ABSTRACT

BALELE, NGULING’WA PHILIP. Essays on Tanzania’s Monetary Sector and the Conduct of Monetary Policy. (Under the direction of Douglas Pearce).

This dissertation consists of three essays about the Tanzanian economy. The first essay is descriptive, tracing the evolution and stance of the monetary and financial sectors since the establishment of the Bank of Tanzania in 1966. It describes developments in the banking and financial sector, the performance of the economy, and the conduct of monetary policy. It provides background for the rest of the study. This study finds that the early 1990s financial sector reforms changed the structure of the banking and financial sector from a small sector that was dominated by government into a large, private-owned and dynamically competitive industry. The key features that contributed to this transformation include the amendments of the BOT Act, particularly the empowerment of the central bank in playing its roles, liberalization of the interest and exchange rates, and more. The ultimate outcome of these reforms can be inferred in terms of a more stable economy as evidenced by stable economic growth, low inflation, and market-determined interest and exchange rates.

The second essay examines whether there has been any systematic relationship between monetary policy targets and indicators during the post-reform period of 1992-2011 and whether monetary policy involves inertia. The results show evidence of a systematic relationship between monetary policy targets and indicators. The central bank tightens monetary policy by raising the interest rate in response any of several factors: increases in inflation, increases in the real output gap, or depreciation in the nominal exchange rate. Also, monetary policy tightening is affected by reduction in the growth of the monetary base as a response to the decrease in the nominal output gap and as a response to the nominal exchange rate depreciation. Using nominal GDP growth as an alternative measure of economic activity,
results show that the central bank decreases the growth in the monetary base in response to increases in the nominal GDP growth or to the depreciation in the nominal exchange rate. With regards to monetary policy inertia, the study finds evidence of partial adjustments to deviations from the monetary base and the interest rate targets, suggesting monetary policy inertia.

The last essay analyzes the drivers of the nominal exchange rate during the floating exchange rate regime (1992-2011). The study investigates whether depreciation in the nominal exchange rate following liberalization of the exchange rate in the early 1990s can be explained by the monetary approach to exchange rate determination as is claimed in the literature. The study finds evidence that the monetary approach to nominal exchange rate determination explains depreciation of the nominal exchange rate during the flexible exchange rate regime. The Tanzanian shilling depreciates with increase in the domestic money stock, price level and the interest rate relative to their foreign (i.e., U.S) counterparts. Further, depreciation of the Tanzanian shilling relative to the U.S. dollar occurs when the domestic real income decreases relative to the foreign income.
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Essays on Tanzania’s Monetary Sector and the Conduct of Monetary Policy

by

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DEDICATION

To my wife, Sapientia, my daughter, Wande, and my son, Eric.
Nguling’wa Philip Balele was born in Shinyanga, Tanzania. He received his Bachelor of Arts and Master of Arts both with majors in Economics from the University of Dar es Salaam, Tanzania, in 1996 and 1998, respectively. In 1999, he joined the Bank of Tanzania where he worked as an Economist in the departments of Monetary and Financial Affairs and Foreign Financial Markets. He joined the doctoral program in the Department of Economics at the North Carolina State University in the Spring of 2008.
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CHAPTER 1: INTRODUCTION

This dissertation consists of five chapters. The first chapter introduces the study; chapter two discusses Tanzania’s monetary sector; chapter three is entitled “The Systematic Relationship between Monetary Policy Targets and Monetary Policy Indicators;” chapter four discusses the determinants of the changes in the nominal exchange rate in Tanzania. Finally, chapter five gives a brief summary of the key results and policy implications.

Chapter two describes Tanzania’s monetary sector with particular emphasis on the last two decades under the post reform period (i.e., 1992q1-2011q4). This is the period when Tanzania undertook extensive economic and financial sector reforms (i.e. liberalization of interest rates, the exchange rate, prices and the banking sector). The chapter lays the groundwork for the whole study by providing detailed background for the third and fourth chapters, particularly on the evolution of the banking and financial sector, the stance of monetary policy, and the performance of the economy. Moreover, chapter two acquaints the reader with the environment under which the Bank of Tanzania (BOT) has been operating since taking over from the East African Currency Board (EACB) in 1966.

This study shows that the early 1990s financial sector reforms in Tanzania brought the envisaged financial and economic goals. It changed the structure of the banking and financial industry from a small sector that was dominated by government into a large, privately-owned and dynamically competitive industry. All these changes were made possible by deliberate initiatives such as the amendments of the BOT Act for the purpose of ensuring autonomy of the BOT and an enabling environment in executing its key roles in the economy. Various reforms such as liberalization of interest rates and the exchange rate
created a favorable environment for the central bank to conduct monetary policy, particularly in the development of new instruments of monetary policy that work through market forces. The ultimate outcome of these reforms can be inferred in terms of a stable economy, particularly stable economic growth, low inflation, and market-determined interest and exchange rates.

The third chapter examines whether there has been any systematic relationship between monetary policy targets (i.e. monetary base and interest rate) and indicators (i.e. inflation rate, output gap, and changes in the nominal exchange rate) by estimating Taylor-type and McCallum-type rules as variants of the Taylor (1993) and McCallum (1988) rules. In these reaction functions, the nominal exchange rate enters exogenously as one of the variables that the central bank reacts to, among other monetary policy indicators. The Taylor-type and McCallum-type rules of this study involve monetary policy partial adjustment following the regularity in the literature which shows that many central banks make monetary policy adjustments slowly to minimize the economic harms associated with abrupt changes in monetary policy.

This study addresses some flaws in the literature related to variable specifications by estimating the Taylor-type and McCallum-type rules using the Generalized Method of Moments (GMM) and Structural Vector Autoregressions (SVAR) while also using appropriate targets and indicators of monetary policy. This is the first empirical study for Tanzania that examines the empirical relationship between monetary policy targets and indicators. The study also adds to the prevailing scanty empirical literature from emerging market economies, particularly from Sub-Saharan Africa (SSA). The key findings of this
study show evidence of a systematic relationship between monetary policy targets and indicators as well as evidence of monetary policy inertia, implying that the central bank executes a partial adjustment monetary policy using the monetary base and interest rate.

The fourth chapter analyzes the drivers of the nominal exchange rate during the floating exchange rate regime (1992-2011). Following the exchange rate liberalization in 1992 and the consequent persistent depreciation in the nominal exchange rate, the Tanzanian shilling has been depreciating over time, but until now, there has been no study conducted to investigate what triggers these changes. This study is the first to provide empirical evidence on the fundamental determinants of the changes in the nominal exchange rate. The main research question of this study investigated whether the changes in the nominal exchange rate could be explained by the monetary approach to floating exchange rate determination as claimed in the literature. The study estimates the monetary model of exchange rate determination using the Vector Error Correction Method (VECM) and takes advantage of the relatively long sample of about two decades of Tanzania’s financial sector.

The main results show that the changes in the nominal exchange rate can be explained by the monetary approach to the exchange rate determination. That is, the Tanzanian shilling depreciates with increases in the domestic money stock, price level and the interest rate relative to their foreign (i.e. U.S.) counterparts. The increase in the domestic income relative to the foreign income tends to appreciate the Tanzanian shilling.

Chapter five summarizes the preceding study results.
CHAPTER 2: TANZANIA’S MONETARY SECTOR AND THE CONDUCT OF MONETARY POLICY

1.0 Introduction

After attaining independence from the British in 1961, Tanzania (then Tanganyika) was a subsistence economy mainly dependent on agriculture with a few cash crops. Agriculture was the main economic sector that was complemented by a small industrial sector made up of processing plants. The financial sector was very small, urban-centered, and was dominated by foreign banks which could not meet the credit demands of the economy. The country continued with the inherited market economy for the first six years of independence (1961-1967) after which it took a different path in terms of political and economic policies by adopting a socialist economic system in 1967. The objective was to establish a rural-based agricultural society with agriculture constituting the main sector of the economy; therefore, socialism was construed as the appropriate vehicle toward this goal. Coming from an established economic system, albeit small and consisting of institutions that worked according to market forces, the switch to socialism brought tremendous changes in the economic structure of the country. Instituting such a political and economic system involved nationalization of all the major means of production (i.e. banks and other financial institutions, manufacturing plants, and land) in 1967. Following this event, the new banking sector was made up of the consolidated nationalized banks into the National Bank of Commerce (NBC). The NBC was made a giant bank with a broad branch network in the country and was completely owned by government. In order to accomplish the goal of
establishing a socialist economy, the government engineered a country-wide campaign of building communal villages in 1974-75 popularly known as *ujamaa* villages.

Nationalization of the major means and setting up of communal villages undermined the economy. On the one hand, nationalization of the major means of production impaired the flow of economic activities due to changes in the ownership of capital and management of the production units. On the other hand, establishment of communal villages entailed relocating farmers from their farm areas to new villages and hence distancing them from their farms. This can be inferred in terms of an overall decrease in the farm-labor supply which weakened the agricultural sector. In general, these two events disturbed the economy’s smooth running and consequently slowed economic growth and real exports, especially during 1970s-1980s, given the fact that a significant share of exports was primary agricultural products (see figure 2.1).

From figure 2.1, three phases in the performance of real GDP and real exports can be identified:

(i) 1967-1983: Real GDP growth and real exports exhibit a declining trend. A significant portion of exports were primary agricultural products (e.g. coffee, cotton, tea, sisal). This declining trend can be explained partly by the mentioned political and economic events. However, there are a number of other economic events (to be mentioned later) which contributed to the unfavorable economic situation during the said period.

(ii) 1983-1993: Both real GDP and real exports exhibit positive but volatile growth rates with no specific pattern or trend. This is the transition period in which most of the
mid-1980s’ economic adjustment programs and the early 1990s’ financial sector reforms took place.

(iii) 1993 and after: Real GDP growth exhibits an increasing trend. This is the period when a number of financial sector reforms took place as will be covered in the latter sections. During this period, real exports were performing fairly well, especially after 2000, growing at around 20% per year on average. The composition of exports had changed since a significant portion during this time came from non-traditional products like minerals, flowers, and tourism.

Another important economic change that took place alongside the nationalization in 1967 and building of communal villages in 1974-75 was the establishment of the East African Community (EAC) in 1967. The EAC was established to broaden the prevailing scope of economic and political integration among Kenya, Tanzania, and Uganda which had existed since the British colonial rule. The Community consisted of various institutions (i.e. posts and telecommunications, airways, shipping, etc.) which were run jointly among the member countries. The EAC collapsed in 1977 for various reasons including asymmetry in benefits from the community among the member countries. Other reasons included political, economic, institutional, structural, and personality conflicts (Adar, 2011).

Nationalization of the major means of production in 1967 and building of communal villages in 1974-75 were just some of the factors contributing to the deterioration of the country’s economy between the 1970s and the early 1980s (shown in figure 2.1). The same trend also can be associated with a number of economic events that transpired during that period. Such economic events include the 1974-75 drought; the World 1973 oil shock; the
collapse of the EAC in 1977; the 1978-79 war with Uganda because of personality conflicts; and the World 1981 oil shock. The collapse of the EAC in 1977 had significant negative impacts on the sectors that were run jointly among the member states. These sectors include transportation (airline and shipping); telecommunications (including postal services); and manufacturing. The impact on these sectors was significant because they were not only managed jointly but also were strategically devised to serve the markets for all the member countries. The collapse of the EAC led to economic problems like shortages of industrial goods in Tanzania as well as in Uganda because most of the Community’s manufacturing plants were located in Kenya. Other problems that contributed to the deteriorating performance of the economy were related to management. Such managerial constraints included inadequate motivation and resources in the agricultural sector, poorly implemented industrial strategy (i.e. import substitution industries), excessive administrative controls on economic sectors particularly on prices, and persistent growth in the public sector that was not compatible with the government’s financial capacity, ultimately leading to large government fiscal deficits as portrayed in figure 2.2 (1970s-1980s).

The plummeting economy, dwindling exports as shown in figure 2.1, and the worsening fiscal deficits as shown in figure 2.2 (during the 1970s-1980s decade) all created an urgent need for economic and structural adjustments in order to salvage the economy. The government adopted a series of economic programs starting with the National Economic and Survival program (NESP-I) in 1981 was aimed at increasing foreign exchange earnings, attaining food self-sufficiency, controlling government spending, and improving management of foreign exchange. NESP-I was succeeded by NESP-II in 1982 to resolve the
constraints in the agricultural production and transportation sectors. These programs did not deliver the envisaged goals because of inadequate resources needed to implement them and lack of specific strategies.

1.1 Economic Reforms of the Mid-1980s

The unsatisfactory performance of NESP-I led to the launching of the comprehensive Structural Adjustment Program (SAP) alongside NESP-II in 1982. The SAP was intended to restructure the economy in the form of better incentive systems, to provide priorities in government spending for sustainable growth and external balance, and to increase the capacity utilization of both physical and human capital. The program was followed by the first Economic and Recovery Program (ERP-I) in 1986, which was later succeeded by ERP-II (alternatively known as the Economic and Social Action Program (ESAP)) in 1989. ESAP was designed to correct the problems that confronted the earlier programs. It was intended to increase agricultural production through various incentive schemes such as prices, improved market structures, and increased budgetary and foreign exchange allocations; to improve the physical infrastructure in order to stimulate production; and to increase industrial output by stimulating capacity utilization and prioritizing the allocation of scarce foreign exchange to priority sectors and firms. The program was also intended to pursue prudent monetary, fiscal and trade policies for the purpose of restoring stability in the economy.

On the fiscal side, a Rolling Plan and Forward Budgeting (RPFB) was introduced starting from the financial year 1993/94. The RPFB stated the government’s annual development strategy, economic targets and budgetary projections. It was intended to ensure effective planning as a means to ensure economic reforms. The first and second RPFB
covered the period 1993/94-1995/96. These reforms (SAP and RPFB) can be associated with the improvement in fiscal deficits, especially during the first decade of their inception as shown in figure 2.2. The economic reforms that started around the mid-1980s followed by the financial sector reforms in the early 1990s brought changes in various sectors of the economy starting from the early 1990s. This chapter identifies two sub-periods in the entire sample: that is, prior reforms (up to 1991) and post reforms (after 1991). All analyses in this study are linked to these key sub-periods.

1.2 The 1990s Financial Sector Reforms

The early 1990s’ financial sector reforms consisted of the comprehensive reforms that were undertaken following recommendations of the Nyirabu Commission in 1988. The Commission recommended reforms in order to revive the banking and financial sectors, which were heavily repressed following government interventions prior two decades since 1967. Most of these reforms took place in the first half of the 1990s.

The key reform that paved the way for the rest of the financial reforms was the liberalization of the banking and financial sector that involved enactment of the Banking and Financial Institutions Act (1991). The Act gave a mandate to the Bank of Tanzania (BOT) to govern the conduct of banking activities and champion the private sector banking in the country. It allowed free entry and exit in the banking business which had been illegal since 1967. In the following year, steps toward liberalization of foreign exchange transactions started with the enactment of the Foreign Exchange Act (FEA) in 1992. The FEA removed controls on foreign trade and ensured an environment that enabled a market-determined exchange rate. In 1993, Bureaus de change markets were introduced; these markets could
trade in foreign currency freely as a means to facilitate a market determined exchange rate. During the same year, foreign exchange auctions were introduced wherein the BOT would sell and buy foreign currency, mainly to or from commercial banks, as a tool for liquidity management and as a mechanism to facilitate determination of the market-based exchange rate. To facilitate the goal of market-determined exchange rate, the Interbank Foreign Exchange Market (IFEM) was introduced in 1994. Through the flexible exchange rate regime, the exchange rate policy was stipulated to be market-determined, with minimum interventions in order to smoothen short-term fluctuations. In the process to ensure market-determined interest rates, the Treasury bill was introduced in 1993. Treasury bills served as a benchmark for interest rates, as a tool for liquidity management under open market operations and as a facility for financing short-term government deficits.

In 1995, the BOT Act was amended to provide for establishment of supervision of private credit reference bureaus and also to empower the BOT to ensure price stability as its primary objective. This marked the first change in the BOT Act that focused on the BOT’s autonomy in relation to the conduct of monetary policy.

The major central banks such as the Federal Reserve Bank, Bank of England and the Bank of Japan provide evidence of the importance of independence of central banks in order to achieve price stability and optimal employment in the economy. However, central bank independence does not mean unconditional independence; the central bank needs to be accountable and transparent in implementing monetary policy to achieve the goals set by government. In his speech, Bernanke (2010) underscored the importance of an independent, accountable and transparent central bank and how the political regimes in the U.S. have
adhered to that. For the case of Tanzania, the central bank Governor is appointed by the president for a maximum of two terms, each five years long. With regards to transparency, the central bank is obliged to table monetary policy statements to the parliament every period after six months as well as to publish monthly and quarterly reports on the developments in the economy. At the end of each financial year, the central bank publishes an economic operations report which is comprehensive with regards to what had developed in the economy during the financial year.

To determine whether the early 1990s’ financial sector reforms had an impact on the independence of the Bank of Tanzania, this study compares the correlation coefficient between fiscal deficit and the change in the monetary base for the pre-reform period (1966-1991) and the post-reform period (1992-2011). The correlation coefficients between fiscal deficit and the change in the monetary base are 0.2430 for the pre-reform period and -0.0994 for the post-reform period. That means the pre-reform period exhibits a positive relationship between fiscal deficit and change in the monetary base while the link between fiscal deficit and the change in the monetary base is very weak—almost negligible—during the post-reform period. In absolute terms, the correlation coefficients between fiscal deficit and the change in the monetary base seem to be smaller than what central bank deficit financing would suggest. Perhaps this can be explained by errors in the fiscal data. To circumvent the “dirty data” effect, this study considers the correlation coefficients between fiscal deficit and the change in the monetary base by looking at the change in the coefficient between the two sample periods. The correlation coefficient changed significantly from 0.2430 during the pre-reform period to -0.0994 in the post-reform period, which is a more than 100% decrease.
This change provides evidence that a fiscal deficit was being financed by the central bank during the pre-reform period. This is an indication that the central bank gained independence during the post-reform period, the change of which can be associated with the 1990s’ financial sector reforms including the amendment of the BOT Act of 1995.

2.0 Evolution of the Structure of Tanzania’s Monetary Sector

2.1.1 The Banking Sector during the First Six Years of Independence (1961-1965/66)

Prior to the establishment of the Bank of Tanzania in 1966, monetary arrangements in Tanzania were undertaken by the East African Currency Board (EACB) which had the mandate to control the supply of currency in the British East Africa Protectorate (Kenya, Tanzania and Uganda). The Board ceased its operations in 1966 when the three East African countries introduced their own central banks. By the time of independence (1961), the inherited banking and financial sector from the colonial rule was very small. A BOT report (2011, p. 43) argues that there were “nine banks and four non-bank financial institutions and a few loan associations serving Asians and whites;” the report also characterizes the inherited banking system to be dominated by foreign banks, to be urban-centered, and to be unable to meet the market demand for credit in the economy.

With regards to the monetary authority, the inherited EACB continued to play the role of monetary authority until 1966 when the Bank of Tanzania was established. The Bank of Tanzania Act of 1965 was enacted to establish a central bank with multiple objectives that included, but were not limited to, currency issuing and conducting monetary policy. The BOT had no mandate to inspect banks and financial institutions until 1978 when the BOT

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11 That is, to issue currency and oversee monetary policy.
Act was amended (1978) to include a provision that empowered it to inspect banks and financial institutions in the country.

2.1.2 The Banking Sector during the Pre-Reform Period (1966-1991)

Until 1991, the banking sector remained small, static, and entirely owned by government. It monopolized the banking market since it was illegal for private banks to operate after 1967 when private banks were nationalized. The Banking and Financial Institutions Act (BFIA) of 1991 gave a mandate to the BOT to govern and conduct banking business and to champion the private sector in the country, thereby allowing competition in the banking industry. The main features of the banking sector during this period was characterized by the following features: dominance of locally owned banks; inadequate saving mobilization, hence inadequate funds to productive sectors; few major banks (NBC with broader network country-wide); poor service because of limited information and communication technology (ICT); monopolistic structure; and more lending to government which propelled more inflation in the economy. To broadly characterize the financial sector during this period, it was comprised of a small financial sector and a constrained central bank as described below.

