAR (table 5.9). Perhaps, one of the most important observations is the significance and negative sign of the lagged parallel market premium variable in the parallel market equation (table 5.11). This negative correlation means that an increase in

the parallel market premium results in the appreciation of the parallel market rate. Thus, contrary to the norm, it is rather the parallel market rate that adjusts to the official rate.

Table 5.12: Aggregate impact of Flows

		Crisis Period		Stable Period	
		Official	Parallel	Official	Parallel
General	UF	0.5940	0.6316	0.0327	0.0071
	EF	1.0185	1.9673	-0.0201	-0.0130
Specific	UF	**0.3748**	0.1780	**0.0330**	-0.0014
	EF	0.1105	0.4330	-0.0202	-0.0070

In order to calculate the overall impact, we just add up the coefficients of the lags.

We calculate the overall impact of flows by adding up the coefficients of the lags in the specific model. For example, an unexpected net customer purchase of $1m over the previous four weeks during the crisis period will result in 0.37% depreciation of today's exchange rate (table 5.12).

In the official market, unexpected order flow has a larger impact on exchange rates relative to expected order flow and is correctly (positively) signed for both crisis and stable periods. Results for the parallel market are mixed. Unexpected order flow has a relatively smaller impact for both periods but is negatively signed during the stable period (table 5.12).

We also observe that the coefficients during the crisis are generally much larger in magnitude compared to those in the stable period. In other words the dollar impact of flows on exchange rates is much larger in the crisis period. This is consistent with findings by Marsh and O'Rourke (2005). They find that there is a connection between the

magnitude of coefficients and the liquidity of the FX market. Specifically in very liquid markets (like the euro-dollar and dollar yen) coefficients are relatively small in comparison to the larger coefficients in the smaller, less liquid markets (like the euro-yen and pound-yen). Similarly in our case the magnitude of the coefficients are much larger during the crisis period when the cedi-dollar market is almost illiquid compared to the coefficients in the stable period when the market is relatively liquid. In other words, the magnitude of the impact of order flows on exchange rates depends on the level of liquidity in the Ghanaian FX market.

In most cases other variables like the lagged changes in exchanges rates (official & parallel) are very significant. As discussed previously, this is consistent with the inefficiencies and under-development in the Ghanaian FX market. As a result agents' speculation about future exchange rate movements is based on immediate past values of the exchange rate itself. Subsequently an initial depreciation induces a series of buying which causes a further depreciation of the domestic currency.

5.2.4 Temporary or Permanent effects of Flow?

It is critical to order flow literature to ascertain whether impacts are temporary or permanent. If the effects of unexpected flows are permanent then that means information is being conveyed by flows. On the other hand the temporary effect of unexpected flows could be as a result of a variety of liquidity effects. To find out whether effects of flows are temporary or permanent, we need to test for the significance of aggregated effect. Subsequently, we conduct a Wald coefficient restriction test on the flow variables.

This consists of an F-test with a null hypothesis that the sum of the coefficients is zero e.g. C (1) +C (2)…. +C (N) =0. In other words the null hypothesis states that the aggregate effect of flows is temporary.

A rejection of the null in favour of the alternative could mean that the aggregate effects of flows are permanent and vice versa. The Wald tests were conducted on both general and specific models. We share the same view with econometricians that a general model which is over-parameterised may result in a situation where a group of variables may be proxying the same thing. Results may be biased because this situation could lead to a restriction not being rejected when it should have been rejected. In light of this, we focus on the results from the specific model.

Table 5.13: P-values from Wald coefficient restriction test for specific and general models

		CRISIS		STABLE	
		Official	Parallel	Official	Parallel
General	UF	0.594 (0.004)	0.632 (0.018)	0.033 (0.000)	0.007 [0.376]
	EF	1.019 (0.069)	1.967 (0.082)	-0.020 (0.000)	-0.001 [0.045]
Specific	UF	**0.375 (0.000)**	0.178 (0.057)	**0.033 (0.000)**	-0.001 [0.662]
	EF	0.111 (0.073)	0.433 (0.049)	-0.020 (0.000)	-0.007 [0.095]

P-values are in parenthesis

Unexpected order flow has a permanent effect on both periods only in the official market (table 5.13). This could be interpreted to mean that unexpected order flow conveys incremental information which causes changes in the exchange rate.

5.3 Interpretation of Results

During the crisis period, unexpected order flow has a larger permanent effect on official and is positively (correctly) signed. Though unexpected order flow is positively signed in the parallel market, its aggregate effect is only temporary (tables 5.12 & 5.13). According to literature this is what we should expect. During this turbulent period, falling cocoa and gold prices coupled with rising oil prices and donor inflows being withheld led to

expectations of poor future fundamentals. This induced an excess demand for FX and economic agents, who were in a state of panic, were willing to pay high premiums for already scarce commodity. This continuous bidding-up of FX at high premiums led to a spiralling of the exchange rate. This contributed to the 50% depreciation.

During the stable period, both expected and unexpected flows, have a permanent impact on the official exchange rate (tables 5.12 & 5.13). Again, unexpected order flow has a relatively larger impact and is positively signed. Nevertheless the price-impact of unexpected order flow is much lower during the stable period. As previously discussed, this could be related to the level of liquidity during both periods. Interestingly, even though expected order flow has a smaller impact, its effect is permanent and is negatively signed. During this relatively calm period, a significant portion of the FX transactions are carried out by firms (mostly multinationals) who follow negative feedback trading rules. In other words, firms buy the currency that has just depreciated.

According to existing literature firms usually take advantage of these short-term exchange rate movements to exchange money for non-speculative reasons like repatriation of funds and import of raw materials. The presence of negative feedback trading is confirmed by the highly significant and negatively signed lagged exchange rate variables in the order flow VAR (table 5.9). Thus negative feedback trading of firms is over-shadowed by the price discovery/information aggregation process. On the parallel market, expected and unexpected order flow have only temporary effects and are both negatively signed (table 5.13). The absence of price discovery reflects the nature of transactions on the parallel market. The official FX market is relatively stable and it costs relatively cheaper (and more convenient) for customers (individuals and institutions) to obtain FX from the banks.

As a result, a majority of the flows are seen by commercial banks. By observing the coefficients we see that the price-impact is relatively small in comparison to the other flows. This is because there are many small players on the parallel market who observe significantly lesser flows in comparison to the banks. These results further confirm previous findings that it is rather the parallel market rate that adjusts to the official spot rate.

5.4 Modelling the long-run relationship between exchange rate and order flows

Previous tests we conducted have been aimed at capturing the short-term dynamics in the Ghanaian FX market. Next, we attempt to investigate the long-run relationship between the levels of exchange rate and the cumulative customer order flow. Since the parallel market rate is rather adjusting to the official rate, we have resolved to include only the level of the official rate in our subsequent cointegration analysis.

Using the augmented Dickey-Fuller (ADF) test (table 5.14), we confirm that the two series are non-stationary. According to the Johansen procedure, the null is rejected at 5 percent level which further suggests that there is only one cointegrating vector (table 5.15) We determine the lag length of 4 for the VAR using Akaike Information Criterion (AIC). We estimate the vector error-correction model. The coefficients of the cointegrating relationship are significant and correctly signed (table 5.16). Results from the short-run dynamics are reinforced as the cumulative customer order flow is positively correlated with the levels of official exchange rate. In order to have an idea of which variables provide adjustment to equilibrium, we examine the error correction coefficients, coefficients of lagged changes in official rate and customer order flow.

The error correction term is highly significant in both the order flow and exchange rate equations (table 5.17). This means that tests for weak exogeneity have been strongly rejected for both variables. The load of adjustment to long- run equilibrium falls solely on the official exchange rate. The negative (wrong) sign of the error correction in the flows equation indicates that flows do not adjust to cause equilibrium but rather move in the opposite direction. However the relatively higher speed of adjustment of flows means that eventually flows should 'catch up' with the official exchange rate in order for the whole

system to attain the equilibrium. Clearly these cointegration results could be described as weak because the adjustment process is ambiguous.

Table 5.14: Unit Root test on level of Official rate and cumulative order flow

Unit root test	Levels of official rate	Cumulative order flow
P-value	**0.722**	**1.000**
t-statistic	**-1.085**	**4.439**

Table 5.15: Cointegration relationship between exchange rates and cumulative order flows

	Max. Eigenvalue statistic	**Trace test statistic**
	46.758	**54.473**
	(15.892)*	**(20.262)***

* 5% critical value of unrestricted cointegration rank test. Both denote significance

Table 5.16: Cointegration equation

Cointegrating Eq	CointEq1
P_{t-1}	**1.000**
X_{t-1}	**-0.001** **[-5.725]**

t-statistics in brackets

Table 5.17: Vector Error Correction Estimates

D variable	ΔP_t	ΔX_t
ECM Coefficient	-0.001(-4.437)	-5.305 (-6.946)
ΔP_{t-1}	-2.318 (-4.437)	-758.634 (-3.183)
ΔP_{t-2}	0.042 (0.693)	-790.349 (-3.225)
ΔP_{t-3}	0.384 (6.411)	-444.026 (-1.817)
ΔX_{t-1}	-0.000 (0.967)	0.059 (0.948)
ΔX_{t-2}	-0.000 (-2.041)	0.108 (1.741)
ΔX_{t-3}	-0.000 (-2.032)	0.075 (1.209)
R^2	0.219	0.273

5.5 Robustness Checks

We conducted additional exercises to check the robustness of our results. We check whether the inclusion of ADB flows, mainly consisting of remittance flows, to total order flow has biased our results. Consequently we excluded the remittance flows so that total order flow consisted of only flows from the other 4 banks and then repeated all our regressions. Generally there were no major changes in the significance and signs of the coefficients.

Cointegration results are very sensitive to the choice of lag length. Choosing one lag above or below (for example 3 or 5) the optimal lag length of 4, results in no cointegration whatsoever.

5.6 Discussion and Conclusion

In Ghana, customer order flow greatly influences exchange rates, reinforcing the importance of order flow stated in previous literature. In considering an emerging market like Ghana, we need to consider some distinct features of the economy. The economic fundamentals governing the Ghanaian cedi are mainly dependent on external factors, mainly world commodity prices and foreign capital flows. For several years the Ghanaian cedi has remained vulnerable. Therefore it could be argued that the trades of customers of the top foreign banks, who control about 80% of the FX market, may convey more superior private information about future fundamentals than their local counterparts. Additionally we can not ignore the existence of a parallel market for foreign exchange.

We test our data using the Evans and Lyons (2002a) model. Before estimation we aggregate the data at a weekly frequency to reduce the noise that we experience at a daily frequency. Initially, we find that there is a contemporaneous relationship between order flow and exchange rates (both official and parallel market), but the order flow coefficient is negatively (wrongly) signed. This could be as a result of the heterogeneity in the data sample. The issue of the heterogeneity of the data sample is dealt with by dividing the sample into crisis and stable periods. Consequently during the crisis period both order flow and the interest differential are significant in explaining contemporaneous movements in the official exchange rate. More importantly order flow is positively (correctly) signed. In this case net purchases of $1m would result in an exchange rate depreciation of about 0.16%. Order flow is not significant in explaining the movements in the parallel market rate.

During the stable period order flow is highly significant but negatively signed. In other words the net buying of the dollar leads to an appreciation of the official exchange rate. This could be evidence of negative feedback trading where the direction of causation runs from changes in the official exchange rate to net order flow. The presence of negative feedback is further confirmed by the negative coefficients of the lagged values of exchange rate in the order flow VAR. This is consistent with Marsh and O'Rourke (2005) and Mende and Menkhoff (2003) who find that non-financial customer order flow is negatively correlated to exchange rate movements and attribute this to negative feedback trading rules. Also significant portions of the customer base of the top five banks are non-financial customers or corporations. Again order flow is insignificant in explaining the parallel market rate.

The Ghanaian economy is characterised with various inefficiencies, poor infrastructure and lack of advanced technology which create delays in the price transmission mechanism. We attempt to capture these delays and other inefficiencies by introducing a dynamic model. For the crisis period weekly changes in the official exchange rate depend on current order flow and lagged changes in the exchange rate and interest differential.

Overall, the order flow variables are correctly (positively) signed and significant. R-squared is relatively high at 40%. For the stable period, the official exchange rates depend on lagged order flow exchange rates. In general, the order flow variables are significant and again negatively correlated with changes in the official exchange rate. This reinforces the possible existence of feedback trading. The magnitude of the effect of customer order flow on exchange rate is relatively high in comparison to previous microstructure studies.

The cedi/US dollar FX market is relatively small and less liquid and it is normal for the price impact of a trade to be larger in the less liquid market where it is more difficult to enter or exit a position. Also just like in other emerging economies, the cedi is relatively volatile compared to currencies of other developed countries. This makes it more risky to hold, and as a result a large price change is required for a risk averse agent to hold it.

Furthermore, we investigate which component (expected or unexpected) of order flow is responsible for movements in the exchange rates. We use the Love and Payne (2008) VAR framework to decompose order flow and find out which components of order flow influence movements in exchange rates. Though we drop the news variable, we enrich their model by including lagged changes in parallel market rates, lagged changes in interest differential and lagged parallel market premium to the right-hand side. Additionally we test for the significance of the aggregated effect of flows to find out if they have a permanent or temporary effect.

Evidence of a permanent effect of unexpected flows would mean that they convey private information and as a result there is price discovery. The main measure of price discovery is unexpected order flow whilst expected order flow represents the inefficiencies in the FX market. Our results indicate that unexpected order flow has a permanent effect only in the official market during both periods. This is consistent with previous literature that unexpected flows convey incremental private information that affects exchange rates. In other words, it is the shock component of flows that matters.

We find that unexpected order flow is highly significant and positively correlated with changes in the official. The only exception is the parallel market during the stable period where unexpected order flow is negatively correlated with exchange rates. In the official

market, unexpected order flow has a relatively larger impact on the exchange rate changes for both crisis and stable period.

The smaller impact of unexpected order flow on the parallel rate might be due to the fact that there are numerous smaller players in the parallel market. The lack of price discovery in the parallel market could be due to the fact that a majority of the FX transactions (by firms and individuals) occur in the official market. On the other hand, transactions on the parallel market are significantly lower in terms of volume and value. Not surprisingly, most of these transactions are conducted by individuals and petty traders. During the 3rd quarter of 2007, total purchases by banks were $1.1bn compared to $96m for FX bureaus whilst total sales by banks were $882m compared to $95m for FX bureaus. We also observe that the lagged parallel market premium (highly significant) is negatively correlated with changes in the parallel market rate. This suggests that it is rather the parallel market rate that adjusts to the official rate to cause equilibrium. For this reason, we drop the levels of parallel market rates in our subsequent cointegration analysis.

Cointegration tests reveal that there is a long-run relationship between levels of official rates and cumulative order flow. Consistent with market microstructure theory, cumulative order flow is positively correlated with the official exchange rate. Adjustment to equilibrium is ambiguous with error correction terms being wrongly signed. We believe this is connected to the omission of the central bank flow variable, which is properly dealt with in chapter 6.

Generally our results give us a deeper insight into the relationship between order flow and the exchange rates for different regimes in emerging markets. Specifically, there is strong evidence of information aggregation and price discovery for the official market during both regimes, similar to findings of Evans and Lyons (2002a).

However for the official FX market during the stable period, order flow is as a result of a mixture of price discovery and negative feedback trading by firms similar to findings by Marsh and O'Rourke (2005).

Unexpected order flow is correctly signed and has a larger impact on exchange rate as theory suggests. Nonetheless, expected order flow too seems to have an impact on order flow and this is due to inefficiencies in the FX market. There is evidence of both price discovery and negative feedback trading but the former overshadows the latter. Yet the negatively signed order flow in the dynamic model during the stable period indicates that expected order flow dominates in terms of volume. Specifically the bank customers are liquidity providers. They react to changes in the exchange rate in order maximise profits from their business operations. Not only do we confirm the contemporaneous relationship (between flows and exchange rate) suggested by previous literature (Evans and Lyons (2002a) but we also observe a lagged interaction between order flow and exchange rates. These lagged effects are due to the delays in the price transmission which are associated with inefficiencies. Additionally we observe that when the market is almost illiquid during crisis, order flow has a relatively larger impact on exchange rates than the in the stable period when the market is more liquid. This confirms findings by Marsh and O'Rourke (2005) who find that there is a connection between the price impact of the order flow and the degree liquidity in the FX market.

CHAPTER SIX

Long-run Liquidity Provision in the Ghanaian FX market

6.1 Introduction

Liquidity, as a fundamental concept in finance is largely regarded as the ability to buy or sell quantities of an asset quickly and at a low cost. Liquidity provision of a Central Bank (BOG) is very important since any runs and crises could lead to fear of future liquidity shocks with its associated policy implications. In Ghana, the study of FX liquidity provision is justified, particularly; researchers would like to know which group of market participants provide long-run liquidity in the foreign exchange market.

Recently there has been intense debate, amongst practitioners and academics, over the stability of the cedi-US dollar exchange rate. They have questioned the extent of BOG's involvement in the foreign exchange market, which allows it to influence the exchange rate so heavily.

According to the 2007 IMF country report, "Staff believes that beyond good macroeconomic policies that build confidence, the stability of the cedi with respect to the U.S. dollar in recent years is a result of the Bank of Ghana's statutory involvement in the foreign exchange market, which allows it to manage the exchange rate heavily…….Consequently, the interbank foreign exchange market is shallow and banks often rely on the BOG for foreign exchange. The authorities maintained that confidence-inducing macroeconomic policies alone were responsible for the relative stability of the cedi against the U.S. dollar".

It is widely believed that the BOG's continuous interventions in the market render the inter-bank foreign exchange market shallow since commercial banks continue to rely on the former (BOG) for foreign exchange.

The Centre for Policy Analysis, an independent Ghanaian think-tank, also noted that "What is perceived as Excessive Central Bank manipulation as well as that by the major dealers are the two most important non-fundamental factors affecting the exchange rate". Therefore, knowledge about the foreign exchange provisioning in the country would help elucidate the existing controversy. Secondly, this knowledge is important to investors and traders who are developing trading strategies and are therefore attempting to identify conditions likely to disturb their operations.

We believe this paper will provide a microscopic view of the Ghanaian FX market in terms of liquidity provision. In fact, the study provides satisfactory answers to the questions about the degree of liquidity in the Ghanaian foreign exchange market and what causes its daily movements. The study covers a sample period long enough to subsume a variety of events, for only then could one be reasonably confident of the results.

6.2 Theoretical Approach and Econometric Analysis

This study adopts the framework proposed by Bjønnes et al. (2005) to address the following important issues.

1. Does order flow explain long-run movements in exchange rates?

2. Which player(s) in the Ghanaian FX market supply liquidity (are pulled by market) and which demand liquidity (push the market around).

3. Is BOG intervening (pushing) or providing balance of payments (BOP) support (i.e. being a pull customer)?

Bjønnes et al. (2005) use an exclusive dataset from the Swedish Krona market. This dataset covers 90-95% of all worldwide trading in SEK and spans six years (January 1993-June 2002). It consists of daily buying and selling transactions of both Swedish and foreign market making banks. They acknowledge that this data is confidential and is not readily available to the market as a whole. At best, reporting banks are able to obtain summaries of flows from the central bank at a substantial lag. This data allows for a classification of market participants into 4 distinct groups namely market making banks (MM), Financial customers (Fin), Non-Financial customers (Non-Fin) and BOG. A market maker trades with other market makers and the other 3 market participants. It is from this relationship that they obtain the flows of the market making banks:

$$\Delta(MM-trade)_i + \Delta(FIN)_i + \Delta(NON-FIN)_i + \Delta CB_i = -\Delta MM_i \qquad (6.1)$$

Where a positive number is equivalent to a net buy of foreign currency

With reference to and with the help of the theory of market making, Bjønnes et al. (2005) highlight two main characteristics that should aid in the identification of liquidity providers:

1) The net flows of a liquidity provider should be negatively correlated with the level of exchange rate.

2) Liquidity providers are usually not the active parties in FX trades. They passively match others demand and supply.

In order to examine this key relationship (between FX rate and flows), the empirical section starts with a test for cointegration between the FX rate and the cumulative flows of the Financial and non-Financial customers. They examine the short-run dynamics at various frequencies. In particular, they need to ascertain that the correlation between the flows of a particular group and the exchange rate are robust. Additionally they have to show that this correlation with the exchange rate is matched by and has the opposite sign for another group. Finally they need to establish that the flows of the group positively correlated with the exchange rate is the active side of the market while the flows of the group negatively correlated to the exchange rate is on the passive side.

Bjønnes et al. (2005) use the log of the SEK/EUR measured at close of the Swedish FX market. They also use the 10year bond yield differential and the 3 month interest differential as proxies for macroeconomic variables. The 10year differential is supposed to take into account long-term macroeconomic expectations and the 3month differential will take into account short-term expectations.

The Evans and Lyons (2002a) model presents Bjønnes et al. (2005) with a set of equations that can be estimated using their data. The first three equations (6.2 to 6.4) represent the first three rounds of trading while the last equation (6.5) represents the relationship between the daily flows of the customers. The nature of their data means that the equations (6.2 to 6.5) can be estimated.

$$P_t = \alpha \sum_{\tau=1}^{t} r_\tau + \beta_{c_1} \sum_{\tau=1}^{t} c_{1,\tau}, \tag{6.2}$$

$$P_t = \alpha \sum_{\tau=1}^{t} r_\tau + \beta_x \sum_{\tau=1}^{t} x_\tau, \tag{6.3}$$

$$P_t = \alpha \sum_{\tau=1}^{t} r_\tau - \beta_{c3} \sum_{\tau=1}^{t} c_{3,\tau} \tag{6.4}$$

$$c_1 = \frac{x}{\gamma} = -c_3 \tag{6.5}$$

The cointegration relations in equations 6.2 & 6.4 are similar and cannot be estimated together. As a result they estimate one of the price equations with the flows equation (6.5). There are two versions of the cointegrating system. The first version involves estimating the price equation with the flows of financial customers and the flows equation. The second version is similar to the first but with financial customers being replaced with non-financial customers. With the exception of the central bank variable, unit root test show that all variables are non-stationary. However, they point out that omitting the central bank from the regression does not impact the cointegration tests.

The Johansen methodology is used to estimate the cointegrating equations. Only the exchange rate level and customer flows are modelled in the VAR. The other variables are not modelled but their differences are added to the VAR as exogenous variables. This special treatment is due to the fact these variables are still stationary.

Table 6.1: Bjønnes et al. 2005 cointegration results

Cointegration results, daily observations

	Financial		Non-Financial	
	SEK/EUR	Non-Fin pos	SEK/EUR	Non-Fin pos
(a) Cointegration				
Financial	0.0092(0.0036)	-1(-)	0(-)	-1(-)
Non-Financial	0(-)		-0.0063(0.0021)	
10-year bond diff	4.83(1.42)	0(-)	3.52(1.36)	0(-)
3-month diff	-1.89(1.00)	0(-)	-1.38(1.09)	0(-)
CB-position	0(-)	-1.68(0.20)	0(-)	-1.83(0.26)
MM-position	0(-)	-0.65(0.19)	0(-)	-0.53(0.24)
Trend	0.00020(0.00006)	0(-)	0(-)	0(-)
(b) Error correction term				
ΔSEK/EUR	-0.0131(0.0029)	-0.000121(0.000054)	-0.0121(0.0030)	- 0.000047(0.000041)
ΔNon-Financial	0(-)	-0.001863(0.000541)	0(-)	-0.001635(0.000473)
ΔFinancial	0(-)	0(-)	0(-)	0(-)
(c) Test LR test of restrictions	Test stat. 4.84 p-value 0.85		Test stat 8.09 p-value 0.62	
No. observations	2214		2214	

Sample: 1.1994-6.2002. Cointegration estimated with the Johansen method. The VAR models the exchange rate change and the flow of the two customer groups. The other variables in the cointegrating vectors are not modelled. Differences of these, and one lag of differences, are included in the VAR. The VAR contains two lags, determined by F-test. Standard errors of coefficient in parenthesis. The SEK/EUR cointegrating vectors are normalized on the exchange rate, while the position cointegrating vectors in column Non-Fin pos are normalized on the position of the Non-Financial customers. Cointegration results are reported as if the normalizing variable is a left-hand-side variable. Panel (b) reports the error correction term. The columns indicate the cointegrating vector, while the rows indicate which equation in the VAR the vector enters. All cells without standard error are the result of restrictions. The test of the restrictions is reported in panel (c).Panel a of the table…… presents the final version of the cointegrating vectors. The price equations are normalised on the exchange rate while the flows equations are normalised on the non-financial flows. Panel b consists of the error correction terms.

The following restrictions were imposed;

1) either financial or non-financial flows are omitted from the cointegrating vector.

2) both financial and non-financial flows are omitted from the error correction term of the price equation. Restriction tests indicate that all restrictions are valid.

From the two price equations, it can be observed that the two flows coefficients are significant. Additionally the positive coefficient for the financial customers indicates that they are the aggressive parties in trades. The negative coefficients for the non-financial customers, confirms their role as liquidity providers. The flows equations also points to the fact that the two groups match each other. Restrictions on the error correction term point towards the flows of both groups being weakly exogenous to price. Weak exogeneity of order flow implies that error correction occurs through exchange rate adjustment, not order flow adjustment. Thus, financial customers use their private information to 'push' the market. The positive and persistent impact of financial customers' flow is a sign that there is an information effect. Also a trend is included in the price equation for financial customers but is restricted to zero in the price equation for non-financial customers.

According to Engle and Yoo (1991), trends are included in order to take into account other 'unobservable variables'. Bjønnes et al. 2005 argue that if financial customers' actions are to a certain extent influenced by private information that is not readily available to the whole market, while non-financial customers merely act as liquidity suppliers, then they would expect the trend to be included only in the price equation of the financial customers. Weak exogeneity of flows means that they can estimate 'single-equation error correction models with contemporaneous flow as an exogenous variable'.

Indeed, the researchers find evidence of FX liquidity provision in the long-run. Similarly, by looking at short-run dynamics, they investigate liquidity provision overnight. The error correction term from the previous cointegration analysis is added to all the subsequent regressions. They employ a GMM procedure to take into account the overlapping observation beyond one day horizons. Exchange rate returns are regressed on FX flows of financial and non-financial customers across various time horizons ranging from 5-90 days.

Analysis of the results shows that the financial customer coefficient is positive and significant for all horizons. As a result an increase in the standard deviation of the coefficient will lead to an increase in the exchange rate. The magnitude of the coefficient rises with the time horizons. The size of the coefficient increase rises from 0.37% at the 5-day horizon to 0.71% per SEK 10 billion at the 90-day horizon.

As expected the error correction term is negatively signed and significant for all horizons. The adjustment to long-term equilibrium takes place by 5%, 21% and 49% in each period for the 5, 30, 90 day horizons respectively. R-squared is relatively high and ranges from 30-72%. This implies that the regressions explain a significant portion of the variation in exchange rate returns.

The regressions are repeated with financial customer flows being replaced by non-financial customer flows. The coefficients are negatively signed and significant for all time horizons. The magnitude of the coefficient varies from -0.30% at the 5-day horizon to -0.67% per SEK 10 billion at a 90-day horizon. Coefficients of the error correction term and macro variables are comparable to those of the previous regressions. Again R-squared is relatively high and ranges from 29% to 69%. They also observe that the coefficient for non-financial customers is approximately an opposite of the coefficient of financial customers. This is interpreted to mean that non-financial customers also provide liquidity during shorter horizons.

Equally important, they test for parameter stability by running a rolling regression with a 3-year window. The result, that coefficients of financial flows are positively signed while those of the non-financial flows are negatively signed, is applicable to all the 3-year windows in the sample. This reinforces the different roles played by the two customer groups.

Furthermore, at the 1-day horizon, the positive correlation between the exchange rate returns and financial customer flows is matched by the negative correlation between the market-making bank flows and exchange rate returns. However, beyond the 1-day horizon, the non-financial customers emerge as the liquidity providers. In other words, market-making banks act as liquidity providers at a 1-day horizon but beyond that non-financial customers gradually take over the role of liquidity provision.

Finally, Bjønnes et al. 2005 use Granger causality to ascertain which customer groups are on the passive or active sides trades. The Granger causality gives an indication of the ability of one series to forecast the other.

The hypothesis that non-financial customer flows do not Granger cause other flows cannot be rejected. Nevertheless, the hypothesis that the financial customer flows and market making bank flows do not Granger-cause non-financial customer flows is rejected. This implies that non-financial customers are on the passive side of trades whiles financial customers are the aggressive party in trades.

In this chapter, we attempt to find evidence of cointegration between the FX rate and some measure of cumulated flows on the Ghanaian FX market. More specifically we require a positive cointegrating relationship;

lspot=β x cumflow

and the FX rate has to adjust to restore equilibrium (negative alpha on the exchange rate). After confirming that there is correlation between one particular group and the FX rate, we check whether this correlation matches and has the opposite sign for another group. Equally important, we also tackle the issue of BOG's actions. We ascertain whether the results of our analysis tallies with prior beliefs about the actions of BOG.

We are therefore faced with four testable hypotheses that will aid us in our empirical analysis:

Hypothesis 1: The exchange rate levels and cumulative order flows are not only separately non-stationary but also jointly cointegrated.

Hypothesis 2: Cumulative customer order flows are equally matched by cumulative central bank flows.