Small Financial Sector

This was made up of a small banking system, with a few state-owned banks and a few non-bank financial institutions. Specifically, until 1991, Tanzania’s financial sector was thin, made up of only three commercial banks but with broader branch networks. There were also few financial institutions mainly serving the urban areas. There was no money market,
capital market or stock market. Prices\textsuperscript{2} were determined administratively while credits were allocated selectively, with priorities given to government parastatals\textsuperscript{3} irrespective of their creditworthiness. The banking sector still had some of the features inherited from the colonial banking sector—it was metropolitan and provided expensive credit conditional on collateral and inadequate credit to the agricultural sector, which was and continues to be the majority employer (BOT, 2011). The only difference from the inherited banking sector was in terms of ownership: while the inherited banking sector was under private ownership and operated under market criteria, the banking sector during 1967-1991 was government-owned with operational and managerial decisions made by the government.

**Constrained Bank of Tanzania**

As mentioned above, the BOT had no mandate to inspect banks and financial institutions in the country until 1978 when it was empowered following amendment of the BOT Act. Its autonomy to implement monetary policy also continued to be limited until 1995 when the BOT Act was amended to include a provision that mandated the BOT to achieve price stability as its primary objective. The central bank was subservient to government as a fiscal agent which had to finance fiscal budget deficits and extend credits to non-performing government parastatals and the banking system as agents for government development goals. These government interventions into the central bank operations jeopardized the autonomy and hence the ability of the central bank to implement monetary policy. Further, the range and quality of instruments of monetary policy were limited given that there were scarce instruments of monetary policy. The market for government securities was narrow as it was

\textsuperscript{2} These include price of goods and services, interest rates, and the exchange rate.

\textsuperscript{3} A parastatal is government owned company or agency.
limited to few players, mainly the state-owned banks and government-owned financial institutions such as pension funds; also, there were no secondary markets. Monetary policy instruments included direct control methods such as minimum reserve requirements, credit ceilings and selective credit controls. Specifically, monetary policy instruments consisted of government development plans such as the Agricultural Finance Credit Plan (AFCP) and the Foreign Exchange Plan (FEP) in 1971/72. Figure 2.3 shows that an increase in fiscal deficit is associated with an increase in the monetary base, suggesting a high chance that the government used the central bank in its budgetary operations, not by printing money but by borrowing from the domestic central bank.

In summary, the period from 1966-1991 was characterized by a small and inefficient financial sector, limited and non-market-based monetary policy instruments, a non-autonomous central bank that was there to serve political interests, and non-market based interest and exchange rates. All these features contributed to an unfavorable environment for the central bank to achieve its stabilization goals.

Financial Sector Reforms as a Response to Repressed Financial Sector

Interest rate controls with negative real interest rates, selective lending and credit allocation (to government parastatals) practices that was facilitated by a direct link (ownership) between the government and banks and financial institutions are the salient feature of the pre-reform period which form the typical features of financial repression that was aimed to provide cheap funds to the government. Financial repression is discussed widely in the literature (Reinhart and Rogoff, 2008). The negative real interest rates benefitted the government by eroding costs of servicing debt which, Reinhart and Kirkegaard
(2012) and Reinhart and Sbrancia (2012) consider to be the transfer of resources from creditors who are savers to borrowers (i.e. government).

Following repression of the financial sector during 1966-1991, the first deliberate initiative that marks the beginning of the prevailing stance of Tanzania’s economic and financial system and the corresponding stance of monetary policy started in 1988 with the Presidential Banking Commission popularly known as the Nyirabu commission. The main goal of the Commission was to recuperate the banking sector which was not doing well at the time. The 2011 BOT report (p. 45-46) itemizes three main reasons behind the Commission, “poorly performing banking sector, increase in subsidizes (burden to the government), and non-declaration of dividends by banks.” The committee recommended transformation of the financial sector in order to come up with a modern banking sector. In response to the Commission’s recommendation, a number of reforms started in 1991 as explained in section 1.2.

Although the early 1990s’ financial sector reforms had some of the envisaged outcomes in the economy and the financial sector, more steps were still needed for any far-reaching outcomes since the financial sector was heavily repressed due to excessive government controls. The central bank autonomy was still limited because of government participation in direct operation of the banking sector and fiscal deficit pressures. One way to reduce government interventions to the central bank was to restructure the state-owned banks and parastatals to enable them stand on their own and free the government from seeking funds for bailing them out.
Restructuring of the Government State-Owned Banks and Parastatals

The exercise involved restructuring the three commercial banks which were owned by the government. It started in 1992 with the restructuring of the National Bank of Commerce (NBC), which was completed in 1997. The giant NBC was split into two banks: the NBC (1997) limited and the National Microfinance Bank (NMB) limited. The Tanzania Housing Bank (THB) was restructured in 1995 while the Cooperative and Rural Development Bank (CRDB) was restructured in 1996 and rebranded as the CRDB Bank (1996) limited.

All these reforms released the government from conducting business and hence from the fiscal obligations in terms of recapitalization of these institutions. The objectives were to resize the government, particularly to reduce the government’s responsibility in bailing out the non-performing parastatals and hence reduce government spending as well as minimize distortions in the banking system in the form of managerial decisions on credit allocations and interest rate setting.

2.1.3 The Banking Sector during the Post-Reform Period (1992-2011)

During this period, the banking and financial sector was growing, dominated by private institutions following privatization of government banks and financial institutions. The banking industry was competitive following the Banking and Financial Institutions Act (BFIA) in 1991 which allowed competition in the industry. Mutaitina (1999) notes a dramatic change in the banking industry following the enactment of the Banking and Financial Institutions Act (BFIA), 1991. The Act provided for governing the operations of banking business to encourage private banking. It is argued in the BOT (2011, p.4) that “the financial
sector intermediation and deepening have improved quite appreciably with the number of banks increasing from 3 before the 1990s to 42 in December 2010.” The 1990s financial sector reforms benefited the banking sector in many ways. The BOT (2011) report enumerates these benefits to include: increased banks’ asset quality and hence increased profitability, and increased competition in the industry and hence increased quality of banking services, and increased corporate governance in the banking sector. Other benefits include increased deepening of financial services as a result of extensive branch networks in the country, and more lending to the private sector.

However, there are still some challenges which need to be addressed. Some of these challenges are related to the persistence of some features of the inherited colonial banking sector. These features include concentration of banking services in urban areas and expensive credit tied to collateral. This has led to proliferation of microfinance institutions to serve the group that is not eligible for commercial banks’ lending. Other features include inadequate credit to the agricultural sector and long term ventures.

The post-reform banking sector is characterized by new features which are not related to the inherited banking sector as follows,

- Cash-dominated transactions which contribute to a small market share as portrayed in the figure 2.4 by a large share of currency in the broad monetary aggregates (i.e. M2 and M3) and small share of the public with banks accounts, particularly in rural areas where the economy remains largely cash-based, Adam et al (2011).

- Absence of credit reference bureaus. This has been a source of friction in the flow of credits because of the asymmetric information between banks and borrowers. The
consequence of this has been higher liquidity in the economy while fewer loans are issued to the private sector. Because of this risk element, commercial banks had relied on investing in Treasury bills rather than issuing loans. The situation has led to higher lending rates and demand for collateral as means to mitigate the problem of default risk. These consequences can also be reflected by the declining Treasury bill yields. Since investing in Treasury bills is relatively less risky to banks than extending loans, there has been a tendency for commercial banks to invest more in Treasury bills than issuing loans mainly to avoid default risk due to information asymmetry. This practice leads to oversubscription and consequently decreases in Treasury bill yields.

- Non-favorable legal conditions. In line with the comprehensive economic reforms that started in the mid-1980s, establishment of an enabling environment for investment and economic development required a favorably operating legal system. Therefore, a commercial court solely for handling commercial disputes was established in 1999 within the Civil Division of the High Court. Despite the presence of this Court, its impact is hardly noticeable in terms of facilitating provision of loans in the credit market, since it has been overwhelmed by a large number of pending cases.

All these constitute the risk elements in the Tanzanian banking system despite the comprehensive reforms in the Tanzanian financial sector, Mutaitina (1999). These challenges need to be addressed by,

- Building public awareness on acceptance of non-cash payment methods: credit and debit cards, mobile money, etc. This would lower the risk of handling voluminous cash in
business transactions and consequently decrease operational costs (rampant bank robbery especially in the years around 2005).

- Setting up credit bureaus to mitigate the problem of adverse selection due to asymmetric information between lenders (banks) and borrowers.

- Streamlining the commercial court to facilitate legal decisions.

Figure 2.4 shows that the currency in circulation (CC) as a percentage of M2 and M3 was higher until 1999, implying that a substantial amount of transactions were taking place outside the banking system. This can be explained by the high inflation and exchange rate depreciation and poor banking services. From 2000, these ratios fell dramatically with the CC to M3 ratio recording below 20% which implies an increase in the preference for banking services perhaps due to improvement in the banking services as a result of competition in the industry and the decrease in inflation rate.

Figure 2.5 shows the pattern of foreign currency deposits as percentage of extended broad money supply (M3). The provision under the foreign exchange liberalization to allow residents to hold foreign currency deposits was received positively as shown by the steep curve of the percentage of foreign currency deposits (FCD) to M3 which rose drastically after introduction of foreign currency deposits, mostly in US dollars in 1993. This increasing pattern continued until the mid-2000, although the rate was declining with time. A plausible explanation for this pattern can be the motive for financial asset (deposits) holders to seek safe-havens for their assets as a means to protect their wealth from high inflation and exchange rate depreciation (Kessy, 2011). When foreign currency deposits were allowed, the inflation rate was still higher (above 30%) while interest rates were low. This implies
negative real returns on deposits as shown in figure 2.13. Liberalization of the exchange rate led to depreciation of the nominal exchange rate. Despite the continued decline in inflation since 1995, the ratio of FCD to M3 continued to increase until the mid-2000 perhaps because of inflation expectations among the asset holders and the continued depreciation of the shilling as a consequence of exchange rate liberalization. After the mid-2000, the ratio started to decline perhaps due to the decay in the inflation expectations among the asset holders and that by then they had already established that the depreciation trend of the shilling (which is almost constant) is the normal long run pattern of the exchange rate such that the exchange rate depreciation was no longer a serious threat to their assets (deposits).

2.2 Evolution of the Conduct of Monetary Policy

The establishment of the Bank of Tanzania in 1966 started with the enactment of the Bank of Tanzania Act in 1965 which provided for the establishment of the central bank and empowered it to perform all central banking functions under the competitive market adopted from the colonial era. That means, the provision entailed indirect instruments of monetary policy. In 1967 the country reoriented toward the socialist economic system, which entailed nationalization of the major means of production, banks and financial institutions included and switched from the inherited market economic system to a planned economic system. With a planned economic system, the traditional indirect instruments of monetary policy as specified in the BOT Act, 1965 became void.

As a consequence the new instruments of monetary policy were devised by the Ministry of Development and Planning in consultation with the central bank, which, together
with the banking system (which was entirely owned by government) had to implement them.

Instruments of monetary policy consisted of national plans, specifically:

(i) The Annual Finance and Credit Plan (AFCP) which was supported by a system of administered interest rates was devised in 1971/72

(ii) The Foreign Exchange Plan, designed to control the use of foreign exchange rate in line with the national priorities.

After reviewing the structure of the Tanzanian economy since independence, this section focuses on the stance and conduct of monetary policy in Tanzania starting from 1966 when the Bank of Tanzania was established to take over from the then East African Currency Board (EACB) following the decision by the three East African countries (Kenya, Tanzania, and Uganda) to establish their own central banks. The EACB was the joint monetary authority under the British colonial rule which oversaw monetary policy for the three British East African colonies of Kenya, Tanzania, and Uganda.

In the introduction of this chapter, we documented the various changes in the economic and financial sectors following nationalization of production capital, the building of the communal villages, and the establishment and collapse of the EAC in 1967 and 1977, respectively. This implies that the architecture of Tanzania’s financial system was changing in response to these economic and political changes. Taking this into account, I also divide the analysis of the conduct of monetary policy into the two main sub-periods 1966-1991 and 1992-2011.
2.2.1 Monetary Policy during 1966-1991

During this period, monetary policy took place in an unfavorable environment. The factors that contributed to the unfavorable environment include the small financial sector and constrained central bank as described above. The financial market was ineffective due to pervasive controls on credits, interest rates and the exchange rate for the purpose of achieving government socio-political and economic goals. For instance, monetary policy was heavily subservient to fiscal policy such that the central bank operated as the government quasi-fiscal agent in mobilizing financial resources for investment in the public sector (education, health, business, infrastructure, etc.). While inflation was higher, interest rates were controlled, rendering negative real interest rates. Interest rates were set administratively rather than determined by market forces. Maje (1981, p. 31) argues that a “greater proportion of savings was held in tangible assets than in financial savings.” The central bank’s ability to conduct monetary policy was limited as it entailed multiple objectives using crude instruments of monetary policy as there were no market-based instruments of monetary policy. The governmental developmental roles delegated to the central bank were overwhelming. These entailed the traditional central banking functions as stipulated in the BOT Act, 1965 plus those devised in the amendment of the BOT Act 1978, that is, management of the development fund schemes (i.e., rural finance, industrial finance, export credit guarantee, and capital and interest subsidy) for the purpose of providing guarantee facilities to banks and financial institutions, as well as the mandate to inspect banks and financial institutions.
2.2.2 Monetary policy during 1992-2011

During this period, monetary policy was conducted using market-based instruments that came as a result of the early 1990s financial sector reforms. This is the period when the Bank of Tanzania had not only a relatively wider range but also better quality instruments of monetary policy compared to the previous one. The interest rates, the exchange rate and other asset prices were determined by market forces and hence created a conducive environment for the central bank to implement monetary policy. It was during this period especially in the mid-1990s when the central bank was able to lower the rate of inflation from above 30% in 1994 to a single digit thereafter. This implied some positive real rates in some of the interest rate categories but not on the saving rate which was still under repression (figure 2.13). There were more financial saving avenues\textsuperscript{4}, an expanding banking sector in terms of the number of banks and other financial institutions e.g., money market, stock market and capital market as well as improvement in the banking services\textsuperscript{5}. Other financial developments include the establishment of the Capital Market and Securities Authorities (CMSA) in 1996 and the Dar es Salaam Stock Exchange (DSE) in 1998. All these financial developments ensure a better environment for monetary policy.

\textsuperscript{4} For example investment in government securities, particularly Treasury bills and Treasury bonds, or shares in the Dar es Salaam Stock Exchange (DSE)

\textsuperscript{5} BOT (2011, p.50) lists the various advantages that emanated from liberalization of the banking sector in Tanzania. This includes: (i) improve asset quality of banks which enhanced profitability, (ii) increased competition leading to better services, (iii) competition led to adoption of information and communication technology (ICT) leading to even better services and new product (e.g. ATM), (iv) improved corporate governance, (v) financial services deepening as a result of increasing number of banks (including community banks) as well as expanding branch network, and (vi) lending to private sector.
Amendments of the BOT Act and the Autonomy of the Central Bank

The BOT amendment of 1978 overloaded the BOT in terms of objectives because it added several national development programs to be implemented by the central bank on top of the “multiple objectives” stipulated in the BOT Act, 1965. The amendment of the BOT Act, 1978 was purely a government response to developmental needs related to the program of building communal villages in 1974/75, the industrialization program (import substitution industries), and the external imbalance problem. All these came as a result of the inability of the banking system to mobilize sufficient credits to meet demands as well as to ensure both domestic and foreign stability in the economy. The government established financing schemes which were to be managed by the central bank mainly to provide for refinance and offer guarantee facilities to banks and financial institutions. Such schemes include rural finance fund, industrial finance fund, export credit guarantee fund, and capital and interest subsidy fund.

The BOT Act amendment of 1995 empowered the central bank to ensure price stability as the primary objective. This amendment was a deliberate initiative aimed to create a favorable environment in conducting monetary policy by providing a mandate to the central bank. It was a necessary move in complementing the early 1990s financial sector reforms. Thus, having liberalized interest rates, exchange rates, etc., real interest rates were still negative since inflation was excessively high (above 30%). This needed empowering the central bank in order to focus on price stability rather than on multiple objectives. The BOT Act was amended in 1995, the amendment which empowered the central bank to establish and oversee private credit reference bureaus as well as to ensure price stability and a firm
financial system, (BOT, 2011). All these were significant changes in terms of central bank’s autonomy in pursuing its roles.

**Instruments of Monetary Policy**

During the pre-reform period, the range of instruments was small; mainly direct instruments that constituted government development plans, particularly the Agricultural and Finance Plan (AFCP) and the Foreign Exchange Plan (FEP) in 1971/72. Monetary instruments during the post-reform period changed. During this period, the Bank of Tanzania used indirect instruments of monetary policy stipulated in the BOT Act 1965 before adoption of socialism in 1967. These include open market operations (OMO) and foreign exchange market operations (FEMO). The OMO refers to selling and buying of government securities, mainly Treasury Bills and Treasury bonds. In order to influence the operating target (i.e. monetary base), the central bank sells or purchases these securities in order to mop up or inject liquidity into the economy, respectively. Under FEMO, the central bank also can conduct the same operation by selling and buying foreign exchange.

2.3 **Exchange Rate Regimes**

Tanzania had a controlled exchange regime until 1986. Under this regime, the government decided the value of the Tanzanian shilling against the U.S. dollar and committed to that rate at all times by buying and selling the Tanzanian shilling at that fixed rate. Following high pressures on the exchange rate, the system was replaced by a crawling peg exchange rate system in 1986 as a gradual approach to liberalizing the exchange rate due
to the higher exchange rate premium\(^6\) which had reached about 480% by the end of 1985 (Cowitt, 1986-1987).

The crawling peg (1986-1992) period was characterized by relatively less controls than the period before 1986. It entailed a sequence of exchange rate devaluations as steps in the implementation of the mid-1980s economic and structural adjustment programs. During the crawling peg exchange rate regime, the sequence of devaluations undertaken lowered the exchange rate premium as shown in figure 2.8.

The exchange rate controls prior to 1986 overvalued the Tanzanian shilling given the fact that output and exports were not adequate, leading to a shortage of foreign exchange at the same time inflation was high. In theory, an overvalued exchange rate leads to loss of competitiveness since exports become relatively expensive. But in the case of Tanzania, there was not sufficient output to export given that the economy was not doing well, as shown in 2.1. The country suffered from shortages of goods due to low production and lack of sufficient foreign exchange to import goods for the domestic market. All these factors contributed to the exchange rate premium as illustrated in figure 2.6 and 2.7. The exchange rate premium emerged after the late 1960s\(^7\). It continued to grow before peaking in 1986 after which it decayed quickly following the adoption of the crawling peg exchange rate regime in 1986-1992 which involved a sequence of devaluations that eased the controls. With total decontrol in the exchange rate market in 1992, the exchange rate premium disappeared. This suggests that the controls were the main cause of the exchange rate premium.

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\(^6\) The exchange rate premium is defined as the additional cost above the official price of buying foreign exchange. That is, \(\text{Premium} = \frac{[(\text{Parallel rate} - \text{Official rate})/\text{Official rate}] \times 100}{\text{Official rate}}\)

\(^7\) However, this study could not obtain data on the additional cost above the official price of buying foreign exchange.
After more than two decades of a controlled exchange rate regime, Tanzania adopted a gradual change in exchange rate policy from the controlled regime to the market regime. Following the late 1960s political-social-economic changes, the style of economic management in Tanzania was dominated by controls which covered prices (e.g., wages, product prices, interest rates and exchange rate), allocation of domestic credits and foreign exchange, Rutasitara (2004). Until 1985, the exchange rate was under tight control. The controls, shortages (goods), and plummeting foreign exchange reserves exerted pressures on the exchange rate and consequently generated a parallel or black market. The foreign exchange rate black markets prevailed in the few big cities like Dar es Salaam in Tanzania, Nairobi in Kenya and along the borders with Kenya and Uganda where there were high demands for the Tanzanian shilling. The main triggers of the black market exchange rate were the excessive exchange rate controls and the economic and social strains from the late 1970s that started to relax in the mid-1980s when the government adopted economic reforms. Government efforts to deal with the black market problem started in 1977 by withdrawing the TZS 100.00 banknote from circulation and replacing it with a new banknote of the same denomination (Cowitt, 1986-1987). However, the strategy could not deliver the envisaged goal of dismantling the black market for foreign exchange. Later, the government adopted a crawling peg regime in 1986-1992 with a sequence of devaluations before adopting a flexible exchange rate in 1992.

The exchange rate premium almost disappeared in 1993 when the official rate and the bureaus rate merged following licensing of the bureaus de change in 1993. The theory of Purchasing Power Parity (PPP) suggests a positive relationship between the domestic price
level and the exchange rate. The high rate of inflation in Tanzania until the mid-1990s can be associated with the higher exchange rate premium as shown in figure 2.10 and 2.13. Rutastara (2004) analyzes the impact of the exchange rate on inflation in Tanzania by estimating the effect of the exchange rate on the inflation rate using quarterly data (1967-1995) and found a strong impact of the parallel exchange rate on inflation until 1990s compared to the effect of the official exchange rate, see figure (2.10 and 2.13).