Hypothesis 3: There is Granger causality from customer flows to central bank flows

Hypothesis 4: Adjustment to equilibrium occurs through exchange rate adjustment, customer flows and/or central bank flows.

The alternative hypothesis is feedback trading, assuming cointegration has been established. This would mean either sign (positive or negative) on the cointegrating relationship with the alpha being significant in the flows equation. In this case flows will react to restore equilibrium.

Although the original data is at a daily frequency (except BOG data), preliminary regressions indicate that daily data is noisy. Thus we conduct subsequent analysis in a weekly frequency.

6.2.1 Granger Causality

Following Granger (1969), a variable P Granger-causes Q if the prediction of Q is improved by including past values of P than by not including them if other relevant information, including past values of Q, are also considered. It therefore follows that tests for causality are essentially tests of the prediction ability of time-series models. If P Granger-causes Q and Q Granger-causes P, then bi-directional causality (or feedback) relationship is said to exist between P and Q.

It is now well known (e.g. Engle and Granger 1987; MacDonald and Kearney 1987) that if two nonstationary time series are cointegrated, then the traditional tests for Granger causality (see Guilkey and Salemi 1982; Geweke, Meese and Dent 1983) are mis-specified, which may lead to erroneous and misleading inferences regarding the direction of causality (i.e. detection of causality where it does not exist or non-detection of causality where it exists). Checking for cointegration properties of the series of interest prior to testing for causality is therefore an important first step. Should two I(1) variables, say, P and Q, be cointegrated then testing for causality between them must be undertaken by specifying the following ECMs:

$$\Delta p_t = \theta_0 + \theta_1 \varepsilon_{t-1} + \sum_{i-1}^{l} \theta_{2j} \Delta \rho_{t-j} + \sum \theta_{3j} \Delta Q_{t-j} + \tau_t \qquad (6.6)$$

$$\Delta Q_t = \gamma_0 + \gamma_1 \varepsilon_{t-1} + \sum_{i-1}^{l} \gamma_{2j} \Delta Q_{t-j} + \sum_{j=1}^{k} \gamma_{3j} \Delta P_{t-j} + \omega_t \qquad (6.7)$$

The optimal lag length k is determined using one of the model selection criteria. The variable Q is deemed to cause P if j 3 q , j=1,2,…,k are significant as a group based on conventional F tests. Likewise, the variable P is deemed to cause Q if j 3 g , j=1,2,…,k are significant as a group. If Q causes P and P causes Q, bi-directional causality (or feedback relationship) between P and Q is deemed to exist. In traditional tests for causality, the error correction terms are omitted from both equations 3 and 4. This omission is valid only if the two time series under investigation are not cointegrated.

The Granger causality test investigates which customer group is on the passive side of trading. The granger causality test allows us to test whether the flows of one group is able to forecast the flows of another group. This enables us to catch a glimpse of the different roles played by different participants. For example, if customers flow forecasts bank flows, then bank flows are on the passive side.

Table 6.2: Probabilities from Granger causality tests

Pairwise Granger Causality Tests
Sample: 10/28/2002 12/30/2007
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
BANKS does not Granger Cause BOG	265	1.1172	0.2915
BOG does not Granger Cause BANKS		0.94	0.3332
CUSTOMERS does not Granger Cause BOG	265	4.8022	0.0293
BOG does not Granger Cause CUSTOMERS		0.0457	0.8309
CUSTOMERS does not Granger Cause BANKS	265	0.8217	0.3655
BANKS does not Granger Cause CUSTOMERS		0.08	0.7775

According to table 6.2, we cannot reject the hypothesis that banks flows do not Granger-cause other flows. We also cannot reject the hypothesis that BOG flows do not Granger-cause other flows. On the contrary, we can reject the hypothesis that customer flows do not Granger-cause BOG flows. This means that BOG is on the passive side of trading and thus, gives an indication that customers could be 'pushing' the market whilst BOG is being pulled into the market. In other words customers demand liquidity and BOG supplies this liquidity in the long-run. In the short-run, it is the banks that supply liquidity to the customers.

We use the Akaike Information Criteria (AIC) to determine the appropriate lag length of 1. An increase in the lag length to 2, however, led to a rejection at the 10% significance level.

6.2.2 Cointegration

We test for cointegration between the FX rate and the cumulated flows of BOG and those of the customers. In our cointegration analysis we use the log of the cedi/dollar rate measured at close.

Prior to testing for cointegration among the variables under study, we test for stationarity of the series using the Augmented Dickey-Fuller (ADF) test (Table 6.3). The results of the standard Augmented Dickey-Fuller (ADF) unit root tests used to check the order of integration of these variables are reported in Table 6.3. The results suggest that stationarity in the variables can be induced in all the variables by differencing the data once. Thus all the variables were found to be integrated of order 1.

Table 6.3: Unit root test on levels of exchange rate and cumulated flows

Table: ADF test

	P-values	t-stat
Lspot	0.722	-1.085
BOG	1.000	2.318
Customers	1.000	6.783

The cointegrating equations are estimated by applying the Johansen methodology on weekly observations. Using the exchange rate levels and cumulated flows, we formulate a Vector Autoregressive (VAR) model and determine the appropriate lag length using the VAR Lag Order Selection Criteria. Based on the Akaike Information Criteria (AIC), table 6.4 shows the appropriate lag length for this model is 4. This is equivalent to 4 trading weeks.

Table 6.4 :VAR Lag Order Selection Criteria

Endogenous variables: LSPOT ΔTOTALXADB ΔCBR

Lag	LR	FPE	AIC	SC	HQ
0	NA	815555.5	22.12526	22.16657	22.14187
1	4852.281	0.004418	3.091556	3.25681	3.158005
2	58.71755	0.003749	2.927389	3.216583*	3.043676
3	35.58371	0.003483	2.853674	3.266809	3.019797
4	32.86793*	0.003266*	2.789286*	3.326362	3.005247*
5	4.926177	0.003433	2.838698	3.499714	3.104495
6	7.028187	0.003575	2.879059	3.664015	3.194693
7	10.75627	0.003664	2.903249	3.812145	3.26872
8	10.91534	0.003751	2.926169	3.959006	3.341478

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

We now proceed to carry out the cointegration test using the Johansen technique. The Johansen technique generates a Trace and Maximum Eigenvalue Tests, which identify the number of cointegrating vectors. From Table 6.5 the null hypotheses of 'none' and 'at most one' cointegrating vectors are rejected against an alternative at a 5% significance level. For the trace test, the null of no cointegrating vectors is rejected since the test statistic of 97.27 is greater than the 5% critical value of 42.92. The null of at most 1 cointegrating vector is also rejected since the test statistic of 45.70 exceeds the 5% critical value of 25.87. Finally the null that there are at most 2 cointegrating vectors cannot be rejected since the test statistic of 6.45 is below the 5% percent critical value.

The trace test results are similar to those of the maximum eigen-value test (Table 6.5). In all, these tests indicate that there are two cointegrating vectors.

Table 6.5: Trace and Maximum Eigenvalue Tests

No. of Cointegrating Vectors	Likelihood ratio Statistics LR(n)	95% critical value
Max Eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level		
None *	51.57	25.82
At most 1 *	39.25	19.38
At most 2	6.45	12.52
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level		
None *	97.27	42.92
At most 1 *	45.70	25.87
At most 2	6.45	12.52

* denotes rejection of the hypothesis at the 0.05 level

The Johansen technique also generates the unnormalised and normalised coefficients linked to the two cointegrating vectors. The unnormalised coefficients are the estimated values of the coefficients in the cointegrating vectors. However we prefer the normalised coefficients, where the coefficient value of one of the variables has been set to unity. Usually normalisation is done with respect to the first variable (in this case exchange rate variable, Lspot):

$$Lspot = 0.00011 * Customers + 0.000665 * trend \quad (6.8)$$

$$BOG = -1.3934 * Customers + 7.7473 * trend \quad (6.9)$$

For both equations (6.8 & 6.9) the coefficients of the three variables have the appropriate signs. The positive sign of the customer coefficient in equation (6.8) means that net customer order flow is positively correlated to the level of exchange rate whilst a negative sign of the customer coefficient in equation (6.9) points to a negative correlation between net customers order flow and the level of exchange rate. Implicitly, in Ghana, the customer net purchase of dollars is associated with a depreciation of the cedi. For the

second equation, a customer net purchase of dollars is associated with a net sale of dollars by BOG.

To test the hypotheses of interest, we impose restrictions on the cointegrating relationships in the Vector Error Correction Model (VECM). Table 6.6 illustrates the two sets of cointegrating vectors. We impose restrictions on the vectors and on the error correction terms. Additionally we insert a linear deterministic trend to take into account unobservable variables. The banks' flow variable is not modelled. We argue that banks act as liquidity providers in the short-run and basically just facilitate trading amongst customers. They eventually 'square' their positions at the end of the trading day. Subsequently differences of the bank flow variable and three lags of its differences are included in the VAR as exogenous variables. The restrictions we impose are:

1) That BOG is excluded from the first (exchange rate) vector i.e. (1,0,α). The equation is normalised on the exchange rate

2) BOG and customers are similar in magnitude but opposite in sign i.e. (0,1,1). The equation is normalised on BOG.

3) BOG is excluded from the first error correction term i.e. (β,0,μ)

4) Customers and Lspot are excluded from the second error correction term i.e. (0,λ,0)

First, we choose to present the unrestricted version of the VECM before we imposed the appropriate restrictions. We also try other variations of our model by imposing different restrictions.

Consequently our models will be presented in the following order:

1. **Unrestricted**-no restrictions with normalisation
2. **Theory**-restrictions imposed according to what basic theory states(BOG adjusts, customers do not, equal and opposite effects etc)
3. **Others**- other variations (e.g. BOG does not adjust, customers do)
4. **Parsimonious**-eliminating insignificant coefficients regardless of what theory says

Unrestricted models

In our unrestricted models (Appendix A), the exchange rate level and cumulative customer flows are positively correlated, as expected. This positive correlation is matched by a negative correlation between the exchange rate level and BOG flows.

The positive coefficient for customer flows and the negative coefficient for BOG flows are consistent with them being push and pull customers respectively. For the second cointegrating relationship in both unrestricted models, the coefficients of BOG and customers have opposite signs but are different in magnitude (i.e. effects are not equal).
The exchange rate and customer flows adjust to restore equilibrium in the first cointegrating relationship. Only BOG flows adjust to restore equilibrium in the second cointegrating relationship. Cointegration between exchange rate level and the flows of customers and BOG is further evidence of a permanent price effect.

Table 6.6: Vector Error Correction Estimates, weekly observation **(Theory)**

P-value restrictions	**0.389**		Adj. R^2 -0.239
	CointEQ1	**CointEQ2**	
Lspot	1	0	
ΔBOG	0	1	
ΔCustomers	-0.009 (-2.585)	1	
trend	0.115 (4.463)	1.437 (15.116)	
error correction	**Δ (LSPOT)**	**Δ(BOG)**	**Δ(Customers)**
cointeq1	-0.0001 (-2.146)	0	0.8143 (7.202)
cointeq2	0	-0.0853 (-6.093)	0

Sample: November 2002- December 2007. Cointegration estimated using Johansen technique. The VAR models the cedi/dollar exchange rate and the flows of BOG and Customers. Bank flows are not modelled but rather its differences and two lags of differences are included in the VAR as exogenous variables. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on BOG. The error correction term and the restrictions test are also reported.

Table 6.6 presents results of the VECM. The P-value for the restriction test is considerably larger than 0.05 so we conclude that all our restrictions are valid. The first cointegrating equation is equivalent to the stable period dynamic equation in chapter 5. To reiterate, the customer order flow coefficient is 0.0330 whiles that of the first cointegrating relationship is 0.009 (approx 0.01).

The magnitude of the coefficient in chapter 1 is significantly larger and this has implications for the price impact of order flow. In chapter 5 a net order flow of $1m will result in 0.03% depreciation but in this chapter the result is a 0.01% depreciation. The reduced price impact of order flow could be attributed to the fact that the actions of BOG have been accounted for in this chapter.

Furthermore the size of customer order flow coefficient is similar to that of Bjønnes et al. (2005). In Bjønnes et al. 2005 the coefficient is 0.0092, which is equal to what we

obtained. The positive coefficient of customer order flow could imply that bank customers are 'push' customers. The result reinforces the work of Bjønnes et al. (2005) and gives our paper more credibility in terms of FX liquidity provision in emerging/African economies.

To ascertain whether BOG and customers are on opposite sides of the market and equally match each other, we impose a restriction (1,-1). This restriction is similar to the one imposed in Bjønnes et al. (2005) where it sought to test whether financial and non-financial customers were on opposite sides of the market. Consistent with existing theory on the subject, the results from the restrictions show that bank customers and BOG are on opposite sides of the market and equally match each other. By assigning the push role to the bank customers in the first cointegrating equation, the relationship in the second cointegrating relationship could imply that BOG is being pulled into the market.

In the first error correction term, we impose restrictions to find out which variables in the first cointegrating relationship adjust to restore equilibrium. Exchange rate and customer variables are significant and correctly signed. This indicates that both exchange rate and customers adjust to restore equilibrium. However the exchange rate alphas are extremely small and this may give the impression that the burden of adjustment falls on bank customer flows.

Subsequently, we find out that the pooling together of different sub-samples has a tremendous effect on the size of exchange rate. Also in the second error correction we impose restrictions to find out which variables in the second cointegrating vector adjust to restore equilibrium. The BOG variable is also significant and correctly signed, meaning that customers do not adjust but rather BOG adjusts to restore equilibrium.

This is representative of the actual situation on the Ghanaian FX market. Customers approach their banks to submit their FX orders resulting in a net demand for dollars. Consequently the banks approach the BOG to satisfy their net liquidity demand. In other words customers are 'pushing' the market whiles BOG is being pulled into the market. The adjusted R-squared is relatively high at 0.2395.

Table 6.7: Vector Error Correction Estimates, weekly observation **(Others)**

P-value restrictions	**0.000**		Adj. R^2 0.241
	CointEQ1	**CointEQ2**	
Lspot	1	0	
ΔBOG	0	1	
ΔCustomers	-0.015 (-2.818)	1	
trend	0.146 (3.508)	1.029 (6.617)	
error correction	**Δ (LSPOT)**	**Δ (BOG)**	**Δ (Customers)**
cointeq1	-0.000 (-2.543)	0	0.495 (4.925)
cointeq2	0	0	-0.061(-3.199)

Sample: November 2002- December 2007. Cointegration estimated using Johansen technique. The VAR models the cedi/dollar exchange rate and the flows of BOG and Customers. Bank flows are not modelled but rather its differences and two lags of differences are included in the VAR as exogenous variables. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on BOG. The error correction term and the restrictions test are also reported.

Table 6.7 presents other variations of our main model. More specifically, we impose a different set of restrictions on the error correction term of the second cointegrating relationship. The restrictions imposed imply that customers adjust but not BOG. All other restrictions remain unchanged. However tests indicate that these restrictions are not valid.

Table 6.8: Vector Error Correction Estimates, weekly observation **(Theory-new restrictions)**

P-value restrictions	**0.368**		Adj. R^2 -0.239
	CointEQ1	**CointEQ2**	
Lspot	1	0	
ΔCustomers	0	1	
ΔBOG	0.008 (2.680)	1	
trend	0.107 (4.497)	1.404 (15.811)	
error correction	**Δ (LSPOT)**	**Δ (Customers)**	**Δ (BOG)**
cointeq1	-0.000 (-2.163)	0.909 (7.172)	0
cointeq2	0	0	-0.09127 (-6.129)

Sample: November 2002- December 2007. Cointegration estimated using Johansen technique. The VAR models the cedi/dollar exchange rate and the flows of BOG and Customers. Bank flows are not modelled but rather its differences and two lags of differences are included in the VAR as exogenous variables. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on CUSTOMERS. The error correction term and the restrictions test are also reported.

Thereafter, we test to find out if the positive correlation between exchange rate levels and bank customers is matched by a negative correlation between exchange rate levels and BOG flows. We test for cointegration between exchange rate levels and BOG flows and present the associated VECM in Table 6.8. The restrictions imposed are similar to the previous model shown in Table 6.6. These restrictions are all satisfactory with P-values more than 0.05 and as a result they cannot be rejected.

Our results indicate that there is indeed a negative correlation between exchange rate levels and BOG flows. According to the first cointegrating relationship, the negative sign of the BOG coefficient is consistent with one of the conditions for identifying a liquidity provider. The size of the BOG coefficient (0.008) is similar to that of the bank customers (0.009).

In the case of Bjønnes et al. (2005) the coefficients of the non-financial customers (liquidity providers) is 0.006, which is slightly less than the size of BOG coefficient. The second cointegrating relationship is again similar to that in the previous model (table 6.6). Specifically BOG and bank customers are on opposite sides of the market and match each others flows.

The adjustment dynamics are also similar to the previous case. The exchange rate and bank customers adjust to restore equilibrium in the first cointegrating relationship whiles only BOG adjusts in the second relationship (table 6.8). Again, we are faced with the problem of extremely small exchange rate alphas and adjusted R^2 of 0.24.

Similar to Bjønnes et al. (2005), we add a trend as an additional variable to take into account unobservable features in our data. The results from the restricted model are similar to those of the unrestricted. As expected, the positive correlation between the exchange rate level and customer flows is matched by a negative correlation between exchange rate level and BOG flows.

The magnitudes of the two (customers and BOG) coefficients are similar. The second cointegrating relationship indicates that the flows of customers and BOG are equal but have opposite effects. Combined with the previous result from the first cointegrating relationship, this implies that BOG equally matches customer flows.

Adjustment to equilibrium occurs through both exchange rate and customer flows adjustment for the first cointegrating relationship. Again, adjustment occurs only through BOG flows adjustment.

6.3 Robustness Checks

In our robustness section we deal with the problem of extremely small exchange rate alphas. We find out that the size of the alphas have been distorted by the pooling of two heterogeneous sub-samples. Consequently the problem of small alphas could be due to mere statistical errors. We also notice an inverse relationship between flows coefficients and exchange rate alphas. Specifically an increase in the exchange rate alphas corresponds to a decrease in the flows coefficient.

In order to check for the robustness of our results, we conduct further tests over two sub-samples (relatively stable and unstable periods). The relatively unstable period spans from the end of 2002 to early 2004. The relatively stable period spans from end of 2004 to the middle of 2007.

Generally our results do not change significantly except for a slight difference in the adjustment dynamics over the two periods. Specifically it is only the exchange rate that adjusts to attain equilibrium in the first sample whilst the adjustment dynamics in the second sample is similar to that of the main result. By splitting our sample, we observe that the trend has disappeared. We also observe that the alphas are much larger in magnitude than the alphas in the main result.

First Sub-sample (relatively unstable period)

Table 6.9: Vector Error Correction Estimates, weekly observation **(Theory)**

P-value restrictions	**0.069**		Adj. R^2 0.249
	CointEQ1	**CointEQ2**	
Lspot	1	0	
ΔBOG	0	1	
ΔCustomers	-0.002 (-4.046)	1	
error correction	**Δ(LSPOT)**	**Δ(BOG)**	**Δ(Customers)**
cointeq1	-0.090 (-3.973)	0	15.980 (0.708)
cointeq2	0	-0.044 (-0.866)	0

Sample:2002-2004. Cointegration estimated using Johansen technique. The VAR models the cedi/dollar exchange rate and the flows of BOG and Customers. Bank flows are not modelled but rather its differences and two lags of differences are included in the VAR as exogenous variables. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on BOG. The error correction term and the restrictions test are also reported

Generally our main results remain almost unchanged for the first sub-sample (Table 6.9). As expected, the flows coefficient is positively signed but its magnitude has dropped significantly. The nature of relationship in the second cointegrating vector has not changed. Customers and BOG are on opposite sides of the market and match each other.

On the contrary, the magnitude of the exchange rate alphas has increased dramatically. Notably, this sharp increase in the size of the exchange rate alphas is at the expense of the size of flows coefficient. We also notice an inverse relationship between the two coefficients. As the exchange rate alpha increases, the flows coefficient decreases. Apart from the higher exchange rate alphas in the first error correction term, we observe that the BOG does not adjust to restore equilibrium in the second cointegrating relationship.

Our first sub-sample represents a period where Ghana was emerging from a crisis of 2000/1. During this period, there was a recovery in Gold and Cocoa prices, a resumption of foreign donor inflows and a cancellation of $4bn debt due to the attainment of HIPC status in 2004. These factors contributed to the gradual build-up of FX reserves.

Consequently, even though BOG was selling FX to customers through the banks, there were not enough reserves to match the customer flows.

During this period the BOG was supplying less than 10% of customer orders. It is therefore not surprising that the exchange rate depreciated relatively faster in the first period compared to the second period (Fig 4.1) Customer imbalances resulting from an inadequate FX supply from BOG will lead to an increase in (or depreciation of) the exchange rate in order to induce liquidity from elsewhere and restore equilibrium.

Second sub-sample (relatively stable period)

Table: 6.10 Vector Error Correction Estimates, weekly observation **(Theory)**

P-value restrictions	**0.132**		Adj. R^2 0.205
	CointEQ1	**CointEQ2**	
Lspot	1	0	
ΔBOG	0	1	
ΔCustomers	-0.0003 (-6.951)	1	
error correction	**Δ(LSPOT)**	**Δ(BOG)**	**Δ(Customers)**
cointeq1	-0.061 (-2.028)	0	395.013 (3.843)
cointeq2	0	-0.076 (-3.322)	0.0000

Sample:2004-2007. Cointegration estimated using Johansen technique. The VAR models the cedi/dollar exchange rate and the flows of BOG and Customers. Bank flows are not modelled but rather its differences and two lags of differences are included in the VAR as exogenous variables. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on BOG. The error correction term and the restrictions test are also reported

With the exception of the sizes of the exchange rate alphas, the second sub-sample results (Table 6.10) are similar to the main results. The positive correlation between the exchange rate level and customers flows is matched by a negative correlation between the exchange rate level and BOG flows. Furthermore BOG flows match customer flows and have opposite effects. Exchange rate and customer flows adjust to restore equilibrium in the first cointegrating relationship whilst BOG flows adjust to restore equilibrium in the second cointegration equilibrium.

By 2004 the BOG had attained the optimal level (40% to 50%) of FX reserves that could adequately support the supply of FX liquidity to customers. In other words, BOG was in the position to satisfy most of the customer imbalances. These actions had the impact of reducing exchange rate volatility. This is evident in the relatively stable exchange rate from 2004 onwards.

6.4 Results

The coefficient on cumulative customer order flow is significant and positively signed, as expected. The use of log exchange rate allows for easy interpretation of the coefficient. Specifically, an increase in cumulative order flow of $1m will lead to a 0.01% increase in the cedi/dollar exchange rate at weekly frequency. Thus, a weekly net dollar purchase of $1m results in a 0.01% depreciation in the exchange rate (fall in value of the cedi).

This is much larger than the impact of order flow estimated by studies like Evans and Lyons (2002a). This could be due to the fact that the Ghanaian FX market is relatively less liquid than the more developed markets. As a result, the price impact of order flow is much higher in the Ghanaian FX market. The above interpretation may suggest that bank customers are driving the exchange rate or 'pushing' the market.

The role of bank customers is confirmed by the second cointegrating relationship. Specifically, the restrictions we impose reveal that the customers' flows are matched by BOG flows. This leads us to conclude that customers demand liquidity (push market around) whiles the BOG supplies liquidity (being pulled by the customers). BOG supplies customer imbalances (net purchases). The customer flows are almost a mirror image of the BOG flows (Fig 4.8).

Next, we examine the adjustment dynamics of this cointegrated system. We are interested in which of the variables provide the adjustment to equilibrium. In order for the system to return to long-run equilibrium, the adjustment of at least some of the variables should react to the size of the disequilibrium. Deviations from the long-run relationship have an effect on short-run dynamics. The error correction model (ECM) will help explain the adjustment dynamics of the system. In order to find out which variables react to

deviations from equilibrium, we look at the test for weak exogeneity of these variables. In this case, test for weak exogeneity will centre on the statistical significance of the ECM coefficients. Weak exogeneity of a particular variable means that error correction in the cointegrating relationship occurs through that variable's adjustment.

This implies that the error correction term is significant in that variable's equation. The lower section of Table 6.10 presents evidence on the adjustment dynamics. Restrictions on the error correction terms in the first cointegrating relationship indicate that error correction occurs through both exchange rate and customer order flow adjustment.

The error correction term is significant in both the exchange rate and order flow equations and this means that the weak exogeneity hypothesis has been strongly rejected. Restrictions on the error correction terms in the second cointegrating relationship indicate that error correction occurs through BOG flow adjustment. Again the error correction is significant in the BOG equation implying that the weak exogeneity hypothesis has been rejected.

The error correction model that could apply to this system is:

$$\Delta S_t = \alpha_s \left(S - \beta C\right)_{t-1} + \varepsilon_{St} \qquad (6.10)$$

$$\Delta C_t = \alpha_c \left(S - \beta C\right)_{t-1} + \varepsilon_{Ct} \qquad (6.11)$$

$$\Delta BOG_t = \alpha_{BOG} \left(BOG + C\right)_{t-1} + \varepsilon_{bogt} \qquad (6.12)$$

Where $\varepsilon_{St}, \varepsilon_{Ct} and \varepsilon_{bogt}$ are white-noise disturbances which may be correlated, $S_t, C_t and BOG_t$ are exchange rates, customer flows and BOG flows respectively, β is the coefficient estimate of customers flow variable and $\alpha_s, \alpha_c and \alpha_{bog}$ are the speed of adjustment parameters for the respective variables. The speed of adjustment coefficients measure the degree to which a respective variable reacts to the deviation from the long-run

equilibrium. For example, the larger α_s is, the greater the response of exchange rate to the previous period's deviation from long-run equilibrium.

Deviations from long-run equilibrium are represented by $(S-\beta C)_{t-1}$ and $(BOG+C)_{t-1}$. The product of the speed of adjustment coefficients and the deviation from long-run equilibrium forms the error correction term e.g. $\alpha_s(S-\beta C)_{t-1}.S_t, C_t and BOG_t$ change in response to stochastic shocks ($\varepsilon_{St}, \varepsilon_{Ct} and \varepsilon_{bogt}$) and also in response to the previous period's deviation from long-run equilibrium.

We then substitute the various parameters in the above system of equation to give us the adjustment process.

$$\Delta S_t = -0.000107(S-0.009C)_{t-1} + \varepsilon_{St} \quad (6.13)$$

$$\Delta C_t = 0.81424(S-0.009C)_{t-1} + \varepsilon_{Ct} \quad (6.14)$$

$$\Delta BOG_t = -0.08528(BOG+C)_{t-1} + \varepsilon_{bogt} \quad (6.15)$$

For equations (6.13 - 6.15), a positive customer order flow (net purchase of dollars) would imply that the previous period's deviation is negative ($(S-0.009C)_{t-1}\langle 0$). Together with their respective adjustment parameters, this means during the next period, the cedi/dollar rate would rise (depreciation) and the customer order flow would fall. The previous period's deviation for the BOG equation is positive ($(BOG+C)_{t-1}$). Due to the negative speed of adjustment coefficient, the BOG flows would fall i.e. BOG would sell dollars.

However it should be noted that the absolute value speed of adjustment coefficient of the exchange rate is relatively small. This may imply the slow adjustment of exchange rate compared to the other variables. In the short-run a net customer purchase of £1m during

the previous period will lead to a relatively small depreciation of 0.0001% in the next period. This also leads to a 1% decline in the customer flows for the next period. There is also an 8% decrease in BOG flows (i.e. BOG sells/supplies dollars) in the next period. The problem of extremely small exchange rate alphas is dealt with by dividing our sample into two sub-samples in the robustness section.

We found out that this problem was due to mere statistical failure as a result of pooling together two sub-samples. In our first sub-sample (crisis period), a net customer purchase of US$1m during the previous period will lead to a significant depreciation of 0.09% in the next period. Also in our second sub-sample (stable period), a net customer purchase of US$1m during the previous period will lead to a relatively smaller depreciation of 0.06%. It is evident that the slower rate of depreciation in the second sub-sample could be due to the supply of liquidity by the BOG.

6.5 Liquidity provision during the pre-intervention period

We analyse the period before BOG actions and attempt to find out which market participant plays the role of liquidity provider. In the absence of BOG, who fills the role of liquidity provider? With the exception of the remittance bank, bank customers are generally net buyers of dollars. As a result we have two main market participants, remittance customers and normal bank customers. The previous methodology is applied here with the remittance customers replacing BOG in the model (Table 6.11).

The restrictions we impose are:

1) Customers are excluded from the first (exchange rate) vector i.e. (1, β, 0). Equation is normalised on the exchange rate

2) REM and customers are similar in magnitude but opposite in sign i.e. (0,1,1). Equation is normalised on REM.

3) REM and Customers are excluded from the first error correction term i.e. (α,0,0)

The coefficient on remittance customers is significant and positively signed, as expected. However we are more concerned with the alphas in the error correction terms. Restrictions on the cointegrating vectors indicate that during the 'pre-intervention' period, both bank customers and remittance customers are adjusting (table 6.11).

The corresponding alphas are similar in both magnitude and statistical significance. Exchange rate adjustment is extremely slow and as a result the burden of adjustment falls on the flows. In other words, the crisis 'forced' the various market participants and the exchange rate to adjust simultaneously to equilibrium. In this case the various market participants cannot be described as push/pull customers. The 'situation' called for an adjustment by all variables involved (table 6.11).