The current flexible exchange rate regime started in 1992. Under the flexible exchange rate regime, the official exchange rate depreciates while the official level of reserves is increasing as illustrated in figure 2.9. This indicates the degree of exchange rate flexibility (no intervention) which confirms the stipulated exchange rate policy that the exchange rate is market determined with minimum intervention just to smooth out short term fluctuations.

The flexible (managed) exchange rate system was adopted following the unification of the parallel and official exchange rates in 1993. Since then the value of the Tanzanian shilling is determined by market forces and changes according to market forces. It can be noted that the adoption of the financial sector reforms released the government not only from the daily management of the financial system but also provided relief from inflationary effects due to exchange rate pressures, foreign exchange shortages, and shortages in the goods market. For instance, following the disappearance of the premium exchange rate as a result of exchange rate unification in 1993, inflation also started falling especially after 1994 as shown in figure 2.10.

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8 This is consistent with Rutastara (2004) who finds that the exchange rate has a significant effect on inflation in Tanzania.
2.4 Financial Sector Development and Performance of the Economy

Until the mid-1980s, interest rates were fixed (see figure 2.12) because of government controls. The central bank administered interest rates of the financial liabilities and assets by establishing floors on deposit rates as well as establishing both floors and ceilings on lending rates (Tuni, 1997).

The economic consequence of the government controls can be seen in terms of flat or fixed interest rates as shown in figure 2.12. In figure 2.13, the negative real interest rates indicate the degree to which the financial sector was repressed for almost the entire period before the early 1990s. With the adoption of the economic and structural adjustment programs in the mid-1980s, nominal interest rates (lending and saving rates) started to increase. Liberalization of interest in 1991 led to a faster increase in the nominal interest rates. Despite the increases in the nominal interest rates, the ex-post real interest rates continued to record negative values because of the high inflation rate of the mid-1990s. From the mid-1990s, nominal interest rates were falling because of a decrease in inflation, but real interest rates continued to record positive values except for the savings rate. It can be observed that the commercial bank lending rate had been above the deposit rate, savings rate, and the Treasury bill rate by a broader margin, especially in the first decade of the financial sector reforms as illustrated in figure 2.12.

According to the interest rate trends portrayed in figures 2.12 and 2.13, three regimes of interest rate developments can be classified from the 1966-2011 sample period: 1966-86, 1987-1996 and 1997-2011. The 1966-86 regime was characterized by very low and fixed nominal interest rates set by government, whereas the 1987-1996 regime was characterized
by high interest rates due to the mid-1980s’ economic reforms and its interactions with the early 1990s financial sector reforms. The 1997-2011 was the period of moderate interest rates determined by market forces.

The mid-1980s’ economic reforms and the 1990s’ financial sector reforms had a small impact on interest rates at the beginning, but the impact got larger over time. From figure 2.12, it can be observed that this impact is asymmetric as it is more pronounced in the type of interest rates charged by banks than on those paid to depositors. This suggests some additional measures on interest rates because of the far-reaching distortions on interest rates before the financial sector reforms. The year 1996 was a turning point for all interest rates following a sudden drop and gradual decline thereafter. This can be associated with a number of economic events such as the maturity of the financial sector reforms that started in the early 1990s, the impact of the sequence of fiscal reforms that led to reduction in the government’s fiscal dominance through raising revenue collection, and streamlining of government spending through public expenditure management. All these eased government pressures on domestic borrowing and hence reduced pressures on interest rate.

**Commercial Banks Credit to the Private Sector**

Credits to the private sector as a percentage of GDP continued to decline from 10% in the late 1960s, reaching a low level of 2% in the late 1980s. This trend probably can be explained by government crowding out of the private sector as more credit allocation was directed to government\(^9\) during the government control regime.

\(^9\) Unfortunately, this study could not find data on commercial banks’ credit to the government.
From the late 1980s, credit to the private sector as a percentage of GDP was increasing until the mid-1990s when it was above 10% before declining suddenly to around 3%, after which it increased at a higher rate (see figure 2.14). By 2010, credit to the private sector as a percentage of GDP was above 15%, which was the highest it had been since the late 1960s. With the establishment of the credit reference bureau, the credit to the private sector, with other things being equal, is expected to increase given the high potential demand for credits and the existing excess liquidity in the economy as shown in figure 2.16.

Given the role of credit to the private sector in the economy, the current level of 15% is still small, which suggests a need for deliberate efforts to improve the situation. Some of these efforts are already in place (e.g. the credit reference bureau, streamlining of the commercial court). In relation to other East African Countries, Tanzania and Uganda still lag behind Kenya. For instance, in 2010, the credits to the private sector for Tanzania and Uganda have been moving very close to each other at above 15%, while for Kenya, it has been around 35% (figure 2.15).

While adequate liquidity in the banking system is very important as it ensures public confidence in the banking system in the sense of the banks’ ability to honor their short term and long term obligations, it is economically undesirable when liquidity is held in excess of the optimal level because the idle (excess) credit creates deadweight loss as an opportunity cost of the un-borrowed funds. Therefore, there is an optimal level of liquidity in the economy which ensures that banks are liquid enough to meet their short-term and long-term financial obligations and also minimizes the deadweight loss associated with the un-
borrowed funds. Nevertheless, the issue of “optimal liquidity” is beyond the scope of this study.

In this study, I characterize the excess liquidity in the Tanzanian banking system using representative data from three major banks (CRDB, NMB and NBC). The data cover a period of 10 years (2000-2009). Because of non-availability of data on total deposits for all banks in Tanzania, I use the available data on deposits from the three major banks as a proxy for the total bank deposits in the economy. The total deposits of the three banks for 2009 and 2010 averaged 50% to total bank deposits in the economy, according to the 2010 Annual Report of the Directory of Banks Supervision.

Table 2.1 and figure 2.16 show the degree of excess liquidity in the economy as indicated by a smaller ratio of “gross loans to total deposits” recorded during the period compared to the excess liquidity threshold of 70%, according to the Bank of Tanzania’s standard measure of liquidity. Specifically, NMB has the most excess liquidity in the banking system, followed by CRDB and then by NBC. Looking at the overall average of the three sampled representative banks, figure 2.16 indicates excess liquidity since the average of the gross loans to total deposits falls short of the excess liquidity threshold of 70%. This pattern of excess liquidity implies that commercial banks are reluctant to issue loans due to fear of default risk.

It can be observed from figure 2.16 that the degree of excess liquidity has been declining over time (in that more deposits are getting used to finance or issue loans than before). This can be a sign of a decrease in the cost of funding, credit risk, volatility of deposits, and/or preference for cash among banks.
Fiscal Policy Performance

It has been shown how the period 1966-1991 was dominated by financial repression as indicated by interest rate patterns. During the same period, fiscal policy was a key tool in implementation of the government development goals. Because of the slow growth of the economy as well as the narrow tax base, the government was unable to collect enough revenue to meet its recurrent and development obligations. This can be associated with an increase in fiscal deficits as shown in figure 2.17 (from the late 1960s to the early 1980s) during the period before the economic reforms. One reason for the increase in budget deficits during this period is the steady growth in government expenditure that was not compatible with the ability of the government to collect sufficient revenue (Kilindo, 1992).

The period 1966-1982 was characterized by expansionary fiscal policy with total expenditure as a percentage of GDP persistently increasing, reaching above 30% in 1975 and just below 30% thereafter. This trend can be explained by an increase in government obligations due such events as the collapse of the EAC in 1977, whereby the government had to undertake and finance various projects such as transportation (shipping and airways) and telecommunications (postal services) which were previously run jointly among the three members of the EAC; spending on the war with Uganda in 1978-79; importation of food following the 1974-75 drought; and spending on the communal village project in 1974-75. Total revenue to GDP ratio ranged between 15-20% versus about 30% expenditure to GDP ratio (figure 2.17), implying that fiscal deficit continued to worsen over time before it bottomed at around 11% of GDP in 1982. The period was also dominated by inflation pressures. The period in the early 1980s was unfavorable for the economy: GDP recorded
negative growth rates in 1982 and 1983, the fiscal deficit was the highest in history, the exchange rate premium averaged 200%, and the official foreign exchange reserves was the lowest (4.82 million USD) in history in 1982.

The era from 1983-1989 was dominated by contractionary fiscal policy—both total expenditures and total revenues were decreasing with total expenditure decreasing faster than total revenue. Significant improvements in fiscal deficits were realized during this period, peaking at around 5% (surplus) of GDP; nevertheless, there were some inflationary pressures, as the rate of inflation was still above 30% for most of the time. These fiscal developments can be explained by the SAP in 1982 as well as the ERP I & II in 1986 and, the objectives of which include prioritization of government spending and increasing capacity utilization in both physical and human capital. The former might have contributed to the lower government spending while the latter might have contributed to an increase in government revenue, both leading to improved fiscal deficit.

During 1990-2011, both total expenditures and total revenues were increasing, with total expenditures increasing faster than total revenues, thus generating a deficit which is currently approaching 7% of GDP.

2.5 Comparison with Relevant Sub-Saharan African (SSA)

2.5.1 Timing of Reforms

The current economic cooperation among the East African Countries is historical as it dates from many years ago. Starting from the colonial rule, the three East African Countries were under a single monetary authority (the EACB) which ceased operations when the three
countries introduced their own central banks in 1966. After attaining independence in the early 1960s, the three countries formed the first EAC in 1967, which prevailed for ten years before collapsing in 1977. While Uganda was dominated by frequent changes in political regimes in the first two decades after independence, Tanzania was seriously dragged back by its reorientation to the socialist economic system. Kenya had no distraction from the inherited economic system apart from poor economic management practices such as controls (including interest rates and exchange rates) which were common in most developing countries after attaining independence. By the mid-1980s, these countries’ economies were not doing well; they were characterized by high inflation, external imbalances, slow economic growth, exchange rate problems, among other problems. With pressures from the International Monetary Fund (IMF), these countries adopted economic and structural adjustment programs (SAPs) from the mid-1980s. The financial sectors were very repressed because of excessive controls and therefore needed deeper financial sector reforms which were adopted in the early 1990s. For instance, Kenya and Tanzania liberalized the interest rates in 1991 while Uganda followed in 1994. Uganda liberalized its exchange rate market in 1991, while Tanzania and Kenya liberalized their exchange rates in 1993. Among the three East African countries, Kenya’s financial sector was relatively less repressed compared to Tanzania’s and Uganda’s where the governments had tight controls of the banking sectors for government developmental goals and other non-commercial goals. Because of this, Kenya liberalized its banking sector earlier (1989) than Tanzania and Uganda, where privatization

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10 The Central Bank of Kenya started on September 14, 1966, while the Bank of Tanzania started June 14, 1966. The Bank of Uganda was introduced in August 15, 1966.

of the banking sectors occurred in 1994 and 1996, respectively. Given the Kenyan financial sector was not disturbed following its independence, Kenya had a stock exchange market that was inherited from the colonial period (established in 1954). Tanzania and Uganda established their own stock exchange market in 1998.

The monetary policy framework for each of the three East African countries is monetary targeting with the monetary base being the operating target. Another common feature among the three countries is the objective of monetary policy. Price stability is the primary objective of monetary policy for each country. This has facilitated the autonomies for the central banks in performing their roles. Also, the exchange rate policy is market-determined in each country with minimum intervention for the purpose of smoothing out the short term fluctuations from the long term path.

The range and quality of instruments of monetary policy do not vary across the three EA countries. Relative to the past, the range of instruments of monetary policy is relatively wider for each country. However, in absolute terms, the range of instruments of monetary policy for each country is still small. The common instruments of monetary policy include open market operations, foreign exchange operations, repurchase agreements, and the discount window. Although there are developments in the financial sectors such as stock exchanges and secondary markets for government securities, participation in these markets is still limited. One reason for such limitation is the still-prevailing elements of capital controls. None of these countries has fully liberalized its capital accounts. This limits the degree of participation in the stock market and hence reduces efficiency of the financial markets.
2.5.2 Macroeconomic Performance

*Exchange Rates*

Figures 2.18 and 2.19 provide a comparison of the East African exchange rates relative to the U.S. dollar. All the three East African currencies (shillings) tend to move in the same direction, especially after the financial sector reforms that started almost at the same time (early 1990s) in the region. However, cross exchange rates show that the Tanzanian shilling has been depreciating against the Kenyan shilling while maintaining its value slightly above the Ugandan shilling for the past two decades.

*Interest Rates*

Selected interest rates show that interest rates in the region have been converging since around the mid-1990s, which is an indication of unification of the money market and banking services in the region. A general pattern of interest rates’ behavior in East Africa as shown in figure 2.20 through 2.24 can be summarized as follows:

(i) Savings rates in the three countries tend to move together, which is a sign of a unified deposit money market in the region.

(ii) For lending rates, the Tanzanian and Kenyan rates track each other, implying unified money and capital markets. This is intuitive because of two reasons: First, most of the potential (big) borrowing businesses serve the whole region and have entities in the three countries (especially Kenya and Tanzania). Examples of such companies/businesses whose demand for loans influence lending rates include manufacturing companies and transportation companies. Second, most of the major banks serve the entire region as they
have branches in all the countries, serving the same customers (corporates) who own investments all over the region.

(iii) Time deposit, Treasury bill rates, and discount rates also tend to converge from the late 1990s with the Tanzanian and Kenyan rates moving closer to each because of the reasons mentioned in (ii).

**Inflation Rates**

Since the mid-1990s, inflation rates for the three East African countries as shown in figure 2.25 tend to move together, converging to a single digit, especially from around the mid-1990s. This shows that the three countries were successful in combating inflation which was a major problem before the mid-1990s.

2.5.3 The Three East African Central Banks

The central banks of the three East African countries (Kenya, Tanzania and Uganda) do not differ in terms of their operations, goals, and monetary and financial policies. Currently there are procedures in place to harmonize their operations as preparatory steps towards the East African Monetary Union (EAMU) as part of the EAC agenda. These procedures involve the harmonization of the payments systems as well as monetary and financial policies. Given the current similarity in their operations, objectives, and financial and monetary policies, the benefits from the envisaged EAMU as one of the EAC agenda are not very significant because the three currencies are already convertible. In pursuing its agenda, including forming the EAMU, the EAC has more lessons to learn from the ongoing crisis in Europe resulting from the European Union. This can be used as an opportunity for
the three East African countries to take time in form of a planned delay in order to learn from the ongoing crisis in Europe.

2.6 Structural Breaks in Macroeconomic Variables

Given the economic reforms that started in the mid-1980s and the financial sector reforms of the early 1990s, it is expected that they had impacts on the economy and the banking and financial sector in general. It is tempting to seek empirical evidence on this. The constraint on seeking this evidence lies on the analytical method used in this chapter. This chapter uses descriptive analysis; therefore, there are no parameter estimates from which to employ the conventional structural break tests. However, the same task may not necessarily require parameter estimates and conventional structural break tests. The same goal can be achieved via investigation of the time series characteristics of the data using the unit roots test that allows for a structural break (Baum, 2001; Hansen, 2001; Zivot and Andrews, 1992). This method allows detection of whether there is any structural break to be associated with the reforms which have been in place since the mid-1980s.

In this study, I use this approach for the purpose of extracting only the results on the structural breaks relevant for this chapter. That means the results on the unit roots test are not relevant in this chapter and hence are not reported. Information on unit root test results is of no relevance in this chapter, but will be reported in the second and third chapters since the knowledge on the time series characteristics of the data is relevant in the estimation exercise.

The results on the structural breaks using Zivot-Andrews (zandrews) test are reported in figure 2.26. On each variable, the figure on the right hand side plots the breakpoint t-statistics for the unit root test that allows a structural break and detects the break date. From
this information (break date), the left-hand figure plots the variable also by indicating the detected breakpoint. I allow a single structural break given that the sample is not very large.

**Discussion of the Structural Breaks**

**Interest Rates**

The structural break tests suggest that the early 1990s’ financial reforms at different periods had impacts on the interest rates. The test also suggests a structural break for the discount and average lending rates in 1995. During this period, the discount and average lending rates started to fall as a result of the decaying momentum generated by the mid-1980s economic reforms and the early 1990s financial sector reforms. The saving rate also exhibits a structural break in 1991. Treasury bills were introduced following the interest rate liberalization in 1991 and started high (above 30%) but immediately declined in response to market forces. The break date in Treasury bill rates is detected in 1998. It separates the higher and lower trends which cannot be associated with any policy changes. The detected structural breaks in regard to the interest rates indicate the changing trend of interest rates from increasing to decreasing. This can be interpreted as the response of interest rates to interactions between the mid-1980s economic reforms, which exerted pressures on interest rates following reduction in controls, and the early 1990s financial sector reforms, which initially induced interest rates to go up\(^{12}\) before falling after reaching their peaks. Therefore, liberalization of interest rates should not only be considered from the 1991; rather, it started earlier with the removal of controls in the economy which were among the recipes of the mid-1980s economic and structural adjustment programs.

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\(^{12}\) This was the impact of the introduction of Treasury bills
**Inflation Rate**

The structural break period on the inflation rate is detected in 1985. By visual inspection, one would be tempted to place the break period in 1994 which gives the last spike before inflation falls steeply to below 10% for almost two decades now. However, the detected break makes more sense since it divides the sample period into two different periods: 1966-1985, which was the period of increasing and volatile inflation; and the post-1985 period, which was characterized by decreasing inflation (albeit with some volatilities) at the beginning along with less volatile and more predictable inflation. This suggests the success of the reforms (both economic and financial sectors).

**Exchange Rate**

The structural break with respect to nominal exchange rate is detected in 1987. This can be associated with various reforms such as NESP-I (1981), which targeted foreign exchange earnings; SAP (1982), which intended to ensure external balance; and the adoption of the crawling peg in 1986-1992. The crawling period with its series of devaluation relaxed the strains on the official exchange rate due to controls. This structural break is also justified by the sudden drop in the parallel exchange rate following the sequence of devaluations after adoption of the crawling peg exchange rate regime. Although the sequence of devaluations during the crawling peg exchange rate regime contains the structural break in the official exchange rate that separates the strictly controlled regime and the relatively flexible exchange rate, it could not stop the growth in the parallel exchange rate. However, adoption of the crawling peg regime lowered the exchange rate premium immediately in 1986, from
which point it started decaying before disappearing in 1993 when the official and bureaus’
rates merged together.

Real GDP Growth

The year 1983 is predicted as the structural break in terms of economic growth. During the period from 1966-1983, real GDP was declining, recording negative growth rates in 1981 and 1983. After 1983, real GDP was growing and volatile until around the mid-1990s, after which time it was growing consistently before stabilizing in the range of 6% and 8% from 2001 onward. As explained before, the poor performance in the economy for the period until 1983 can be explained by many factors such as poor economic management, controls following nationalization in 1967, collapse of the EAC in 1977, the war with Uganda and the World Oil shocks in 1973 and 1981.

3.0 Summary and Conclusions

The early 1990s’ financial sector reforms in Tanzania had significant impacts on the monetary sector and the overall economy. One such impact is the transformation of the structure of the banking and financial sector from a small, static and government- dominated industry into a more private and competitive one. However, a couple of challenges still need to be resolved. Concentration of the banking and financial services in urban areas and costly credits tied up with collateral requirement are some of the remaining challenges. Another challenge still facing the banking sector is excess liquidity as a result of frictions in the credit market. Because of a lack of a credit bureau and collateral requirements, the majority of the population, especially in the informal sector, is unable to access bank loans. This has led to proliferation of the microfinance institutions to fill up the vacuum. The downside with these
microfinance institutions is that they are still not well-regulated and they charge excessive interest rates on loans. With the introduction of the credit reference bureau and streamlining of the commercial court system, it is hoped that these challenges will be resolved imminently.

The amendments of the BOT Act, particularly in 1978 and 1995, amplified the central bank’s autonomy in executing its key functions. The BOT Act 1978 empowered the central bank to inspect banks and financial institutions in the country, while the BOT Act of 1995 empowered it to ensure price stability as the primary objective. These provided a good environment for the central bank to conduct sound monetary policy compared to the period when the central bank had no information on what was happening in the banking and financial sectors at the same time it was overwhelmed with a series of objectives mainly to meet government development plans. With the 1990s’ financial sector reforms, the central bank was able to switch from using crude instruments of monetary policy, mainly control-related instruments into market-based instruments. This was a positive move since it entailed abandoning the distortions associated with controls in interest rates, credit allocations and adopting a market economy in which interest rates and direction of credit flows were determined by market forces.

These reforms also led to a switch from the fixed exchange rate regime, gradually starting with a crawling peg in 1986 before moving to the flexible exchange rate regime in 1992. With a flexible (market-determined) exchange rate regime, the economy was free from the distortions related to exchange rate controls such as exchange rate premium or speculations related to the ability of the central bank to back up the value of the shilling.
The ultimate outcome of the 1990s’ financial sector reforms is the stability in macroeconomic variables which was the envisaged main goal. That is, interest rates became market-determined inflation was reduced from above 30% in 1994 to a single digit starting from 1995. Further, these reforms have led to stable economic growth, currently averaging above 6% and a market-determined exchange rate which depends on market forces. It can be noted that with exchange rate liberalization, the exchange rate has been depreciating over time. This indicates the role of market forces in the exchange rate adjustment, which is a subject discussed in chapter four. Given these reforms, chapter three examines whether there has been a systematic relationship between monetary policy targets and indicators.

Table 2.1: Percentage of Gross Loans to Total Deposits

<table>
<thead>
<tr>
<th>Year</th>
<th>CRDB</th>
<th>NMB</th>
<th>NBC</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>25.3</td>
<td>0.1</td>
<td>21.4</td>
<td>15.6</td>
</tr>
<tr>
<td>2001</td>
<td>19.5</td>
<td>4.2</td>
<td>26.0</td>
<td>16.5</td>
</tr>
<tr>
<td>2002</td>
<td>17.1</td>
<td>2.8</td>
<td>28.4</td>
<td>16.1</td>
</tr>
<tr>
<td>2003</td>
<td>19.0</td>
<td>7.7</td>
<td>43.7</td>
<td>23.5</td>
</tr>
<tr>
<td>2004</td>
<td>38.4</td>
<td>16.2</td>
<td>48.9</td>
<td>34.5</td>
</tr>
<tr>
<td>2005</td>
<td>30.9</td>
<td>13.6</td>
<td>53.2</td>
<td>32.6</td>
</tr>
<tr>
<td>2006</td>
<td>52.0</td>
<td>20.6</td>
<td>53.9</td>
<td>42.1</td>
</tr>
<tr>
<td>2007</td>
<td>59.5</td>
<td>39.1</td>
<td>60.8</td>
<td>53.1</td>
</tr>
<tr>
<td>2008</td>
<td>66.9</td>
<td>49.1</td>
<td>75.8</td>
<td>63.9</td>
</tr>
<tr>
<td>2009</td>
<td>66.9</td>
<td>47.4</td>
<td>68.0</td>
<td>58.8</td>
</tr>
</tbody>
</table>

Data Source: Qin and Pastory (2012)
Figure 2.1: Growth Rates in Real GDP and Real Exports

Figure 2.2: Fiscal Deficits as Percentage of GDP
Figure 2.3: Developments in Monetary Base and Fiscal Deficit

Note: There is no data on fiscal deficit before 1996.

Figure 2.4: Percentage of Currency to Broad Money Supply (M2 and M3)
Figure 2.5: Foreign Currency Deposits as Percentage of Extended Broad Money Supply (M3)

Figure 2.6: Official and Parallel Exchange Rates (TZS/USD)
Figure 2.7: Exchange Rate Premium (Parallel minus Official)

Figure 2.8: Official Level of Foreign Exchange Reserves and Exchange Rate Premium
Figure 2.9: Developments in Exchange Rates and Official Foreign Exchange Reserves

Figure 2.10: Exchange Rate Premium and Inflation Rate
Figure 2.11: Parallel Exchange Rate and Inflation Rate

Figure 2.12: Nominal Interest Rates
Figure 2.13: Real Interest Rates

Figure 2.14: Private Credit to the Private Sector as Percentage of GDP
Figure 2.15: Comparison of Credit to the Private Sector (% of GDP) in East Africa

Data Source: Qin and Pastory (2012)

Figure 2.16: Gross Loans as Percentage of Total Deposits

Data Source: Qin and Pastory (2012)
Figure 2.17: Fiscal Performance

Figure 2.18: Comparison of Exchange Rate in East Africa
Figure 2.19: Cross Exchange Rates in East Africa

Figure 2.20: Comparison of Treasury Bill Rates in East Africa
Figure 2.21: Comparison of Discount Rates in East Africa

Figure 2.22: Comparison of Time Deposit Rates in East Africa
Figure 2.23: Comparison of Saving Rates in East Africa

Figure 2.24: Comparison of Lending Rates in East Africa
Figure 2.25: Comparison of Inflation Rates in East Africa
Figure 2.26: Breakpoint t-statistics for Structural Break test
REFERENCES


CHAPTER 3: THE SYSTEMATIC RELATIONSHIP BETWEEN MONETARY POLICY TARGETS AND MONETARY POLICY INDICATORS

1.0 Introduction

The Bank of Tanzania (BOT) has been doing all the usual central bank functions\(^{13}\) since its inception in 1966. However, the conduct of monetary policy has not been static, changing over time to catch up with various changes taking place in the political, economic and financial arenas. Such changes can be attributed to changes in government goals. For instance, during implementation of government goals like the building of the socialist economy and execution of agricultural and industrial programs, instruments of monetary policy were linked to these endeavors. That is, monetary policy instruments were customized to reflect government development plans. Typical examples of government development plans which were executed by the central bank in the form of instruments of monetary policy are the Agricultural Finance Credit Plan (AFCP) and the Foreign Exchange Plan (FEP) in 1971-72. Other factors that contributed to changes in the conduct of monetary policy include the evolution of the banking and financial sector following the 1990s financial sector reforms, changes in the exchange rate regimes, increasing autonomy of the Central Bank in conducting monetary policy and supervision of the banking and financial sector following the various amendments of the Bank of Tanzania Act (the BOT Acts of 1978 and 1995).

This study focuses on monetary policy as an important role of any central bank. Since the establishment of the BOT in 1966, the conduct of monetary policy has moved from using non-market-based instruments (direct instruments) to market-based instruments (indirect

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\(^{13}\) Issuance of currency, device and implement monetary policy, supervise the banking and financial system, lender of the last resort to government and banks, and custodian and manager of the country’s foreign exchange reserves.
instruments) of monetary policy. In terms of the monetary policy framework, the BOT now targets the monetary base, which is deemed to offer an effective monetary policy transmission mechanism given the low level of financial development as a result of the heavy financial sector repression which existed for two decades until the early 1990s. Monetary targeting, which works through the credit channel, is thought to offer a more relevant transmission mechanism than interest rate targeting (that works through an interest rate channel) in a less developed financial sector (Khan, 2010; Sanchez-Fung, 2002).

In the early-1990s, Tanzania started to pursue financial sector reforms which have now transformed the banking and financial sectors. With such changes in the banking and financial sectors, there are signs that a monetary policy transmission mechanism via an interest rate channel is plausible as indicated by the dynamic and market-determined interest rates following liberalization of interest rates in 1991 as illustrated in chapter two. Monetary targeting (monetary base) has been preferred in emerging market economies because of inefficient financial markets in addition to uncompetitive banking and financial sector. While it is hard to determine financial market efficiency, there has been significant improvement in Tanzania’s banking and financial sectors as explained in chapter two. The current Tanzanian banking and financial sector can be said to be competitive as indicated by the fast-growing number of commercial banks and relatively low lending rates. Although the BOT currently does not target an interest rate explicitly in conducting monetary policy, it does so indirectly through manipulation of the monetary base. This means that in conducting monetary policy, the BOT keeps an eye on the short-term indicative interest rates (average lending rate, 3-

14 Nevertheless, deposit rates are still low compared to lending rates which poses a challenge to the banking and financial sector despite the significant transformation made by the 1990s financial sector reforms.
month Treasury bill rate, discount rate, and the repo rate). The literature reveals a consensus that the exchange rate is an important variable in the central bank reaction function for small and open market economies (Mehrotra & Sanchez-Fung, 2011; Rotich et al., 2007; Sanchez-Fung, 2002).

The objective of this study is to determine how the Bank of Tanzania reacts to inflation and output gaps as well as to changes in exchange rates. This study is not an assessment of the effectiveness of monetary policy; rather, it is about uncovering the rule-like behavior of the BOT in regard to inflation, output and exchange rates. Specifically, it seeks to establish empirical relationships between monetary policy targets and monetary policy indicators. This involves testing whether the BOT responds to inflation and the output gap and to changes in the nominal exchange rate. The nominal exchange rate is considered in this study because of its role in monetary policy especially for a small open-market economy like Tanzania’s. From this analysis, I hope to come up with a proximate standard reaction function that describes the rule-like behavior of the BOT towards shocks related to inflation, output and the exchange rate. This study contributes to the literature in several ways. It is the first empirical work on Tanzania that investigates the behavior of the central bank in conducting monetary policy. The study also adds to the prevailing scanty empirical literature on emerging market economies, particularly from Sub-Saharan Africa (SSA).

I test two main hypotheses. First I test whether there is a systematic relationship between monetary policy targets and monetary policy indicators which can be explained by the Taylor-type or McCallum-type rules. Specifically, does the central bank tighten monetary policy in response to increases in output and inflation above the perceived long-term average
targets (potential) or when the exchange rate depreciates? Second, does the central bank use a partial adjustment approach when implementing monetary policy? In testing these hypotheses, the basic models of this study are the Taylor and McCallum rules as specified in equations (3.1) and (3.2).

**Taylor – Type Rule**

Brouwer and Gilbert (2005) restate the Taylor rule that “the monetary authorities move the nominal interest rate above (below) neutral when inflation is above (below) the target and/or output is above (below) potential” (p. 125). Using the specification of Clarida et al (2000), this statement can be written as,

\[
i_t^* = i^* + \beta_r (E_t[\pi_{t+n}|\Omega_t - \pi^*]) + \lambda_r (E_t[y_{t+m}|\Omega_t] - y^*)
\]

(3.1)

where \(i_t^*\) is the nominal target rate, \(i^* = r^* + E_t[\pi_{t+n}|\Omega_t]\) is the desired nominal interest rate. \(E_t[\pi_{t+n}|\Omega_t]\) and \(E_t[y_{t+m}|\Omega_t]\) are the expected inflation and real output. \(\pi^*\) is the inflation target and \(y^*\) is the potential output. The parameter \(\Omega_t\) is the information set at the time the central bank sets the nominal interest rate. The Taylor rule requires \(\beta_r >0\) and \(\lambda_r >0\).

**McCallum-Type Rule**

McCallum (2002) specifies the central bank monetary base rule as

\[
\Delta b_t^* = \Delta x^* - \Delta v_t + \lambda_M (\Delta x^* - \Delta x_{t-1})
\]

(3.2)

---

15 Since \(i^* = r^* + E_t[\pi_{t+n}|\Omega_t]\), \(\beta_r >0\) implies that the interest rate target rises by more than the increase in inflation.

16 Consistent with other studies in the literature (e.g., McCallum, 1988), this study considers the general parameter “\(\lambda\)” as the coefficient on nominal output changes, instead of the 0.5 special case in McCallum 2002. \(b_t, x_t\) and \(v_t\) logs.
\(\Delta b_t^*\) is the desired growth in the monetary base, \(\Delta v_t\) is the annual growth of the monetary base velocity measured as an average over the four preceding years. The change in the monetary base velocity is intended to take into account the effect of technology and regulatory changes on the growth of base velocity (Rotich et al., 2007). \(\Delta x^*\) is the nominal income (GDP) target. \(\lambda_M\) is the coefficient on nominal output gap with the subscript ‘M’ stands for McCallum. The rule requires that \(\lambda_M > 0\) so that the central bank increases the rate of growth of the monetary base when nominal GDP growth is below the target. All these variables are measured as annual percentage changes. For more details on the definition and construction of the variables in the central bank reactions functions, see table 3.2 in section 3.2.

2.0 Literature Review

A number of studies have been conducted on the central bank reaction functions by academicians and policymakers. However, most of these studies are concentrated in developed countries, (Frankel, 2010; Rotich et al., 2007). There are few studies in emerging market economies, particularly from Sub-Saharan Africa. Studies on this topic basically focus on assessing how central banks behave when subjected to economic shocks. Since these are empirical questions, most studies are empirical in nature. Further, most of these studies focus on whether a central bank accommodates (leans with the wind) or does not accommodate (leans against the wind) shocks.

Apart from the common set of questions in the literature, the types of models used in most studies is another area of general consensus. The key baseline models in the literature are the Taylor rule (1993), McCallum or monetary base rule (1988, 2002) and, in a few cases,
the Nominal Income Targeting (NIT) of McCallum (1997). The Taylor rule has been commonly applied in developed market economies where the financial system is effective and therefore the monetary policy transmission mechanism through interest rates is effective.

Despite these commonalities in the literature (research questions and models), estimation techniques vary greatly. Estimation techniques in the literature include Ordinary Least Squares (OLS), Generalized Method of Moments (GMM), or Vector Autoregressive (VAR).

One of the challenges facing monetary policy formulation and implementation in developing countries is the issue of ineffective financial markets (Kasekende & Brownbridge, 2011; Khan, 2010). Emerging market economies are characterized by various challenges such as less developed and fragile financial institutions, limited central bank autonomy, and scarce monetary policy instruments (Mehrotra & Sanchez-Fung, 2011). All these factors impede the monetary policy transmission mechanism process via the interest rate channel, rendering the Taylor rule less feasible, especially before the economic and financial sector reforms, which for most emerging market economies (particularly from Sub-Saharan Africa) took place from the early 1990s. The credit channel in which monetary policy works by influencing the money stock (and credit) tends to be the relevant transmission mechanism in developing countries (Khan, 2010; Rotich et al., 2007; Sanchez, 2002). In response to the weak transmission mechanism, some studies in the literature advocate the monetary base rule (McCallum, 1988, 2002) or the nominal income target-NIT (Dennis, 2001; Frisch and Staudinger, 2003; McCallum, 1997).
Given the nature of the transmission mechanism in developing market economies and the problem of data uncertainty, a number of advantages are associated with the use of the NIT. Among others, it provides a solution to the problem of decomposing nominal income growth between real growth and inflation and also reduces nominal income variability, (McCallum, 1988). However, the NIT is criticized because such models generate higher instabilities in inflation and output, (Ball, 1999; Rudebusch, 2002; Svensson, 1999). A review of the past literature shows that the effect of NIT on inflation and output instability rests on the specification of the Phillips curve. Some studies (Dennis, 2001; Frisch & Staudinger, 2003; Rudebusch, 2002) acknowledge that the New Keynesian Phillips Curve (NKPC) offers a crucial theoretical analysis. Nevertheless, empirical evidence does not support the Ball-Svensson instability problem if the specification of the Phillips Curve involves some elements of non-zero forward-looking rules (Dennis, 2001; Frisch & Staudinger, 2003; McCallum, 1997).

Ball (1999) criticizes the forward-looking models despite their strong theoretical foundations on the grounds that they fail to fit the data as they are incapable of generating the inflation inertia contained in the data. However, empirical evidence by many policymakers shows that the role of forward-looking behavior in monetary policymaking is crucial, especially when the model involves nominal income targeting. The literature shows that both backward looking and forward looking assumptions are valid depending on what is in a central bank’s information set at the time of setting the policy target.

The presence of the exchange rate term in the central bank reaction function is generally acceptable in the literature, especially for emerging market economies (Ball, 1999;
Mehrotra & Sanchez-Fung, 2011; Rotich et al., 2007). The argument for the exchange rate term in the central bank reaction function is that it captures shocks related to the open market economy. Thus, the exchange rate in small open market economies generates an additional and crucial channel through which the monetary policy transmission mechanism takes place (Svensson, 2000).

Despite the consensus portrayed in the literature on the role of the exchange rate, studies differ on the specification of the exchange rate term. For instance, while some studies consider changes in the nominal exchange rate (Rotich et al., 2007), others consider the differential between the official and parallel exchange rates (Sanchez-Fung, 2011). However, the choice between exchange rate changes and the differential between the official and parallel is obvious since it depends on the prevailing exchange rate regime of a country. For instance, Sanchez-Fung (2011) uses the exchange rate differential in the Brazilian central bank reaction function because the economy was running dual exchange rate regimes (official and black market exchange rate) at the time.

This study underscores the role of the exchange rate in a small open economy like Tanzania’s. Since the sample period in this study falls in the post-reform period (wherein official and parallel exchange rates were merged), the main concern of the central bank during this period was not the exchange rate premium but the stability of the official exchange rate. Therefore, the relevant specification of the exchange rate term in this study is the change in the exchange rate.

Most central bank reaction functions in the literature include the lagged policy target variable in order to capture partial adjustment to the policy target, (Ball, 1999; Leitemo and
Looning, 2006). Ball (1999) argues that, “models that lack inflation inertia produce misleading prescriptions for policy. --- a rise in inflation does not require tighter policy because, without inertia inflation disappears by itself” (p. 68). Leitemo and Looning (2006) also argue, “The reason why central banks add changes in interest rates is that, changes in interest rates may cause financial instability” (p. 1630). Yau (2010) agrees and argues further that central banks smooth interest rates to avoid abrupt changes that would lead to a loss of credibility. Taking a different angle, Rudebusch (2002) argues that the rationale for the lagged policy variable is not about partial adjustment but its ability to mop up serial correlations of the relevant omitted variables. The above economic (partial adjustment) and econometric (mopping up serial correlations) arguments both validate the presence of the lagged dependent variable in the model. That is, the lagged policy variable plays both the economic role of partial adjustment and the econometric role of mopping up serial correlations (Kristen, 2004).

To measure the output gap, many studies in the literature employ the Hodrick-Prescott (HP) filter given that potential output or unemployment is not recorded in many developing countries. Since the Bank of Tanzania does not formally target inflation, and the monetary policy framework is monetary targeting, there is no observable data on the inflation target and the desired interest rate. Therefore, in this study, I estimate the Taylor-type and McCallum-type rules using inflation rate and output gap (and nominal output growth) in addition to changes in the nominal exchange rate as monetary policy indicators.

The literature shows some flaws in the specification of the McCallum rule (Rotich et al., 2007; Sanchez-Fung, 2002). Sanchez-Fung normalizes the monetary base with GDP
while Rotich et al. (2007) uses the extended money supply (M3) in the place of the monetary base. These contradict the McCallum specification because the policy target has to be under the control of the central bank. Normalizing the monetary base by GDP eliminates the qualities of being a policy target because the central bank has no control over GDP. The same argument renders M3 unsuitable to stand in the place of the monetary base.

With regards to estimation method, most of the studies use the Generalized Method of Moments (Bernanke & Blinder, 1992; Brouwer and Gilbert, 2005; Clarida et al., 2000; Rotich et al., 2007). Brouwer and Gilbert (2005) argue that “GMM is the workhorse of rational expectations,” pointing out that the OLS estimates for models involving rational expectations are not consistent because the regressors are correlated with the error term and hence violates the exogeneity condition, which is one of the crucial Gauss Markov assumptions. Other estimation methods include Dynamic OLS (DOLS); Instrumental Variable (IV) (Brouwer & Gilbert, 2005); Vector Autoregressions (VAR) (Bernanke & Blinder, 1992; Murchison & Siklos, 1998); Multiple Indicators Multiple Causes-MIMIC, (Bernanke & Blinder, 1992). In this study I estimate the Taylor-type and McCallum-type rules using the GMM estimation technique in order to handle the possible serial correlation problem and the potential simultaneity between the interest rate and the inflation rate.

The results in the literature vary significantly perhaps because of the great variability in the assumptions used in the model specifications, variability in sample sizes, and differences in the specification of the variables used. Below is a brief discussion of empirical results on central bank reaction functions.
Clarida et al. (2000) estimate what they claim is a forward-looking Taylor-type monetary policy reaction function for the U.S. for the period before and after Volcker’s chairmanship of the Federal Reserve in 1979. They fit the Taylor rule model with an inflation gap and two versions of the output gap (output-based and unemployment-based). The results reveal evidence of significant difference between the two regimes. They find that monetary policy was exceedingly non-accommodating during the Volcker-Greenspan era compared to the pre-Volcker period\textsuperscript{17}.

Naraidoo and Raputsoane (2010) estimate the optimal response of the South African Reserve Bank (SARB) to deviations in inflation and output from their target values over the inflation targeting period. Their model allows zone-like and asymmetric policy behavior of the central bank. Their findings show that the SARB response to the inflation zone is symmetric while the response to the output gap fluctuations is asymmetric. The SARB responds less aggressively when inflation is in the target zone band, but it reacts aggressively when inflation crosses out of the target band.

Rotich et al. (2007) investigate the behavior of the Central Bank of Kenya in relation to changes in inflation, output growth, and the exchange rate by estimating modified Taylor-type and McCallum-type rules that take account of the Kenyan economic characteristics (market efficiency and the competitiveness of the banking sector). Using the generalized method of moments (GMM), they conclude that the central bank of Kenya leans against the wind (non-accommodative monetary policy).