It is also interesting to note that the coefficients of bank and remittance customers flows are equal in the magnitude for the second error correction term.

Table 6.11: Vector Error Correction Estimates, weekly observation **(Theory)**

P-value restrictions	**0.081**		Adj. R^2 0.540
	CointEQ1	**CointEQ2**	
Lspot	1	0	
ΔCustomers	0	1	
ΔREM	-0.009 (-3.261)	1	
error correction	**Δ (LSPOT)**	**Δ (Customers)**	**Δ (REM)**
cointeq1	-0.012 (-3.234)	0	0
cointeq2	0.000 (2.463)	-0.029 (-2.192)	-0.029 (-4.574)

Sample: 2000 -2002. Cointegration estimated using Johansen technique. The VAR models the cedi/dollar exchange rate and the flows of remittance (REM) and normal Customers. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on CUSTOMERS. The error correction term and the restrictions test are also reported.

Table 6.12:Vector Error Correction Estimates, weekly observation **(Theory)**

P-value restrictions	**0.079**		Adj. R^2 -0.541
	CointEQ1	**CointEQ2**	
Lspot	1	0	
∆REM	0	1	
∆Customers	0.008 (4.806)	1	
error correction	**∆(LSPOT)**	**∆(REM)**	**∆(Customers)**
cointeq1	-0.012 (-3.222)	0	0
cointeq2	0.000 (2.743)	-0.029 (-4.573)	-0.029 (-2.192)

Sample: 2000 -2002. Cointegration estimated using Johansen technique. The VAR models the cedi/dollar exchange rate and the flows of remittance (REM) and normal Customers. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on REM. The error correction term and the restrictions test are also reported.

6.6 Discussion

Our results suggest that bank customers, banks and BOG play different roles in the Ghanaian FX market. Bank customers "push" the market. Banks provide liquidity to their customers in the short-run, while BOG acts as a liquidity provider in the long-run.

It seems logical that bank customers are push customers. Over past decades, Ghana has pursued weak macroeconomic policies. Periodic monetary and fiscal indiscipline has led to high and volatile inflation, large movements in exchange rates and negative real interest rates over long periods. This unstable macroeconomic environment has created a high degree of uncertainty and potentially has the effect of discouraging customers from willingly holding the domestic currency (cedi). The continued lack of trust in sustained economic policies has naturally induced customers to hold relatively more FX or conduct a significant portion of transactions in FX. As a result Ghanaian bank customers are constantly purchasing/demanding FX (predominantly dollars). This is evident in the positive order flow (net dollar purchases) for the whole data sample.

Furthermore it is important to note that the Ghanaian economy is heavily dependent on imports. The manufacturing sector is almost non-existent. Subsequently most of the bank

FX transactions are induced by importers due to the nature of their business. The constant net purchase of dollars emanating from importers is responsible for the positive order flow experienced in our dataset. In the category of Push customers, importers could be viewed as dominant players.

BOG actions are consistent with actions of 'pull' customers. BOG does not sell FX to the market for the purpose of intervening or pushing the market. Specifically BOG sells FX to banks to enable them cover oil payments or to provide BOP support. At the end of each trading/week, in the event of customer imbalance (unmet demand) (e.g. net dollar purchases), the bank approaches BOG to submit an order to buy dollars at prevailing market rates. The order flow is usually equivalent to the magnitude of the customer imbalance and in some cases the BOG rations FX depending on the availability. In other words, BOG stands to passively supply FX to any authorised dealer bank that submits an order. In effect BOG is being 'pulled' into to the market. BOG actions seem to have the effect slowing the rate of depreciation of the cedi.

During the pre-intervention period, we are not able to assign push/pull roles to any of the market participants. This emanates from the fact the FX crisis induced a collective adjustment by all parties involved. Market participants endeavour to make the best out of a chaotic situation.

6.7 Conclusion

The importance of liquidity provision in the FX market cannot be over-emphasised. In an attempt to answer the question of which market players provide liquidity, we gain a deeper understanding of FX market dynamics and ultimately exchange rate determination. It is well-known that banks usually provide liquidity in the short-run. The aim of this paper is to investigate which market players provide liquidity in the long-run in the Ghanaian FX market. We adopt the liquidity provision framework proposed by Bjønnes et al. (2005). Consistent with the Bjønnes et al. (2005), our study highlights **two** main characteristics that should help identify liquidity providers:

(i) The net flows of a liquidity provider should be negatively correlated with the level of exchange rate.

(ii) Liquidity providers are usually not the active parties in FX trades. They passively match others' demand and supply.

However, unlike Bjønnes et al. (2005), our unique data does not distinguish between the various customer types. Thus our analysis focuses on three main FX market participants namely: Market making banks, banks customers and the Central Bank. Our results seem to suggest that the central bank (BOG) is the main liquidity provider in the Ghanaian FX market.

Using the Johansen cointegration technique, we prove that there is indeed a positive correlation between customer order flow and exchange rate movements. This implies that when customers buy dollars, the cedi depreciates (dollar appreciates). This positive correlation is matched by a negative correlation between exchange rate level and BOG flows.

In addition, we find that customer order flows are equally matched by BOG flows. Restrictions indicate that coefficients of customer and BOG flows are similar in magnitude but opposite in sign. These results reinforce the liquidity provision role of BOG.

Furthermore we use Granger causality test to find out if indeed the BOG is passive in matching the liquidity demand of bank customers. We find that bank customer flows can forecast BOG flows (unidirectional causality). We deduce this as evidence that BOG is the passive party in trading.

To the best of our knowledge, this paper is the first to study long-run liquidity provision in an emerging economy using such a unique dataset. It becomes immediately obvious that, unlike developed economies (Bjønnes et al. 2005), the central bank is a major player in the Ghanaian FX market. Exchange rates adjust to ensure that liquidity supply matches liquidity demand. Thus by passively matching the net liquidity demand (unmet demand) of customers, the central bank may be influencing exchange rate movement and smoothening out the FX market in terms of volatility. It is therefore not surprising that our results point to a relatively slow exchange rate adjustment to equilibrium.

The findings raise further fruits for thought. For instance, will the findings apply to other emerging/African economies? If so, what factors determine customer order flows in Ghana? We shall try to address these questions in the next chapter.

From chapter 5, we observe how customer order flows push the exchange rate around. In this chapter, we show that the BOG intervenes to supply liquidity and as a result slow down the rate of depreciation of the exchange. However, BOG is rather a pull player not a push player. Evidently, customers are of paramount importance.

This is in line with the situation in the advanced markets where central banks are largely absent and lends huge support to the microstructure approach. Moreover, understanding what drives customer order flows is critical. As already mentioned above, flows are not

the underlying causes but just the proximate causes. This means that flows are carriers of information to the market and so investigating what drives flows is very crucial. Ghana is both a smaller and simpler economy and because our data is complete, we might expect to gain a deeper insight into what drive flows in Ghana than elsewhere.

CHAPTER SEVEN

The Macroeconomic determinants of order flow in Ghana

7.1 Introduction

In chapter 5, our results confirm a clear correlation between order flows and the cedi/dollar exchange rate. Furthermore, in chapter 6, we identify the roles played by various market participants in the FX market. Specifically, we find that bank customers 'push' the market by demanding dollars whiles the central bank is 'pulled' and thus passively supplies dollars. Logically, the next step is to determine the drivers of order flow. Unearthing the drivers of order flow would go a long way in resolving the issue of macroeconomic variables' inability to explain exchange rates. Order flow is defined as a proximate cause of exchange rate returns but this does not imply that it drives exchange rates. According to Sarno and Taylor (2001),

"*The fact that order flow helps explain exchange rate behaviour does not necessarily imply that order flow drives exchange rates. Indeed, it may well be that macroeconomic fundamentals are the driving force, but that conventional measures of the macroeconomic fundamentals are so imprecise that order flow 'proxy' performs better in estimation* ."

Following the seminal paper by Evans and Lyons (2002a), several studies have emerged which fail to find a robust link between macroeconomic information and exchange rate fluctuations (Cheung, Chinn and Pascual, 2005). This is in sharp contrast to previous research by some renowned economists Chenn and Rogoff (2003). Moreover, Chen, Rogoff and Rossi (2008) assert that, to their knowledge, no study has considered the relation between order flow and commodity prices. King, Sarno and Sojli (2010), however, documents other studies which appear to have found a strong relation between order flow, commodity prices and macroeconomic fundamentals. Sojli also documents a strong relation between order flows and changes in commodity prices especially gold and aluminium. Clearly, the evidence surrounding the question as to whether there is a strong

link between order flow and economic fundamentals and commodity prices appear to be mixed.

Consequently, we proceed to investigate the hypothesis that there is a strong relation between order flow, commodity prices and macro fundamentals using emerging market data, particularly African data.

Thus our null hypothesis, H_0, is that fundamental information and commodity price changes are the main drivers of order flow.

Indeed, the assumptions underlying our study are consistent with those of King, Sarno and Sojli (2010). For instance, our approach draws heavily on market microstructure work and relies on different set of assumptions from classical macroeconomic studies. Besides, macroeconomic models assume that agents are identical, information is perfect, trading is costless, and the trading process is irrelevant. However, micro-based FX models relax all these assumptions. Furthermore, microstructure models examine more realistic settings where information is dispersed and heterogeneous agents have different information sets and models. Consequently, we adopt the approach used by King, Sarno and Sojli (2010) in the subsequent analysis.

In this chapter, we lay emphasis on the role of order flow as transmitter of macroeconomic information. In other words, order flow could be the missing link between macroeconomic information and exchange rate returns. Does order flow convey any fundamental information? Thus the main objective of this chapter is to examine the underlying macroeconomic determinants of order flow, in the context of Ghana. This work is unique in so many ways. In terms of emerging markets/African FX microstructure, this is the first study that attempts to empirically investigate the relationship between order flow and macroeconomic fundamentals. We examine 6-years of order flow data based on spot transactions reported by the top 5 Ghanaian-based banks

with their customers. Additionally, the order flow data is disaggregated into local and foreign customer flows. This dataset covers about 80% of the daily FX volumes in spot cedi/dollar transactions between 2002 and 2007. To the best of our knowledge, our FX microstructure study has a large span of data from an emerging (African) economy.

All our macroeconomic variables are available in a monthly frequency. Accordingly, we aggregate our daily order flow data into a monthly frequency.

Tables and Charts with descriptive statistics of the data can be found in Figures 7.1 and 7.2. It is worthwhile to look at the correlations between the different order flows, as it can give us a preliminary hint on the roles of different customer types. One interesting result is that some order flow indicators show strong correlations with each other. It can be noted therefore that in general correlation between banks and customers order flow is negative. This suggests that they may play opposite roles on the market, i.e. being "push customers" and "pull customers" as shown in chapter 6.

7.2 Preliminary analysis

As indicated in Chapter two, Ghana is predominantly an agricultural economy whose currency is affected by global commodity (gold, cocoa and crude oil) prices. It has also been argued in literature that exchange rates of commodity exporting countries are closely linked to commodity prices. Ghana, being a small open economy, is directly affected by developments on the international markets. Consequently any small deviation or volatility in the external commodity prices has huge implications for cedi/dollar exchange rate movements. In other words, the major foreign exchange earners for Ghana are cocoa and gold. Meanwhile, the nation spends almost 70% of its foreign exchange earning on crude oil importation. For these reasons, we feel it is expedient to incorporate commodity prices into our analysis.

Additionally, it has been posited in the microstructure literature, that order flow shoul reflect changes in expectations of macroeconomic conditions. Since the generally accepted core variables used in macroeconomic announcements are inflation, GDP, interest rates, money supply, fiscal deficit, trade deficit etc, we select those series that are available in the country and at a higher frequency basis. On the real sector side, GDP is available on an annual basis so we compute it into a monthly series using interpolation techniques.

Previous research (Chen and Rogoff, 2003; Chen, Rogoff and Rossi, 2008) has documented a strong relation between commodity currencies and commodity prices. King, Sarno and Sojli (2010) is able to show that including order flow to regressions on exchange rate returns that include commodity variables and interest rate expectations considerably increases the explanatory power. According to King, Sarno and Sojli (2010), this implies that order flow may contain additional information that affects exchange rate movements.

As argued by Evans and Lyons (2005a), order flow may be viewed as a medium for aggregating both differences in interpretation of news in real time and changes in heterogeneous expectations about the developments of the economy. The exchange rate can be written as the discounted present value of current and expected fundamentals:

$$s_t = (1-\delta)\sum_{j=0}^{\infty} \delta^j E_t(f_{t+j}) \tag{7.1}$$

Where s_t is the log normal exchange rate (defined as the domestic price of the foreign currency), δ is the discount factor, f_t denotes the fundamentals at time t, and $E_t(f_{t+j})$ is the market-makers expectation about future fundamentals conditional on information available at time t.

By iterating the equation forward and reorganising terms we obtain:

$$\Delta s_{t+1} = \frac{(1-\delta)}{\delta}(s_t - E_t\, f_t) + \varepsilon_{t+1}, \qquad (7.2)$$

Where $\varepsilon_{t+1\equiv}(1-\delta)\sum_{j-0}^{\infty}\delta^j(E_{t+1}f_{t+j+1} - E_t\, f_{t+j+1})$

It is important to note that, in present value models, current fundamentals are observable without error in real time i.e. $E_t f_t = f_t$. Nevertheless, in reality, macroeconomic data are not available in real time because most data is reported at a monthly or quarterly lag.

The form for fundamentals differs according to the macroeconomic structure of the economy. For example in Evans and Lyons (2004b), f_t includes home and foreign money supplies and household consumption. It is asserted that, in models where central banks conduct monetary policy via the control of short-term interest rates (i.e. follow Taylor rules), f_t will include variables used to set policy. More generally, f_t will include a term that identifies the foreign exchange risk premium.

Our dataset of monthly macroeconomic indicators and commodity prices is obtained from the BOG database. Below is a definition of the main variables:

ΔX_t - Net order flow

CPI_t -Consumer Price Index

$GOLD_t$ -Gold Price per metric tonne

$M2_t$ -Money Supply

PR_t -Prime rate

GDP_t -Gross Domestic Product

OIL_t -Oil Price per barrel

$COCOA_t$ -Cocoa Price per metric tonne

Figure 7.1 Graphs of the variables

Figure 7.1a: Levels of monthly series for the period 2002-2007

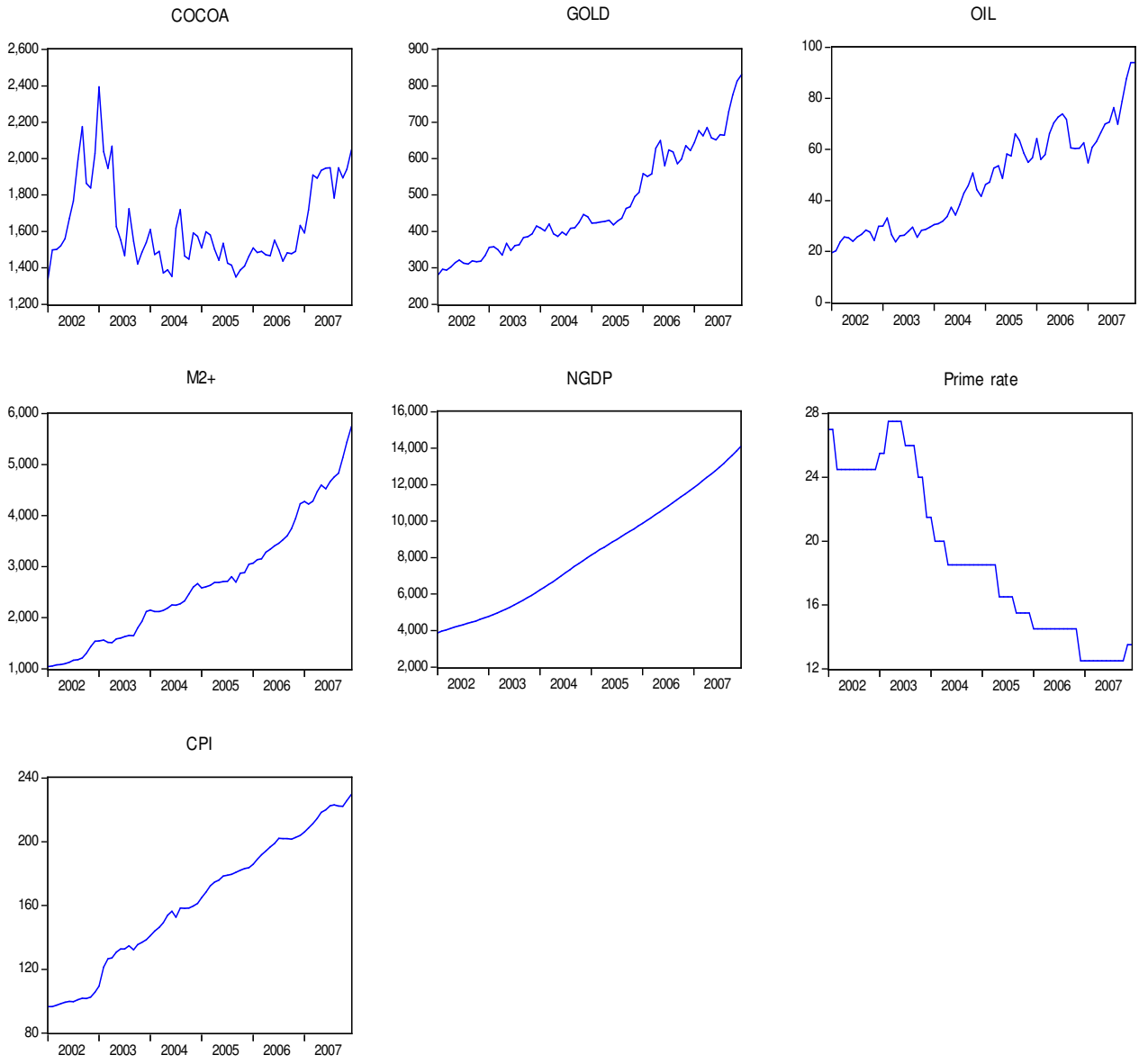
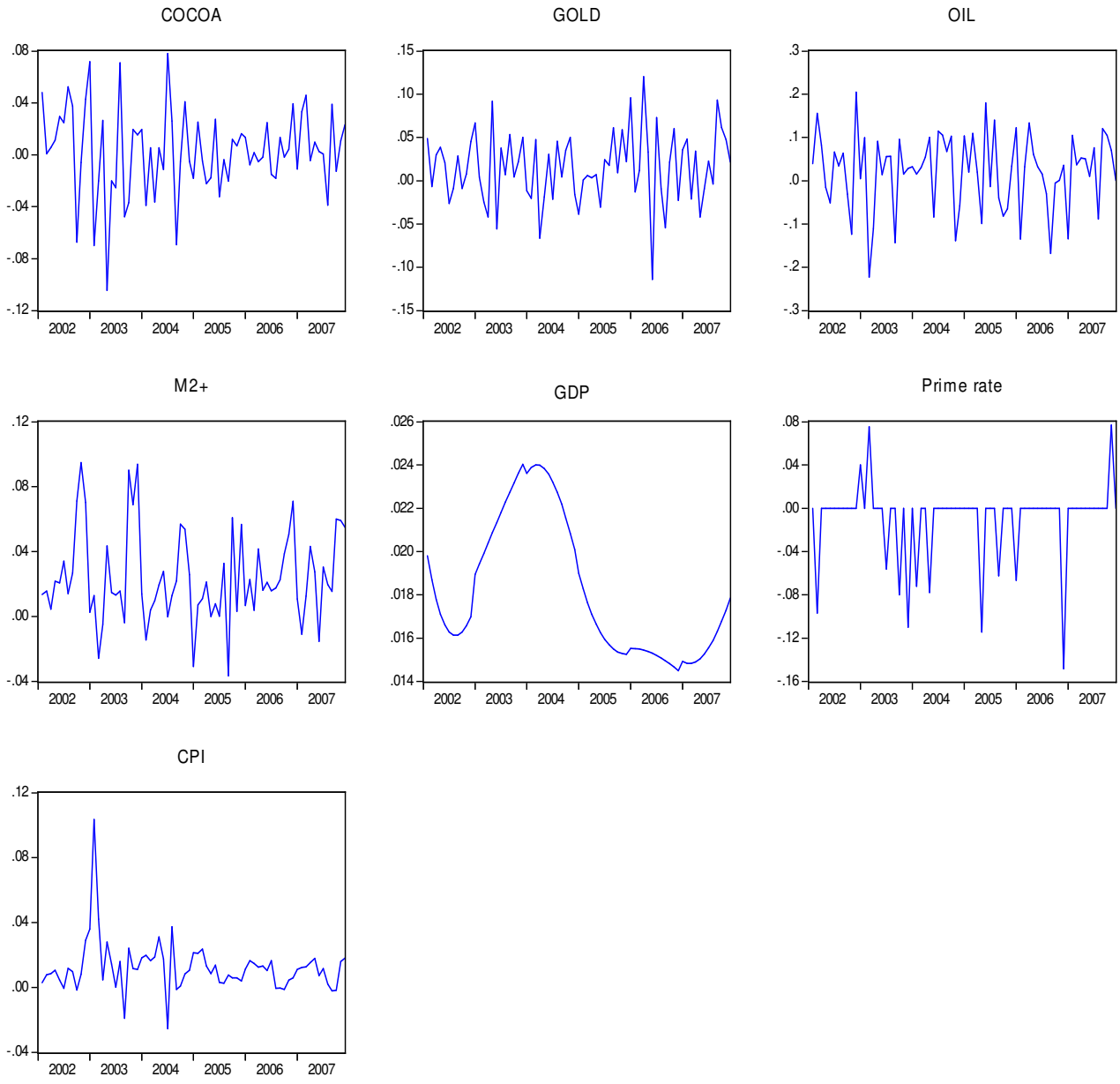


Figure 7.1b: Changes in monthly series for the period 2002-2007



Throughout our analysis, we spilt the order flow into domestic and foreign flows and repeat the regression over the full sample space. We attempt to address the issue of heterogeneity by splitting the flows into foreign and domestic components. This is principally because Ghana, as an emerging economy, relies heavily foreign capital flows. As a result a large proportion of Ghanaian macroeconomic fundamentals governing the cedi/dollar exchange rate are dependent on external factors. Implicitly, the foreign flows dictate the direction of the information flow into the FX markets through trading activities. Therefore we expect to see strong relationships between foreign flows and domestic macroeconomic fundamentals.

This is achieved by analysing the nature of the customer base of these banks. Foreign-owned banks have a relatively larger proportion of expatriate customers while the customers of Ghanaian owned banks are predominantly Ghanaian. Based on this assessment, total order flow is split into local and foreign components. By so doing, we are able to examine the relationship between fundamentals/commodity prices and the different components of order flow.

7.3 Descriptive Statistics

Figure 7.2 below shows the descriptive statistics and correlations for the monthly aggregated data. The mean, maximum, minimum and standard deviations of all the series are all presented. The probability for the null hypothesis for the Jacque-Bera test for normality is also shown. The sample size is 71 covering the period from January 2002 through December 2007. Generally, analysis of figure 7.1 shows that the series have very low correlations. Thus we expect to generate reasonable and interpretable, significant results.

Figure 7.2: Preliminary Statistics

Correlations

	ΔX_t	Δ CPI	Δ GOLD	Δ M2	Δ PR	Δ GDP	Δ OIL	Δ COCOA
ΔX_t	1.0000	0.1770	-0.1012	-0.0629	-0.0980	0.5354	-0.0104	-0.0471
Δ CPI	0.1770	1.0000	-0.0258	-0.0798	0.0872	0.1586	0.1507	-0.1836
Δ GOLD	-0.1012	-0.0258	1.0000	0.1531	0.0280	-0.0746	0.1639	-0.0175
Δ M2	-0.0629	-0.0798	0.1531	1.0000	-0.1352	-0.0076	0.0944	0.0039
Δ PR	-0.0980	0.0872	0.0280	-0.1352	1.0000	-0.1235	-0.1508	0.0651
Δ GDP	0.5354	0.1586	-0.0746	-0.0076	-0.1235	1.0000	0.0595	-0.1179
Δ OIL	-0.0104	0.1507	0.1639	0.0944	-0.1508	0.0595	1.0000	0.1354
Δ COCOA	-0.0471	-0.1836	-0.0175	0.0039	0.0651	-0.1179	0.1354	1.0000

Variance-Covariance

	ΔX_t	Δ CPI	Δ GOLD	Δ M2	Δ PR	Δ GDP	Δ OIL	Δ COCOA
ΔX_t	6049741	6.7454	-10.1665	-4.2883	-8.6941	4.1712	-2.2238	-3.8431
Δ CPI	6.7454	0.0002	0.0000	0.0000	0.0000	0.0000	0.0002	-0.0001
Δ GOLD	-10.1665	0.0000	0.0017	0.0002	0.0000	0.0000	0.0006	0.0000
Δ M2	-4.2883	0.0000	0.0002	0.0008	-0.0001	0.0000	0.0002	0.0000
Δ PR	-8.6941	0.0000	0.0000	-0.0001	0.0013	0.0000	-0.0005	0.0001
Δ GDP	4.1712	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Δ OIL	-2.2238	0.0002	0.0006	0.0002	-0.0005	0.0000	0.0076	0.0004
Δ COCOA	-3.8431	-0.0001	0.0000	0.0000	0.0001	0.0000	0.0004	0.0011

Descriptive statistics

	ΔX_t	Δ CPI	Δ GOLD	Δ M2	Δ PR	Δ GDP	Δ OIL	Δ COCOA
Mean	-3098.06	0.0122	0.0152	0.0240	-0.0098	0.0182	0.0222	0.0026
Median	-2505.71	0.0112	0.0179	0.0176	0.0000	0.0168	0.0330	0.0027
Maximum	-26.2452	0.1035	0.1201	0.0948	0.0770	0.0240	0.2047	0.0780
Minimum	-8893.25	-0.0254	-0.1140	-0.0365	-0.1484	0.0145	-0.2226	-0.1044
Std. Dev.	2477.13	0.0156	0.0411	0.0279	0.0363	0.0032	0.0876	0.0334
Skewness	-0.6393	2.7369	-0.1712	0.5620	-1.6148	0.6540	-0.5693	-0.4161
Kurtosis	2.3485	18.1875	3.5745	3.2135	7.0717	1.9200	2.9977	3.9027
Jarque-Bera	6.0924	771.01	1.3230	3.8727	79.9020	8.5117	3.8357	4.4594
Probability	0.0475	0.0000	0.5161	0.1442	0.0000	0.0142	0.1469	0.1076
Sum	-219962	0.8686	1.0818	1.7066	-0.6931	1.2896	1.5744	0.1841
Sum Sq. Dev.	4300000	0.0171	0.1185	0.0546	0.0923	0.0007	0.5368	0.0781
Observations	71	71	71	71	71	71	71	71

From the correlation matrix, we are given the first glimpse of the expected signs of the various coefficients. We observe negative correlations between order flow and fundamental and commodity price changes. The only exceptions are the positive correlations observed between order flow and changes in CPI and GDP. One expects that any significant increases in the prices of gold and cocoa would lead to an appreciation of the cedi/dollar. Gold and cocoa prices increases point to a future appreciation of the exchange rate and in anticipation of this movement, individuals and institution will reduce their holding of dollars. Therefore increases in these prices are associated with the selling of dollars. Favourable commodity prices imply a buoyant economy and translate into higher profit repatriation for foreign firms. Thus foreign firms will buy relatively more dollars (7.5). On the contrary, significant increases in the prices of crude oil would lead to massive depreciation and increase inflationary expectations. Typically, agents will take advantage of the high interest rate environment by selling dollars and buying cedi-denominated short-term instruments (e.g. 91-day treasury bills). Higher oil prices will mean a reduction in profits for foreign firms and thus they will buy fewer dollars (7.5). The a-priori signs of the coefficients are indicated below the relevant variables as shown in equations 7.4 to 7.9.

Thus the corresponding effect on order flow can be presented in the following equations:

$$\Delta X_t = f(\underset{-}{\Delta cocoa_t}, \underset{-}{\Delta gold_t}, \underset{-}{\Delta oil_t}) \tag{7.4}$$

$$\Delta X_t^{for} = f(\underset{+}{\Delta cocoa_t}, \underset{+}{\Delta gold_t}, \underset{-}{\Delta oil_t}) \tag{7.5}$$

$$\Delta X_t^{loc} = f(\underset{-}{\Delta cocoa_t}, \underset{-}{\Delta gold_t}, \underset{-}{\Delta oil_t}) \tag{7.6}$$

According to the correlation matrix, an increase in GDP is associated with the purchase of dollars and vice versa. This is not surprising because foreign flows constitute a large portion of total order flow and thus an increase in GDP is associated with increased profit repatriation. In other words, when the economy is doing well, foreign firms earn more profits and therefore increase their repatriations to their home countries.

Changes in the broad money supply and interest rates are also negatively correlated with order flow. Increases in money growth are normally due to lax fiscal and monetary policies. Naturally, this development contributes to increased inflationary expectations and points to future interest rate hikes. In trying to hedge against present and future inflation, local customers will demand more cedis to facilitate the purchase of short-term government securities.