\textsuperscript{17} The coefficients associated with inflation gap are 0.83 and 2.15 in the pre-Volcker and Volcker-Greenspan, respectively, while the coefficient associated with output gap are 0.27 and 0.93 in the pre-Volcker and Volcker-Greenspan eras, respectively.
Mehrotra and Sanchez-Fung (2010) estimate central bank reaction functions for twenty emerging market economies. In the Taylor-type rules, they define the nominal interest rates as the official policy interest rate; they estimate the rules using OLS and GMM techniques. The Taylor-rule results show that the coefficient on the inflation gap is statistically significant with the expected positive sign in five countries but is smaller than one, implying that central banks are not aggressive enough in combating inflation. The coefficient on the output gap is statistically significant with the expected positive sign in seven countries. The Hybrid McCallum-Taylor rule results show that the coefficient on the output gap is either not statistically significant or has the wrong sign for most of the countries under study. Most of the coefficients on the output gap are significant but with an unexpected negative sign except for South Korea. The coefficient on the exchange rate is statistically significant with the expected positive sign for Israel, Peru, Philippines, South Africa, and Thailand. The McCallum-type results show that the output gap is statistically significant with the expected negative sign for Costa Rica and Malaysia while the coefficient of the exchange rate is statistically significant with the expected negative sign only for Malaysia. They conclude that the McCallum-Taylor model with an interest rate target and nominal income gap target performs better than the baseline rule reaction function in describing monetary policy of inflation targeting economies.

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18 Overnight bank loans (Peru), repo rate (Philippines and Thailand), discount rate (South Africa), and overnight lending rate (Turkey)
19 The countries and the respective coefficients: Chile (0.45), Israel (0.12), Philippine (0.19), Thailand (0.39), and Turkey (0.54)
20 The countries and the respective coefficients: Chile (0.48), Colombia (0.41), Mexico (0.20), Peru (0.24), Poland (0.36), South Africa (0.84), and South Korea (0.11).
Sanchez-Fung (2002) estimates a hybrid monetary policy reaction function for the Dominican Republic (DR) in which the monetary base is the dependent variable. He also includes the exchange rate differential between the market rate and the official rate to capture the shocks from multiple exchange rates given that the DR had a multiple-exchange-rate regime. The model is specified as an autoregressive distributed lag (ADL) and estimated with OLS starting with an over-parameterized model with two lags (ADL (2, 2)). The final parsimonious model is the monetary base as a function of its first lag, the contemporaneous and second lag of the exchange rate differential, and an impulse dummy variable that captures the impact of devaluation in 1985.

The results of the final model\textsuperscript{21} show evidence of leaning against the wind with respect to the contemporaneous exchange rate differential (coefficient of -0.66). On the basis of the statistical significance of the lagged monetary base, the results show evidence of monetary policy partial adjustment. The author concludes that the central bank of the Dominican Republic is biased towards targeting the exchange rate differentials between the market and official exchange rates. Table 3.1 provides a summary of the empirical estimates on selected studies based on Taylor and McCallum rules.

This study is similar to the Rotich et al. (2007) using Kenyan data in a number of ways, including the objective and some of the research questions. Kenya and Tanzania are part of the current East African Community (EAC) which has a package of economic goals (common market). Other member countries include Burundi, Rwanda and Uganda. One of the economic motives that render this subject important at the moment is the envisaged

\textsuperscript{21} The results (Sanchez-Fung, 2002) reported in table 3.1 are those from a complete model rather than from the parsimonious model
monetary cooperation among the EAC member countries. Rotich et al. (2007) mirror what the Central Bank of Kenya has been doing in monetary policy execution and also provide a guide to the management process of macroeconomics towards the envisaged East African Monetary Cooperation. For the same reason, such a study is relevant for Tanzania (also for the rest of the member countries) before the monetary cooperation comes into full swing. Given this importance, I conducted this study for Tanzania while circumventing some of the flaws in the Rotich et al. (2007) study.

Though Rotich et al. (2007) deserve credit for their contribution to the thin empirical literature on the subject of Sub-Saharan Africa, their paper contains some flaws that imply biases in their results. In their model specification, Rotich et al. (2007) treat the extended broad money supply (M3) as the dependent variable, which implies that the Central Bank of Kenya targets the broad money supply. This contradicts the McCallum rule specification which uses the monetary base because it is controlled by the central bank. Another troubling issue in their study is the short period of observation, which would imply a small sample (1997-2006), but they circumvent the short-sample problem by using monthly time series via interpolation of gross national product (GDP) from annual data. This is likely to lead to biased results due to the concentration of the policy changes in a short period of only nine years because of negative cycles around elections and other political changes (such as coup d’états) in developing countries.

This study differs from Rotich et al. (2007) by employing the appropriate sequence of the effects of monetary policy on output and inflation as advocated in the literature using the monetary base (in the McCallum rule) as the policy target instead of other monetary
aggregates; this study also uses appropriate variables which are likely to play the role of indicator variables in the economy. Further, this study differs from Rotich et al. (2007) by using a relatively longer period of about 20 years (1992-2011) with quarterly data, which is hoped to ensure adequate degrees of freedom while capturing the actual policy changes.

3.0 Models, Variables and Estimation Method

3.1 Models

In the models section, I derive modified versions of the Taylor (1993) and McCallum (1988) rules that include the exchange rate in order to examine whether there is any systematic relationship between monetary policy targets and indicators. The models also allow for partial adjustments in order to determine whether monetary policy involves partial adjustment. Since they are modifications of the baseline Taylor and McCallum rules, I start by describing the baseline Taylor and McCallum rules to which I introduce the relevant deviations (partial adjustment and exchange rate).

Deviation from the Taylor and McCallum Baseline Rules

While the Taylor rule was highly cerebrated because it tracked developments in the funds rate in the U.S., studies in the literature use variants rather than the original form. The same also has been the case for the McCallum rule. The key modifications from the baseline rules in most cases include introduction of the exchange rate and partial adjustment. While the exchange rate variable enters into the central bank reaction function because it captures external shocks especially for small open market economies, the lagged dependent variable allows for possible monetary policy inertia.
Introduction of the Exchange Rate Variable

One can include the change in the nominal exchange rate ($\Delta s_t$) in the baseline Taylor and McCallum rules in equation (3.1) and (3.2) as one of the indicator variables, which the central bank takes into account when conducting monetary policy. Note that the exchange rate is defined as Tanzanian shillings per unit of U.S. dollar, such that a positive change in the exchange rate ($\Delta s_t > 0$) implies depreciation of the exchange rate. Including the exchange rate in the monetary policy rule implies the assumption that the central bank changes the interest rate or the monetary base in response to changes in the nominal exchange rate. Specifically, the central bank tightens monetary policy in response to exchange rate depreciation. By introducing the change in the nominal exchange rate variable in the central bank reaction function, equations (3.1) and (3.2) become

$$i_t^* = i^* + \beta_T (E_t [\pi_{t+n} | \Omega_t] - \pi^*) + \lambda_T (E_t [y_{t+m} | \Omega_t] - y^*) + \delta_T \Delta s_t$$

(3.3)

$$\Delta b_t^* = \Delta x^* - \Delta v_t + \lambda_M (\Delta x^* - \Delta x_{t-1}) + \delta_M \Delta s_t$$

(3.4)

The parameters $\delta_T$ and $\delta_M$ are the coefficients of the change in the nominal exchange rate in the Taylor-type and McCallum-type rules, respectively. The Taylor-type and McCallum-type rules require that $\delta_T > 0$ and $\delta_M < 0$, respectively.

Equation (3.3) states that the target rate is determined by the desired rate, deviations from the targets for inflation and real output, and changes in the nominal exchange rate. Equation (3.4) implies that the target growth in the monetary base is determined by the difference between the desired growth in the nominal output ($\Delta x^*$) and change in the monetary base velocity ($\Delta v_t$) adjusted for the nominal output gap ($\Delta x^* - \Delta x_{t-1}$) and by changes in the nominal exchange rate ($\Delta s_t$).
**Introduction of the Partial Adjustment Term**

Clarida et al. (2000) argue that without monetary policy partial adjustment, the target rule would be too restrictive to describe the actual movements in the interest rate. They argue further that a central bank’s rule without partial adjustment would incorrectly mean that the central bank has perfect control over interest rates in the sense that any observed change in the interest rate would be interpreted to reflect the central bank’s systematic reaction to monetary policy indicators. Another rationale for partial adjustment in the central bank reaction function is to provide a mechanism to minimize abrupt changes in the interest rate (and growth in monetary base) in order to preserve credibility of the central bank to the public and ensure stability of the financial markets (Yau, 2010). Giannoni and Woodford (2003a and 2003b) provide both theoretical and empirical justifications for the importance of partial adjustment in monetary policy rules based on optimal monetary policy rules. This study assumes that the central bank adjusts the short term nominal interest rate ($i_t$) and growth in the monetary base ($\Delta b_t$) according to the rules in equations (3.5) and (3.6) below:

\[ i_t = \rho_T i_{t-1} + (1 - \rho_T) i^*_t + \varepsilon_t \quad (3.5) \]

\[ \Delta b_t = \rho_M \Delta b_{t-1} + (1 - \rho_M) \Delta b^*_t + u_t \quad (3.6) \]

The $\Delta b_t$ is the percentage change in the monetary base. $\rho_T$ and $\rho_M$ are smoothing parameters in the Taylor-type and McCallum-type rules, respectively, such that $0 \leq \rho_T, \rho_M \leq 1$. Monetary policy inertia or partial adjustment is said to exist when $0 < \rho_T, \rho_M < 1$. The variables $\varepsilon_t$ and $u_t$ are the zero-mean constant-variance monetary policy shocks.
Equations (3.5) and (3.6) describe partial adjustment of the monetary policy to its targets; the current values of \(i_t\) or \(\Delta b_t\) are determined as weighted sums of the targets and the previous values of \(i_t\) and \(\Delta b_t\).

**Derivations of the Taylor-Type and McCallum-Type Rules**

Substituting equation (3.3) into equation (3.5) and equation (3.4) into (3.6) yields

\[
i_t = \rho_T i_{t-1} + (1 - \rho_T)(i^* - \beta_T \pi^*) + \beta_T (E_t[\pi_{t+n}|\Omega_t]) + \\
+ \lambda_T (E_t[y_{t+m}|\Omega_t] - y^*) + \delta_T s_t + \varepsilon_t
\]  

(3.7)

\[
\Delta b_t = \rho \Delta b_{t-1} + (1 - \rho_M)(\Delta x^* - \Delta v_t) + (1 - \rho_M) \lambda_M (\Delta x^* - \Delta x_{t-1}) + \\
\delta_M s_t + u_t
\]  

(3.8)

One of the challenges in estimating equation (3.7) is that the parameters \(i^*\) and \(\pi^*\) are not observable. For countries with less frequent regulations and slow pace of development in financial technology (financial products), it seems justifiable to set the change in monetary base velocity to zero (i.e., \(\Delta v_t = 0\)), especially in a short period such as one year. Alternatively, the safest way to get rid of the velocity term is to put it under the constant term and error term.

Let the constants \(\alpha_T\) and \(\alpha_M\) be

\[
\alpha_T = i^* - \beta_T \pi^*
\]  

(3.9)

\[
\alpha_M = \Delta x^* - \Delta v_t
\]  

(3.10)

Substituting equation (3.9) into (3.7), and (3.10) into (3.8), yields

\[
i_t = (1 - \rho_T) \alpha_T + \rho_T i_{t-1} + (1 - \rho_T) \beta_T \pi_{t+n} + (1 - \rho_T) \lambda_T (y_{t+m} - y^*) + \\
(1 - \rho_T) \delta_T s_{t+k} + \eta_t
\]  

(3.11)
\[ \Delta b_t = (1 - \rho_M)\alpha_M + \rho_M \Delta b_{t-1} + (1 - \rho_M) \lambda_M (\Delta x^* - \Delta x_{t-1}) + \\
(1 - \rho_M) \delta_M \Delta s_t + \xi_t \]  

(3.12)

The error terms \( \eta_t \) and \( \xi_t \) are the linear combinations of forecast errors and are assumed to be orthogonal to each variable in the central bank information set.

Equations (3.11) and (3.12) contain observable variables and parameters that can be estimated by taking expected values of the error terms:

\[ E(Z_t \eta_t(\theta_0)) = 0 \]

\[ E(W_t \xi_t(\phi_0)) = 0 \]

The \( Z_t \) and \( W_t \) are the vectors of instruments in the Taylor-type and McCallum-type rules, respectively, while \( \theta_0 \) and \( \phi_0 \) are the vectors of parameters in the Taylor-type and McCallum-type rules, respectively. Equations (3.11) and (3.12) are the Taylor-type and McCallum-type rules to be estimated in this study.

**Theoretical Predictions of the Taylor-Type and McCallum-Type Rules**

According to the Taylor-type rule in equation (3.11), a higher real output gap exerts inflationary pressures. In this case, the best response for the central bank is to pursue a tighter monetary policy in order to slow down the growth in aggregate demand. This can be achieved by increasing the short term (policy) nominal interest rate. This implies that the coefficient on the real output gap has to be positive, i.e., \( (1 - \rho_T) \lambda_T > 0 \). Since \( 0 < \rho_T < 1 \) under partial adjustment, then \( \lambda_T > 0 \). Monetary tightening is also the central bank’s best response to a positive inflation shock. This requires increasing the nominal interest rate in order to reduce the supply of money in the economy. Therefore, the coefficient on the inflation variable has to be positive, i.e., \( (1 - \rho_T) \beta_T > 0 \), which implies that \( \beta_T > 0 \). The
coefficient on the nominal change in the exchange rate variable also has to be positive since the central bank defends its currency against depreciation by tightening monetary policy through raising the policy interest rate i.e., \((1 - \rho_T)\delta_T > 0\), which suggests that \(\delta_T > 0\).

For the monetary base rule, since the central bank responds to an excess output gap and exchange rate depreciation by tightening monetary policy, the coefficients on the nominal output gap and change in the nominal exchange rate are predicted to be positive and negative, respectively. That is, \((1 - \rho_M)\lambda_M > 0\) and \((1 - \rho_M)\delta_M < 0\), implying that \(\lambda_M > 0\) and \(\delta_M < 0\).

### 3.2 Variables and Data Transformations

Table 3.2 describes the variables and data transformations for the data used in this chapter. Data availability poses a challenge to the estimation of central bank reaction functions. While data on GDP are not available at a quarterly frequency, there are no published data on potential output; therefore, there is no observable data on output gaps, which are the key indicators in the Taylor rule (real output gap) and the McCallum rule (nominal output gap). Moreover, there are no data on other alternative measures of economic activity like unemployment. Given this challenge, I adopt the common approaches applied in the literature to resolve this challenge: interpolation of annual GDP to quarterly data and obtain output gaps (real and nominal) by de-trending GDP data based on the Hodrick-Prescott (HP) filter.

The quarterly data on GDP (nominal and real) are obtained by interpolating annual GDP data using the broad money supply (M2) seasonal distribution properties. M2 is chosen because it is not among the indicator (independent) variables in the two central bank reaction
functions, but it is theoretically related (in the demand for money function) to economic activity in a monetized economy.

With regards to inflation, this study does not use the gap concept because the target is not known, so it is estimated (i.e., $\alpha_T = i^* - \beta_T \pi^*$). Figure 3.1 shows bivariate illustrations of the variables in the monetary policy rules as they are defined in table 3.2.

**Variables in the Taylor-Type Rule**

This section describes the bivariate plots between the interest rate (monetary policy target) and each of the indicator variables in the Taylor-type rule as portrayed in the left panel of figure 3.1. The bivariate plot between the discount rate and the real output gap does not provide a comprehensible pattern between the two variables. This can be explained by the volatility in the real output gap, which, on average, tends to oscillate around zero percent. The interest rate and inflation rate clearly depict a positive relationship as shown by the co-movements between the two. Over the sample period, the interest rate and inflation rate declined over time while maintaining a strong positive relationship. This is consistent with the Taylor rule prediction and Fisher relationship. Although the changes in the nominal exchange rate are volatile, one can still establish a positive relationship between the interest rate and the change in the nominal exchange rate since each variable broadly tracks the swings of the other.

**Variables in the McCallum-Type Rule**

In figure 3.1, the right panel portrays bivariate plots between the change in the monetary base and each of the indicator variables in the McCallum-type rule. The bottom plot in the right panel is the plot between the two target variables (interest rate and change in
the monetary base). For the variables in the McCallum-type rule, one can establish a positive relationship between the growth in the monetary base and the nominal output gap since the two variables seem to move together. The same clear relationship can be established between the growth in the monetary base and the changes in the nominal exchange rate. These negative relationships are consistent with the prediction of the McCallum rule.

3.3 Estimation Method

This section provides a brief description of the GMM estimation technique which is the main estimation method in this chapter. It was observed in the literature review that most studies use the GMM estimation method because of the potential serial correlation as a result of rational expectations embedded in the central bank reaction functions. In setting monetary policy targets, central bank decisions depend on the past values (backward looking) or expected value (forward looking). Therefore, central bank reaction functions are estimated using either lead or lagged indicators. Further, the central bank reaction functions suffer from a simultaneity (or endogeneity) problem (interest rate and inflation rate). These problems can adequately be handled by using the GMM estimation technique.

Stationarity Tests

The Augmented Dickey Fuller (ADF) and Phillips Perron (PP) unit roots tests are used to determine the time series characteristics of the data. Unit roots tests are sensitive to the number of lags; therefore, the optimal number of lags for each variable is determined as suggested by information criteria\textsuperscript{22}.

\textsuperscript{22} These are Akaike Information Criteria (AIC), Final Prediction Error (FPE), and the Schwartz or Bayesian Information Criteria (SBIC)
**Hansen’s Over-Identifying Restrictions**

To ascertain the validity of the instruments used in the GMM estimation of the identified model, I use the Hansen’s J-test under the null hypothesis that all the instruments are valid. The test is asymptotically Chi-square distributed with degrees of freedom equal to the number of over-identifying restrictions (Cameron & Trivedi, 2010). Thus, rejection of the null hypothesis implies that at least one of the instruments is not valid. However, non-rejection does not guarantee that all the instruments are valid, as it may be due to model misspecification. This implies that a proper model specification is crucial when using the GMM estimation technique.

**Description of the GMM Estimation Method**

The GMM estimation technique is widely used in the literature because of its convenience as it does not require specific assumptions on the distribution of errors (Hall, 2005). Another reason is that it is a multiple estimation technique in one as it nests several estimation techniques as special cases (Classical Method of Moments, Ordinary Least Squares, and the Maximum Likelihood Method)

Using standard notation (Cameron & Trivedi, 2010) in the derivation of the method, let $\mathbf{W}_t$ be a vector of random variables, $\Theta_0$ be a $p \times 1$ vector of parameters, $g(.)$ be a $q \times 1$ vector value functions and ‘$E$’ is the expectation notation. The population moment is defined as

$$E[g(\mathbf{W}_t, \Theta_0)]=0$$

(3.13)

From the population moment in equation (3.13), the sample moment can be derived by averaging the population moment:
\[ g_T(W, \theta) = T^{-1} \sum_{t=1}^{T} g(W_t, \theta_0) \]  

(3.14)

Minimize equation (3.14) with respect to the parameter \( \theta \), the first order condition is the optimal value moment denoted as

\[ Q_T(\theta) = g_T(W, \theta)' W_T g_T(W, \theta) \]  

(3.15)

which can be written as

\[ \hat{\theta} = \text{Argmin}_\theta Q_T(\theta) \]  

(3.16)

The \( W_T \) is a \( q \times q \) semi-definite matrix that depends on data but has to converge in probability to a positive definite matrix in order to obtain a well-defined estimator in equation (3.16). The estimator in equation (3.16) also requires that the model is at least exactly identified. That is, at least the number of moment equations (\( q \)) is greater than the number of parameters in the system (\( p \)), (Cameron & Trivedi, 2010).

4.0 Empirical Results

4.1 Introduction

This section reports the empirical results of the study as follows. Section 4.2 reports the unit roots test results. Section 4.3 reports and discusses the GMM results for the Taylor-type and McCallum-type rules, and section 4.4 reports and discusses the impulse response functions (IRFs) based on the Structural Vector Autoregressions (SVAR) systems of the variables in the Taylor-type and McCallum-type rules.

In reporting the main results in sections 4.3 and 4.4, the study accomplishes two main objectives as documented in the introduction of this chapter: First, to provide empirical evidence whether the changes in the central bank monetary policy targets (interest rate and monetary base) are systematically related to the changes in the economic fundamentals
(monetary policy indicators); second, to determine whether there has been any monetary policy inertia in the central bank’s conduct of monetary policy during the post reforms.

4.2 Unit Roots Test Results

The Augmented Dickey Fuller (ADF) and Phillips Perron (PP) unit roots test results are reported in table 3.3. Both tests show that all the variables in the monetary policy reaction functions (i.e., monetary policy targets and indicators) are stationary.

4.3 GMM Results

Timing between the Monetary Policy Targets and Monetary Policy Indicators

In order to decide on the directions of the interest rate, the central bank needs to form expectations about the values of the indicator variables (inflation rate, real output gap, and changes in the nominal exchange rate). Since the central bank sets the contemporaneous policy target, the meaningful information on the indicator variables to enter the central bank’s information set is either the past value (backward looking) or future value (forward looking) of the indicator variables.

Taking this into account, estimation of the Taylor-type rule takes account of forward looking assumptions. With regards to forward looking rule, I assume that the central bank considers future values of inflation \((n=3)\), real output gap \((m=1)\), and the contemporaneous change in the nominal exchange rate \((k=0)\).

Determining the lags needs no test but economic intuition of the chosen lags which yield the results. For instance, in testing for robustness of the Taylor rule estimates, Clarida et al. (2000) consider what they call “more realistic-target horizons” for the target variables in which the inflation target horizon is four quarters and two quarters for output (p. 160).
Rudebusch (2002) has a view that policy takes one lag to affect output and two lags to affect inflation. So there is no explicit consensus on what are the standard lags, but the implicit consensus between Clarida et al. (2000) and Rudebusch (2002) is that policy affects output before affecting inflation, which is consistent with my lag choices of three and one horizons for inflation and real output, respectively.

**The Taylor-Type Rule**

The results of the Taylor-type rule (table 3.4) suggest that the inflation rate and the output gap are relevant to the central bank’s decision-making as suggested by the statistically significant coefficients with the expected positive signs in the Taylor-type rules without and with the exchange rate. The change in the nominal exchange rate variable is unambiguously relevant to the central bank’s conduct of monetary policy as shown in the rule with the exchange rate. The results show evidence of the interest rate partial adjustment in both Taylor-type rules. The estimates of the interest rate smoothing parameters are 0.80 and 0.79, in the Taylor-type rules without and with the exchange rate, respectively. This suggests that about 20% of the deviation from the target in the interest rate is adjusted each quarter. The coefficients on the inflation rate are 1.28 and 1.35 for the Taylor-type rules without and with the exchange rate, respectively, which suggests that a 1% increase in the inflation rate leads to more than 1% increase in the interest rate in both rules. This is consistent with the prediction of the Taylor rule. The coefficients on the real output gap in both rules are statistically significant at the 5% level with the positive sign consistent with the prediction. These coefficients imply that a 1% increase in the real output gap leads to 2.88% increase in the nominal interest rate in the rule without the exchange rate, while the same 1% increase in
the real output gap is associated with a 3.54% increase in the nominal interest rate for the rule with the exchange rate. Consistent with the prediction, the coefficient on the change in the nominal exchange rate is statistically significant (at the 10% level) with the predicted positive sign. This suggests that a 1% depreciation in the nominal exchange rate leads to 0.51% increase in the nominal interest rate. The parameter $\alpha_r$ in both Taylor-type rules is not statistically significant.

The Hansen’s J-statistic in both Taylor-type rule specifications suggests that all the instruments used in the GMM estimation are valid as shown by the statistically insignificant J-statistic, which suggests a non-rejection of the null hypothesis that all the instruments are valid.

The results from the Taylor-type rules suggest that there has been a systematic relationship between monetary policy targets and indicators. These results suggest that: (i) Tanzania’s monetary policy involves partial adjustment; that is, the central bank adjusts the interest rate using the discount rate with about 20% of the deviations in the nominal interest rate from the target are adjusted each quarter; (ii) a 1% increase in the inflation rate leads to 1.28% and 1.35% increase in the interest rate in the rules without and with the exchange rate, respectively. This is consistent with the Taylor rule prediction that a non-accommodative central bank needs to increase the nominal interest rate by more than 1% in response to a 1% increase in the inflation rate in order to raise the expected real interest rate for the purpose of cooling the overheating economy; (iii) a 1% positive real output gap is associated with 2.88% and 3.54% increases in the nominal interest rate for the rules without and with the exchange rate, respectively; and (iv) based on the rule with the exchange rate, a 1% depreciation in the
Tanzanian shilling is associated with 0.51% increase in the nominal interest rate. The significant coefficients on the lagged interest rate (smoothing parameter) in both Taylor-type rule specifications provide evidence of partial adjustment in the nominal interest rate.

On the basis of these results, it can be argued that the central bank has been pursuing non-accommodative monetary policy. That is, an increase in any of the Taylor-type indicator variables (inflation rate, real output gap, and change in the nominal exchange rate) is associated with an increase in the nominal interest rate. In other words, the central bank tightens monetary policy in response to increases in inflation, real output gap, and when the nominal exchange rate depreciates. This shows the commitment of the central bank to economic stabilization and fulfillment of the goal of price stability as stipulated in the BOT Act 1995.

**The McCallum-Type Rule**

The results on the McCallum-type rules with the nominal output gap as a measure of economic activity are reported in table 3.5. The results of the rule without the exchange rate show that all the parameter estimates are statistically significant except the coefficient on the nominal output gap. The estimate on the smoothing parameter (0.76) is also statistically significant at the 1% level with the expected positive sign, while the estimate on the parameter \( \alpha_M \) is statistically significant at the 1% level.

For the model with the exchange rate, all the parameter estimates are statistically significant. The parameters associated with the nominal output gap (\( \lambda_M \)) and changes in the nominal exchange rate (\( \delta_M \)) are statistically significant at 10% and 1%, respectively, with the predicted positive and negative signs, respectively. The coefficient on the lagged growth in
the monetary base (smoothing parameter) is statistically significant at the 1% with the predicted positive sign. The results for the rule with the exchange rate suggest that a 1% increase in the nominal output gap is associated with 1.1% increase in the growth of the monetary base. Regarding the response to the change in the nominal exchange rate, a depreciation of 1% in the Tanzanian shilling is accompanied by a 0.99% decrease in growth of the monetary base. The coefficients on the lagged growth in the monetary base (0.73) suggest that about 30% of the deviations in the growth of monetary base from the target are adjusted each quarter. The significant estimate on the smoothing parameter ($\rho_M$) provides evidence of monetary policy inertia. The significant coefficients on the change in the nominal exchange rate variable indicate that the central bank has been vigilant on the value of the shilling against non-fundamental drivers according to the stipulated exchange rate policy of minimum interventions just for the purpose of smoothing short run fluctuations (BOT, 2012).

In both McCallum-type rules, the Hansen’s J-statistics are statistically insignificant, suggesting a non-rejection of the null hypothesis that all the instruments used in the GMM estimation of the McCallum-type rules are valid.

**McCallum-Type Rule: Alternative Measure of Economic Activity**

For non-inflation targeting countries, the McCallum nominal output gap is often obtained by using the HP filter as shown in table 3.1 and in the definition of the variable $\Delta x^*$ in table 3.2 as described by Mehrotra and Sanchez-Fung (2011). However, this requires one to assume that the trend nominal output growth is the desired (target) output, which is not
always the case especially under high inflation\textsuperscript{23}. This study also uses nominal GDP growth as an alternative measure of economic activity to the nominal output gap in the McCallum-type rule.

From equation (3.4), let

\[ \alpha_M = (1 + \lambda_M)\Delta x^* - \Delta v_t \]  \hspace{1cm} (3.17)

Therefore equation (3.4) can be written as

\[ \Delta b_t^* = \alpha_M - \lambda_M \Delta x_{t-1} + \delta_M \Delta s_t \]  \hspace{1cm} (3.18)

Substituting (3.17) into the monetary base partial adjustment rule in equation (3.6) yields

\[ \Delta b_t = (1 - \rho_M) \alpha_M + \rho_M \Delta b_{t-1} - (1 - \rho_M) \lambda_M \Delta x_{t-1} + (1 - \rho_M) \delta_M \Delta s_t + u_t \]  \hspace{1cm} (3.19)

The coefficient on the nominal output growth is predicted to be negative, suggesting that a higher GDP growth in the recent previous period prompts the central bank to lower the current period’s growth in the monetary base.

Table 3.6 shows the McCallum-type rule estimates using the nominal GDP growth as a measure of economic activity as specified in equation (3.19). Exclusion of the exchange rate in the rule leads to statistically insignificant parameters except for the smoothing parameter. When the exchange rate (change) is included in model, all the parameters are statistically significant with the predicted signs. On the basis of the estimates of the rule with the change in the exchange rate, a 1% increase in the nominal GDP growth leads to 0.3% reduction in the monetary base growth, while a 1% nominal exchange rate depreciation is associated with a 1.2% reduction in the monetary base growth.

\textsuperscript{23} Note that nominal output growth is the sum of real output growth and the inflation rate
Comparing the results in the McCallum rules with the nominal output gap and those with the nominal GDP growth, the estimates in the models including the exchange rate are similar since all the parameters are statistically significant with the predicted signs. In terms of size, the coefficient on the nominal output gap is smaller (-0.30) than the coefficient on the nominal output growth (1.10). The estimates of the smoothing parameter for rules with the change in the nominal exchange rate does not change as a result of the change in the measure of the economic activity, implying that the speed of the monetary base adjustment is indifferent between the two measures of economic activity and that the results and conclusion from the McCallum-type rule are robust.

**Overall GMM Results**

The GMM results of the Taylor-type and McCallum-type rules without and with the exchange rate show evidence of partial adjustment or monetary policy inertia and substantiate the role of the exchange rate in monetary policy. The results support the economic role of partial adjustment. Partial adjustment is argued for as it minimizes the losses associated with loss of credibility and unstable financial markets due to volatility in the interest rate (Yau, 2010).

These estimates indicate the importance of the exchange rate on Tanzania’s monetary policy. The significant role of the exchange rate in monetary policy is consistent with the central bank’s effort to curb inflation, particularly from the external side (imported inflation).
The results according to the two rules\textsuperscript{24} provide evidence of a systematic relationship between the monetary policy targets and the indicators variables as hypothesized. One can argue that the Taylor-type and McCallum-type rules tend to describe the Bank of Tanzania’s behavior in executing monetary policy. From these results, it is evident that when implementing monetary policy with the primary goal of price stability, the central bank keeps an eye on the output gap (nominal and real), inflation, and the value of the shilling. The results also suggest that during the past two decades, on average, the Bank of Tanzania followed a policy of monetary policy non-accommodation (leaning against the wind).

The estimates on the smoothing parameters of 0.79 and 0.73 for the Taylor-type and McCallum-type rules suggest monetary policy partial adjustment. These corroborate other studies in the literature which find evidence of monetary policy partial adjustment. Studies with significant estimates on the interest rate smoothing parameters with the respective coefficients in brackets include Rotich et al, (2007) [0.94 for Kenya]; Mehrotra and Sanchez-Fung (2011) [0.94 for Philippine; 0.67 for South Korea; and 0.68 for Colombia]; Clarida et al. (2000) [0.68 and 0.71 during the pre-Volcker and the Volcker and Greenspan eras, respectively in the U.S.]. With regards to the McCallum rule, the studies with significant estimates on the monetary base smoothing parameter include Rotich et al. (2007) [0.85 for

\textsuperscript{24} The Taylor and McCallum rules are related to each other. The Taylor rule allows the interest rate target to change by different amounts depending on inflation and the change in real output if there is no data for the inflation target and potential output, i.e., \( i_t^* = \theta_0 + \theta_1 \pi_t + \theta_2 \Delta y_t + \theta_3 \Delta S_t + \epsilon_t \). Also one can estimate a McCallum rule as \( \Delta b_t^* = \gamma_0 + \gamma_1 \pi_t + \gamma_2 \Delta y_t + \gamma_3 \Delta S_t + u_t \). Note that, the McCallum rule restricts that \( \gamma_1 = \gamma_2 \) since the two coefficients are disaggregated from the coefficient on the nominal output, which is the sum of inflation and real output in the original McCallum rule.
Kenya]; and Mehrotra and Sanchez-Fung (2011) [0.84 and 0.49 for Venezuela and Uruguay, respectively].

**How the Monetary Policy Rules Characterize the Actual Monetary Targets**

Figures 3.2 and 3.3 show that in most cases the Taylor-type and McCallum-type rules closely trail the movements of the actual interest rate and the growth in the monetary base. Exceptions can be observed for the period before 1995 when the rules seem to miss their respective actuals by substantial differences.

**Implications of the Various Rule Specifications**

Inclusion of the exchange rate has implications on the results. In both rules, inclusions of the nominal exchange rate variable seem to boost the responses of the monetary policy target variables to the respective conventional indicator variables. In addition to the statistical significance of the coefficient on changes in the nominal exchange rate, empirical outcomes of this study tend to be consistent with Svensson’s (2000) argument that the exchange rate provides an additional channel for monetary policy transmission mechanism. The change in the nominal exchange rate in the rule leads to a slight decline in the size of the smoothing parameter estimate, which translates itself into slight increases in the amount of the deviation in the interest rate from the target adjusted in each quarter.

**4.4 The Taylor-Type and McCallum-type Rules in SVAR Approach**

Despite the complementarity between the central bank reaction functions (McCallum and Taylor rules) and the GMM estimation technique as revealed in the literature, it is difficult to rule out the problem of model uncertainty and biased estimates. However, if diverse models generate similar results, then confidence is established in the results and the
conclusions. In this study I also use the SVAR approach to estimate the impulse response functions (IRFs) using the monetary policy variables in the McCallum-type and Taylor-type rules. The IRFs are useful tools in depicting the dynamic relationship among variables in a model and serves as a robustness check to the GMM results.

I estimate a quadrivariate SVAR of the variables in the Taylor-type rule in the order: policy target, real output gap, inflation, and the changes in the nominal exchange rate. For the McCallum-type rule, I estimate a trivariate SVAR of the variables in the McCallum-type rule in the order: policy target, nominal output gap and changes in the nominal exchange rate. Swanson and Granger (1997) contend that, “ordering of the variables is essential to the interpretation of the impulse response functions” (p. 357). That is, the ordering of the variables in the $Y_t$ vector determines the recursive causal relationships between the variables. Therefore, these orderings are intended to ensure the recursive causal relationship specified in the Taylor-type and McCallum-type rules.

The number of parameter estimates in the SVAR system depends on (or increases with) the number of the variables in the system and the number of lags chosen. Therefore the SVAR results involve a large number of parameters, most of which are statistically not significant except the first own lags (see Canova, 2007). Most studies in the literature report the summary information from the SVAR results in form of the SVAR\textsuperscript{25} functions. In this study, I report only the dynamic impulse response functions of the Taylor-type and McCallum-type system of equations.

\textsuperscript{25} The common three of these functions are: Impulse response functions, variance decomposition, and historical decomposition.
4.4.1 The SVAR Model Specification

Consider a simple VAR model of the form

\[ Y_t = C(L)Y_t + \varepsilon_t \]  \hspace{1cm} (3.20)

where \( L \) is a lag operator and \( C \) is a polynomial function of order \( p \). \( \varepsilon_t \) is the random shock such that

\[ E(\varepsilon_t \varepsilon'_t) = \Sigma, \text{ but } E(\varepsilon_t \varepsilon'_{t+j}) = 0 \text{ for all } j \neq 0 \]

For the system of variables in the Taylor-type rule, \( Y_t = [i_t, (y_{t+m} - y^*), \pi_t, \Delta s_t]' \) is a 4x1 vector of time series of the variables in the Taylor-type rule (i.e., interest rate, real output gap, inflation rate, and change in the nominal exchange rate, respectively). With regards to the McCallum-type rule, I define \( Y_t = [h_t, (\Delta x_t^* - \Delta x_{t-1}), \Delta s_t]' \) to be a 3x1 vector of time series of the variables in the McCallum-type rule (i.e., change in the monetary base, nominal output gap, and change in the nominal exchange rate, respectively).

The VAR models, however, are criticized of being devoid of economic theory and hence suffer from deficiency of economic content (Gottschalk, 2011). Instead, I specify and estimate a Structural VAR (SVAR) since SVAR models take into account economic theories in the model. The SVAR representation can be obtained by pre-multiplying both sides of equation (3.17) by a matrix \( B \), which is a contemporaneous relationship between the variables in each system (rule)

\[ BY_t = B C(L)Y_t + u_t \]  \hspace{1cm} (3.21)

where \( u_t = B e_t \)

\[ u_t \] is a time \( t \) serially independent innovation (error term) to the \( i \)th variable. These innovations are linearly associated with independently distributed economic shocks, \( e_{it} \).
4.4.2 Identification Strategy

To identify the impact of the shocks from the indicator variables, I apply the SVAR method (Bernanke, 1986; Sims, 1986), which imposes contemporaneous restrictions according to the Taylor and McCallum rule predictions. Most theoretical macroeconomic models do not bother about the timing of the effects needed for the SVAR identification (Berkelmans, 2005).

The Taylor-type rule

If the shocks in the quadrivariate SVAR system are independent, the order condition requires \( k(k-1)/2 = 6 \) zero restrictions (i.e., \( k = 4 \)). Assume the restrictions in Taylor-type rule quadrivariate SVAR of the order \( Y_t = [\Delta s_t, \pi_t, (y_{t+m} - y'), i_t] \).

In imposing restrictions to the SVAR Taylor-type rule system, let the output shocks be independent of all other shocks in the system such that it follows an autoregressive process of order \( p \) (AR\((p)\)), where \( p \) is the number of lags used in estimating the model. This restriction is based on the assumption that production, especially in the agricultural sector, takes long gestation periods such that shocks in the exchange rate as well as inflation and interest rates will cause no contemporaneous effects on real output. This can be presented as

\[ u_{yt} = e_{yt} \quad (3.22) \]

The shocks to the exchange rate are caused by innovations to the real output shock and exogenous factors such as flow aid, terms of trade, etc., which are independent from the variables of the system.

\[ u_{st} = \kappa e_{yt} + e_{st} \quad (3.23) \]
Inflation shocks are assumed to be associated with aggregate demand and exchange rate shocks, in the form

\[ u_{\pi_t} = \gamma y_t + \tau s_t + e_{\pi_t} \]  \hspace{1cm} (3.24)

Inflation shocks feed through into the Taylor-type rule equation. The shocks to interest rate are associated with shocks in the money supply. But the shocks to money supply are also associated with inflation shocks. Therefore interest rate shocks are associated with inflation shocks because of the direct relationship between money supply and inflation on the one hand and money supply and interest rate on the other hand. This yields

\[ u_{it} = \delta_T y_t + \lambda_T s_t + \beta_T e_{\pi_t} + e_{it} \]  \hspace{1cm} (3.25)

From these assumptions, the system of shocks can be presented in matrix form (below), which is estimated to obtain the impulse response functions.

\[
\begin{bmatrix}
1 & 0 & 0 & 0 \\
\kappa & 1 & 0 & 0 \\
\gamma & \tau & 1 & 0 \\
\delta_T & \lambda_T & \beta_T & 1
\end{bmatrix}
\]

**The McCallum-type rule**

The order condition for independent shocks in the trivariate McCallum-type rule SVAR requires k(k-1)/2 zero restrictions. Since there are three variables (i.e., k=3) in the McCallum-type rule, we need 3 zero restrictions (i.e., k(k-1)). Let the restriction in the trivariate SVAR of the McCallum-type rule with the order \((Y_t = [\Delta s_t, (\Delta x^*_t - \Delta x_{t-1})_t, \Delta b_t])\) The sources of shocks in the nominal output gap and exchange rate and the assumptions are the same as specified in equations (3.22) and (3.23) above. I derive the causes of the shocks in the monetary base from well-known notion that inflation is always and everywhere a
monetary phenomenon. Since the level of the money supply in the economy is managed by the central bank using the monetary base as an instrument of monetary policy, there is a positive association between inflation and the monetary base. Assuming this relationship is strong, the errors in the monetary base growth equation are also associated with the errors in inflation. That is,

\[ u_{\Delta b_t} = u_{\pi_t} \]  

(3.26)

Substituting equation (3.24) into (3.26) yields the equation on the monetary base shocks as

\[ u_{\Delta b_t} = \gamma e_{yt} + \tau e_{st} + e_{\pi_t} \]  

(3.27)

The correlations between the errors in the monetary base growth and inflation rate allow replacing \( e_{\pi_t} \) with \( e_{\Delta b_t} \). Let the coefficients \( \gamma = \lambda_M \) and \( \tau = \delta_M \), equation (3.27) can be written

\[ u_{\Delta b_t} = \lambda_M e_{yt} + \delta_M e_{st} + e_{\Delta b_t} \]  

(3.28)

This implies that the shocks to the monetary base are caused by nominal output shocks and exchange rate shocks.