The same argument applies to the relationship between order flow and interest rates. The prime rate represents the benchmark interest rate in the economy. An increase in this prime rate is associated with an increase in the rates of return on government short/medium term instruments. For example, an increase in the prime rate that is associated with an increase in the 3-month Treasury bills will require customers to buy more of the local currency (or sell dollars) to facilitate the purchase of the relevant instruments in order to take advantage of the real positive returns.

However, we also observe that changes in CPI are positively correlated to order flow.

Similarly, the relationship between order flow and macroeconomic variables is presented in the following equation:

$$\Delta X_t = f(\underset{+}{\pi_t}, \underset{+}{\Delta GDP_t}, \underset{-}{\Delta M_t}, \underset{-}{\Delta IR}) \tag{7.7}$$

$$\Delta X_t^{for} = f(\underset{+}{\pi_t}, \underset{+}{\Delta GDP_t}, \underset{+}{\Delta M_t}, \underset{+}{\Delta IR}) \tag{7.8}$$

$$\Delta X_t^{loc} = f(\underset{+}{\pi_t}, \underset{-}{\Delta GDP_t}, \underset{-}{\Delta M_t}, \underset{-}{\Delta IR}) \tag{7.9}$$

Where ΔX_t is equal to order flow, ΔX_t^{for} is foreign order flow, ΔX_t^{loc} is local order flow, $\Delta cocoa_t$ is equal to cocoa price changes, $\Delta gold_t$ is equal to gold price changes, Δoil_t is equal oil price changes, π_t is equal to changes in CPI (inflation), ΔGDP_t is equal to changes in GDP, ΔM_t is equal to changes in broad money supply and ΔIR is equal to interest rate changes.

Based on our a-priori expectations, we are faced with six testable hypotheses that will guide us in subsequent empirical analysis.

Hypothesis 1: Changes in cocoa, gold and oil prices are negatively correlated with total order flow.

Hypothesis 2: Changes in cocoa and gold prices are positively correlated with foreign order flow whiles oil price changes are negatively correlated.

Hypothesis 3: Changes in cocoa, gold and oil prices are all negatively correlated with local order flow.

Hypothesis 4: Inflation and GDP growth are positively correlated with total order flow whiles money growth and interest rate movements are negatively correlated.

Hypothesis 5: Inflation, GDP growth, money growth and interest rate changes are all positively correlated with foreign order flow.

Hypothesis 6: Only inflation is positively correlated with local order flow whiles GDP growth, money growth and interest rate changes are negatively correlated.

7.4 Variables and Stationarity Test

Non-stationarity, a property common to many macroeconomic and financial time series, means that a variable has no clear tendency to return to a constant value or a linear trend. As shown in Figure 7.1 above, most of the series (the levels) do not appear to be stationary, i.e., return to a fixed value or fluctuate around a linear trend (in which case the deviations from trend are stationary). It is therefore proper to assume that they have been generated by non-stationary processes and follow stochastic trends.

An important objective of empirical research in macroeconomics is to test hypotheses and estimate relationships, derived from economic theory, among such aggregate variables. The statistical theory that was applied well into the 1980s in building and testing large simultaneous-equation models was based on the assumption that the variables in these models are stationary. The problem is that statistical inference associated with stationary processes is no longer valid if the time series are indeed realizations of non-stationary processes.

Consistent with our a-priori expectations, the variables (with the exception of order flow) are non-stationary in levels. However, subsequent OLS analysis requires the use of stationary variables in order to avoid spurious results. Consequently, we compute the changes in variables and conduct unit root tests to ascertain their stationarity. ADF tests, as shown in Table 7.1, indicate that the changes in the variables are all stationary at a 5% significance level. Changes in GDP, however, are only stationary at a 10% significance level.

Table 7.1 Augmented Dickey-Fuller test on levels of variables

Variable	ADF, p-value
ΔX_t	0.027
CPI_t	0.940
$GOLD_t$	0.998
$M2_t$	1.000
PR_t	0.677
GDP_t	1.000
OIL_t	0.963
$COCOA_t$	0.143

Table 7.2 Augmented Dickey-Fuller test on changes in variables

Variable	ADF, p-value
ΔX_t	0.027
ΔCPI_t	0.000
$\Delta GOLD_t$	0.000
$\Delta M2_t$	0.000
ΔPR_t	0.000
ΔGDP_t	0.096
ΔOIL_t	0.000
$\Delta COCOA_t$	0.000

7.5 Econometric Analysis

In a bivariate OLS framework, total order flow is regressed on changes in fundamentals and commodity prices. This is represented by the equation:

$$\Delta x_t = \alpha_0 + \sum_{n=3}^{N} f_{t-n} + \sum_{n=0}^{N} c_{t-n} + u_t \qquad (7.10)$$

Where Δx_t is the total order flow, f_t is macro variable and c_t is commodity price variable.

Standard error estimates are corrected for serial correlation and heteroscedasticity using the Newey-West HAC correction. Serial correlation shows the p-values for the Breusch-Godfrey Lagrange multiplier tests for first-order residual correlation. Heteroscedasticity shows the p-value for the White first-order conditional heteroscedasticity test with cross terms in the residuals. Significant variables are reported at least at a 10% level. In order to obtain a more parsimonious model, a general-to-specific modelling approach is adopted. Besides the macro variables and commodity prices, two dummy variables were added to ascertain the significance of certain developments in the economy. To be precise, REDM, is a dummy variable which represents the introduction of currency revaluation which occurred effective July 2007. As described in chapter 2, this redenomination exercise involved the elimination of four zeros from the national currency. It is therefore prudent to assess how the exercise has impacted on the order flow analysis. Additionally, Ghana became classified as a HIPC country in 2004, during which period it received a substantial debt cancellation from both bilateral and multilateral sources. A dummy variable called HIPC is accordingly used to represent this significant event to enable us assess its effectiveness on subsequent analysis.

7.6 RESULTS

With regard to the regressions, we start by first using current commodity prices and 3 month lagged fundamental variables. Principally, because any major shift in international commodity prices has an instantaneous effect on the nation's FX flows, while the impact of the flows becomes clearly evident on quarterly basis.

Table 7.3 Relationship between changes in fundamentals/commodity prices and order flow

OLS regression of total order flow on lagged changes in fundamentals and commodity prices (General model). Coefficients of lags have been added together:
$\Delta x_t = \alpha_0 + \sum_{n=3}^{N} f_{t-n} + \sum_{n=0}^{N} c_{t-n} + u_t$ ..

	ΔX_t^{total}
ΔGDP_t	-4.225
ΔCPI_t	-0.647
$\Delta M2_t$	-0.175
ΔPR_t	-0.201
$\Delta COCOA_t$	-0.339
ΔOIL_t	0.001
$\Delta GOLD_t$	-0.050
REDM	-0.016
HIPC	0.013
R^2	0.159
Diagnostics	
Serial	0.034
heteroscedasticity	0.863

Standard error estimates are corrected for serial correlation and heteroscedasticity using the Newey-West HAC correction. Serial correlation shows the p-values for the Breusch-Godfrey Lagrange multiplier tests for first-order residual correlation. Heteroscedasticity shows the p-value for the White first-order conditional heteroscedasticity test with cross terms in the residuals. Significant variables are reported at least at a 10% level. For each equation, the total number of observations is 71, spanning the period from January 2002 – December 2007

Table 7.3 represents the results of the regression between the order flow and changes in the fundamentals and commodity prices. This is a general model that includes both significant and insignificant variables. In other words, all the explanatory variables have been left in the equation. More importantly, the diagnostics suggests the presence of auto-correlation and heteroscedasticity in this regression. In an attempt to tackle auto-correlation, subsequent analysis will include lagged flows. Also due to publication lags, the first and second lags of fundamental changes will be excluded in all regressions. We proceed by employing the Akaike Information Criterion (AIC) in selecting the optimal lag lengths of the variables.

Further regressions were carried out by regressing order flow (total, foreign and local) on changes in commodity prices only (Table 7.4) and similar regression were repeated for changes in fundamentals (Table 7.5). Finally, order flow was regressed on both changes in fundamentals and commodity prices (Table 7.6).

Table 7.4 Relationship between changes in commodity prices and order flow

OLS regression of order flow (total, foreign and local) on lagged changes in commodity prices (General-to-Specific Approach):

$\Delta x_t = \alpha_0 + \sum_{n=0}^{N} c_{t-n} + hipc + redm + u_t$ ..

	ΔX_t^{total}	$\Delta X_t^{foreign}$	ΔX_t^{local}
$\Delta COCOA_{t-1}$		-0.053 (-1.849)	
ΔOIL			0.573 (6.421)
$\Delta GOLD_{t-1}$	0.070 (1.876)		
ΔX_{t-1}	0.866 (13.183)	0.771 (10.343)	
REDM	-0.069 (-13.406)	-0.027 (-11.301)	-0.029 (-9.769)
R^2	0.671	0.539	0.244
Diagnostics			
Serial	0.056	0.099	0.011
heteroscedasticity	0.000	0.047	0.540

T-values are in parenthesis. Standard error estimates are corrected for serial correlation and heteroscedasticity using the Newey-West HAC correction. Serial correlation shows the p-values for the Breusch-Godfrey Lagrange multiplier tests for first-order residual correlation. Heteroscedasticity shows the p-value for the White first-order conditional heteroscedasticity test with cross terms in the residuals. Significant variables are reported at least at a 10% level. For each equation, the total number of observations is 71, spanning the period from January 2002 – December 2007

Table 7.5 Relationship between changes in fundamentals and order flow

OLS regression of order flow (total, foreign and local) on lagged changes in fundamentals only (General-to-Specific Approach):

$$\Delta x_t = \alpha_0 + \sum_{n=3}^{N} f_{t-n} + hipc + redm + u_t$$

	ΔX_t^{total}	$\Delta X_t^{foreign}$	ΔX_t^{local}
ΔCPI_{t-4}			0.064 (1.976)
ΔCPI_{t-5}	-0.176 (-2.397)		
ΔGDP_{t-3}	0.351 (2.881)		
$\Delta M2+_{t-5}$	-0.094 (-2.662)		
ΔPR_{t-3}	-0.103 (-1.785)		-0.065 (-3.110)
ΔX_{t-1}	0.552 (5.115)	0.587 (5.877)	0.197 (2.175)
ΔX_{t-3}			0.325 (2.402)
ΔX_{t-4}	0.432 (3.377)	0.350 (3.018)	0.374 (4.606)
HIPC			0.003 (4.435)
REDM	-0.081 (-15.833)	-0.040 (-7.783)	-0.023 (-7.699)
R^2	0.758	0.593	0.452
Diagnostics			
Serial	0.194	0.116	0.180
heteroscedasticity	0.032	0.005	0.414

T-values are in parenthesis. Standard error estimates are corrected for serial correlation and heteroscedasticity using the Newey-West HAC correction. Serial correlation shows the p-values for the Breusch-Godfrey Lagrange multiplier tests for first-order residual correlation. Heteroscedasticity shows the p-value for the White first-order conditional heteroscedasticity test with cross terms in the residuals. Significant variables are reported at least at a 10% level. For each equation, the total number of observations is 71, spanning the period from January 2002 – December 2007

Table 7.6 Relationship between changes in fundamentals/commodity prices and order flow

OLS regression of order flow (total, foreign and local) on lagged changes in fundamentals and commodity prices (General-to-Specific Approach):

$$\Delta x_t = \alpha_0 + \sum_{n=3}^{N} f_{t-n} + \sum_{n=0}^{N} c_{t-n} + u_t ..$$

	ΔX_t^{total}	$\Delta X_t^{foreign}$	ΔX_t^{local}
ΔX_{t-1}	0.575 (5.415)	0.581 (6.298)	
ΔX_{t-3}			0.413 (3.664)
ΔX_{t-4}	0.401 (3.074)		0.389 (3.466)
ΔX_{t-5}			0.197 (2.221)
ΔX_{t-6}		0.258 (2.782)	
ΔCPI_{t-4}			0.118 (3.364)
ΔGDP_{t-4}		0.241 (2.597)	
$\Delta COCOA_{t-2}$		0.056 (2.469)	
$\Delta GOLD_{t-3}$		0.051 (1.768)	-0.057 (-2.276)
ΔOIL_{t-5}		-0.028 (-2.052)	
$\Delta M2+_{t-5}$	-0.087 (-2.348)		-0.077 (-2.127)
ΔPR_{t-3}	-0.106 (-1.878)		-0.114 (-5.972)
REDM	-0.081 (-15.214)		
R^2	0.749	0.550	0.551
Diagnostics			
Serial	0.390	0.122	0.384
heteroscedasticity	0.006	0.001	0.030

T-values are in parenthesis. Standard error estimates are corrected for serial correlation and heteroscedasticity using the Newey-West HAC correction. Serial correlation shows the p-values for the Breusch-Godfrey Lagrange multiplier tests for first-order residual correlation. Heteroscedasticity shows the p-value for the White first-order conditional heteroscedasticity test with cross terms in the residuals. Significant variables are reported at least at a 10% level. For each equation, the total number of observations is 72, spanning the period from January 2002 – December 2007

Tables 7.4 to 7.6 show the results of the regressions. Evidently, most of the signs of the coefficients are consistent with expectations (equation 7.4 to 7. 9).

In Table 7.4, changes in gold price are significant (10% significance level) and are negatively correlated with total order flow. This is contrary to expectations (equation 7.4) but not surprising because in times of recession and uncertainty, gold is viewed as a safe-haven. Investors sometimes use gold to hedge against future inflation. An increase in gold prices may signal bad macro news and may induce local customers to purchase dollars and sell the local currency, resulting in the positive correlation between local order flow and changes in gold price. Changes in cocoa price are significant and negatively correlated with foreign order flow, as expected (equation 7.4). It must be noted that cocoa is the main foreign exchange earner for the Ghanaian economy. Favourable cocoa prices (assuming volume remains constant) imply that there's excess FX in the economy. From the point of view of local customers, this is good macro news and as result would prefer to buy cedis (and sell dollars) (equation 7.6).

Contrary to expectations, changes in oil price are positively correlated with local order flow (equation 7.6). Ghana is a net importer of crude oil and any sharp rise in the oil price could have serious repercussions on the macroeconomy. Local individuals and customers may decide to hedge against these adverse domestic conditions by increasing their holding of FX (selling cedis).

In Table 7.5, changes in CPI, money supply and prime rate are negatively correlated with total order flow. Changes in GDP, on the other hand, are positively correlated as expected (equation 7.7). With the exception of changes in CPI, the signs of the variables are in line with our expectations (equation 7.7). Increases in the CPI are an indication of the upward movements in the general price level in the economy. This has direct implications for food prices, cost of production for local firms, real wages and cost of living. Relatively more cedis would be needed to be able to afford the higher price level, and this would lead to the

purchase of more cedis (or sale of FX). Changes in CPI are positively correlated with local order whiles changes in the prime rate are negatively correlated, as expected (equation 7.9).

Table 7.6 contains one the most important results of this chapter. Changes in money supply and prime rate are significant and negatively correlated with total order flow, as expected. Also changes in GDP, gold and cocoa prices are significant and positively correlated to foreign order flow.

Most of these foreign customers are multi-national, mining companies etc. We therefore observe that repatriation of their profits involves selling the local currency and buying FX (mainly dollars) and transferring funds to their parent companies. Furthermore, in Ghana, such corporate entities usually maintain most of their cash holding in foreign currency due to the constant depreciation of the local currency and the uncertainties related to macroeconomic fundamentals.

Consequently, an increase in the GDP emanating from rising export prices and/or increased real sector activity will translate into foreign customers having more dollars to sell or buying more cedis. The estimated regression further shows that changes in gold prices, money growth, prime rate and consumer price index are significant in explaining local customer flows. Changes in gold prices, money growth and prime rate are negatively correlated with local flows, as expected. On the other hand, changes in CPI are positively correlated with local flows.

We observe that foreign firms are much more concerned with general state of the economy (movements in GDP) and the performance of the export sector whiles local firms are preoccupied with demand factors (changes in CPI, money growth and prime rate) that directly influence their business operations.

Adjusted R^2 is relatively high in terms of FX microstructure and ranges from 24% to 78%. Our diagnostics indicate that the models are of a relatively good fit and the auto-correlation present in the initial stages has been successfully eliminated.

It is also interesting to note that the currency redenomination is significant in the total order flow equation. This confirms the possible relationship between currency redenomination and order flows.

Similar to King, Sarno and Sojli (2010), we have been able to ascertain that fundamentals explain order flow.

The above regressions will form the basis for decomposition of order flow into its expected and unexpected components in the next section.

7.7 Order flow and Macroeconomic expectations

In order to assess whether order flow reflects changes in expectations, with regard to current economic conditions, we continue to conduct further investigations. As has been argued in the literature, order flow should reflect changes in expectations with regards to current economic conditions (King, Sarno and Sojli (2010)). Accordingly, our analysis is performed by splitting foreign and local order flows into their expected and unexpected components. From the equation in table 7.6, the fitted values are stored as expected flows while residual values are stored as unexpected flows.

We also add together the expected flows from locals and foreign flows, and unexpected flows from local and foreign flows in order to obtain just one series of expected and unexpected flows, and then use those in the subsequent regression. Subsequently, the changes in exchange rate are regressed on the unexpected flows and the expected flows (7.7). The REDM and HIPC dummies are included in all the equations. The approach used to obtain this measure of order flow is different from the approach adopted in chapter 5, where we regress order flow on changes in exchange rates and interest rates. It is interesting to note that the overall results are similar and fall in line with our initial expectations. First, order flow performed well in explaining changes in the exchange rate dynamics. The unexpected flows coefficient is significant and positively signed (Table 7.7) and confirms our previous findings in chapter 5. Expected order flow, on the other hand, is insignificant. According to table 7.7, an unexpected net purchase of $1m is associated with a 0.12% depreciation of the CEDI. The magnitude of this unexpected flow coefficient is not directly comparable to the coefficient in chapter 5. In chapter 5, we test our model on different sample periods, the data was weekly and order flow was spilt using a different set of variables. This explains the difference in magnitude between the two unexpected order flow variables.

Table 7.7: Relationship between changes in exchange rate and expected and unexpected flows

OLS regression of changes in exchange rate on Foreign and Local expected/unexpected order flows and lagged changes in exchange rate (General model):

$$\Delta S_t = \alpha_0 + \sum_{n=0}^{1} EF_{t-n} + \sum_{n=0}^{1} UF_{t-n} + REDM + HIPC + u_t ..$$

	ΔS_t
ΔEF_t	-0.026 (-1.317)
ΔUF_t	0.076 (2.907)
HIPC	-0.003 (-5.087)
REDM	0.007 (3.295)
R^2	0.173
Serial	0.485
heteroscedasticity	0.000

T-values are in parenthesis. Standard error estimates are corrected for serial correlation and heteroscedasticity using the Newey-West HAC correction. Serial correlation shows the p-values for the Breusch-Godfrey Lagrange multiplier tests for first-order residual correlation. Heteroscedasticity shows the p-value for the White first-order conditional heteroscedasticity test with cross terms in the residuals. Significant variables are reported at least at a 10% level. For each equation, the total number of observations is 71, spanning the period from January 2002 – December 2007

7.7.1 Forecasting Future Fundamentals

We have not only been able to show that current flows are in part a reflection of past fundamentals, but also show that these fundamentals are reflected in the current exchange rate since the expected flows derived from past fundamentals are not significant in explaining exchange rate changes. Nevertheless, since unexpected flows are significant, the question becomes "what do these flows represent?" Preferably, these flows should represent future fundamentals, much like the Citibank flows of Evans and Lyons (2007) which predict future fundamentals. In the spirit of Evans and Lyons (2007), we test one of the empirical implications of their model which states that flows should convey more precise information about future fundamentals much better than current spot rates do. According to their model, order flow should have significant forecasting power for future spot rates when agents' transactions flows transmit information about future fundamentals that is news to dealers.

Order flow will have forecasting power when agents have different forecasts of future fundamentals, information aggregation is partial or the distribution of wealth has forecasting power for fundamentals.

Our approach to forecasting fundamentals is similar to that of Evans and Lyons (2007). They compare the goodness of fit between models forecasting say GDP growth using just lagged GDP growth, just lagged spot rates, just lagged order flow and using all three since this demonstrates the marginal contribution of order flow. As a result, one can conclude that order flow has substantial forecasting power when this forecasting power is a significant increment over the forecasting variables. Also, we present all the regression outputs illustrating the general-to-specific approach (Appendix C1-C3).

Our previous results indicate that flows from different sources are explained by different fundamentals. Therefore, we would also like to find out if unexpected flows from different

sources help explain different future fundamentals. Thus, we attempt to forecast using local and foreign banks flows separately and test for the differences in forecasting power.

Our results (table 7.8-7.10) are mixed and ambiguous. Order flow does not seem have adequate forecasting power which represents a significant increment over the forecasting power of the other variables. The results indicate that, in the CEDI/USD market, most of the future fundamentals can be forecast with past fundamental information and spot rates. Contrary to Evans and Lyons (2007), the marginal contribution of unexpected order flows to forecasting future fundamentals is not obvious.

We observe that though flows alone are relatively successful in predicting GDP growth, lagged GDP growth is able to perfectly forecast GDP growth. This leaves no allowance for the marginal contribution of order flow to forecasting GDP growth (table 7.8 – 7.10).

Spot rates are relatively much more successful in forecasting inflation. This observation is not too surprising, considering the BOG's passive FX interventions which keeps the exchange rate stable. Flows provide information about future fundamentals but not more than spot rates (table 7.8).

Flows are relatively unsuccessful in forecasting money growth, gold and cocoa prices. However adding flows to the system increases the R^2. Additionally local flows help in forecasting money growth and cocoa prices whiles foreign flows contribute to predicting gold prices (table 7.9 – 7.10).

Foreign unexpected flows have forecasting power for oil price changes (table 7.10 and appendix C3). Generally, we do not expect flows to have significant forecasting power for commodity price changes. Yet, we observe that foreign unexpected flows are able to predict future oil prices changes. This result is driven by the fact that the foreign bank customers (i.e. mainly multinationals) could be incorporating global economic information into Ghanaian flows.

Our results fall short of backing and confirming the empirical findings of Evans and Lyons (2007) who find that transaction flows have forecasting power for future fundamentals relative to current spot price and fundamentals. Similarly, Evans and Lyons (2007) show that transaction flows in the EUR/USD market forecast GDP growth, money growth and inflation. Using their empirical findings, they argue that if dealers believe that signals of future macro realizations are truly incremental to public macro information, then they will impound this information in price-setting.

So in conclusion, there is no overwhelming evidence that flows predict future fundamentals and more data is needed to thoroughly investigate this relationship.

Table 7.8: Forecasting Fundamentals using total order flow

Forecasting Variables	GDP	Forecasting Variables	PR
GDP	0.946	PR	0.011
Spot	0.137	Spot	0.028
GDP & Spot rates	0.965	PR & Spot rates	0.028
Order Flow	0.690	Order Flow	0.010
ALL	0.973	ALL	0.051
Forecasting Variables	CPI	Forecasting Variables	Oil
CPI	0.014	Oil	0.032
Spot	0.135	Spot	0.029
CPI & Spot rates	0.275	Oil & Spot rates	0.034
Order Flow	0.064	Order Flow	0.058
ALL	0.289	ALL	0.024
Forecasting Variables	M2+	Forecasting Variables	Cocoa
M2+	0.079	Cocoa	0.053
Spot	0.053	Spot	0.023
GDP & Spot rates	0.209	Cocoa & Spot rates	0.098
Order Flow	0.059	Order Flow	0.041
ALL	0.292	ALL	0.165
Forecasting Variables	Gold		
Gold	0.057		
Spot	0.057		
Gold & Spot rates	0.088		
Order Flow	0.028		
ALL	0.173		

The table reports the R^2 from the forecasting OLS regression for the fundamentals and commodity prices listed in the header of each panel using the forecasting variables on the left. The regressions are estimated in monthly data. The monthly estimates of fundamentals are based on the history of macro announcements.

Table 7.9: Forecasting Fundamentals with Foreign Flows

Forecasting Variables	GDP	Forecasting Variables	PR
GDP	0.946	PR	0.011
Spot	0.137	Spot	0.028
GDP & Spot rates	0.965	PR & Spot rates	0.028
Order Flow	0.588	Order Flow	0.001
ALL	0.971	ALL	0.027
Forecasting Variables	CPI	Forecasting Variables	Oil
CPI	0.014	Oil	0.032
Spot	0.135	Spot	0.029
CPI & Spot rates	0.275	Oil & Spot rates	0.034
Order Flow	0.068	Order Flow	0.063
ALL	0.349	ALL	0.169
Forecasting Variables	M2+	Forecasting Variables	Cocoa
M2+	0.079	Cocoa	0.053
Spot	0.053	Spot	0.023
GDP & Spot rates	0.209	Cocoa & Spot rates	0.090
Order Flow	0.004	Order Flow	0.000
ALL	0.209	ALL	0.096
Forecasting Variables	Gold		
Gold	0.026		
Spot	0.057		
Gold & Spot rates	0.088		
Order Flow	0.004		
ALL	0.141		

The table reports the R^2 from the forecasting OLS regression for the fundamentals and commodity prices listed in the header of each panel using the forecasting variables on the left. The regressions are estimated in monthly data. The monthly estimates of fundamentals are based on the history of macro announcements.

Table 7.10: Forecasting Fundamentals with local order flow

Forecasting Variables	GDP	Forecasting Variables	PR
GDP	0.946	PR	0.011
Spot	0.137	Spot	0.028
GDP & Spot rates	0.965	PR & Spot rates	0.028
Order Flow	0.748	Order Flow	0.006
ALL	0.975	ALL	0.078
Forecasting Variables	CPI	Forecasting Variables	Oil
CPI	0.014	Oil	0.032
Spot	0.135	Spot	0.029
CPI & Spot rates	0.275	Oil & Spot rates	0.034
Order Flow	0.064	Order Flow	0.019
ALL	0.286	ALL	0.034
Forecasting Variables	M2+	Forecasting Variables	Cocoa
M2+	0.079	Cocoa	0.053
Spot	0.053	Spot	0.001
GDP & Spot rates	0.209	Cocoa & Spot rates	0.098
Order Flow	0.117	Order Flow	0.044
ALL	0.302	ALL	0.187
Forecasting Variables	Gold		
Gold	0.057		
Spot	0.057		
Gold & Spot rates	0.088		
Order Flow	0.004		
ALL	0.117		

The table reports the R^2 from the forecasting OLS regression for the fundamentals and commodity prices listed in the header of each panel using the forecasting variables on the left. The regressions are estimated in monthly data. The monthly estimates of fundamentals are based on the history of macro announcements.

7.8 Conclusion

As argued by King, Sarno and Sojli (2010), there has been decades of unsuccessful attempts to link exchange rates to macroeconomic fundamentals. In recent times, however, several studies have emerged with strong contemporaneous relation between order flow and exchange rate. Most researchers conclude that any attempt to contribute meaningfully to the debate would require a long and comprehensive dataset in order to provide robust and reliable results for easy replication.

In this chapter, we examine the link between order flow, commodity prices and macro fundamentals in the context of the Ghanaian economy (an emerging economy in sub-Saharan Africa). We employ monthly order flow data reported by five commercial banks (both foreign and domestic).

This chapter has four key empirical findings:

1. A significant proportion of flows can be forecasted using lagged public information
2. Flows from different sources are driven by different fundamentals
3. Expected flows do not affect spot rates but unexpected flows do. This is a very significant result since the advanced market literature cannot really find much predictable flow (all flow is surprising)
4. There is no overwhelming evidence to suggest that unexpected flows predict future fundamentals. Results are mixed.

The empirical results are broadly in line with the microstructure approach to exchange rates. In general, we find a strong link between order flow commodity prices and macro fundamentals. Also, our presumptions about the different (expected and unexpected) flows and their impact on the exchange rates of an emerging economy in sub-Saharan Africa are backed by our data.

We would like to emphasis that our analysis reveals some additional features worth commenting on. For example, contrary to our a-priori expectation, only changes in money growth and prime rate were significant in explaining monthly order flow in the Ghanaian economy. Implicitly, changes in growth of the economy (GDP) and the performance of the export sector are the most important factors determining foreign order flows; all other macroeconomic indicators do not matter much. However, changes in other macroeconomic variables (prime rate, money supply, CPI) and oil prices are the major determinants of local order flows. These results imply that while foreign customers only consider the performance of the general economy, local customers consider 'demand' factors that have a direct bearing on their operations.

The results are consistent with Sarno and Taylor's assertion that order flows better proxy macro determinants than macro variables themselves. Furthermore, order flows are closely related to commodity price fluctuations as one would expect from a small open economy like Ghana. Our results fall short in confirming the empirical findings of Evans and Lyons (2007) who observe that order flow aid in predicting future fundamentals. Additional data may be needed to thoroughly investigate the forecasting power of order flow.

In summary, the results provided in this chapter adds further evidence to existing literature that order flow is key to understanding changes in exchange rate. This relationship may be responsible for the high explanatory power of order flow found in previous literature and reinforces other empirical evidence that macro information influences exchange rates at high frequency (Andersen et al., 2003). King, Sarno and Sojli (2010) makes similar observations for Canadian FX market. Specifically, King, Sarno and Sojli (2010) asserts that order flow captures changes in expectations for macroeconomic fundamentals and responds to changes in commodity futures, especially gold and aluminum. This view is consistent with leading microstructure theories which consider order flow as a forward

looking variable (Evans and Lyons, 2005). Order flow is, thus, strongly related to economic fundamentals which in turn can provide useful guidance for macroeconomic management. Thus our results confirm previous findings by Evans and Lyons (2007) and Bacchetta and van Wincoop (2006) who argue that the order flow channel is the missing link between exchange rates and fundamentals.