The system of shocks to be estimated based on the McCallum-type rule can be presented in matrix form with the above restrictions as

\[
\begin{bmatrix}
1 & 0 & 0 \\
\chi & 1 & 0 \\
\lambda_M & \delta_M & 1
\end{bmatrix}
\]

Since growth in nominal GDP is the sum of real GDP and inflation, it is difficult to separate the sources of shocks to nominal GDP from those of real GDP. Exogenous factors which influence aggregate demand supply in the economy such as weather conditions which impact production sectors (i.e. industrial production, transportation infrastructure, energy
production, agricultural output) also can be considered to be the sources of nominal shocks. However, since inflation is the component which separates real GDP from nominal GDP, domestic price shocks can be considered to be one of the sources of shocks to nominal GDP. These can be in form of non-fundamental rise in the price of essential imported items such as fuel, rise in prices of key items such maize/corn flour in urban areas because of temporary transportation problems related to transportation infrastructure, for example.

Tanzania is a small open economy, so the worldwide recession would be transmitted in through trade (exports and imports). The three main exports of Tanzania are agricultural products, minerals, and services (tourism), while the main import is fuel followed by intermediate goods. A worldwide recession would lower the worldwide demand for goods and services which would result in dampening the demand for Tanzanian exports. On the imports side, a decline in the worldwide demand would decrease the world price of fuel which could be a positive thing for Tanzania. However, the domestic market for fuel in Tanzania is asymmetric; that is, prices rise when the world price rises but do not fall when the world price declines\textsuperscript{27}. The net effect would be negative because it would reduce exports while imports would not respond accordingly. It would most likely benefit traders (importers and local distributors) by increasing their profit margins. Therefore, the worldwide recession can be interpreted in terms of negative shocks to the system.

\textsuperscript{27} According to the empirical literature, this seems to be a common practice in the local fuel (gasoline) markets (e.g., Chesnes, 2010 and Verlinda, 2008)
4.4.3 Impulse Response Functions (IRFs)

While Elder (2003) defines the non-technical IRF as “the effect of a primitive impulse $\varepsilon_{i,t}$ on $y_{j,t+k}$,” (p.4) he defines the technical IRF as “the revision in the conditional forecast of $y_{j,t+k}$, given a primitive impulse $\varepsilon_{i,t}$,” (p.5). Respectively, these definitions can be specified as

$$IRF(j) = \frac{\delta y_{j,t+k}}{\delta \varepsilon_{i,t}}$$ \hspace{1cm} (3.29)

$$IRF(j) = \frac{\delta E(y_{j,t+k}|\varepsilon_{i,t},\psi_{t-1})}{\delta \varepsilon_{i,t}}$$ \hspace{1cm} (3.30)

where $\varepsilon_{i,t}$ is a zero-mean constant variance error term in equation $y_{i,t}$, and $\psi_{t-1}$ is the information set at time $t-1$.

Figure 3.4 illustrates the IRFs from the Taylor-type and McCallum-type rules, particularly the dynamic patterns and the timing of the response variables (monetary policy targets) to shocks.

Discussion of the IRFs Results

The IRFs based on the system of variables in the Taylor-type rule in figure 3.4 portray positive responses of the interest rate to inflation, real output and exchange rate shocks. The figure illustrates how the exchange rate and inflation shocks drive the nominal interest rate up, which is consistent with the Taylor rule predictions. However, the impulse responses of the interest rate to the real output gap are not statistically significant. This can be attributed to the small sample size given that the study is confined only to the post reform period which is believed to provide a better environment for monetary policy. The impulse response of the interest rate to monetary policy shocks shows the following common
characteristics: they all converge to zero, implying that they are one-time (temporary shocks); and their patterns or directions are consistent with the Taylor rule prediction (positive responses to indicators) and hence provide the typical Taylor rule results. This suggests that the central bank tightens monetary policy in response to an increase in inflation and depreciation of the Tanzanian shilling relative to the U.S dollar.

The responses of the monetary base to the shocks from the key monetary policy indicator variables (figure 3.5) are statistically significant with correct signs consistent with the McCallum rule prediction. They show positive responses of the monetary base to the nominal output shock, while the response of the monetary base to exchange rate shock is negative, consistent with the McCallum rule prediction. The response of the monetary base to its own shock is positive but declining, consistent with expectation and the empirical GMM estimates on the McCallum-type rule, which show a positive and statistically significant coefficient on the lagged monetary base.

**Statistical Significance of the IRFs**

It can be noted, however, that the 68% confidence intervals for the impulse response of the interest rate to the output shock in figure 3.4 includes zero, implying that the impulse response functions are not statistically significant. This does not mean that the model is not correct; the results may be from the effect of inadequate sample size (about 80 observations), especially for the SVAR model which requires large samples. Griffiths and Lutkepohl (1990) suggest quantile simulation methods if the IRFs based on asymptotic confidence bounds are not significant. This is beyond the scope of this study but is considered as an interesting potential area for future extension of this study. On the basis of the SVAR results, the
impulse responses in the Taylor-type and McCallum-type rules seem to provide an adequate description of the actual data and the behavior of the Bank of Tanzania in general, despite the short sample constraint.

4.6 Robustness of the GMM Results

To test for the robustness of the results, I estimate the rules in different specifications, particularly with and without the exchange rate in the Taylor-type and McCallum-type rules. Also, I switch the estimation technique from the GMM to Structural Vector Autoregressions (SVAR) from which the IRFs of the monetary policy target variables to the shocks from the monetary policy indicators are plotted.

The Taylor-type rule estimates in the rule with and without the exchange rate are consistent with each other. This means that inclusion or exclusion of the exchange rate variable in the rules does not lead to significant difference in the conclusions from the estimates. The only difference is on the strength of the response of the monetary policy targets to the conventional indicators. That is, inclusion of the exchange rate tends to boost the responses of the monetary policy target variables to the monetary policy shocks, but it does not lead to changes in the significance and conclusions from the estimates. However, the exchange rate is an important variable in the McCallum-type rule. The McCallum-type rule estimates in table 3.5 and 3.6 show that the rule holds only when the exchange rate variable is included in the model among the indicator variables. With regards to the variables in the Taylor-type rule, the conclusions from the GMM results are consistent with those from the IRFs.
From the SVAR results, the patterns of the impulse responses are consistent with the
signs associated with the GMM estimates in the Taylor-type and McCallum-type rules.

5.0 Summary and Conclusions

This chapter investigates the rule-like behavior of the Bank of Tanzania via its
execution of monetary policy by estimating the McCallum-type and Taylor-type reaction
functions in various specifications and two different estimation methods. The results provide
evidence in answering the questions whether there has been a systematic relationship
between monetary policy targets and monetary policy indicators and whether monetary
policy involves policy inertia.

The results of the Taylor-type rule using the GMM and SVAR estimation approaches
suggest that the Bank of Tanzania has been reacting to increases in the inflation rate, real
output gap, and the nominal exchange rate depreciation by raising the interest rate. This
implies that the Bank of Tanzania has been pursuing a non-accommodative monetary policy,
which is consistent to its anti-inflationary stance and the pledge to economic stabilization
during the post-liberalization period.

With regards to the McCallum-type rule, the GMM results indicate significant
responses to the two measures of economic activity (nominal GDP growth and nominal
output gap) and changes in the exchange rate, suggesting the existence of a systematic or
rule-like relationship between the monetary policy target (monetary base) and monetary
policy indicators (nominal GDP growth and nominal GDP gap and changes in the exchange
rate). Using the SVAR approach, the McCallum-type impulse responses suggest a systematic
relationship between monetary target (monetary base) and monetary policy indicators
(change in the nominal exchange rate and nominal output gap). These results are robust given the consistent conclusion between the GMM and SVAR results.

On the basis of these results, one can conclude that the Bank of Tanzania has been pursuing a non-accommodative monetary policy consistent with the primary goal of price stability as stipulated in the BOT Act of 1995. The outcome of this non-accommodative monetary policy has been the success in reduction of inflation from above 30% before 1995 to a single digit thereafter. This indicates a serious commitment by the central bank to economic stabilization as well as in building confidence to the public.

Linking the results to our hypotheses, there is sufficient evidence that monetary policy targets are systematically related to monetary policy indicators. With regards to the policy inertia, the two models provide evidence of monetary policy inertia. The estimates on the smoothing parameters (for the rules with exchange rate) in both Taylor-type and McCallum-type rules approximate 0.80 and 0.70, thereby suggesting that about 20% and 30% of the deviations in the monetary policy variables from the targets are adjusted each quarter. In explicit terms, the BOT has been targeting monetary base according to its monetary policy framework. At the same time, short term interest rate (discount rate) has been the central bank’s implicit monetary policy target as it performs well in characterizing the rule-like behavior of the central bank in implementing monetary policy.

A couple of implications can be drawn from these results: there is consistency between the stipulated monetary policy objective of price stability and what the Bank of Tanzania does in the process of achieving macroeconomic stability. Comparison of the stance of monetary policy for the period before the financial liberalization as described in
chapter two and the results of this chapter show that there has been some significant improvement in terms of the ability of the central bank to contain inflation and fine-tune the economy via the central bank’s management of interest rate (Taylor-type rule) and liquidity (McCallum-type rule) in the economy. This has been enhanced by the 1990s financial sector reforms which created a conducive environment for monetary policy. The exchange rate is an important monetary policy indicator in Tanzania’s monetary policy.
Table 3.1: Selected Empirical Estimates on the Taylor-Type and McCallum-Type Rules

<table>
<thead>
<tr>
<th>Variable</th>
<th>Taylor-Type Rule</th>
<th>McCallum-Type Rule</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td></td>
</tr>
<tr>
<td>Lagged dep.</td>
<td>0.940*</td>
<td>0.07</td>
</tr>
<tr>
<td>Inflation gap</td>
<td>2.961*</td>
<td>1.01*</td>
</tr>
<tr>
<td>RGDP</td>
<td>0.244</td>
<td>0.52*</td>
</tr>
<tr>
<td>Ex. Rate change</td>
<td>0.02*</td>
<td>0.00. †</td>
</tr>
<tr>
<td>NGDP</td>
<td>-0.086*</td>
<td>-0.16*</td>
</tr>
<tr>
<td>Est. Method</td>
<td>GMM</td>
<td>OLS</td>
</tr>
<tr>
<td>Country</td>
<td>Kenya</td>
<td>Brazil</td>
</tr>
<tr>
<td>Data freq.</td>
<td>Month</td>
<td>Month</td>
</tr>
<tr>
<td>De-Trend method</td>
<td>HP</td>
<td>HP</td>
</tr>
<tr>
<td>Target Variable</td>
<td>Repo Rate</td>
<td>Selic Int. rate</td>
</tr>
</tbody>
</table>

Notes: *: indicates significant at the 5% (or below) level; †: Hybrid Taylor-McCallum rule where interest rate is used in the place of the monetary base; ‡: The coefficient is very small and statistically not significant; DR: Dominican Republic; HP: Hodrick-Prescott filter; GMM: Generalized Method of Moments; OLS: Ordinary Least Squares; M&S: Mehtrotra and Sanchez-Fung

28 The estimates for South Africa are extracted from the panel of 20 emerging market economies covered in the study.
Table 3.2: Variables in the Monetary Policy Rules

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i_t)</td>
<td>Interest rate managed by the central bank</td>
<td>Percent</td>
</tr>
<tr>
<td>(\Delta b_t)</td>
<td>Annual growth in the monetary base, defined as the change in the log of monetary base</td>
<td>Percent</td>
</tr>
<tr>
<td></td>
<td>Measured as, (\Delta b_t = (b_t - b_{t-4}) \times 100)</td>
<td></td>
</tr>
<tr>
<td>(y_t - y^*)</td>
<td>Real GDP gap measured as the log of real GDP from trend log computed using the HP filter, multiplied by 100.</td>
<td>Percent</td>
</tr>
<tr>
<td>(\Delta x_t)</td>
<td>Nominal income (GDP) growth, defined as (\Delta x_t = (x_t - x_{t-4}) \times 100), where (x_t = \ln(NGDP))</td>
<td>Percent</td>
</tr>
<tr>
<td>(\Delta x^*)</td>
<td>Nominal income (growth) target(^{29}).</td>
<td>Percent</td>
</tr>
<tr>
<td>(\Delta x^* - \Delta x_{t-1})</td>
<td>The McCallum nominal income gap with the two components as defined above.</td>
<td>Percent</td>
</tr>
<tr>
<td>(\pi_t)</td>
<td>Annual rate of inflation</td>
<td>Percent</td>
</tr>
<tr>
<td>(\Delta s_t)</td>
<td>Exchange rate(^{30}) depreciation/appreciation, defined as the annual change in the log of nominal exchange rate</td>
<td>Percent</td>
</tr>
<tr>
<td></td>
<td>Measured as, (\Delta s_t = (s_t - s_{t-4}) \times 100)</td>
<td></td>
</tr>
</tbody>
</table>

\(^{29}\) For non-inflation targeting countries, the nominal income target is obtained by applying the HP filter to the nominal GDP data. The resulting trends series are used to construct the annual growth rates, which are free from the effects of cyclical movements in nominal output, see Mehrotra and Sanchez-Fung (2011).

\(^{30}\) Exchange rate is defined as Tanzanian shilling per U.S. dollar.
Table 3.3: Unit Roots Tests.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Lags</th>
<th>ADF (H0: Unit root) (p-value)</th>
<th>PP (H0: Unit root) (p-value)</th>
<th>Order of Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy targets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$i_t$</td>
<td>3</td>
<td>0.0837</td>
<td>0.0940</td>
<td>I(0)</td>
</tr>
<tr>
<td>$\Delta b_t$</td>
<td>3</td>
<td>0.0201</td>
<td>0.0059</td>
<td>I(0)</td>
</tr>
<tr>
<td>Indicator Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\gamma_t - \gamma^*$</td>
<td>3</td>
<td>0.0748</td>
<td>0.0000</td>
<td>I(0)</td>
</tr>
<tr>
<td>$\Delta x^* - \Delta x_{t-1}$</td>
<td>3</td>
<td>0.0000</td>
<td>0.0000</td>
<td>I(0)</td>
</tr>
<tr>
<td>$\pi_t$</td>
<td>3</td>
<td>0.0001</td>
<td>0.0428</td>
<td>I(0)</td>
</tr>
<tr>
<td>$\Delta s_t$</td>
<td>3</td>
<td>0.0090</td>
<td>0.0067</td>
<td>I(0)</td>
</tr>
<tr>
<td>$\Delta x_t$</td>
<td>3</td>
<td>0.0151</td>
<td>0.0008</td>
<td>I(0)</td>
</tr>
</tbody>
</table>

Notes:
p<0.01: significant at the 1% level; 
p<0.05: significant at 5% level; and 
p<0.1: significant at 10% level. 
ADF: Augmented Dickey Fuller 
PP: Phillips Perron

Table 3.4: Taylor-Type Rule Estimates using GMM (equation 3.11)

<table>
<thead>
<tr>
<th></th>
<th>$\alpha_T$</th>
<th>$\beta_T$</th>
<th>$\lambda_T$</th>
<th>$\delta_T$</th>
<th>$\rho_T$</th>
<th>J-stat. (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>4.90</td>
<td>1.28***</td>
<td>2.88**</td>
<td>0.80***</td>
<td></td>
<td>0.7341</td>
</tr>
<tr>
<td></td>
<td>[0.135]</td>
<td>[0.008]</td>
<td>[0.030]</td>
<td>[0.000]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W/exchange rate</td>
<td>1.17</td>
<td>1.35***</td>
<td>3.54**</td>
<td>0.51*</td>
<td>0.79***</td>
<td>0.6989</td>
</tr>
<tr>
<td></td>
<td>[0.777]</td>
<td>[0.001]</td>
<td>[0.013]</td>
<td>[0.082]</td>
<td>[0.000]</td>
<td></td>
</tr>
</tbody>
</table>

Notes: ***, **, and * indicates statistically significant at the 1%, 5%, and 10% respectively. p-values in brackets. The set of GMM instruments include the lags of inflation, real GDP growth, exchange rate, money supply and government expenditure.
Table 3.5: McCallum-Type Rule\textsuperscript{31} Estimates using GMM (equation 3.12)

<table>
<thead>
<tr>
<th></th>
<th>$\alpha_M$</th>
<th>$\lambda_M$</th>
<th>$\delta_M$</th>
<th>$\rho_M$</th>
<th>J-stat. (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>14.69***</td>
<td>0.59</td>
<td>0.76***</td>
<td>0.5506</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.000]</td>
<td>[0.511]</td>
<td>[0.000]</td>
<td>0.5506</td>
<td></td>
</tr>
<tr>
<td>W/Exchange Rate</td>
<td>23.42***</td>
<td>1.10*</td>
<td>-0.99***</td>
<td>0.73***</td>
<td>0.6420</td>
</tr>
<tr>
<td></td>
<td>[0.000]</td>
<td>[0.089]</td>
<td>[0.003]</td>
<td>[0.000]</td>
<td>0.6420</td>
</tr>
</tbody>
</table>

Notes: ***$, **$, and * indicates statistically significant at the 1%, 5%, and 10% respectively. p-values in brackets. The set of GMM instruments include the lags of inflation rate, broad money supply and government expenditure.

Table 3.6: McCallum-Type Rule\textsuperscript{32} Estimates using GMM (equation 3.19)

<table>
<thead>
<tr>
<th></th>
<th>$\alpha_M$</th>
<th>$\lambda_M$</th>
<th>$\delta_M$</th>
<th>$\rho_M$</th>
<th>J-stat. (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>8.06</td>
<td>0.38</td>
<td>0.77***</td>
<td>0.6460</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.175]</td>
<td>[0.196]</td>
<td>[0.000]</td>
<td>0.6460</td>
<td></td>
</tr>
<tr>
<td>W/Exchange Rate</td>
<td>18.94***</td>
<td>-0.30*</td>
<td>-1.20***</td>
<td>0.73***</td>
<td>0.5025</td>
</tr>
<tr>
<td></td>
<td>[0.000]</td>
<td>[0.089]</td>
<td>[0.000]</td>
<td>[0.000]</td>
<td>0.5025</td>
</tr>
</tbody>
</table>

Notes: ***$, **$, and * indicates statistically significant at the 1%, 5%, and 10% respectively. p-values in brackets. The set of GMM instruments includes the first four lags of inflation, real GDP and exchange rate.

\textsuperscript{31}Nominal output gap is the measure of economic activity

\textsuperscript{32}Nominal output growth is the measure of economic activity
Figure 3.1: Bivariate Analysis of the Monetary Policy Rules in Graphical Method
Figure 3.2: Taylor-Type Rule versus Discount Rate

Figure 3.3: McCallum-Type Rule versus Monetary Base Growth
Figure 3.4: Impulse Response Functions for the Variables in the Taylor-Type Rule
Figure 3.5: Impulse Response Functions for the Variables in the McCallum-Type Rule
REFERENCES


Bank of Tanzania (2012), Monetary Policy Statement.


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CHAPTER 4: THE DETERMINANTS OF THE NOMINAL EXCHANGE RATE CHANGES IN TANZANIA

1.0 Introduction

The exchange rate systems in Tanzania can be described as having three regimes:\(^3\): the fixed exchange rate regime (1967-1985); the crawling peg exchange rate regime (1986-1992); and the prevailing flexible exchange rate regime since 1992. The fixed exchange rate regime was characterized by state controls in pursuing the socialist economic system. Before the mid-1980s, economic management took the form of controls which covered almost all prices (wages, goods prices, interest rates, and exchange rates) and allocation of domestic credit and foreign exchange (Rutasitara, 2004). Between the end of the 1970s and the early 1980s, the negative effects of the controlled exchange rate regime heightened. Roger et al. (2009) and Rutasitara (2004) characterize this period as the period of severe economic strains. That is, the period is characterized by acute foreign exchange shortages following the dwindling of the official foreign exchange reserves, resulting in a rising premium between the market and official exchange rates as well as a rising rate of inflation as a consequence of devaluations undertaken for the sake of easing external imbalances.