In general, this chapter lends further support to past empirical findings that order flow is vital to understanding exchange rate movements.

Chapter 8

Summary and Conclusions

Customer order flow is a key concept in the microstructure approach to exchange rates. The contribution of this thesis to empirical exchange rate economics is three-fold. First, the Evans and Lyons (2002a) model is applied to Ghanaian data using the analytical framework of the FX microstructure literature, in order to find out the nature of the relationship between order flow and exchange rates. This unique dataset is the first of its kind for Africa and spans a relatively longer time period than most papers in existing literature.

Our key results can be summarised as follows. Weekly customer order flow is able to explain a significant part of the fluctuations of the Cedi/US$ exchange rate. The explanatory power of the different models considered is comparable to other empirical findings.

The positive correlation between exchange rate movements and order flow, which has been reported in numerous studies in microstructure literature, is confirmed. Specifically, this positive relationship is observed during the crisis period whiles a negative relationship observed for the relatively stable period. This finding is consistent with the model of 'push' and 'pull' customers. However, this result differs from the findings of other authors who usually find that financial clients are the push customers and non-financial customers are the pull ones, irrespective of location.

Our key results are relatively stable over time. The sign and the magnitude of the key order flow coefficients are similar in both the pre-2003 and the post-2003 sample, and they are also comparable to the full-sample results. The only key exception is the central bank's order flow, which is present with a strong and significant coefficient in the full-sample regression, and is insignificant in the post-2003 regression.

Another interesting finding is related to central bank intervention: it seems that central bank is highly successful during times of market turmoil, but its FX transactions during normal times have no measurable impact on the exchange rate. Future research is needed, however, to confirm these claims with stronger evidence. We regard this analysis as a first step in understanding the microstructure of the CEDI/USD market.

We believe the negative relationship between order flow and exchange rates points to the possible presence of negative feedback trading by the corporate entities. However, this paper lays more emphasis on the nature of expected and unexpected flows and how each component influences exchange rate movements.

In the spirit of Love and Payne (2008), the Campbell-Schiller decomposition is used to split order flow into expected and unexpected components. As expected, unexpected flows are statistically significant and positively signed. We also discover that the highly inefficient FX market is mainly responsible for the significance of expected flows in explaining exchange rate movements.

We acknowledge the existence of the parallel market and find that the parallel market rate adjusts to the official market rate in the long-run. The issue of liquidity has serious implications for the relationship between order flow and exchange rate. During the crisis period, the Ghanaian FX market is relatively illiquid and this results in a relatively larger impact of order flow on exchange rate movements. An unexpected net customer purchase of $1m during the crisis period results in a 0.37% depreciation of the exchange rate while the same purchase results in only 0.03% depreciation during the stable period.

The issue of information effects of order flow was also tackled. The persistent long-run effect of order flow on exchange rate movements is evidence of the information aggregation role of order flow. Using Wald coefficient restrictions tests, we find that unexpected order flows have a permanent effect on exchange rates. Even though the static E&L model has been altered to account for the inefficiencies in the FX market, this is the first time that the E&L model has been applied in any form to African data.

This is the only microstructure study that has acknowledged the role of parallel FX markets in emerging markets and has accordingly incorporated this in its analysis. Attempts to establish a long-run relationship between order flow and exchange rate levels proved futile as the Johansen methodology yielded inconclusive results. However, it must be stressed that this cointegration framework does recognize the central role being played by BOG in the FX market.

The issue of BOG activity on the FX market leads to our second contribution. After a establishing a strong positive correlation between order flow and exchange rate movements, we attempt to examine how customers' demand for dollars is satisfied. BOG activity has generated intense debate amongst practitioners and academicians. Whiles BOG always describes its role on the FX market as passive, critics accuse it of actively embarking on sustained long-term interventions to smoothen volatility and maintain a stable exchange rate.

Delving into Ghanaian FX market and identifying liquidity demanders and suppliers will help us to better understand the role of BOG, banks and customers. Bjønnes et al. (2005) use the Johansen cointegration framework to identify liquidity demanders and suppliers in the Swedish Krona market. They find that non-financial customers are liquidity suppliers

(pull customers) whiles financial customers are liquidity demanders (push customers). Subsequently, we adopt the Bjønnes et al. (2005) framework and apply it to Ghanaian data. However, the variables used in our study differ significantly from those used by Bjønnes et al. (2005). Instead of financial and non-financial variables, the main variables in our study are BOG, bank and customers. Initially, Granger-Causality tests indicate that BOG is on the passive side of trades whiles bank customers are the aggressors. In other words, as customers demand liquidity, BOG passively supplies liquidity.

In the Ghanaian context, BOG is the pull customer and bank customers are the push customers. In the short-run, the banks assume the role of liquidity providers. These preliminary results are reinforced by the main results obtained from the Johansen cointegration framework.

Interestingly, the customer flow is positively correlated with exchange rate levels in the long-run for the first cointegrating equation. According to the second cointegrating equation, BOG equally matches customer flows. In the error correction model, customer flows and exchange rate adjust to attain equilibrium in the long-run for the first cointegrating equation whiles only BOG adjusts in second cointegrating relationship.

Small sizes of the exchange rate alphas indicate the relatively slow speed of exchange rate adjustment. The problem of extremely small exchange rate alphas is resolved by splitting the data set in to crisis and stable periods. The previous results are robust across the two sub-samples and the exchange rate alphas assume 'normal' sizes. During the pre-intervention period, it is the remittance customers that act as liquidity providers. These

results have been corroborated by Ghanaian bank treasurers. Typically, BOG satisfies roughly 40 to 50 percent of FX orders, consisting of unmet customer demand. However, during crisis periods characterised with inadequate FX reserves, BOG barely satisfies 10% of FX orders thus leading to an accelerated depreciation of the CEDI.

This has serious policy implications for the economy as a whole. Banks should actively search for other sources of FX in order to reduce over-reliance on Ghana's scarce FX reserves. A shift from this practise will definitely free up more FX to develop vital sectors of the economy. Ideally, BOG should only intervene in times of crisis, where short-term interventions would aid in the smoothening of any sharp volatility on the FX market.

Our third and most important contribution consists of unearthing the main drivers of order flow. After establishing the positive correlation between order flow and exchanges rates and identifying participants who were behind the order flow, this thesis attempts to investigate the determinants of order flow. In other words, we attempt to explore the driving forces behind the 'push' customers.

It is widely accepted in FX microstructure that order flow is only a proximate determinant of exchange rate movements. According to Sarno and Taylor (2001), macro fundamentals could still be the main drivers of exchange rates but their imprecise measures renders order flow a better proxy in estimation.

Other studies like Evans and Lyons (2002a, 2007) present results that suggest that order flow is the missing link between exchange rates and fundamentals. The main aim of chapter 7 is to find out if changes in macro fundamentals are linked to order flow. The variables in the monthly dataset consist of macroeconomic variables and commodity

prices. The heavy reliance of the Ghanaian economy on commodity exports and the strong relationship between commodity prices and exchange rates necessitates the inclusion of commodity prices in our empirical analysis.

Using OLS, we find that changes in fundamentals are the main drivers of order flow in Ghana. Moreover, we know how the local and foreign components of order flow are affected by changes in macro fundamentals and commodity prices. Flows from different sources are explained by different fundamentals. It is interesting to note that, only changes in GDP and export sector performance explain foreign order flow whiles changes in both macro fundamentals and oil prices explain local flows.

Additionally, we find that there is no overwhelming evidence that order flow has significant forecasting power for GDP growth, inflation and money growth. Order flow has predictive power but not over and above that of spot rates and past fundamental information. On the CEDI/USD market, most of the future fundamentals can be forecast with past fundamental information and spot rates. A more comprehensive dataset may be necessary in order to facilitate a rigorous analysis of the predictive power of order flow.

In sum, results from this thesis indicate that order flow is critical to understanding exchange rate movements in an emerging economy like Ghana. We observe that order flow is strongly correlated with exchange rate movements and is also linked to changes in the fundamentals. Consequently, order flow could be described as the missing link between exchange rates and macro fundamentals. Additionally, current flows reflect changes in past fundamentals and these past fundamentals are reflected in the current exchange rate. The expected flows derived from past fundamentals are not significant in explaining exchange rate changes whiles the unexpected flows are significant. Importantly, our findings are

consistent with the view that the key driver of exchange rate is standard macro fundamentals.

Oour results confirm previous findings by Evans and Lyons (2002a and 2007) and Bacchetta and van Wincoop (2006) who argue that the order flow channel is the missing link between exchange rates and fundamentals.

We believe that this thesis has made a significant contribution to FX microstructure of an emerging economy. For the first time, microstructure tools have been applied to African data. Taking into account the peculiar nature of the Ghanaian FX market, deepens our understanding of FX dynamics in Ghana.

This thesis could serve as a benchmark for further FX microstructure studies in other African markets. Though we present a comprehensive and detailed analysis of the relationship between macro fundamentals, exchange rates and order flow, further analysis will be required in order to fully appreciate the relationship between these variables.

A. Appendix: Further Results from chapter 6

A1: Vector Error Correction Estimates, weekly observation **(unrestricted)**

	CointEQ1	**CointEQ2**	Adj. R^2 - 0.224
Lspot	1	0	
ΔBOG	0	1	
ΔCustomers	-0.000 (-5.255)	0.384 (4.859)	
error correction	**Δ(LSPOT)**	**Δ(BOG)**	**Δ(Customers)**
cointeq1	-0.028 (–4.206)	-8.544 (-0.242)	-113.744 (-3.167)
cointeq2	0.000 (1.773)	-0.003 (-1.419)	-0.012 (-5.968)

Sample: November 2002- December 2007. Cointegration estimated using Johansen technique. The Unrestricted VAR models the cedi/dollar exchange rate and the flows of BOG and Customers. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on BOG. The error corrections are also reported.

A2: Vector Error Correction Estimates, weekly observation **(unrestricted)**

	CointEQ1	**CointEQ2**	Adj. R^2 -0.224
Lspot	1	0	
ΔCustomers	0	1	
ΔBOG	0.0001 (7.840)	2.601 (10.984)	
error correction	**Δ(LSPOT)**	**Δ(Customers)**	**Δ(BOG)**
cointeq1	-0.028 (-4.206)	-113.744 (-3.167)	-8.544 (-0.242)
cointeq2	0.000 (5.008)	-0.004 (-4.292)	-0.002 (1.693)

Sample: November 2002- December 2007. Cointegration estimated using Johansen technique. The Unrestricted VAR models the cedi/dollar exchange rate and the flows of BOG and Customers. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on CUSTOMERS. The error corrections are also reported.

A3: Vector Error Correction Estimates, weekly observation **(Unrestricted)**

	CointEQ1	**CointEQ2**	Adj. R^2 -0.262
Lspot	1	0	
ΔBOG	0	1	
ΔCustomers	-0.002 (-4.262)	3.205 (4.856)	
error correction	**Δ(LSPOT)**	**Δ(BOG)**	**Δ(Customers)**
cointeq1	-0.128 (-3.003)	-129.429 (-1.247)	24.370 (0.436)
cointeq2	0.000 (-1.047)	-0.167 (-2.141)	0.023 (0.543)

Sample: 2002-2004. Cointegration estimated using Johansen technique. The Unrestricted VAR models the cedi/dollar exchange rate and the flows of BOG and Customers. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on BOG. The error correction term and the restrictions test are also reported

A4: Vector Error Correction Estimates, weekly observation **(Unrestricted)**

	CointEQ1	**CointEQ2**	Adj. R^2 -0.262
Lspot	1	0	
ΔCustomers	0	1	
ΔBOG	0.001 (3.606)	0.312 (2.940)	
error correction	**Δ(LSPOT)**	**Δ(Customers)**	**Δ(BOG)**
cointeq1	-0.128 (-3.003)	24.370 (0.436)	-129.429 (-1.247)
cointeq2	0.000 (1.785)	0.033 (0.453)	-0.325 (-2.369)

Sample: 2002-2004. Cointegration estimated using Johansen technique. The Unrestricted VAR models the cedi/dollar exchange rate and the flows of BOG and Customers. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on CUSTOMERS. The error correction term and the restrictions test are also reported

A5: Vector Error Correction Estimates, weekly observation **(Others)**

P-value restrictions	**0.009**		Adj. R^2 -0.242
	CointEQ1	**CointEQ2**	
Lspot	1	0	
ΔCustomers	0	1	
ΔBOG	0.001 (2.817)	1	
error correction	**Δ(LSPOT)**	**Δ(Customers)**	**Δ(BOG)**
cointeq1	-0.159 (-3.905)	-2.773 (-0.070)	0
cointeq2	0	0.005 (0.194)	0

Sample: 2002-2004. Cointegration estimated using Johansen technique. The VAR models the cedi/dollar exchange rate and the flows of BOG and Customers. Bank flows are not modelled but rather its differences and two lags of differences are included in the VAR as exogenous variables. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on CUSTOMERS. The error correction term and the restrictions test are also reported

A6: Vector Error Correction Estimates, weekly observation **(Parsimonious)**

P-value restrictions	**0.057**		Adj. R^2 -0.271
	CointEQ1	**CointEQ2**	
Lspot	1	0	
ΔBOG	0	1	
ΔCustomers	-0.002 (-3.919)	1	
error correction	**Δ(LSPOT)**	**Δ(BOG)**	**Δ(Customers)**
cointeq1	-0.104 (-4.635)	0	0
cointeq2	0	-0.000	0

Sample: 2002 - 2004. Cointegration estimated using Johansen technique. The VAR models the cedi/dollar exchange rate and the flows of BOG and Customers. Bank flows are not modelled but rather its differences and two lags of differences are included in the VAR as exogenous variables. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on BOG. The error correction term and the restrictions test are also reported.

A7: Vector Error Correction Estimates, weekly observation **(Parsimonious)**

P-value restrictions	**0.074**		Adj. R^2 -0.285
	CointEQ1	**CointEQ2**	
Lspot	1	0	
ΔCustomers	0	1	
ΔBOG	0.001 (3.295)	1	
error correction	**Δ(LSPOT)**	**Δ(Customers)**	**Δ(BOG)**
cointeq1	-0.1322 (-2.932)	0	0
cointeq2	0	0	0

Sample: 2002-2004. Cointegration estimated using Johansen technique. The VAR models the cedi/dollar exchange rate and the flows of BOG and Customers. Bank flows are not modelled but rather its differences and two lags of differences are included in the VAR as exogenous variables. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on CUSTOMERS. The error correction term and the restrictions test are also reported

A8: Vector Error Correction Estimates, weekly observation **(Unrestricted)**

	CointEQ1	**CointEQ2**	Adj. R^2 -0.312
Lspot	1	0	
ΔBOG	0	1	
ΔCustomers	-0.001 (-4.996)	11.826 (5.232)	
error correction	**Δ(LSPOT)**	**Δ(BOG)**	**Δ(Customers)**
cointeq1	0.057 (2.612)	-30.879 (-0.344)	-238.807 (-2.452)
cointeq2	0.000 (-1.047)	-0.023 (-2.430)	-0.0028 (-0.319)

Sample: 2004-2007. Cointegration estimated using Johansen technique. The Unrestricted VAR models the cedi/dollar exchange rate and the flows of BOG and Customers. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on BOG. The error correction term and the restrictions test are also reported

A9: Vector Error Correction Estimates, weekly observation **(Unrestricted)**

	CointEQ1	**CointEQ2**	Adj. R^2 -0.302
Lspot	1	0	
ΔCustomers	0	1	
ΔBOG	0.0001 (3.606)	-1.538 (-2.540)	
error correction	**Δ(LSPOT)**	**Δ(Customers)**	**Δ(BOG)**
cointeq1	0.086 (3.917)	-356.507 (-3.570)	-31.963 (-0.357)
cointeq2	0.000 4.832	0.0001 (0.042)	-0.011 (-3.440)

Sample: 2004-2007. Cointegration estimated using Johansen technique. The Unrestricted VAR models the cedi/dollar exchange rate and the flows of BOG and Customers. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on CUSTOMERS. The error correction term and the restrictions test are also reported

A10: Vector Error Correction Estimates, weekly observation **(Others)**

P-value restrictions	**0.067**		Adj. R^2 -0.197
	CointEQ1	**CointEQ2**	
Lspot	1	0	
ΔBOG	0	1	
ΔCustomers	-0.000 (-8.945)	1	
error correction	**Δ(LSPOT)**	**Δ(BOG)**	**Δ(Customers)**
cointeq1	-0.049 (-2.059)	0.0000	417.373 (4.089)
cointeq2	0	0	-0.079 (-3.551)

Sample: 2004 -2007. Cointegration estimated using Johansen technique. The VAR models the cedi/dollar exchange rate and the flows of BOG and Customers. Bank flows are not modelled but rather its differences and two lags of differences are included in the VAR as exogenous variables. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on BOG. The error correction term and the restrictions test are also reported.

A11: Vector Error Correction Estimates, weekly observation **(Others)**

P-value restrictions	**0.073**		Adj. R^2 -0.197
	CointEQ1	**CointEQ2**	
Lspot	1	0	
ΔCustomers	0	1	
ΔBOG	0.000 (2.817)	1	
error correction	**Δ(LSPOT)**	**Δ(Customers)**	**Δ(BOG)**
cointeq1	-0.043 (-2.108)	-416.743 (-4.085)	0
cointeq2	0	0.098 (-3.783)	0

Sample: 2004-2007. Cointegration estimated using Johansen technique. The VAR models the cedi/dollar exchange rate and the flows of BOG and Customers. Bank flows are not modelled but rather its differences and two lags of differences are included in the VAR as exogenous variables. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on CUSTOMERS. The error correction term and the restrictions test are also reported

A12: Vector Error Correction Estimates, weekly observation **(Unrestricted)**

	CointEQ1	**CointEQ2**	Adj. R^2 -0.5049
Lspot	1	0	
ΔCustomers	0	1	
ΔREM	-0.007 (-2.520)	1.481 (18.792)	
error correction	**Δ (LSPOT)**	**Δ(REM)**	**Δ(Customers)**
cointeq1	-0.008 (-2.802)	-1.984 (-2.687)	-0.818 (-2.367)
cointeq2	0.000 (0.959)	0.012 (0.404)	-0.048 (-3.435)

Sample: 2000 -2002. Cointegration estimated using Johansen technique. The Unrestricted VAR models the cedi/dollar exchange rate and the flows of remittance (REM) and normal Customers. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on CUSTOMERS. The error correction term is also reported.

A13: Vector Error Correction Estimates, weekly observation (Unrestricted)

	CointEQ1	**CointEQ2**	Adj. R^2 -0.536
Lspot	1	0	
ΔREM	0	1	
ΔCustomers	-0.0033 (1.955)	0.695 (24.442)	
error correction	**Δ(LSPOT)**	**Δ(REM)**	**Δ(Customers)**
cointeq1	-0.011 (-3.123)	-0.668 (-1.542)	-1.919 (-2.036)
cointeq2	0.001 (2.155)	-0.0701 (-3.352)	0.017 (0.371)

Sample: 2000 -2002. Cointegration estimated using Johansen technique. The Unrestricted VAR models the cedi/dollar exchange rate and the flows of remittance (REM) and normal Customers. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on REM. The error correction term is also reported.

A14: Vector Error Correction Estimates, weekly observation **(Theory)**

P-value restrictions	**0.0624**		Adj. R^2 -0.2812
	CointEQ1	**CointEQ2**	
Lspot	1	0	
ΔCustomers	0	1	
ΔBOG	0.001 (2.817)	1	
error correction	**Δ (LSPOT)**	**Δ(Customers)**	**Δ(BOG)**
cointeq1	-0.150 (-3.120)	-70.460 (-1.456)	0
cointeq2	0.0000	0.0000	-0.042 (-0.828)

Sample: 2002-2004. Cointegration estimated using Johansen technique. The VAR models the cedi/dollar exchange rate and the flows of BOG and Customers. Bank flows are not modelled but rather its differences and two lags of differences are included in the VAR as exogenous variables. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on CUSTOMERS. The error correction term and the restrictions test are also reported

A15: Vector Error Correction Estimates, weekly observation **(Theory)**

P-value restrictions	**0.098**		Adj. R^2 -0.209
	CointEQ1	**CointEQ2**	
Lspot	1	0	
ΔCustomers	0	1	
ΔBOG	0.000 (6.734)	1	
error correction	**Δ(LSPOT)**	**Δ(Customers)**	**Δ(BOG)**
cointeq1	-0.065 (-2.195)	376.686 (3.623)	0.0000
cointeq2	0.0000	0.0000	-0.077 (-3.260)

Sample: 2004-2007. Cointegration estimated using Johansen technique. The VAR models the cedi/dollar exchange rate and the flows of BOG and Customers. Bank flows are not modelled but rather its differences and two lags of differences are included in the VAR as exogenous variables. The VAR has three lags. The first cointegrating vector is normalised on the exchange rate, while the second cointegrating vector is normalised on CUSTOMERS. The error correction term and the restrictions test are also reported

B. Appendix: Role of BOG in Ghanaian FX market

The Bank of Ghana's powers to deal in Foreign Exchange is empowered in the Bank of Ghana Act, 2002, Act 612 part VI section 50 which states inter alia that:

"PART VI—FOREIGN OPERATIONS

Transactions in assets of international value

50. (1) The Bank may

(a) purchase and sell external convertible currencies;

(b) discount and re-discount treasury bills drawn in convertible currencies;

(c) purchase and sell bills of exchange drawn in convertible currencies;

(d) import, export, refine, hold, sell, transfer or otherwise deal in gold, gold coins and bullion, silver, platinum and any other precious metals as determined by the Board;

(e) accept deposits from foreign banking institutions, international financial institutions, foreign governments and their agencies or the organs of the United Nations;

(f) acquire, hold and transfer foreign exchange and foreign government securities;

(g) maintain accounts with central banks and reputable international financial institutions;

(h) act as correspondent bank or agent for an international banking institution or a monetary authority; and

(i) effect foreign exchange transactions of any kind.

(2) The Bank shall not acquire, hold or transfer any foreign government securities unless those securities are denominated in convertible currency.

Power to borrow and guarantee

51. (1) The Bank may,

(a) without the prior approval of the Minister borrow money from foreign institutions for a period not exceeding ninety days for the day-to-day operations of the Bank;

(b) in accordance with this Act or any other enactment, borrow money from foreign institutions and pledge assets held by it as security for the repayment of the loan;

(c) lend money or grant short-term credits to any financial institutions;

but the Bank may, without the approval of the Minister, lend to those institutions in the ordinary course of business.

(2) The Bank may, at the written request of the Minister, guarantee a loan granted to the Government or an agency of Government by a foreign institution.

(3)The Bank may shall put a limit on the aggregate of guarantees issued by it in each year. .

(4) The Bank may request security to cover its exposure to any guarantee it issues.

(5) The Government may guarantee on behalf of the Republic a loan granted under paragraph (a) and (b) of subsection (1).

Exchange rate of the cedi

52. The Board may, in consultation with the Minister, formulate exchange rate policy.

Holding of state foreign exchange

53 The Bank shall hold all foreign exchange of the State and be responsible to Parliament in the performance of its function in relation to the foreign exchange."

C1. Appendix: Forecasting Fundamentals using Total unexpected Flows

General	ΔGDP_t
ΔGDP_{t-3}	2.992 (7.573)
ΔGDP_{t-4}	-2.080 (-5.162)
REDM	0.0004 (1.760)
HIPC	-0.001 (-1.724)
R^2	0.946
Diagnostics	
Serial	0.016
hetero	0.000

General	ΔGDP_t
ΔS_{t-1}	-0.068 (-0.878)
ΔS_{t-2}	0.168 (1.674)
ΔS_{t-3}	0.182 (2.099)
ΔS_{t-4}	0.258 (2.427)
REDM	-0.002 (-2.439)
HIPC	0.005 (5.138)
R^2	0.138
Diagnostics	
Serial	0.000
hetero	0.459

Specific	ΔGDP_t
ΔS_{t-3}	0.222 (2.305)
ΔS_{t-4}	0.235 (2.326)
REDM	-0.002 (-2.805)
HIPC	0.004 (4.901)
R^2	0.137
Diagnostics	
Serial	0.000
hetero	0.833

General	ΔGDP_t
ΔS_{t-1}	0.060 (2.251)
ΔS_{t-2}	0.082 (2.166)
ΔS_{t-3}	0.038 (1.346)
ΔS_{t-4}	0.011 (0.475)
ΔGDP_{t-3}	2.420 (4.360)
ΔGDP_{t-4}	-1.515 (-2.789)
REDM	0.001 (3.147)
HIPC	-0.0001 (-0.949)
R^2	0.965
Diagnostics	
Serial	0.008
hetero	0.000

Specific	ΔGDP_t
ΔS_{t-1}	0.068 (2.877)
ΔS_{t-2}	0.086 (2.055)
ΔGDP_{t-3}	2.593 (5.677)
ΔGDP_{t-4}	-1.684 (-3.741)
REDM	0.001 (3.150)
R^2	0.965
Diagnostics	
Serial	0.087
hetero	0.000

General	ΔGDP_t
UF_{t-1}	0.046 (2.604)
UF_{t-2}	0.021 (1.472)
UF_{t-3}	0.045 (3.529)
UF_{t-4}	0.052 (3.055)
REDM	0.003 (4.046)
HIPC	0.002 (3.351)
R^2	0.688
Diagnostics	
Serial	0.000
hetero	0.558

Specific	ΔGDP_t
UF_{t-1}	0.054 (3.205)
UF_{t-3}	0.052 (3.898)
UF_{t-4}	0.057 (3.366)
REDM	0.004 (4.813)
HIPC	0.002 (3.267)
R^2	0.690
Diagnostics	
Serial	0.000
hetero	0.216

General	ΔGDP_t
ΔS_{t-1}	0.056 (2.984)
ΔS_{t-2}	0.053 (1.671)
ΔS_{t-3}	0.011 (0.399)
ΔS_{t-4}	-0.029 (-1.425)
ΔGDP_{t-3}	2.211 (4.604)
ΔGDP_{t-4}	-1.403 (-2.974)
UF_{t-1}	0.021 (2.895)
UF_{t-2}	0.001 (0.139)
UF_{t-3}	0.002 (0.367)
UF_{t-4}	0.008 (1.168)
REDM	0.001 (3.704)
HIPC	-0.0003 (-1.104)
R^2	0.971
Diagnostics	
Serial	0.217
hetero	0.167

Specific	ΔGDP_t
ΔS_{t-1}	0.051 (2.869)
ΔS_{t-2}	0.066 (1.671)
ΔGDP_{t-3}	2.259 (5.080)
ΔGDP_{t-4}	-1.425 (-3.263)
UF_{t-1}	0.024 (3.579)
REDM	0.001 (4.661)
R^2	0.973
Diagnostics	
Serial	0.166
hetero	0.000

General	ΔCPI_t
ΔCPI_{t-3}	0.144 (1.799)
ΔCPI_{t-4}	-0.182 (-1.512)
REDM	-0.002 (-0.774)
HIPC	-0.006 (-1.442)
R^2	0.046
Diagnostics	
Serial	0.114
hetero	0.988

Specific	ΔCPI_t
ΔCPI_{t-3}	0.119 (2.284)
R^2	0.014
Diagnostics	
Serial	0.157
hetero	0.935

General	ΔCPI_t
ΔS_{t-1}	0.569 (0.888)
ΔS_{t-2}	1.314 (1.693)
ΔS_{t-3}	0.949 (1.745)
ΔS_{t-4}	0.463 (0.648)
REDM	0.004 (1.853)
HIPC	-0.005 (-1.735)
R^2	0.226
Diagnostics	
Serial	0.931
hetero	0.0002

Specific	ΔCPI_t
ΔS_{t-2}	1.673 (1.643)
HIPC	-0.008 (-3.996)
R^2	0.135
Diagnostics	
Serial	0.889
hetero	0.054

General	ΔCPI_t
ΔS_{t-1}	0.252 (0.449)
ΔS_{t-2}	1.573 (2.035)
ΔS_{t-3}	1.097 (2.047)
ΔS_{t-4}	0.538 (0.564)
ΔCPI_{t-3}	0.048 (0.334)
ΔCPI_{t-4}	-0.252 (-2.338)
REDM	0.005 (2.034)
HIPC	-0.001 (-0.241)
R^2	0.255
Diagnostics	
Serial	0.959
hetero	0.000

Specific	ΔCPI_t
ΔS_{t-2}	1.703 (2.059)
ΔS_{t-3}	1.348 (2.542)
ΔCPI_{t-4}	-0.256 (-2.115)
REDM	-0.005 (2.435)
R^2	0.275
Diagnostics	
Serial	0.831
hetero	0.132

General	ΔCPI_t
UF_{t-1}	0.089 (0.643)
UF_{t-2}	-0.093 (-0.542)
UF_{t-3}	0.069 (0.713)
UF_{t-4}	0.235 (2.339)
REDM	0.012 (3.126)
HIPC	-0.016 (-5.910)
R^2	0.020
Diagnostics	
Serial	0.401
hetero	0.790

Specific	ΔCPI_t
UF_{t-4}	0.277 (2.136)
REDM	0.009 (2.659)
HIPC	-0.017 (-3.917)
R^2	0.064
Diagnostics	
Serial	0.398
hetero	0.643

General	ΔCPI_t
ΔS_{t-1}	0.327 (0.598)
ΔS_{t-2}	1.553 (1.965)
ΔS_{t-3}	0.999 (1.683)
ΔS_{t-4}	0.584 (0.539)
ΔCPI_{t-3}	0.017 (0.119)
ΔCPI_{t-4}	-0.254 (-2.323)
UF_{t-1}	-0.049 (-0.406)
UF_{t-2}	-0.182 (-1.108)
UF_{t-3}	0.032 (0.310)
UF_{t-4}	0.251 (2.119)
REDM	0.012 (2.571)
HIPC	-0.006 (-1.150)
R^2	0.234
Diagnostics	
Serial	0.217
hetero	0.167

Specific	ΔCPI_t
ΔS_{t-2}	1.569 (1.976)
ΔS_{t-3}	1.131 (1.853)
ΔCPI_{t-4}	-0.284 (-2.277)
UF_{t-4}	0.153 (1.759)
REDM	0.011 (3.002)
R^2	0.289
Diagnostics	
Serial	0.714
hetero	0.227

General	$\Delta M2+_t$
$\Delta M2+_{t-3}$	-0.332 (-3.717)
$\Delta M2+_{t-4}$	-0.061(-0.511)
REDM	0.013 (2.809)
HIPC	0.026 (4.697)
R^2	0.081
Diagnostics	
Serial	0.151
hetero	0.606

Specific	$\Delta M2+_t$
$\Delta M2+_{t-3}$	-0.335 (-3.808)
REDM	0.013 (3.143)
HIPC	0.025 (4.244)
R^2	0.079
Diagnostics	
Serial	0.099
hetero	0.408

General	$\Delta M2+_t$
ΔS_{t-1}	2.842 (3.767)
ΔS_{t-2}	-0.766 (-0.835)
ΔS_{t-3}	-0.949 (-0.533)
ΔS_{t-4}	-0.989 (-0.883)
REDM	0.008 (1.741)
HIPC	0.032 (6.814)
R^2	0.080
Diagnostics	
Serial	0.693
hetero	0.192

Specific	$\Delta M2+_t$
ΔS_{t-1}	1.764 (2.868)
REDM	0.009 (2.543)
HIPC	0.036 (9.489)
R^2	0.053
Diagnostics	
Serial	0.209
hetero	0.788

General	$\Delta M2+_t$
ΔS_{t-1}	3.128 (3.811)
ΔS_{t-2}	-0.373 (-0.445)
ΔS_{t-3}	-0.698 (-0.452)
ΔS_{t-4}	-0.568 (-0.487)
$\Delta M2+_{t-3}$	-0.389 (-4.136)
$\Delta M2+_{t-4}$	-0.086 (-0.824)
REDM	0.017 (3.881)
HIPC	0.026 (5.098)
R^2	0.222
Diagnostics	
Serial	0.659
hetero	0.096

Specific	$\Delta M2+_t$
ΔS_{t-1}	2.486 (3.920)
$\Delta M2+_{t-3}$	-0.414 (-4.564)
REDM	0.019 (4.947)
HIPC	0.027 (5.138)
R^2	0.209
Diagnostics	
Serial	0.144
hetero	0.845

General	$\Delta M2+_t$
UF_{t-1}	0.221 (0.686)
UF_{t-2}	-0.309 (-0.824)
UF_{t-3}	0.813 (3.054)
UF_{t-4}	-0.611 (-2.046)
REDM	0.021 (1.417)
HIPC	0.044 (6.435)
R^2	0.024
Diagnostics	
Serial	0.048
hetero	0.866

Specific	$\Delta M2+_t$
UF_{t-3}	0.743 (3.871)
UF_{t-4}	-0.670 (-3.047)
HIPC	0.045 (7.279)
R^2	0.059
Diagnostics	
Serial	0.112
hetero	0.138

General	$\Delta M2+_t$
ΔS_{t-1}	3.033 (3.884)
ΔS_{t-2}	-0.661 (-0.649)
ΔS_{t-3}	-0.964 (-0.707)
ΔS_{t-4}	-0.947 (-0.757)
$\Delta M2+_{t-3}$	-0.326 (-3.567)
$\Delta M2+_{t-4}$	-0.177 (-1.798)
UF_{t-1}	0.132 (0.404)
UF_{t-2}	-0.169 (-0.477)
UF_{t-3}	0.8.2 (3.214)
UF_{t-4}	-0.473 (-1.662)
REDM	0.031 (1.972)
HIPC	0.034 (3.634)
R^2	0.257
Diagnostics	
Serial	0.486
hetero	0.701

Specific	$\Delta M2+_t$
ΔS_{t-1}	2.499 (3.964)
$\Delta M2+_{t-3}$	-0.358 (-3.678)
$\Delta M2+_{t-4}$	-0.202 (-1.806)
UF_{t-3}	0.713 (3.143)
UF_{t-4}	-0.603 (-2.564)
REDM	0.022 (2.267)
HIPC	0.040 (5.635)
R^2	0.292
Diagnostics	
Serial	0.229
hetero	0.491

General	ΔPR_t
ΔPR_{t-3}	0.054 (0.612)
ΔPR_{t-4}	0.087 (0.696)
REDM	0.008 (1.430)
HIPC	0.008 (1.430)
R^2	0.011
Diagnostics	
Serial	0.401
hetero	0.979

General	ΔPR_t
ΔS_{t-1}	0.723 (0.742)
ΔS_{t-2}	0.912 (0.532)
ΔS_{t-3}	-0.102 (0.066)
ΔS_{t-4}	1.145 (1.112)
REDM	0.013 (2.881)
HIPC	0.015 (2.853)
R^2	0.046
Diagnostics	
Serial	0.331
hetero	0.773

Specific	ΔPR_t
ΔS_{t-4}	1.596 (2.108)
REDM	0.101 (2.051)
HIPC	0.013 (2.454)
R^2	0.028
Diagnostics	
Serial	0.312
hetero	0.844

General	ΔPR_t
ΔS_{t-1}	0.788 (0.768)
ΔS_{t-2}	0.879 (0.501)
ΔS_{t-3}	-0.165 (-0.103)
ΔS_{t-4}	1.029 (0.944)
ΔPR_{t-3}	0.024 (0.252)
ΔPR_{t-4}	0.073 (0.599)
REDM	0.012 (2.173)
HIPC	0.014 (2.135)
R^2	0.051
Diagnostics	
Serial	0.305
hetero	0.975

Specific	ΔPR_t
ΔS_{t-1}	1.596 (2.108)
REDM	0.010 (2.051)
HIPC	0.013 (2.454)
R^2	0.028
Diagnostics	
Serial	0.312
hetero	0.844

General	ΔPR_t
UF_{t-1}	0.166 (0.367)
UF_{t-2}	-0.083 (-0.137)
UF_{t-3}	-0.301 (-0.549)
UF_{t-4}	0.135 (0.270)
REDM	0.007 (0.298)
HIPC	0.007 (0.864)
R^2	0.011
Diagnostics	
Serial	0.487
hetero	0.841

Specific	ΔPR_t
UF_{t-3}	-0.133 (-0.488)
HIPC	0.009 (1.954)
R^2	0.006
Diagnostics	
Serial	0.429
hetero	0.813

General	ΔPR_t
ΔS_{t-1}	0.709 (0.597)
ΔS_{t-2}	1.625 (0.788)
ΔS_{t-3}	0.338 (0.212)
ΔS_{t-4}	2.239 (1.439)
ΔPR_{t-3}	-0.009 (-0.079)
ΔPR_{t-4}	0.083 (0.648)
UF_{t-1}	-0.158 (-0.307)
UF_{t-2}	-0.283 (-0.478)
UF_{t-3}	-0.306 (-0.533)
UF_{t-4}	0.191 (0.344)
REDM	0.0001 (-0.0006)
HIPC	0.018 (1.643)
R^2	0.098
Diagnostics	
Serial	0.228
hetero	0.895

Specific	ΔPR_t
ΔS_{t-4}	2.514 (2.882)
UF_{t-2}	-0.347 (-1.645)
HIPC	0.016 (2.757)
R^2	0.051
Diagnostics	
Serial	0.271
hetero	0.733

General	Δoil_t
Δoil_{t-1}	-0.247 (-2.089)
Δoil_{t-2}	-0.207 (-2.052)
Δoil_{t-3}	-0.251 (-1.882)
Δoil_{t-4}	-0.185 (-1.396)
REDM	0.077 (5.135)
HIPC	0.122 (5.739)
R^2	0.043
Diagnostics	
Serial	0.151
hetero	0.687

Specific	Δoil_t
Δoil_{t-1}	-0.219 (-1.819)
Δoil_{t-2}	-0.182 (-2.053)
Δoil_{t-3}	-0.215 (-1.940)
REDM	0.071 (5.113)
HIPC	0.134 (6.446)
R^2	0.032
Diagnostics	
Serial	0.621
hetero	0.599

General	Δoil_t
ΔS_{t-1}	3.025 (1.129)
ΔS_{t-2}	-0.447 (-0.091)
ΔS_{t-3}	-5.024 (-0.918)
ΔS_{t-4}	-0.026 (-0.008)
REDM	0.053 (3.965)
HIPC	0.077 (5.545)
R^2	0.067
Diagnostics	
Serial	0.387
hetero	0.469

Specific	Δoil_t
ΔS_{t-1}	1.802 (1.302)
REDM	0.062 (6.022)
HIPC	0.088 (8.648)
R^2	0.029
Diagnostics	
Serial	0.399
hetero	0.814

General	Δoil_t
ΔS_{t-1}	4.367 (1.528)
ΔS_{t-2}	-0.065 (-0.014)
ΔS_{t-3}	-5.409 (-1.274)
ΔS_{t-4}	-1.579 (-0.424)
Δoil_{t-1}	-0.287 (-2.165)
Δoil_{t-2}	-0.192 (-1.649)
Δoil_{t-3}	-0.276 (-2.002)
Δoil_{t-4}	-0.209 (-1.516)
REDM	0.073 (4.018)
HIPC	0.113 (5.274)
R^2	0.046
Diagnostics	
Serial	0.127
hetero	0.853

Specific	Δoil_t
ΔS_{t-1}	2.635 (1.675)
Δoil_{t-1}	-0.229 (-1.865)
Δoil_{t-2}	-0.187 (-2.091)
Δoil_{t-3}	-0.234 (-2.166)
REDM	0.076 (4.898)
HIPC	0.141 (6.298)
R^2	0.034
Diagnostics	
Serial	0.340
hetero	0.632

General	Δoil_t
UF_{t-1}	-0.445 (-0.373)
UF_{t-2}	0.376 (0.307)
UF_{t-3}	
UF_{t-4}	-1.418 (-1.355)
REDM	1.509 (1.822)
HIPC	0.048 (1.089)
R^2	0.062 (4.329)
Diagnostics	0.061
Serial	
hetero	0.458
	0.930

Specific	Δoil_t
UF_{t-3}	-1.443 (0.062)
UF_{t-4}	1.518 (1.826)
REDM	0.058 (2.391)
HIPC	0.060 (4.190)
R^2	0.058
Diagnostics	
Serial	0.476
hetero	0.481

General	Δoil_t
ΔS_{t-1}	4.925 (1.669)
ΔS_{t-2}	-0.0520 (-0.113)
ΔS_{t-3}	-5.776 (-1.159)
ΔS_{t-4}	-2.395 (-0.631)
Δoil_{t-1}	-0.266 (-2.025)
Δoil_{t-2}	-0.191 (-1.504)
Δoil_{t-3}	-0.276 (-2.053)
Δoil_{t-4}	-0.192 (1.385)
UF_{t-1}	-0.288 (-0.269)
UF_{t-2}	0.172 (0.150)
UF_{t-3}	-1.144 (-1.056)
UF_{t-4}	1.641 (1.968)
REDM	0.081 (2.016)
HIPC	0.085 (2.799)
R^2	0.016
Diagnostics	
Serial	0.363
hetero	0.548

Specific	Δoil_t
UF_{t-3}	-0.259 (-0.527)
REDM	0.049 (2.109)
HIPC	0.086 (9.109)
R^2	0.024
Diagnostics	
Serial	0.470
hetero	0.622

General	$\Delta cocoa_t$
$\Delta cocoa_{t-1}$	-0.189 (-2.198)
$\Delta cocoa_{t-2}$	-0.219 (-1.518)
$\Delta cocoa_{t-3}$	-0.040 (-0.237)
$\Delta cocoa_{t-4}$	0.168 (1.286)
REDM	-0.005 (-0.596)
HIPC	-0.008 (-0.597)
R^2	0.029
Diagnostics	
Serial	0.375
hetero	0.047

Specific	$\Delta cocoa_t$
$\Delta cocoa_{t-1}$	-0.180 (-2.315)
$\Delta cocoa_{t-2}$	-0.272 (-2.028)
HIPC	-0.011 (-1.999)
R^2	0.053
Diagnostics	
Serial	0.068
hetero	0.600

General	$\Delta cocoa_t$
ΔS_{t-1}	0.478 (0.419)
ΔS_{t-2}	-1.161 (-0.952)
ΔS_{t-3}	-0.041 (-0.335)
ΔS_{t-4}	-0.169 (-0.076)
REDM	-0.003 (-0.657)
HIPC	-0.009 (-2.577)
R^2	0.021
Diagnostics	
Serial	0.387
hetero	0.469

Specific	$\Delta cocoa_t$
ΔS_{t-3}	-1.320 (-1.389)
HIPC	-0.008 (-2.175)
R^2	0.023
Diagnostics	
Serial	0.038
hetero	0.349

General	$\Delta cocoa_t$
ΔS_{t-1}	0.668 (0.541)
ΔS_{t-2}	-0.577 (-0.545)
ΔS_{t-3}	-0.604 (-0.399)
ΔS_{t-4}	-1.095 (-0.471)
$\Delta cocoa_{t-1}$	-0.244 (-2.290)
$\Delta cocoa_{t-2}$	-0.224 (-1.659)
$\Delta cocoa_{t-3}$	-0.032 (-0.172)
$\Delta cocoa_{t-4}$	0.155 (1.201)
REDM	-0.006 (-0.777)
HIPC	-0.016 (-0.776)
R^2	0.147
Diagnostics	
Serial	0.744
hetero	0.005

Specific	$\Delta cocoa_t$
$\Delta cocoa_{t-1}$	-0.180 (-2.315)
$\Delta cocoa_{t-2}$	-0.272 (-2.028)
HIPC	-0.011 (-1.999)
R^2	0.098
Diagnostics	
Serial	0.068
hetero	0.600

General	$\Delta cocoa_t$
UF_{t-1}	0.106 (0.320)
UF_{t-2}	0.392 (0.858)
UF_{t-3}	-0.935 (-2.797)
UF_{t-4}	0.275 (0.892
REDM	-0.019 (-1.230)
HIPC	-0.013 (-2.459)
R^2	0.075
Diagnostics	
Serial	0.167
hetero	0.348

Specific	$\Delta cocoa_t$
UF_{t-3}	-0.364 (-2.059)
REDM	-0.0145 (-2.099)
R^2	0.041
Diagnostics	
Serial	0.067
hetero	0.003

General	$\Delta cocoa_t$
ΔS_{t-1}	0.630 (0.488)
ΔS_{t-2}	-0.388 (-0.342)
ΔS_{t-3}	-0.135 (-0.103)
ΔS_{t-4}	-1.073 (-0.408)
$\Delta cocoa_{t-1}$	-0.244 (-2.257)
$\Delta cocoa_{t-2}$	-0.195 (-1.326)
$\Delta cocoa_{t-3}$	-0.081 (-0.389)
$\Delta cocoa_{t-4}$	0.202 (1.403)
UF_{t-1}	-0.265 (-0.871)
UF_{t-2}	0.563 (1.079)
UF_{t-3}	-0.794 (-2.284)
UF_{t-4}	0.322 (0.961)
REDM	-0.029 (-1.551)
HIPC	-0.017 (-0.757)
R^2	0.210
Diagnostics	
Serial	0.819
hetero	0.012

Specific	$\Delta cocoa_t$
$\Delta cocoa_{t-1}$	-0.236 (-2.879)
$\Delta cocoa_{t-2}$	-0.301 (-2.533)
UF_{t-3}	-0.370 (-1.797)
R^2	0.165
Diagnostics	
Serial	0.720
hetero	0.059

General	$\Delta gold_t$
$\Delta gold_{t-1}$	-0.178 (-1.432)
$\Delta gold_{t-2}$	-0.083 (-0.544)
$\Delta gold_{t-3}$	0.207 (1.706)
$\Delta gold_{t-4}$	0.047 (0.319)
REDM	-0.004 (-0.459)
HIPC	0.027 (2.642)
R^2	0.086
Diagnostics	
Serial	0.043
hetero	0.688

Specific	$\Delta gold_t$
$\Delta gold_{t-3}$	0.234 (1.828)
HIPC	0.028 (3.933)
R^2	0.057
Diagnostics	
Serial	0.418
hetero	0.924

General	$\Delta gold_t$
ΔS_{t-1}	2.989 (2.324)
ΔS_{t-2}	-0.736 (-0.523)
ΔS_{t-3}	-2.578 (-1.513)
ΔS_{t-4}	-0.942 (-0.682)
REDM	0.054 (0.856)
HIPC	0.015 (2.230)
R^2	0.010
Diagnostics	
Serial	0.144
hetero	0.998

Specific	$\Delta gold_t$
ΔS_{t-1}	2.508 (2.237)
ΔS_{t-3}	-2.858 (-2.191)
HIPC	0.017 (2.932)
R^2	0.057
Diagnostics	
Serial	0.118
hetero	0.956

General	$\Delta gold_t$
ΔS_{t-1}	3.065 (2.085)
ΔS_{t-2}	0.183 (0.142)
ΔS_{t-3}	-2.573 (-1.547)
ΔS_{t-4}	-2.043 (-1.599)
$\Delta gold_{t-1}$	-0.260 (-2.346)
$\Delta gold_{t-2}$	-0.084 (-0.519)
$\Delta gold_{t-3}$	0.161 (1.162)
$\Delta gold_{t-4}$	0.019 (0.136)
REDM	-0.006 (-0.671)
HIPC	0.020 (1.580)
R^2	0.037
Diagnostics	
Serial	0.115
hetero	0.817

Specific	$\Delta gold_t$
ΔS_{t-1}	2.736 (2.593)
ΔS_{t-3}	-3.028 (-2.338)
$\Delta gold_{t-1}$	-0.211 (-2.238)
HIPC	0.014 (2.229)
R^2	0.088
Diagnostics	
Serial	0.469
hetero	0.977

General	$\Delta gold_t$
UF_{t-1}	-0.317 (-0.527)
UF_{t-2}	1.409 (2.204)
UF_{t-3}	-0.613 (-0.959)
UF_{t-4}	-0.648 (-1.195)
REDM	-0.035 (-1.600)
HIPC	0.027 (2.586)
R^2	0.010
Diagnostics	
Serial	0.133
hetero	0.455

Specific	$\Delta gold_t$
UF_{t-2}	0.891 (2.159)
UF_{t-4}	-0.915 (-2.318)
HIPC	0.032 (4.653)
R^2	0.028
Diagnostics	
Serial	0.114
hetero	0.959

General	$\Delta gold_t$
ΔS_{t-1}	2.680 (1.650)
ΔS_{t-2}	-0.032 (-0.237)
ΔS_{t-3}	-2.167 (-1.332)
ΔS_{t-4}	-3.115 (-1.938)
$\Delta gold_{t-1}$	-0.237 (-1.687)
$\Delta gold_{t-2}$	-0.092 (-0.606)
$\Delta gold_{t-3}$	0.253 (1.775)
$\Delta gold_{t-4}$	-0.055 (-0.403)
UF_{t-1}	-0.427 (-0.576)
UF_{t-2}	1.775 (3.034)
UF_{t-3}	-0.563 (-0.807)
UF_{t-4}	-0.644 (-1.506)
REDM	-0.049 (-1.924)
HIPC	0.029 (1.919)
R^2	0.118
Diagnostics	
Serial	0.227
hetero	0.747

Specific	$\Delta gold_t$
ΔS_{t-1}	2.584 (1.828)
ΔS_{t-3}	-2.864 (-1.845)
ΔS_{t-4}	-3.163 (-2.183)
$\Delta gold_{t-1}$	-0.264 (-2.312)
$\Delta gold_{t-3}$	0.255 (2.034)
UF_{t-2}	1.305 (3.560)
UF_{t-4}	-0.964 (-2.833)
REDM	-0.025 (-1.986)
HIPC	0.028 (2.762)
R^2	0.173
Diagnostics	
Serial	0.612
hetero	0.367

C2. Appendix: Forecasting Fundamentals using Foreign unexpected Flows

General	ΔGDP_t
ΔGDP_{t-3}	2.992 (7.573)
ΔGDP_{t-4}	-2.080 (-5.162)
REDM	0.0004 (1.760)
HIPC	-0.001 (-1.724)
R^2	0.946
Diagnostics	
Serial	0.016
hetero	0.000

General	ΔGDP_t
ΔS_{t-1}	-0.068 (-0.878)
ΔS_{t-2}	0.168 (1.674)
ΔS_{t-3}	0.182 (2.099)
ΔS_{t-4}	0.258 (2.427)
REDM	-0.002 (-2.439)
HIPC	0.005 (5.138)
R^2	0.138
Diagnostics	
Serial	0.000
hetero	0.459

Specific	ΔGDP_t
ΔS_{t-3}	0.222 (2.305)
ΔS_{t-4}	0.235 (2.326)
REDM	-0.002 (-2.805)
HIPC	0.004 (4.901)
R^2	0.137
Diagnostics	
Serial	0.000
hetero	0.833

General	ΔGDP_t
ΔS_{t-1}	0.060 (2.251)
ΔS_{t-2}	0.082 (2.166)
ΔS_{t-3}	0.038 (1.346)
ΔS_{t-4}	0.011 (0.475)
ΔGDP_{t-3}	2.420 (4.360)
ΔGDP_{t-4}	-1.515 (-2.789)
REDM	0.001 (3.147)
HIPC	-0.0001 (-0.949)
R^2	0.965
Diagnostics	
Serial	0.008
hetero	0.000

Specific	ΔGDP_t
ΔS_{t-1}	0.068 (2.877)
ΔS_{t-2}	0.086 (2.055)
ΔGDP_{t-3}	2.593 (5.677)
ΔGDP_{t-4}	-1.684 (-3.741)
REDM	0.001 (3.150)
R^2	0.965
Diagnostics	
Serial	0.087
hetero	0.000

General	ΔGDP_t
UF_{t-1}	0.079 (3.559)
UF_{t-2}	0.034 (1.552)
UF_{t-3}	0.068 (2.423)
UF_{t-4}	0.066 (2.041)
REDM	0.003 (2.886)
HIPC	0.002 (2.631)
R^2	0.585
Diagnostics	
Serial	0.000
hetero	0.586

Specific	ΔGDP_t
UF_{t-1}	0.093 (3.939)
UF_{t-3}	0.084 (2.996)
UF_{t-4}	0.071 (2.140)
REDM	0.004 (3.317)
HIPC	0.002 (2.519)
R^2	0.588
Diagnostics	
Serial	0.000
hetero	0.217

General	ΔGDP_t
ΔS_{t-1}	0.059 (2.980)
ΔS_{t-2}	0.061 (1.689)
ΔS_{t-3}	0.019 (0.722)
ΔS_{t-4}	-0.019 (-0.794)
ΔGDP_{t-3}	2.343 (4.851)
ΔGDP_{t-4}	-1.494 (-3.125)
UF_{t-1}	0.026 (2.018)
UF_{t-2}	0.004 (0.332)
UF_{t-3}	-0.001 (-0.009)
UF_{t-4}	0.004 (0.359)
REDM	0.001 (1.968)
HIPC	-0.0004 (-1.339)
R^2	0.968
Diagnostics	
Serial	0.091
hetero	0.008

Specific	ΔGDP_t
ΔS_{t-1}	0.057 (3.263)
ΔS_{t-2}	0.070 (2.357)
ΔGDP_{t-3}	2.382 (5.506)
ΔGDP_{t-4}	-1.526 (-3.604)
UF_{t-1}	0.028 (2.406)
REDM	0.001 (3.452)
R^2	0.971
Diagnostics	
Serial	0.170
hetero	0.000

General	ΔCPI_t
ΔCPI_{t-3}	0.144 (1.799)
ΔCPI_{t-4}	-0.182 (-1.512)
REDM	-0.002 (-0.774)
HIPC	-0.006 (-1.442)
R^2	0.046
Diagnostics	
Serial	0.114
hetero	0.988

Specific	ΔCPI_t
ΔCPI_{t-3}	0.119 (2.284)
R^2	0.014
Diagnostics	
Serial	0.157
hetero	0.935

General	ΔCPI_t
ΔS_{t-1}	0.569 (0.888)
ΔS_{t-2}	1.314 (1.693)
ΔS_{t-3}	0.949 (1.745)
ΔS_{t-4}	0.463 (0.648)
REDM	0.004 (1.853)
HIPC	-0.005 (-1.735)
R^2	0.226
Diagnostics	
Serial	0.931
hetero	0.0002

Specific	ΔCPI_t
ΔS_{t-2}	1.673 (1.643)
HIPC	-0.008 (-3.996)
R^2	0.135
Diagnostics	
Serial	0.889
hetero	0.054

General	ΔCPI_t
ΔS_{t-1}	0.252 (0.449)
ΔS_{t-2}	1.573 (2.035)
ΔS_{t-3}	1.097 (2.047)
ΔS_{t-4}	0.538 (0.564)
ΔCPI_{t-3}	0.048 (0.334)
ΔCPI_{t-4}	-0.252 (-2.338)
REDM	0.005 (2.034)
HIPC	-0.001 (-0.241)
R^2	0.255
Diagnostics	
Serial	0.959
hetero	0.000

Specific	ΔCPI_t
ΔS_{t-2}	1.703 (2.059)
ΔS_{t-3}	1.348 (2.542)
ΔCPI_{t-4}	-0.256 (-2.115)
REDM	-0.005 (2.435)
R^2	0.275
Diagnostics	
Serial	0.831
hetero	0.132

General	ΔCPI_t
UF_{t-1}	0.294 (1.065)
UF_{t-2}	-0.238 (-0.970)
UF_{t-3}	0.125 (0.858)
UF_{t-4}	0.332 (2.248)
REDM	0.014 (2.640)
HIPC	-0.016 (-4.433)
R^2	0.044
Diagnostics	
Serial	0.399
hetero	0.871

Specific	ΔCPI_t
UF_{t-4}	0.429 (2.231)
REDM	0.007 (2.925)
HIPC	-0.015 (-4.354)
R^2	0.068
Diagnostics	
Serial	0.484
hetero	0.593

General	ΔCPI_t
ΔS_{t-1}	0.257 (0.540)
ΔS_{t-2}	1.584 (2.075)
ΔS_{t-3}	0.926 (1.694)
ΔS_{t-4}	0.619 (0.579)
ΔCPI_{t-3}	-0.002 (-0.017)
ΔCPI_{t-4}	-0.265 (-2.319)
UF_{t-1}	-0.182 (-0.796)
UF_{t-2}	-0.427 (-1.579)
UF_{t-3}	0.071 (0.392)
UF_{t-4}	0.298 (2.316)
REDM	0.013 (1.966)
HIPC	-0.005 (-1.160)
R^2	0.249
Diagnostics	
Serial	0.829
hetero	0.317

Specific	ΔCPI_t
ΔS_{t-2}	1.545 (1.971)
ΔS_{t-3}	1.169 (1.968)
ΔCPI_{t-4}	-0.271 (-2.222)
UF_{t-4}	0.235 (2.096)
REDM	0.009 (3.442)
R^2	0.349
Diagnostics	
Serial	0.714
hetero	0.319

General	$\Delta M2+_t$
$\Delta M2+_{t-3}$	-0.332 (-3.717)
$\Delta M2+_{t-4}$	-0.061(-0.511)
REDM	0.013 (2.809)
HIPC	0.026 (4.697)
R^2	0.081
Diagnostics	
Serial	0.151
hetero	0.606

Specific	$\Delta M2+_t$
$\Delta M2+_{t-3}$	-0.335 (-3.808)
REDM	0.013 (3.143)
HIPC	0.025 (4.244)
R^2	0.079
Diagnostics	
Serial	0.099
hetero	0.408

General	$\Delta M2+_t$
ΔS_{t-1}	2.842 (3.767)
ΔS_{t-2}	-0.766 (-0.835)
ΔS_{t-3}	-0.949 (-0.533)
ΔS_{t-4}	-0.989 (-0.883)
REDM	0.008 (1.741)
HIPC	0.032 (6.814)
R^2	0.080
Diagnostics	
Serial	0.693
hetero	0.192

Specific	$\Delta M2+_t$
ΔS_{t-1}	1.764 (2.868)
REDM	0.009 (2.543)
HIPC	0.036 (9.489)
R^2	0.053
Diagnostics	
Serial	0.209
hetero	0.788

General	$\Delta M2+_t$
ΔS_{t-1}	3.128 (3.811)
ΔS_{t-2}	-0.373 (-0.445)
ΔS_{t-3}	-0.698 (-0.452)
ΔS_{t-4}	-0.568 (-0.487)
$\Delta M2+_{t-3}$	-0.389 (-4.136)
$\Delta M2+_{t-4}$	-0.086 (-0.824)
REDM	0.017 (3.881)
HIPC	0.026 (5.098)
R^2	0.222
Diagnostics	
Serial	0.659
hetero	0.096

Specific	$\Delta M2+_t$
ΔS_{t-1}	2.486 (3.920)
$\Delta M2+_{t-3}$	-0.414 (-4.564)
REDM	0.019 (4.947)
HIPC	0.027 (5.138)
R^2	0.209
Diagnostics	
Serial	0.144
hetero	0.845

General	$\Delta M2+_t$
UF_{t-3}	0.486 (1.189)
UF_{t-4}	-0.177 (-0.482)
REDM	0.022 (1.719)
HIPC	0.033 (5.830)
R^2	0.043
Diagnostics	
Serial	0.266
hetero	0.301

Specific	$\Delta M2+_t$
HIPC	0.033 (7.958)
R^2	0.019
Diagnostics	
Serial	0.143
hetero	0.498

General	$\Delta M2+_t$
ΔS_{t-1}	3.141 (3.762)
ΔS_{t-2}	-0.679 (-0.648)
ΔS_{t-3}	-0.943 (-0.605)
ΔS_{t-4}	-1.184 (-0.945)
$\Delta M2+_{t-3}$	-0.405 (-4.250)
$\Delta M2+_{t-4}$	-0.129 (-1.029)
UF_{t-1}	-0.182 (-0.461)
UF_{t-2}	0.252 (0.563)
UF_{t-3}	0.642 (1.320)
UF_{t-4}	-0.130 (-0.304)
REDM	0.036 (2.437)
HIPC	0.022 (2.564)
R^2	0.218
Diagnostics	
Serial	0.719
hetero	0.331

Specific	$\Delta M2+_t$
ΔS_{t-1}	2.486 (3.920)
$\Delta M2+_{t-3}$	-0.414 (-4.564)
REDM	0.019 (4.947)
HIPC	0.027 (5.138)
R^2	0.209
Diagnostics	
Serial	0.144
hetero	0.845

General	ΔPR_t
ΔPR_{t-3}	0.054 (0.612)
ΔPR_{t-4}	0.087 (0.696)
REDM	0.008 (1.430)
HIPC	0.008 (1.430)
R^2	0.011
Diagnostics	
Serial	0.401
hetero	0.979

General	ΔPR_t
ΔS_{t-1}	0.723 (0.742)
ΔS_{t-2}	0.912 (0.532)
ΔS_{t-3}	-0.102 (0.066)
ΔS_{t-4}	1.145 (1.112)
REDM	0.013 (2.881)
HIPC	0.015 (2.853)
R^2	0.046
Diagnostics	
Serial	0.331
hetero	0.773

Specific	ΔPR_t
ΔS_{t-4}	1.596 (2.108)
REDM	0.101 (2.051)
HIPC	0.013 (2.454)
R^2	0.028
Diagnostics	
Serial	0.312
hetero	0.844

General	ΔPR_t
ΔS_{t-1}	0.788 (0.768)
ΔS_{t-2}	0.879 (0.501)
ΔS_{t-3}	-0.165 (-0.103)
ΔS_{t-4}	1.029 (0.944)
ΔPR_{t-3}	0.024 (0.252)
ΔPR_{t-4}	0.073 (0.599)
REDM	0.012 (2.173)
HIPC	0.014 (2.135)
R^2	0.051
Diagnostics	
Serial	0.305
hetero	0.975

Specific	ΔPR_t
ΔS_{t-1}	1.596 (2.108)
REDM	0.010 (2.051)
HIPC	0.013 (2.454)
R^2	0.028
Diagnostics	
Serial	0.312
hetero	0.844

General	ΔPR_t
UF_{t-1}	0.182 (0.281)
UF_{t-2}	0.616 (1.084)
UF_{t-3}	-0.619 (-0.774)
UF_{t-4}	-0.298 (-0.544)
REDM	-0.011 (-0.485)
HIPC	0.012 (1.635)
R^2	0.029
Diagnostics	
Serial	0.367
hetero	0.973

Specific	ΔPR_t
HIPC	0.009 (1.954)
R^2	0.001
Diagnostics	
Serial	0.429
hetero	0.813

General	ΔPR_t
ΔS_{t-1}	0.660 (0.549)
ΔS_{t-2}	1.353 (0.670)
ΔS_{t-3}	0.349 (0.217)
ΔS_{t-4}	1.858 (1.189)
ΔPR_{t-3}	0.004 (0.032)
ΔPR_{t-4}	0.026 (0.176)
UF_{t-1}	-0.082 (-0.102)
UF_{t-2}	0.323 (-0.561)
UF_{t-3}	-0.639 (-0.718)
UF_{t-4}	-0.354 (-0.659)
REDM	-0.016 (-0.704)
HIPC	0.023 (2.127)
R^2	0.092
Diagnostics	
Serial	0.237
hetero	0.912

Specific	ΔPR_t
ΔS_{t-4}	1.594 (2.127)
HIPC	0.013 (2.465)
R^2	0.027
Diagnostics	
Serial	0.299
hetero	0.766

General	Δoil_t
Δoil_{t-1}	-0.247 (-2.089)
Δoil_{t-2}	-0.207 (-2.052)
Δoil_{t-3}	-0.251 (-1.882)
Δoil_{t-4}	-0.185 (-1.396)
REDM	0.077 (5.135)
HIPC	0.122 (5.739)
R^2	0.043
Diagnostics	
Serial	0.151
hetero	0.687

Specific	Δoil_t
Δoil_{t-1}	-0.219 (-1.819)
Δoil_{t-2}	-0.182 (-2.053)
Δoil_{t-3}	-0.215 (-1.940)
REDM	0.071 (5.113)
HIPC	0.134 (6.446)
R^2	0.032
Diagnostics	
Serial	0.621
hetero	0.599

General	Δoil_t
ΔS_{t-1}	3.025 (1.129)
ΔS_{t-2}	-0.447 (-0.091)
ΔS_{t-3}	-5.024 (-0.918)
ΔS_{t-4}	-0.026 (-0.008)
REDM	0.053 (3.965)
HIPC	0.077 (5.545)
R^2	0.067
Diagnostics	
Serial	0.387
hetero	0.469

Specific	Δoil_t
ΔS_{t-1}	1.802 (1.302)
REDM	0.062 (6.022)
HIPC	0.088 (8.648)
R^2	0.029
Diagnostics	
Serial	0.399
hetero	0.814

General	Δoil_t
ΔS_{t-1}	4.367 (1.528)
ΔS_{t-2}	-0.065 (-0.014)
ΔS_{t-3}	-5.409 (-1.274)
ΔS_{t-4}	-1.579 (-0.424)
Δoil_{t-1}	-0.287 (-2.165)
Δoil_{t-2}	-0.192 (-1.649)
Δoil_{t-3}	-0.276 (-2.002)
Δoil_{t-4}	-0.209 (-1.516)
REDM	0.073 (4.018)
HIPC	0.113 (5.274)
R^2	0.046
Diagnostics	
Serial	0.127
hetero	0.853

Specific	Δoil_t
ΔS_{t-1}	2.635 (1.675)
Δoil_{t-1}	-0.229 (-1.865)
Δoil_{t-2}	-0.187 (-2.091)
Δoil_{t-3}	-0.234 (-2.166)
REDM	0.076 (4.898)
HIPC	0.141 (6.298)
R^2	0.034
Diagnostics	
Serial	0.340
hetero	0.632

General	Δoil_t
UF_{t-1}	-0.368 (-0.234)
UF_{t-2}	0.549 (0.309)
UF_{t-3}	-2.552 (-1.570)
UF_{t-4}	2.012 (1.973)
REDM	-0.001 (-0.012)
HIPC	0.010 (7.113)
R^2	0.065
Diagnostics	
Serial	0.487
hetero	0.835

Specific	Δoil_t
UF_{t-3}	-2.430 (-2.289)
UF_{t-4}	2.069 (2.059)
HIPC	0.083 (7.819)
R^2	0.063
Diagnostics	
Serial	0.457
hetero	0.481

General	Δoil_t
ΔS_{t-1}	4.691 (1.610)
ΔS_{t-2}	-0.587 (-0.123)
ΔS_{t-3}	-4.901 (-1.065)
ΔS_{t-4}	-1.879 (-0.491)
Δoil_{t-1}	-0.264 (-1.785)
Δoil_{t-2}	-0.187 (-1.528)
Δoil_{t-3}	-0.275 (-2.136)
Δoil_{t-4}	-0.171 (1.097)
UF_{t-1}	-0.122 (-0.083)
UF_{t-2}	0.656 (0.367)
UF_{t-3}	-2.106 (-1.385)
UF_{t-4}	1.511 (1.513)
REDM	0.026 (0.556)
HIPC	0.113 (3.902)
R^2	0.228
Diagnostics	
Serial	0.283
hetero	0.637

Specific	Δoil_t
ΔS_{t-1}	3.433 (1.827)
Δoil_{t-1}	-0.221 (-1.669)
Δoil_{t-2}	-0.191 (-1.995)
Δoil_{t-3}	-0.239 (-2.082)
UF_{t-3}	-2.667 (-2.389)
UF_{t-4}	1.672 (1.657)
HIPC	0.143 (5.115)
R^2	0.169
Diagnostics	
Serial	0.375
hetero	0.739

General	$\Delta cocoa_t$
$\Delta cocoa_{t-1}$	-0.189 (-2.198)
$\Delta cocoa_{t-2}$	-0.219 (-1.518)
$\Delta cocoa_{t-3}$	-0.040 (-0.237)
$\Delta cocoa_{t-4}$	0.168 (1.286)
REDM	-0.005 (-0.596)
HIPC	-0.008 (-0.597)
R^2	0.029
Diagnostics	
Serial	0.375
hetero	0.047

Specific	$\Delta cocoa_t$
$\Delta cocoa_{t-1}$	-0.180 (-2.315)
$\Delta cocoa_{t-2}$	-0.272 (-2.028)
HIPC	-0.011 (-1.999)
R^2	0.053
Diagnostics	
Serial	0.068
hetero	0.600

General	$\Delta cocoa_t$
ΔS_{t-1}	0.478 (0.419)
ΔS_{t-2}	-1.161 (-0.952)
ΔS_{t-3}	-0.041 (-0.335)
ΔS_{t-4}	-0.169 (-0.076)
REDM	-0.003 (-0.657)
HIPC	-0.009 (-2.577)
R^2	0.021
Diagnostics	
Serial	0.387
hetero	0.469

Specific	$\Delta cocoa_t$
ΔS_{t-3}	-1.320 (-1.389)
HIPC	-0.008 (-2.175)
R^2	0.023
Diagnostics	
Serial	0.038
hetero	0.349

General	$\Delta cocoa_t$
ΔS_{t-1}	0.668 (0.541)
ΔS_{t-2}	-0.577 (-0.545)
ΔS_{t-3}	-0.604 (-0.399)
ΔS_{t-4}	-1.095 (-0.471)
$\Delta cocoa_{t-1}$	-0.244 (-2.290)
$\Delta cocoa_{t-2}$	-0.224 (-1.659)
$\Delta cocoa_{t-3}$	-0.032 (-0.172)
$\Delta cocoa_{t-4}$	0.155 (1.201)
REDM	-0.006 (-0.777)
HIPC	-0.016 (-0.776)
R^2	0.147
Diagnostics	
Serial	0.744
hetero	0.005

Specific	$\Delta cocoa_t$
$\Delta cocoa_{t-1}$	-0.180 (-2.315)
$\Delta cocoa_{t-2}$	-0.272 (-2.028)
HIPC	-0.011 (-1.999)
R^2	0.098
Diagnostics	
Serial	0.068
hetero	0.600

General	$\Delta cocoa_t$
UF_{t-1}	-0.367 (-0.806)
UF_{t-2}	0.524 (1.036)
UF_{t-3}	-0.616 (-1.425)
UF_{t-4}	0.198 (0.366)
REDM	-0.023 (-1.626)
HIPC	-0.003 (-0.649)
R^2	0.026
Diagnostics	
Serial	0.068
hetero	0.265

Specific	$\Delta cocoa_t$
REDM	-0.001 (-0.212)
R^2	0.000
Diagnostics	
Serial	0.061
hetero	0.554

General	$\Delta cocoa_t$
ΔS_{t-1}	0.553 (0.430)
ΔS_{t-2}	-0.549 (-0.486)
ΔS_{t-3}	0.092 (0.062)
ΔS_{t-4}	-1.090 (-0.387)
$\Delta cocoa_{t-1}$	-0.247 (-2.087)
$\Delta cocoa_{t-2}$	-0.231 (-1.471)
$\Delta cocoa_{t-3}$	-0.096 (-0.433)
$\Delta cocoa_{t-4}$	0.207 (1.353)
UF_{t-1}	-0.709 (-1.637)
UF_{t-2}	0.855 (1.354)
UF_{t-3}	-0.701 (-1.274)
UF_{t-4}	0.271 (0.499)
REDM	-0.036 (-1.831)
HIPC	-0.006 (-0.230)
R^2	0.191
Diagnostics	
Serial	0.986
hetero	0.009

Specific	$\Delta cocoa_t$
$\Delta cocoa_{t-1}$	-0.170 (-2.299)
$\Delta cocoa_{t-2}$	-0.274 (-2.056)
R^2	0.096
Diagnostics	
Serial	0.107
hetero	0.476

General	$\Delta gold_t$
$\Delta gold_{t-1}$	-0.178 (-1.432)
$\Delta gold_{t-2}$	-0.083 (-0.544)
$\Delta gold_{t-3}$	0.207 (1.706)
$\Delta gold_{t-4}$	0.047 (0.319)
REDM	-0.004 (-0.459)
HIPC	0.027 (2.642)
R^2	0.086
Diagnostics	
Serial	0.043
hetero	0.688

Specific	$\Delta gold_t$
$\Delta gold_{t-3}$	0.234 (1.828)
HIPC	0.028 (3.933)
R^2	0.057
Diagnostics	
Serial	0.418
hetero	0.924

General	$\Delta gold_t$
ΔS_{t-1}	2.989 (2.324)
ΔS_{t-2}	-0.736 (-0.523)
ΔS_{t-3}	-2.578 (-1.513)
ΔS_{t-4}	-0.942 (-0.682)
REDM	0.054 (0.856)
HIPC	0.015 (2.230)
R^2	0.010
Diagnostics	
Serial	0.144
hetero	0.998

Specific	$\Delta gold_t$
ΔS_{t-1}	2.508 (2.237)
ΔS_{t-3}	-2.858 (-2.191)
HIPC	0.017 (2.932)
R^2	0.057
Diagnostics	
Serial	0.118
hetero	0.956

General	$\Delta gold_t$
ΔS_{t-1}	3.065 (2.085)
ΔS_{t-2}	0.183 (0.142)
ΔS_{t-3}	-2.573 (-1.547)
ΔS_{t-4}	-2.043 (-1.599)
$\Delta gold_{t-1}$	-0.260 (-2.346)
$\Delta gold_{t-2}$	-0.084 (-0.519)
$\Delta gold_{t-3}$	0.161 (1.162)
$\Delta gold_{t-4}$	0.019 (0.136)
REDM	-0.006 (-0.671)
HIPC	0.020 (1.580)
R^2	0.037
Diagnostics	
Serial	0.115
hetero	0.817

Specific	$\Delta gold_t$
ΔS_{t-1}	2.736 (2.593)
ΔS_{t-3}	-3.028 (-2.338)
$\Delta gold_{t-1}$	-0.211 (-2.238)
HIPC	0.014 (2.229)
R^2	0.088
Diagnostics	
Serial	0.469
hetero	0.977

General	$\Delta gold_t$
UF_{t-1}	0.192 (0.217)
UF_{t-2}	1.012 (1.162)
UF_{t-3}	-0.412 (-0.398)
UF_{t-4}	-0.884 (-1.233)
REDM	-0.014 (-0.499)
HIPC	0.023 (3.865)
R^2	0.057
Diagnostics	
Serial	0.128
hetero	0.045

Specific	$\Delta gold_t$
HIPC	0.021 (4.503)
R^2	0.004
Diagnostics	
Serial	0.255
hetero	0.529

General	$\Delta gold_t$
ΔS_{t-1}	3.021 (1.939)
ΔS_{t-2}	-0.212 (-0.178)
ΔS_{t-3}	-3.056 (-1.941)
ΔS_{t-4}	-3.008 (-1.867)
$\Delta gold_{t-1}$	-0.275 (-2.349)
$\Delta gold_{t-2}$	-0.035 (-0.247)
$\Delta gold_{t-3}$	0.185 (1.345)
$\Delta gold_{t-4}$	0.019 (0.147)
UF_{t-1}	0.386 (0.467)
UF_{t-2}	1.156 (1.526)
UF_{t-3}	-0.014 (-0.012)
UF_{t-4}	-0.988 (-1.513)
REDM	-0.009 (-0.319)
HIPC	0.016 (1.151)
R^2	0.047
Diagnostics	
Serial	0.182
hetero	0.722

Specific	$\Delta gold_t$
ΔS_{t-1}	3.329 (2.884)
ΔS_{t-3}	-3.151 (-2.208)
ΔS_{t-4}	-2.718 (-1.922)
$\Delta gold_{t-1}$	-0.293 (-2.876)
UF_{t-2}	1.321 (2.398)
UF_{t-4}	-0.909 (-1.866)
R^2	0.141
Diagnostics	
Serial	0.758
hetero	0.536

C2. Appendix: Forecasting Fundamentals using Local unexpected Flows

General	ΔGDP_t
ΔGDP_{t-3}	2.992 (7.573)
ΔGDP_{t-4}	-2.080 (-5.162)
REDM	0.0004 (1.760)
HIPC	-0.001 (-1.724)
R^2	0.946
Diagnostics	
Serial	0.016
hetero	0.000

General	ΔGDP_t
ΔS_{t-1}	-0.068 (-0.878)
ΔS_{t-2}	0.168 (1.674)
ΔS_{t-3}	0.182 (2.099)
ΔS_{t-4}	0.258 (2.427)
REDM	-0.002 (-2.439)
HIPC	0.005 (5.138)
R^2	0.138
Diagnostics	
Serial	0.000
hetero	0.459

Specific	ΔGDP_t
ΔS_{t-3}	0.222 (2.305)
ΔS_{t-4}	0.235 (2.326)
REDM	-0.002 (-2.805)
HIPC	0.004 (4.901)
R^2	0.137
Diagnostics	
Serial	0.000
hetero	0.833

General	ΔGDP_t
ΔS_{t-1}	0.060 (2.251)
ΔS_{t-2}	0.082 (2.166)
ΔS_{t-3}	0.038 (1.346)
ΔS_{t-4}	0.011 (0.475)
ΔGDP_{t-3}	2.420 (4.360)
ΔGDP_{t-4}	-1.515 (-2.789)
REDM	0.001 (3.147)
HIPC	-0.0001 (-0.949)
R^2	0.965
Diagnostics	
Serial	0.008
hetero	0.000

Specific	ΔGDP_t
ΔS_{t-1}	0.068 (2.877)
ΔS_{t-2}	0.086 (2.055)
ΔGDP_{t-3}	2.593 (5.677)
ΔGDP_{t-4}	-1.684 (-3.741)
REDM	0.001 (3.150)
R^2	0.965
Diagnostics	
Serial	0.087
hetero	0.000

General	ΔGDP_t
UF_{t-1}	0.066 (2.694)
UF_{t-2}	0.100 (4.711)
UF_{t-3}	0.132 (6.667)
UF_{t-4}	0.113 (4.869)
REDM	0.001 (2.993)
HIPC	0.003 (6.168)
R^2	0.748
Diagnostics	
Serial	0.000
hetero	0.120

General	ΔGDP_t
ΔS_{t-1}	0.058 (3.186)
ΔS_{t-2}	0.061 (1.607)
ΔS_{t-3}	0.017 (0.735)
ΔS_{t-4}	-0.026 (-1.403)
ΔGDP_{t-3}	2.043 (4.159)
ΔGDP_{t-4}	-1.272 (-2.653)
UF_{t-1}	0.022 (1.961)
UF_{t-2}	0.019 (2.457)
UF_{t-3}	0.027 (2.178)
UF_{t-4}	0.029 (2.598)
REDM	0.001 (4.357)
HIPC	-0.0004 (-0.138)
R^2	0.974
Diagnostics	
Serial	0.064
hetero	0.112

Specific	ΔGDP_t
ΔS_{t-1}	0.053 (3.264)
ΔS_{t-2}	0.055 (2.061)
ΔGDP_{t-3}	2.043 (4.290)
ΔGDP_{t-4}	-1.268 (-2.749)
UF_{t-1}	0.021 (2.143)
UF_{t-2}	0.017 (2.508)
UF_{t-3}	0.025 (2.154)
UF_{t-4}	0.029 (2.735)
REDM	0.001 (4.512)
R^2	0.975
Diagnostics	
Serial	0.093
hetero	0.0001

General	ΔCPI_t
ΔCPI_{t-3}	0.144 (1.799)
ΔCPI_{t-4}	-0.182 (-1.512)
REDM	-0.002 (-0.774)
HIPC	-0.006 (-1.442)
R^2	0.046
Diagnostics	
Serial	0.114
hetero	0.988

Specific	ΔCPI_t
ΔCPI_{t-3}	0.119 (2.284)
R^2	0.014
Diagnostics	
Serial	0.157
hetero	0.935

General	ΔCPI_t
ΔS_{t-1}	0.569 (0.888)
ΔS_{t-2}	1.314 (1.693)
ΔS_{t-3}	0.949 (1.745)
ΔS_{t-4}	0.463 (0.648)
REDM	0.004 (1.853)
HIPC	-0.005 (-1.735)
R^2	0.226
Diagnostics	
Serial	0.931
hetero	0.0002

Specific	ΔCPI_t
ΔS_{t-2}	1.673 (1.643)
HIPC	-0.008 (-3.996)
R^2	0.135
Diagnostics	
Serial	0.889
hetero	0.054

General	ΔCPI_t
ΔS_{t-1}	0.252 (0.449)
ΔS_{t-2}	1.573 (2.035)
ΔS_{t-3}	1.097 (2.047)
ΔS_{t-4}	0.538 (0.564)
ΔCPI_{t-3}	0.048 (0.334)
ΔCPI_{t-4}	-0.252 (-2.338)
REDM	0.005 (2.034)
HIPC	-0.001 (-0.241)
R^2	0.255
Diagnostics	
Serial	0.959
hetero	0.000

Specific	ΔCPI_t
ΔS_{t-2}	1.703 (2.059)
ΔS_{t-3}	1.348 (2.542)
ΔCPI_{t-4}	-0.256 (-2.115)
REDM	-0.005 (2.435)
R^2	0.275
Diagnostics	
Serial	0.831
hetero	0.132

General	ΔCPI_t
UF_{t-1}	-0.093 (-0.488)
UF_{t-2}	0.201 (0.887)
UF_{t-3}	0.263 (1.106)
UF_{t-4}	0.241 (1.261)
REDM	0.003 (0.809)
HIPC	-0.014 (-5.547)
R^2	0.087
Diagnostics	
Serial	0.234
hetero	0.973

Specific	ΔCPI_t
UF_{t-4}	0.465 (1.941)
REDM	0.007 (2.089)
HIPC	-0.017 (-3.778)
R^2	0.064
Diagnostics	
Serial	0.249
hetero	0.855

General	ΔCPI_t
ΔS_{t-1}	0.370 (0.646)
ΔS_{t-2}	1.515 (1.863)
ΔS_{t-3}	1.127 (1.831)
ΔS_{t-4}	0.478 (0.466)
ΔCPI_{t-3}	0.053 (0.367)
ΔCPI_{t-4}	-0.262 (-2.302)
UF_{t-1}	-0.416 (-1.193)
UF_{t-2}	0.033 (0.184)
UF_{t-3}	0.153 (0.859)
UF_{t-4}	0.291 (1.304)
REDM	0.004 (0.918)
HIPC	-0.003 (-0.621)
R^2	0.230
Diagnostics	
Serial	0.976
hetero	0.254

Specific	ΔCPI_t
ΔS_{t-2}	1.690 (2.065)
ΔS_{t-3}	1.339 (2.552)
ΔCPI_{t-4}	-0.255 (-2.129)
R^2	0.286
Diagnostics	
Serial	0.816
hetero	0.089

General	$\Delta M2+_t$
$\Delta M2+_{t-3}$	-0.332 (-3.717)
$\Delta M2+_{t-4}$	-0.061(-0.511)
REDM	0.013 (2.809)
HIPC	0.026 (4.697)
R^2	0.081
Diagnostics	
Serial	0.151
hetero	0.606

Specific	$\Delta M2+_t$
$\Delta M2+_{t-3}$	-0.335 (-3.808)
REDM	0.013 (3.143)
HIPC	0.025 (4.244)
R^2	0.079
Diagnostics	
Serial	0.099
hetero	0.408

General	$\Delta M2+_t$
ΔS_{t-1}	2.842 (3.767)
ΔS_{t-2}	-0.766 (-0.835)
ΔS_{t-3}	-0.949 (-0.533)
ΔS_{t-4}	-0.989 (-0.883)
REDM	0.008 (1.741)
HIPC	0.032 (6.814)
R^2	0.080
Diagnostics	
Serial	0.693
hetero	0.192

Specific	$\Delta M2+_t$
ΔS_{t-1}	1.764 (2.868)
REDM	0.009 (2.543)
HIPC	0.036 (9.489)
R^2	0.053
Diagnostics	
Serial	0.209
hetero	0.788

General	$\Delta M2+_t$
ΔS_{t-1}	3.128 (3.811)
ΔS_{t-2}	-0.373 (-0.445)
ΔS_{t-3}	-0.698 (-0.452)
ΔS_{t-4}	-0.568 (-0.487)
$\Delta M2+_{t-3}$	-0.389 (-4.136)
$\Delta M2+_{t-4}$	-0.086 (-0.824)
REDM	0.017 (3.881)
HIPC	0.026 (5.098)
R^2	0.222
Diagnostics	
Serial	0.659
hetero	0.096

Specific	$\Delta M2+_t$
ΔS_{t-1}	2.486 (3.920)
$\Delta M2+_{t-3}$	-0.414 (-4.564)
REDM	0.019 (4.947)
HIPC	0.027 (5.138)
R^2	0.209
Diagnostics	
Serial	0.144
hetero	0.845

General	$\Delta M2+_t$
UF_{t-1}	1.057 (1.607)
UF_{t-2}	0.025 (0.062)
UF_{t-3}	0.703 (1.564)
UF_{t-4}	-1.718 (-2.883)
REDM	-0.006 (-0.650)
HIPC	0.054 (6.618)
R^2	0.098
Diagnostics	
Serial	0.055
hetero	0.842

Specific	$\Delta M2+_t$
UF_{t-1}	1.366 (2.257)
UF_{t-4}	-1.493 (-3.048)
HIPC	0.049 (6.664)
R^2	0.117
Diagnostics	
Serial	0.056
hetero	0.169

General	$\Delta M2+_t$
ΔS_{t-1}	3.141 (3.762)
ΔS_{t-2}	-0.679 (-0.648)
ΔS_{t-3}	-0.943 (-0.605)
ΔS_{t-4}	-1.184 (-0.945)
$\Delta M2+_{t-3}$	-0.405 (-4.250)
$\Delta M2+_{t-4}$	-0.129 (-1.029)
UF_{t-1}	-0.182 (-0.461)
UF_{t-2}	0.252 (0.563)
UF_{t-3}	0.642 (1.320)
UF_{t-4}	-0.130 (-0.304)
REDM	0.036 (2.437)
HIPC	0.022 (2.564)
R^2	0.218
Diagnostics	
Serial	0.719
hetero	0.331

Specific	$\Delta M2+_t$
ΔS_{t-1}	2.591 (3.785)
$\Delta M2+_{t-3}$	-0.331 (3.218)
$\Delta M2+_{t-4}$	-0.161 (-1.679)
UF_{t-3}	0.884 (1.976)
UF_{t-4}	-1.023(-2.314)
HIPC	0.045 (5.337)
R^2	0.302
Diagnostics	
Serial	0.325
hetero	0.682

General	ΔPR_t
ΔPR_{t-3}	0.054 (0.612)
ΔPR_{t-4}	0.087 (0.696)
REDM	0.008 (1.430)
HIPC	0.008 (1.430)
R^2	0.011
Diagnostics	
Serial	0.401
hetero	0.979

General	ΔPR_t
ΔS_{t-1}	0.723 (0.742)
ΔS_{t-2}	0.912 (0.532)
ΔS_{t-3}	-0.102 (0.066)
ΔS_{t-4}	1.145 (1.112)
REDM	0.013 (2.881)
HIPC	0.015 (2.853)
R^2	-0.058
Diagnostics	
Serial	0.331
hetero	0.773

Specific	ΔPR_t
ΔS_{t-4}	1.596 (2.108)
REDM	0.101 (2.051)
HIPC	0.013 (2.454)
R^2	0.028
Diagnostics	
Serial	0.312
hetero	0.844

General	ΔPR_t
ΔS_{t-1}	0.788 (0.768)
ΔS_{t-2}	0.879 (0.501)
ΔS_{t-3}	-0.165 (-0.103)
ΔS_{t-4}	1.029 (0.944)
ΔPR_{t-3}	0.024 (0.252)
ΔPR_{t-4}	0.073 (0.599)
REDM	0.012 (2.173)
HIPC	0.014 (2.135)
R^2	-0.092
Diagnostics	
Serial	0.305
hetero	0.975

Specific	ΔPR_t
ΔS_{t-1}	1.596 (2.108)
REDM	0.010 (2.051)
HIPC	0.013 (2.454)
R^2	0.028
Diagnostics	
Serial	0.312
hetero	0.844

General	ΔPR_t
UF_{t-1}	-0.369 (-0.532)
UF_{t-2}	-1.039 (-1.243)
UF_{t-3}	-0.052 (-0.085)
UF_{t-4}	1.106 (0.884)
REDM	0.019 (1.234)
HIPC	-0.001 (-0.056)
R^2	0.053
Diagnostics	
Serial	0.315
hetero	0.039

Specific	ΔPR_t
REDM	0.009 (1.946)
R^2	0.010
Diagnostics	
Serial	0.382
hetero	0.697

General	ΔPR_t
ΔS_{t-1}	1.025 (0.784)
ΔS_{t-2}	1.631 (0.902)
ΔS_{t-3}	0.241 (0.144)
ΔS_{t-4}	2.240 (1.348)
ΔPR_{t-3}	0.025 (0.221)
ΔPR_{t-4}	0.119 (0.927)
UF_{t-1}	-1.084 (-1.628)
UF_{t-2}	-1.387 (-1.672)
UF_{t-3}	-0.271 (-0.399)
UF_{t-4}	1.264 (0.926)
REDM	0.0132 (0.742)
HIPC	0.006 (0.392)
R^2	0.169
Diagnostics	
Serial	0.092
hetero	0.821

Specific	ΔPR_t
ΔS_{t-4}	2.613 (2.949)
UF_{t-2}	-1.074 (-2.767)
R^2	0.078
Diagnostics	
Serial	0.168
hetero	0.501

General	Δoil_t
Δoil_{t-1}	-0.247 (-2.089)
Δoil_{t-2}	-0.207 (-2.052)
Δoil_{t-3}	-0.251 (-1.882)
Δoil_{t-4}	-0.185 (-1.396)
REDM	0.077 (5.135)
HIPC	0.122 (5.739)
R^2	0.043
Diagnostics	
Serial	0.151
hetero	0.687

Specific	Δoil_t
Δoil_{t-1}	-0.219 (-1.819)
Δoil_{t-2}	-0.182 (-2.053)
Δoil_{t-3}	-0.215 (-1.940)
REDM	0.071 (5.113)
HIPC	0.134 (6.446)
R^2	0.032
Diagnostics	
Serial	0.621
hetero	0.599

General	Δoil_t
ΔS_{t-1}	3.025 (1.129)
ΔS_{t-2}	-0.447 (-0.091)
ΔS_{t-3}	-5.024 (-0.918)
ΔS_{t-4}	-0.026 (-0.008)
REDM	0.053 (3.965)
HIPC	0.077 (5.545)
R^2	0.067
Diagnostics	
Serial	0.387
hetero	0.469

Specific	Δoil_t
ΔS_{t-1}	1.802 (1.302)
REDM	0.062 (6.022)
HIPC	0.088 (8.648)
R^2	0.029
Diagnostics	
Serial	0.399
hetero	0.814

General	Δoil_t
ΔS_{t-1}	4.367 (1.528)
ΔS_{t-2}	-0.065 (-0.014)
ΔS_{t-3}	-5.409 (-1.274)
ΔS_{t-4}	-1.579 (-0.424)
Δoil_{t-1}	-0.287 (-2.165)
Δoil_{t-2}	-0.192 (-1.649)
Δoil_{t-3}	-0.276 (-2.002)
Δoil_{t-4}	-0.209 (-1.516)
REDM	0.073 (4.018)
HIPC	0.113 (5.274)
R^2	0.046
Diagnostics	
Serial	0.127
hetero	0.853

Specific	Δoil_t
ΔS_{t-1}	2.635 (1.675)
Δoil_{t-1}	-0.229 (-1.865)
Δoil_{t-2}	-0.187 (-2.091)
Δoil_{t-3}	-0.234 (-2.166)
REDM	0.076 (4.898)
HIPC	0.141 (6.298)
R^2	0.034
Diagnostics	
Serial	0.340
hetero	0.632

General	Δoil_t
UF_{t-1}	-0.842 (-0.390)
UF_{t-2}	0.366 (0.239)
UF_{t-3}	-0.157 (-0.106)
UF_{t-4}	1.396 (0.928)
REDM	0.073 (1.903)
HIPC	0.071 (3.626)
R^2	0.034
Diagnostics	
Serial	0.320
hetero	0.449

Specific	Δoil_t
REDM	0.058 (6.533)
HIPC	0.084 (9.526)
R^2	0.019
Diagnostics	
Serial	0.381
hetero	0.613

General	Δoil_t
ΔS_{t-1}	5.564 (1.791)
ΔS_{t-2}	-0.928 (-0.207)
ΔS_{t-3}	-6.508 (-1.250)
ΔS_{t-4}	-3.404 (-0.907)
Δoil_{t-1}	-0.321 (-2.604)
Δoil_{t-2}	-0.220 (-1.727)
Δoil_{t-3}	-0.288 (-2.213)
Δoil_{t-4}	-0.218 (-1.804)
UF_{t-1}	-1.270 (-0.564)
UF_{t-2}	-0.214 (-0.136)
UF_{t-3}	0.442 (0.335)
UF_{t-4}	3.193 (2.372)
REDM	0.111 (2.929)
HIPC	0.082 (3.124)
R^2	0.032
Diagnostics	
Serial	0.533
hetero	0.788

Specific	Δoil_t
ΔS_{t-1}	2.635 (1.675)
Δoil_{t-1}	-0.229 (-1.865)
Δoil_{t-2}	-0.186 (-2.091)
Δoil_{t-3}	-0.234 (-2.166)
REDM	0.076 (4.898)
HIPC	0.141 (6.298)
R^2	0.034
Diagnostics	
Serial	0.340
hetero	0.632

General	$\Delta cocoa_t$
$\Delta cocoa_{t-1}$	-0.189 (-2.198)
$\Delta cocoa_{t-2}$	-0.219 (-1.518)
$\Delta cocoa_{t-3}$	-0.040 (-0.237)
$\Delta cocoa_{t-4}$	0.168 (1.286)
REDM	-0.005 (-0.596)
HIPC	-0.008 (-0.597)
R^2	0.029
Diagnostics	
Serial	0.375
hetero	0.047

Specific	$\Delta cocoa_t$
$\Delta cocoa_{t-1}$	-0.180 (-2.315)
$\Delta cocoa_{t-2}$	-0.272 (-2.028)
HIPC	-0.011 (-1.999)
R^2	0.053
Diagnostics	
Serial	0.068
hetero	0.600

General	$\Delta cocoa_t$
ΔS_{t-1}	0.478 (0.419)
ΔS_{t-2}	-1.161 (-0.952)
ΔS_{t-3}	-0.041 (-0.335)
ΔS_{t-4}	-0.169 (-0.076)
REDM	-0.003 (-0.657)
HIPC	-0.009 (-2.577)
R^2	0.021
Diagnostics	
Serial	0.387
hetero	0.469

Specific	$\Delta cocoa_t$
ΔS_{t-3}	-1.320 (-1.389)
HIPC	-0.008 (-2.175)
R^2	0.001
Diagnostics	
Serial	0.038
hetero	0.349

General	$\Delta cocoa_t$
ΔS_{t-1}	0.668 (0.541)
ΔS_{t-2}	-0.577 (-0.545)
ΔS_{t-3}	-0.604 (-0.399)
ΔS_{t-4}	-1.095 (-0.471)
$\Delta cocoa_{t-1}$	-0.244 (-2.290)
$\Delta cocoa_{t-2}$	-0.224 (-1.659)
$\Delta cocoa_{t-3}$	-0.032 (-0.172)
$\Delta cocoa_{t-4}$	0.155 (1.201)
REDM	-0.006 (-0.777)
HIPC	-0.016 (-0.776)
R^2	0.147
Diagnostics	
Serial	0.744
hetero	0.005

Specific	$\Delta cocoa_t$
$\Delta cocoa_{t-1}$	-0.180 (-2.315)
$\Delta cocoa_{t-2}$	-0.272 (-2.028)
HIPC	-0.011 (-1.999)
R^2	0.098
Diagnostics	
Serial	0.068
hetero	0.600

General	$\Delta cocoa_t$
UF_{t-1}	0.954 (1.770)
UF_{t-2}	0.189 (0.289)
UF_{t-3}	-1.591 (-2.874)
UF_{t-4}	-0.009 (-0.018)
REDM	0.010 (1.159)
HIPC	-0.013 (-2.208)
R^2	0.009
Diagnostics	
Serial	0.349
hetero	0.014

Specific	$\Delta cocoa_t$
UF_{t-1}	0.966 (1.999)
UF_{t-3}	-1.588 (-2.969)
REDM	0.011 (1.809)
HIPC	-0.012 (-3.1690
R^2	0.044
Diagnostics	
Serial	0.251
hetero	0.067

General	$\Delta cocoa_t$
ΔS_{t-1}	0.377 (0.299)
ΔS_{t-2}	-0.094 (-0.093)
ΔS_{t-3}	-0.469 (-0.361)
ΔS_{t-4}	-0.443 (-0.181)
$\Delta cocoa_{t-1}$	-0.215 (-1.664)
$\Delta cocoa_{t-2}$	-0.222 (-1.738)
$\Delta cocoa_{t-3}$	-0.102 (-0.556)
$\Delta cocoa_{t-4}$	0.119 (0.862)
UF_{t-1}	0.434 (0.788)
UF_{t-2}	0.001 (0.002)
UF_{t-3}	-1.279 (-2.361)
UF_{t-4}	0.226 (0.379)
REDM	0.003 (0.243)
HIPC	-0.015 (-0.741)
R^2	0.204
Diagnostics	
Serial	0.418
hetero	0.017

Specific	$\Delta cocoa_t$
$\Delta cocoa_{t-1}$	-0.222 (-2.884)
$\Delta cocoa_{t-2}$	-0.292 (-2.444)
UF_{t-3}	-1.009 (-2.080)
R^2	0.187
Diagnostics	
Serial	0.436
hetero	0.149

General	$\Delta gold_t$
$\Delta gold_{t-1}$	-0.178 (-1.432)
$\Delta gold_{t-2}$	-0.083 (-0.544)
$\Delta gold_{t-3}$	0.207 (1.706)
$\Delta gold_{t-4}$	0.047 (0.319)
REDM	-0.004 (-0.459)
HIPC	0.027 (2.642)
R^2	0.086
Diagnostics	
Serial	0.043
hetero	0.688

Specific	$\Delta gold_t$
$\Delta gold_{t-3}$	0.234 (1.828)
HIPC	0.028 (3.933)
R^2	0.057
Diagnostics	
Serial	0.418
hetero	0.924

General	$\Delta gold_t$
ΔS_{t-1}	2.989 (2.324)
ΔS_{t-2}	-0.736 (-0.523)
ΔS_{t-3}	-2.578 (-1.513)
ΔS_{t-4}	-0.942 (-0.682)
REDM	0.054 (0.856)
HIPC	0.015 (2.230)
R^2	0.010
Diagnostics	
Serial	0.144
hetero	0.998

Specific	$\Delta gold_t$
ΔS_{t-1}	2.508 (2.237)
ΔS_{t-3}	-2.858 (-2.191)
HIPC	0.017 (2.932)
R^2	0.057
Diagnostics	
Serial	0.118
hetero	0.956

General	$\Delta gold_t$
ΔS_{t-1}	3.065 (2.085)
ΔS_{t-2}	0.183 (0.142)
ΔS_{t-3}	-2.573 (-1.547)
ΔS_{t-4}	-2.043 (-1.599)
$\Delta gold_{t-1}$	-0.260 (-2.346)
$\Delta gold_{t-2}$	-0.084 (-0.519)
$\Delta gold_{t-3}$	0.161 (1.162)
$\Delta gold_{t-4}$	0.019 (0.136)
REDM	-0.006 (-0.671)
HIPC	0.020 (1.580)
R^2	0.037
Diagnostics	
Serial	0.115
hetero	0.817

Specific	$\Delta gold_t$
ΔS_{t-1}	2.736 (2.593)
ΔS_{t-3}	-3.028 (-2.338)
$\Delta gold_{t-1}$	-0.211 (-2.238)
HIPC	0.014 (2.229)
R^2	0.088
Diagnostics	
Serial	0.469
hetero	0.977

General	$\Delta gold_t$
UF_{t-1}	-0.656 (-0.831)
UF_{t-2}	1.295 (1.439)
UF_{t-3}	-0.719 (-1.204)
UF_{t-4}	-0.388 (-0.397)
REDM	-0.006 (-0.293)
HIPC	0.019 (1.696)
R^2	0.064
Diagnostics	
Serial	0.192
hetero	0.545

Specific	$\Delta gold_t$
HIPC	0.021 (4.503)
R^2	0.004
Diagnostics	
Serial	0.255
hetero	0.529

General	$\Delta gold_t$
ΔS_{t-1}	2.747 (1.736)
ΔS_{t-2}	0.284 (0.176)
ΔS_{t-3}	-2.076 (-1.194)
ΔS_{t-4}	-2.352 (-1.420)
$\Delta gold_{t-1}$	-0.178 (-0.991)
$\Delta gold_{t-2}$	-0.169 (-0.905)
$\Delta gold_{t-3}$	0.283 (1.587)
$\Delta gold_{t-4}$	-0.028 (-0.163)
UF_{t-1}	-1.098 (-1.079)
UF_{t-2}	1.925 (2.366)
UF_{t-3}	-0.854 (-0.731)
UF_{t-4}	0.113 (0.131)
REDM	-0.021 (-0.975)
HIPC	0.226 (1.714)
R^2	0.067
Diagnostics	
Serial	0.108
hetero	0.954

Specific	$\Delta gold_t$
ΔS_{t-3}	-2.451 (-1.696)
$\Delta gold_{t-3}$	0.349 (2.257)
UF_{t-2}	1.880 (2.586)
UF_{t-3}	-1.411 (-2.756)
HIPC	0.018 (2.361)
R^2	0.117
Diagnostics	
Serial	0.662
hetero	0.967

Bibliography

1. Andersen, Torben G., Tim Bollerslev, Francis X. Diebold, and Clara Vega, 2003, Micro Effects of Macro Announcements: Real-Time Price Discovery in the Foreign Exchange, The American Economic Review.

2. Aron Gereben, Gyorgy Gyomai and Norbert Kiss M., 2006, Customer Order Flow, Information and Liquidity on the Hungarian Foreign Exchange Market, MNB Working Papers.

3. Aryeetey E., Harigan J., and Nissanke M., 2000, Economic Reforms in Ghana: The Miracle and the Mirage, UK, James Currey Limited.

4. Bacchetta, P., and E. Van Wincoop, 2006, Can Information Heterogeneity Explain The Exchange Rate Determination Puzzle? The American Economic Review 96 (3):552-576.

5. Bhagwati, J., 1978, Foreign Trade Regimes and Economic Development: Anatomy and Consequences of Exchange Controls, in Aryeetey Ernest, Jane Harigan and Machiko Nissanke. Economic Reforms in Ghana: The Miracle and the Mirage, UK, James Currey.

6. Bhargava, A. and Sargan, J. D., 1983, Estimating Dynamic Random Effects Models from Panel Data Covering Short Time Periods, Econometrica, Econometric Society, vol. 51(6), 1635-59.

7. BIS, 2001, Triennal Central Bank Survey: Foreign Exchange and Derivatives Market Activity in 2001. Bank of International Settlement, Basel.

8. BIS, 2004, Triennal Central Bank Survey: Foreign Exchange and Derivatives Market Activity in 2004. Bank of International Settlement, Basel.

9. Bjonnes, G., and D. Rime, 2001, Customer Trading and Information in Foreign Exchange Markets, Norwegian School of Management.

10. Bjonnes, G., D. Rime, and H. Solheim, 2005, Liquidity Provision in the Overnight Foreign Exchange Market, Journal of International Money and Finance 24, 175-96

11. Breedon, Francis, and Paolo Vitale, 2004, An Empirical Study of Liquidity and Information Effects of Order Flow on Exchange Rates, Journal of International Money and Finance, 2009 Forthcoming.

12. Campbell, John Y. and Shiller, Robert J., 1988, Stock Prices, Earnings and Expected Dividends, Journal of Finance, American Finance Association, vol. 43(3), 661-76, July.

13. Campbell, John Y. and Shiller, Robert J., 1988, The Dividend-Price Ratio and Expectations of Future Dividends and Discount Factors, Review of Financial

Studies, Oxford University Press for Society for Financial Studies, vol. 1(3), 195-228.

14. Carpenter, A., and J. Wang, 2007, Herding and information content of trades in the Australian dollar market, Pacific-Basin Finance Journal, 15(2):173-194.

15. Centre for Policy Analysis (CEPA), 1997, Macroeconomic Review and Outlook, Accra: CEPA

16. Chen, Y.-C., Rogoff, K.S., 2003, Commodity Currencies. Journal of International Economics 60, 133-169.

17. Chen, Y.-C., Rogoff, K.S., and Rossi, B. 2008. Can Exchange Rates Forecast Commodity Prices? NBER Working Paper No. 13901.

18. Cheung Y.W., M.D. Chinn, and A.G. Pascual, 2005, Empirical Exchange Rate Models of the Nineties: Are any fit to survive? Journal of International Money and Finance 24.

19. Danielsson, J., and R.Love, 2004, Feedback Trading, International Journal of Finance & Economics, 11(1):35-53.

20. Dickey, D. A., and W. A. Fuller, 1981, Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root, Econometrica 49, 1057-1072.

21. Dordunoo, C.K., 1993, 1997, A Development-Oriented Macroeconometric Model of Ghana, Michigan, Temple University, Bell and Howell Company.

22. Dornbusch, Rudiger, 1976, Expectations and Exchange Rate Dynamics, Journal of Political Economy 84, 1161-76.

23. Enders, Walter, 2004. Applied Econometric Time Series (Wiley).

24. Engle, R. and Granger, C., 1987, Cointegration and Error Correction: Representation, Estimation and Testing, Econometrica, 55, 251-76.

25. Engle, R. F. and B.S. YOO, 1991, Cointegrated Economic Time Series: An Overview with New Results, in R. F. Engle and C.W. J. Granger (eds), Long-run Economic Relationships: Readings in Cointegration, Oxford University Press, New York.

26. Evans, Martin D. D., and Richard K. Lyons, 2002a, Order Flow and Exchange Rate Dynamics, Journal of Political Economy 110.

27. Evans, Martin. D., and Richard K. Lyons, 2002b, Informational Integration and FX Trading, Journal of International Money and Finance 21, 807-831.

28. Evans, Martin D. D., and Richard K. Lyons, 2005a, Meese-Rogoff Redux: Micro-Based Exchange Rate Forecasting, American Economic Review, 95:405-414.

29. Evans, Martin D. D., and Richard K. Lyons, 2006, Understanding Order Flow, International Journal of Finance and Economics 11, 3-23.

30. Evans, Martin D. D., and Richard K. Lyons, 2007, Exchange Rate Fundamentals and Order Flow, NBER Working Paper No. 13151

31. Evans, Martin D. D., and Richard K. Lyons, 2008, How is Macro News Transmitted to Exchange Rates? Journal of Financial Economics 88, 26-50.

32. Fan, Mintao, and Richard K. Lyons, 2002, Customer Trades and Extreme Events, in Paul Mizen, ed.: Essays in Honor of Charles Goodhart (Edward Elgar, Northampton, MA).

33. Froot, Kenneth, A., and Tarun Ramadorai, 2005, Currency Returns, Intrinsic Value, and Institutional-Investor Flows, Journal of Finance 60, 1535-1566.

34. Gereben, A´ ron, Gyo¨rgy Gyomai, and Norbert Kiss, 2006, Customer order flow, information and liquidity on the Hungarian foreign exchange market, Working Paper 8. Magyar Nemzeti Bank.

35. Geweke, J., R. Meese and D. T. dent, 1983, Comparing Alternative Tests of Causality in Temporal Systems: Analytic Results and Experimental Evidence, Journal of Economics, 21, 161-94.

36. Granger, C. W. J., 1969, Investigating Causal Relations by Econometric Models and Cross-Spectral Methods, Econometrica, 37, 424-59.

37. Guilkey, D.K. and M.K. Salemi, 1982, Some Sample Properties of Three tests for Granger Causal Ordering in a Bivariate Stochastic system, The Review of Economics and Statistics, 64, 668-80.

38. Hamilton, James, 1994. Time Series Analysis (Princeton University Press).

39. Hasbrouck, Joel, 1991, Measuring the Information Content of Stock Trades, Journal of Finance XLVI, 179-207.

40. Islam, R.. and Wetzel, D., 1994, Ghana: Adjustment, Reform and Growth, Chapter 7 in W. easterly C. A Rodriguez, and K. Schmidt_Hebbel (eds), Public Sector Deficits and Macroeconomic Performance. Washington D.C., World Bank.

41. ISSER, 1997, The State of the Ghanaian Economy 1996, Institute of Statistical Social and Economic Research, University of Ghana, Legon.

42. ISSER, 1998, The State of the Ghanaian Economy 1997, Institute of Statistical Social and Economic Research, University of Ghana, Legon.

43. ISSER, 1999, The State of the Ghanaian Economy 1998, Institute of Statistical Social and Economic Research, University of Ghana, Legon.

44. ISSER, 2000, The State of the Ghanaian Economy 1999, Institute of Statistical Social and Economic Research, University of Ghana, Legon.

45. ISSER, 2001, The State of the Ghanaian Economy 2000, Institute of Statistical Social and Economic Research, University of Ghana, Legon.

46. ISSER, 2002, The State of the Ghanaian Economy 2001, Institute of Statistical Social and Economic Research, University of Ghana, Legon.

47. ISSER, 2003, The State of the Ghanaian Economy 2002, Institute of Statistical Social and Economic Research, University of Ghana, Legon.

48. ISSER, 2004, The State of the Ghanaian Economy 2003, Institute of Statistical Social and Economic Research, University of Ghana, Legon.

49. ISSER, 2005, The State of the Ghanaian Economy 2004, Institute of Statistical Social and Economic Research, University of Ghana, Legon.

50. ISSER, 2006, The State of the Ghanaian Economy 2005, Institute of Statistical Social and Economic Research, University of Ghana, Legon.

51. ISSER, 2007, The State of the Ghanaian Economy 2006, Institute of Statistical Social and Economic Research, University of Ghana, Legon.

52. ISSER, 2008, The State of the Ghanaian Economy 2007, Institute of Statistical Social and Economic Research, University of Ghana, Legon.

53. Johansen, S. and Juselius, K., 1992, Testing Structural Hypothesis in a Multivariate Cointegration Analysis of the PPP and the UIP for UK, Journal of Econometrics, July-Sept. 1992, 212-44

54. Jorge IvÃ¡n Canales Kriljenko, 2003, Foreign Exchange Intervention in Developing and Transition Economies: Results of a Survey, IMF Working Papers 03/95, International Monetary Fund.

55. Jorge IvÃ¡n Canales Kriljenko, 2004, Foreign Exchange Market Organisation in Selected Developing and Transition: Evidence of Survey, IMF Working Papers 04/04, International Monetary Fund.

56. Killeen, William, P., Richard K. Lyons, and Micheal J. Moore, 2005, Fixed versus flexible: Lessons from EMS order flow, Journal of International Money and Finance 25.

57. Killick, T., !978, Development Economics in Action: A Study of Economic Policies in Ghana. Heinemann Educational Books, London.

58. King, M., Sarno L., and Sojli, E., 2010, Timing exchange rates using order flow: The case of the Loonie, Journal of Banking and Finance, Forthcoming.

59. Kwiatkowski, D. P., Phillips C. B., Schmidt P., and Shin Y., 1992, Testing the null of stationary against the alternative of a unit root, Journal of Econometrics 54, 159-78.

60. Kyle, Albert S., 1985, Continuous Auctions and Insider Trading, Econometrica 53, 1315-1336.

61. Leith, J. C., 1974, Foreign Trade Regimes and Economic Development, Ghana, N.Y National Bureau of Economic Research, Published by Columbia University Press.

62. Love, R., and R Payne, 2008, Macroeconomic News, Order Flows and Exchange Rates, Journal of Financial and Quantitative Analysis, Vol. 43, 467-488.

63. Lyons, Richard K., 1995, Tests of Microstructural Hypotheses in the Foreign Exchange Market, Journal of Financial Economics, October 1995, 321-351.

64. Lyons, Richard K., 1997, A Simultaneous Trade Model of the Foreign Exchange Hot Potato, Journal of International Economics 42, 275-298.

65. Lyons, Richard K., 2001. The Microstructure Approach to Exchange Rates (MIT Press).

66. MacDonald, R. and Kearney, C., 1987, On the Specification of Granger-Causality Tests using the Cointegration Methodology, Economic Letters, Elsevier, vol. 25(2), 149-53

67. Mackinnon, J., 1991, Critical Values for Cointegration Tests, in R. F. Engle and C. W. J. Granger (eds) Long-Run Economic Relationship: Readings in Cointegration, Oxford University Press, Oxford, 267-76

68. Marsh, Ian W., and Ceire O'Rourke, 2005, Customer Order Flow and Exchange Rate Movements: Is there really Information Content?, Cass Business School, London.

69. Marsh, Ian W., Y-W Cheung and M. Chinn, 2004, How do UK-Based Foreign Exchange Dealers Think Their Market Operates? International Journal of Finance Economics, Vol. 9.

70. Meese, Richard, and Kenneth Rogoff, 1983a, Empirical exchange rate models of the seventies: Do they fit out of sample? Journal of International Economics 14, 3-24.

71. Meese, Ricahrd, and Kenneth Rogoff, 1983b, The Out-of-sample Failure of Empirical Exchange Rate Models: sampling Error or Model Misspecification?, in J. Frenkel, ed.: Exchange Rates and International Macroeconomics (University of Chicago Press, Chicago).

72. Mende, A., and L. Menkhoff, 2003, Different counterparties, different foreign exchange trading? The perpective of a median bank, Typescript, University of Hannover.

73. Obstfeld, Maurice, and Kenneth Rogoff, 2000, The Six Major Puzzles in International Macroeconomics: Is there a Common Cause? in Ben S. Bernake, and Kenneth Rogoff, eds.:NBER Macroeconomics Annual (MIT Press, Cambridge, Massachusetts).

74. Osler, Carol L., 2008, Foreign exchange microstructure: A survey, In Robert A. Meyers (ed), Encyclopedia of Complexity and System Science, Springer, Forthcoming.

75. Payne, R., 2003, Informed Trade in Spot Foreign Exchange Markets: An Empirical Investigation, Journal of International Economics 61, 307-329.

76. Phillips, P.C.B., 1987, Times Series Regression with a Unit Root, Econometrica 55, 277-301.

77. Phillips, P.C.B, and P. Perron, 1988, Testing for a Unit Root in Times Series Regresions, Biometrika 75, 335-346.

78. Phylaktis K, (1997) Parallel Market for Foreign Currency: A Survey of Theoretical and Empirical Issues Financial Markets, Institutions and Instruments 6 , 102-124

79. Rime, D., 2000, Private or Public Information in Foreign Exchange Markets? An Empirical Analysis, typescript, Norwegian School of Management, April.

80. Rime, D., Sarno, L. and Sojli, E., 2010, Exchange Rate and Forecasting, Order Flow and Macroeconomic Information, Journal of International Economics 80(1): 72-88.

81. Roe, A. and Schneider H., 1992, Adjustment and Equity in Ghana, Adjustment and Equity in Developing Countries, Development Centre Studies, OECD.

82. Rogoff, Kenneth, 2000, The Failure of Empirical Exchange Rate Models: no longer new, but still true, Economic Policy Web Essay.

83. Sager, Michael J., and Mark P. Taylor, 2006, Under the Microscope: The Structure of the Foreign Exchange Market, International Journal of Finance and Economics 11, 81-95.

84. Sarno, L. and M. Taylor, 2002, The Economics of Exchange rates, Cambridge: Cambridge University Press.

85. Sarpong, D. B., 1993, A Growth Oriented Macroeconometric Model of Ghana, The Economic Science, Vol.43, No. 4, March, Nagoya University.

86. Shaw, E., 1973, Financial Deepening in Economic Development. Oxford, Oxford University Press.

87. Sowa, N. K., 1994, Fiscal Deficits, Output Growth and Inflation Targets in Ghana, World Development, Vol.22, No. 8.

88. Tanzi, V. and H. H. Zee, 1996, Fiscal Policy and Long run Growth, IMF Working Paper, WP/96/119, International Monetary Fund, Washington, D.C.

89. Vitale, Paolo, 2008, A Guided Tour of the Market Microstructure Approach to Exchange Rate Determination, Journal of Economic Surveys, **21**(5):903–934.

90. Wei, S.-J. and J. Kim, 1997, The Big Players in the Foreign Exchange Market: Do they Trade on Information or Noise, Working Paper 6256, NBER.

91. Wu, Thomas, 2007, Order Flow in the South: Anatomy of the Brazilian FX Market, typescript, UC Santa Cruz

92. www.bog.gov.gh