By the mid-1980s, the government could not withstand the control-related economic strains (Roger et al., 2009; Rutasitara, 2004). In order to rectify the external situation, the country adopted a crawling peg exchange rate regime in 1986 as one of the International

---

\(^3\) Deardorff in the Glossary of International Economics defines exchange rate regimes as follows: Crawling Peg “An exchange rate that is pegged, but for which the par value is changed frequently by small amounts and in a preannounced fashion in response to signals from the exchange market”, Fixed Exchange Rate “Usually synonymous with a pegged exchange rate. Although ‘fixed’ seems to imply less likelihood of change, in practice countries seldom if ever achieve a fixed rate” Flexible (or floating) Exchange Rate “A regime in which a country’s exchange rate is allowed to fluctuate freely and be determined without intervention in the exchange rate market by the government or the central bank”
Monetary Fund (IMF) and World Bank (WB) conditions to obtain loans. With the crawling peg regime, it followed a sequence of gradual devaluations aimed at regaining the country’s competitiveness and reducing the higher exchange rate premium. Roger et al. (2009) argue that until 1992, the continued significant depreciations that started in the mid-1980s had significantly diminished the parallel market premium which stood at just 60% from the recorded average of 250% during 1980-1985. However, government efforts to implement economic and financial sector reforms did not end there. In March 1992, the government liberalized the exchange rate by passing the Foreign Exchange Act of 1992. In this Act, some exchange rate related controls were abandoned. For instance, it allowed Tanzanians to hold and maintain foreign currency accounts in local banks and foreign exchange bureaus to freely trade foreign currencies commenced. This led to a growing share of the Foreign Currency Deposits (FCD) in the total extended broad money supply (M3) as illustrated in chapter two.

Following liberalization of the foreign exchange rate in 1992, the continued and fast depreciation of the Tanzanian shilling significantly reduced the exchange rate premium that summarily disappeared in 1993. This marked the unification of the parallel and official exchange rates. The volume of transactions that took place in the bureaus grew significantly, (Roger et al., 2009); and the volume of foreign currency deposits in commercial banks increased immediately with an upward trend overtime (Kessy, 2011). Kessy (2011) associates this increasing trend in foreign currency deposits with an effort by residents to find safe-haven or shelter for their income and wealth following the prolonged depreciation of the nominal exchange rate since the adoption of the flexible exchange rate regime34.

34 He finds no empirical evidence that inflation could be another reason for the increasing trend in foreign
This sequence of exchange rate regime shifts from the controlled exchange rate regime to a flexible exchange regime is explained by Jimoh (2004), who describes such shifts as desperate moves adopted as remedial measures to both domestic (high inflation and exchange rate and foreign exchange reserve problems) and foreign (balance of payment problems) imbalances. The same view is also reinforced by Rutasitara (2004), who notes that despite the imbalances in the form of rising inflation, supply shortages, dwindling official foreign exchange reserves, and pressures on the exchange rate, exchange rate regime shifts (from controlled) were initially resisted or sporadically adopted. For most countries, the switch from a controlled exchange rate regime to flexible exchange rate regime, especially during the 1990s, was not optional as they were part of the fulfillment of the IMF and WB conditions for loans following poor performance of developing countries’ economies. Since the unification of the parallel and official exchange rate in Tanzania, the nominal exchange rate has been depreciating consistently at almost a constant rate. This trend has inspired this study to investigate what actually is behind such nominal exchange rate changes.

In this study, I examine the determinants of the nominal exchange rate changes in Tanzania with a focus on the post reform (flexible exchange regime) period. The exchange rate is an important factor in understanding the degree of macroeconomic stability of a given economy as well as the competitiveness of a country. Since liberalization of the exchange rate in 1992, the Tanzanian nominal exchange rate has been depreciating continuously. Nevertheless, to the best of my understanding, there has been no study conducted to
investigate what drives these changes. The study provides empirical evidence on the fundamental determinants of the changes in the nominal exchange rate.

1.1 The Model

Chapter two discussed in detail the three exchange rate regimes that Tanzania has had since independence in 1961: the controlled exchange rate regime up to 1986; the crawling peg exchange rate regime of 1986-1992; and the floating exchange regime that has prevailed since 1992. With the floating exchange rate regime, it is apparent that market mechanisms determine the adjustments in the nominal exchange rate. This suggests that there should be some fundamentals which govern the adjustment in the short and long runs.

The framework of this study follows the often-used monetary approach to exchange rate determination as employed in developing countries (Edwards (1983) and Lyons (1992) for Peru; Odedokun (1997) for Sub-Saharan Africa (SSA)\(^{35}\); Chinn (1999) for South Africa; and Jimoh (2004) for Nigeria). The monetary model is built on two crucial assumptions: stable money demand functions and equilibrium money markets and that the PPP condition holds at least in the long run. Other assumptions include instant adjustment in money markets and identical elasticities of real income and interest rates across countries. One critique of the monetary model is that the Uncovered Interest Rate Parity (UIP) condition may not hold especially for developing market economies (Pearce, 1983). However, Chinn (1999) argues that, “as long as the implied exchange rate risk premium is stationary (i.e., l(0)), the long run monetary model should still be identifiable” (p.7). Tanzania liberalized the exchange rate and the exchange rate premium disappeared in April 1992 when the official and the parallel rates

\(^{35}\) Covering five countries: Gambia, Ghana, Nigeria, South Africa, and Zaire
were unified. Therefore, the monetary model is likely to be feasible at least in the long run. Given these assumptions, I now give a step-by-step derivation of the monetary model to be estimated in this study.

**Assumption 1: Purchasing Power Parity (PPP) Theory**

The mathematical specification of the PPP theory takes the form

\[ P_t = S_t P_t^* \] (4.1)

where \( P_t \) is the domestic price, \( P_t^* \) is the foreign price, and \( S_t \) is the nominal exchange rate (amount of local currency (TZS) per unity of foreign currency (USD)). In log form, equation (4.1) can be written as,

\[ s_t = p_t - p_t^* \] (4.2)

where \( s_t = \ln(S_t) \), \( p_t = \ln(P_t) \), and \( p_t^* = \ln(P_t^*) \)

Equation (4.2) suggests that the nominal exchange rate is determined by the price differential between domestic and foreign economies.

**Assumption 2: Stable Money Demand Functions and Equilibrium Money Markets**

**Assumption 2.1: Money Demand Functions**

This requires specification of a stable money demand function for each country. Let

\[ \left( \frac{M_t}{P_t} \right)^d = A \gamma_t^{\beta_2} e^{-\beta_3 i_t} \] (4.3)

where \( M_t \), \( P_t \), \( y_t \), and \( i_t \) are the nominal money stock, domestic price, real income and nominal interest rate in the domestic country. The superscript “d” is an abbreviation for “demand.” \( \beta_2 \) and \( \beta_3 \) are constant parameters, where \( A \) is a constant term.
Equation (4.3) is the domestic real money demand function which states that the demand for real money balances is a function of real income and the opportunity cost of holding money (i.e., the interest rate). The parameters $\beta_2$ and $-\beta_3$ are the elasticity of real income and interest rate semi-elasticity with respect to real money demand.

Symmetrically, let the money demand for the foreign country take the same functional form with variables in stars (i.e., “\*”) to distinguish it from the domestic variables. That is,

$$\left(\frac{M_t^*}{P_t^*}\right)^d = A^* y_t^* e^{-\beta_3 i_t}$$  \hspace{1cm} (4.4)

**Assumption 2.2: Equilibrium Money Markets**

By imposing the money market equilibrium condition in each country we have

$$\left(\frac{M_t}{P_t}\right)^d = \left(\frac{M_t}{P_t}\right)$$  \hspace{1cm} (4.5)

$$\left(\frac{M_t^*}{P_t^*}\right)^d = \left(\frac{M_t^*}{P_t^*}\right)$$  \hspace{1cm} (4.6)

That is, in equilibrium, the money market clears and there is no excess money in the economy since money demand is equal to money supply.

**Assumption 3: Identical Income Elasticities and Interest Rate Elasticities between Countries**

In the literature this is called a simplifying assumption as it makes the model more parsimonious, easy to estimate and also serves as a solution to a potential problem of multicollinearity due to correlations among the variables.
Substituting (3) in (5) and (4) in (6), equilibrium conditions in (5) and (6) can be written as

\[
\ln(M_t) - \ln(P_t) = \alpha + \beta_2 \ln(y_t) - \beta_3 i_t \tag{4.7}
\]

\[
\ln(M_t^*) - \ln(P_t^*) = \alpha^* + \beta_2 \ln(y_t^*) - \beta_3 i_t^* \tag{4.8}
\]

**Assumption 4: Money Markets Adjust Instantly**

Instant money market adjustment and domestic prices eliminate excess supply of or demand for money in the economy. This enables one to subtract equation (4.8) from (4.7). Using the PPP condition in equation (4.2), we can write,

\[
s_t = \beta_0 + (m_t - m_t^*) + \beta_2 (y_t - y_t^*) + \beta_3 (i_t - i_t^*) + \varepsilon_t \tag{4.9}
\]

where \(s_t\) is the log of nominal exchange rate; \(\beta_0 = \alpha - \alpha^*\); \(m_t\) and \(m_t^*\) are logs of domestic and foreign money supply; \(y_t\) and \(y_t^*\) are logs of domestic and foreign real GDP; and \(i_t\) and \(i_t^*\) are domestic and foreign nominal interest rates (\(\beta_3\) is semi-interest elasticity).

From equation (4.9), the coefficient on the monetary terms is predicted to be unity. However, empirical data may not guarantee an exact unity coefficient because of errors, omissions, distortions due to some data transformations, etc. A unity coefficient of the real money balance would be too strict a condition for the monetary approach to exchange rate determination. We impose the condition that the coefficient on the monetary term is \(\beta_1 \approx 1\) in order to relax the condition such that, given errors in the data, the monetary model holds for some values of \(\beta_1\) approximately equal to unity. Therefore equation (4.9) can be written

\[
s_t = \beta_0 + \beta_1 (m_t - m_t^*) + \beta_2 (y_t - y_t^*) + \beta_3 (i_t - i_t^*) + \varepsilon_t \tag{4.10}
\]

---

\(^{36}\) \(\alpha\) and \(\alpha^*\) are constant natural logs of \(A\) and \(A^*\)
In other words, the monetary model in equation (4.10) states that a country’s exchange rate depends on several factors such as the growth in the money supply, economic growth, and the interest rate relative to the rest of the world (Pearce, 1983). Although private speculation is one of the crucial variables in determining changes in the exchange rate, it is not considered explicitly as a variable in the model because of unavailability of data; instead it is part of the error term ($\epsilon_t$).

Equation (4.10) is often used in testing for the relevance of the monetary approach to floating exchange rate determination, (Edward, 1983; Jimoh, 2004; Lyons, 1992). The monetary approach to exchange rate determination is true if $\beta_1$, $\beta_2$, and $\beta_3$ are statistically significant and have the predicted signs with the magnitude of $\beta_1$ approximately equal to unity. Specifically, the monetary model holds if

$\beta_1 \approx 1$, implying that an excess supply of domestic currency relative to the foreign country causes a proportional depreciation of the domestic currency.

$\beta_2 < 0$, meaning that an increase in domestic real income relative to the foreign country generates an appreciation of the domestic currency.

$\beta_3 > 0$, implying that an increase in domestic nominal interest rate relative to foreign rate causes the domestic currency to depreciate.

**Prediction of the Monetary Model**

It is customary in economics to analyze issues in a partial equilibrium framework since it is not possible to capture every fact related to particular events. As a result, statements like “other things being equal” or any of its alternatives are common in economic analyses. In this study, I devise a simple framework for the purpose of demonstrating the
transmission mechanisms underlying predictions of the monetary model in equation (4.10) assuming that other things remain constant. Let

(i) \[ EM_t^{ss} = \bar{M}_t^{ss} - M_t^{dd}, \]

where \( EM_t^{ss} \) = excess money supply, \( \bar{M}_t^{ss} \) = money supply, which is fixed at time \( t \), \( M_t^{dd} \) = money demand.

(ii) The PPP condition be as defined in equation (4.2)

From this framework, other things remaining the same, it can be demonstrated that an increase in domestic money stock leads to depreciation of the nominal exchange rate

\( \left( \uparrow M_t^{ss} \rightarrow \uparrow EM_t^{ss} \rightarrow \uparrow p_t \rightarrow \downarrow s_t \right). \)

An increase in domestic real income leads to appreciation of the nominal exchange rate

\( \left( \uparrow y_t \rightarrow \uparrow M_t^{dd} \rightarrow \downarrow EM_t^{ss} \rightarrow \downarrow p_t \rightarrow \downarrow s_t \right). \)

An increase in domestic nominal interest rate leads to depreciation of the nominal exchange rate

\( \left( \uparrow i_t \rightarrow \downarrow M_t^{dd} \rightarrow \uparrow EM_t^{ss} \rightarrow \uparrow p_t \rightarrow \uparrow s_t \right). \)

1.2 Purchasing Power Parity as a Condition for the Monetary Model

As in other studies in the literature, this study considers two economically different countries. Tanzania is one of the developing countries that has achieved significant milestones in the last two decades in the economic and financial sectors. The U.S. is a developed country with a large economy and a more sophisticated financial infrastructure. It is likely that the PPP condition may not hold in absolute terms because of the possibility of
non-fulfillment of the homogeneity and symmetry properties\(^{37}\). Krichene (1998) provides three main reasons for the plausibility of non-fulfillment of the two properties and hence non-fulfillment of the PPP condition in its absolute form. The reasons are related to weights in consumption patterns, relative prices, and measurement errors. Because of differences in consumption patterns between Tanzania and the U.S., the weights assigned in the compilation of consumer price indices (CPIs) differ. Even if these weights happen to be equal, they get updated at different frequencies due to differences in the level of development between the two countries, while the actual prices of goods and services change over time. Given these diversities, it is obvious that the composition of price indices of traded and non-traded goods would differ. Further, the relative prices of traded and non-traded goods and services change over time at different speeds between the two countries. Lastly, measurement errors, which are pervasive in developing countries, affect the reported prices. In brief, the non-availability of absolute price-level data with standardized baskets between the two countries is a major constraint to the relevance of the absolute PPP condition (Gokcan & Ozmen, 2002). Based on these reasons, this study adopts the weak (relative) version of PPP condition by relaxing the homogeneity and symmetry properties of the absolute PPP condition according to Krichene (1998):

\[
s_t = \delta_0 + \delta_1 p_t + \delta_2 p^*_t + \varepsilon_t
\]  

(4.11)

where \(\delta_0\) is a constant, \(\varepsilon_t\) is the error term, and \(\delta_1\) and \(\delta_2\) are the domestic and foreign price elasticities with respect to the nominal exchange rate. Unlike the absolute version of the PPP

\(^{37}\) Homogeneity and symmetry require unity coefficients of the domestic and foreign prices to have positive and negative signs, respectively.
condition, the parameters $\delta_1$ and $\delta_2$ need not be equal to unity in absolute terms under the weak version of the PPP condition. The condition holds if $\delta_1 > 0$, $\delta_2 < 0$ and $\varepsilon_t$ is stationary ($I(0)$). This test basically investigates the presence of a long-run relationship among the nominal exchange rate, domestic and foreign prices. In this study, the weak version of the PPP condition is tested by investigating the long-run relationship among the nominal exchange rate, domestic and foreign prices variables by employing a Vector Error Correction Model (VECM).

In the literature of nominal exchange rates, the depreciation pattern is established as an empirical regularity for most developing countries following the adoption of a floating exchange rate regime. The reason for this depreciation pattern is that market forces tend to drive the exchange rates towards their perceived long run equilibria (Chinn, 1999; Jimoh, 2004; Lyons, 1992). In the case of Tanzania, as is the case in many other developing countries, this study aims to establish whether the depreciation pattern of the exchange rate during the post-reform period can be explained by the monetary approach to floating exchange rate determination. This is the main hypothesis of this study which is broken down into the following hypotheses:

(i) Increases in the domestic money supply relative to its foreign counterpart depreciate the nominal exchange rate;

(ii) Increases in domestic income relative to foreign income appreciate the domestic currency;

(iii) Increases in the domestic nominal interest rates depreciate the domestic currency; and
Since the adoption of the floating exchange rate regime, the depreciating pattern of the exchange rate accords with the PPP condition, i.e. it converges to the perceived long run equilibrium\textsuperscript{38}.

1.3 Dynamics between the Exchange Rate and its Potential Determinants

Figures 4.1 and 4.2 present graphical overviews as an alternative way of examining the relationship between the nominal exchange rate and its potential determinants. In this analysis, the nominal exchange rate is plotted versus each of the potential determinants.

1.3.1 Exchange Rate versus Domestic Variables

Since the adoption of the flexible exchange rate regime in 1992, the nominal exchange rate has been depreciating at almost a constant rate. This pattern reveals the phenomenon advanced in the literature that after being liberalized in the early 1990s, the exchange rate tends to depreciate towards its perceived long run equilibrium path (Chinn, 1997; Jimoh, 2004). During the same period, the official foreign exchange reserves increased faster, especially after the year 2000. Among the factors that caused the surge in the official foreign exchange reserves is the central bank’s decision to limit its sales of foreign exchange when it was decided to decrease the mopping up of liquidity from the aid-financed government budget support (Roger et al., 2009). From the patterns seen in chapter two regarding the nominal exchange rate, inflation rate and total reserves, other things being equal, it is arguable that liberalization of the exchange rate was perhaps a solution to some of the imbalances that stemmed from the controlled exchange rate regime.

\textsuperscript{38} There is no explicit long term exchange rate target in Tanzania in the standard meaning of purchasing power parity. However, we assume that it exists as it is implied by the long term annual absolute exchange rate targets in the form of International Monetary Fund’s benchmarks.
Exchange Rate versus Domestic Money Stock

The log of money stock exhibits an increasing trend, moving together with the nominal exchange rate. This suggests that an increase in the domestic money stock, ceteris paribus, is associated with a decrease in the U.S. dollar value of the Tanzanian shilling. This is consistent with the prediction of the monetary model in which nominal exchange rate adjustments are assumed to be determined in the money market equilibrium. The outcome is also consistent with the traditional model\(^{39}\) which also predicts the same relationship. However, unlike the monetary model which is based on the stock of assets and requires that the coefficient associated with the monetary term approximate unity, the traditional model is based on the flow of assets and is considered to hold as long as the coefficient on the monetary term is positive.

Exchange Rate versus Domestic Price Level

The increases in the domestic price are associated with exchange rate depreciation which is consistent with the prediction of the PPP condition.

Exchange Rate versus Real Domestic Income (Real GDP)

The log of real income has been increasing overtime. This positive relationship between exchange rate and the domestic income is not consistent with the prediction of the model. Instead, it supports the traditional model.

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\(^{39}\) The traditional model suggests that an increase in domestic income relative to its foreign counterpart is associated with depreciation because the increase in domestic real income stimulates an outflow of assets via purchases of imports. This worsens the country’s foreign exchange position leading to depreciation of the local currency.
Exchange Rate versus Domestic Interest Rate

During the post-reform period (especially from 1995), the relationship between the exchange rate and the interest rate is negative. This is consistent with the traditional model but not with the monetary model. The negative relationship between nominal exchange rate and interest rate differential as predicted in the traditional model rests on the notion that higher interest rate differential attracts more inflows, which leads to appreciation of the local currency. The monetary model predicts a positive relationship between exchange rate and interest differentials, implying that a wider interest rate differential tends to fuel expected inflation, thereby leading to depreciation of the local currency. During the first decade after introduction of the economic and structural adjustment programs (1986-1995), the relationship between the exchange rate and interest rate corroborates the positive relationship predicted by the monetary model.

1.3.2 Exchange Rate versus Differential Variables

Exchange Rate versus Monetary Differential

Since the early 1970s, the nominal exchange rate and monetary differential have been increasing as shown in the top chart of figure 4.2. The nominal exchange rate was relatively volatile until the mid-1980s, after which it was increasing smoothly. During the decade between the mid-1980s and the mid-1990s, the money stock differential was increasing at a relatively higher rate as indicated by the relatively steep sloped curve. This is the period when inflation was high in Tanzania as illustrated in chapter two. In general, the patterns depicted by the relative movements between the nominal exchange rate and the money stock
differential in the figure 4.2 are consistent with the prediction of the monetary model, that is, an increase in the money differential is associated with exchange rate depreciation.

**Exchange Rate versus Income Differential**

From the middle chart in figure 4.2, there is no specific pattern for the relationship between the nominal exchange rate and the income differential. The income differential is characterized by two patterns. From the early 1970s until the mid-1980s, the income differential was falling while the exchange rate on average was not changing. This declining pattern of the income differential recurs again from around 1990 until the mid-1990s. While the exchange rate shows an increasing and constant pattern from the mid-1980s following the economic and structural adjustment programs and later on the early 1990s financial sector reforms, the income differential shows a fluctuating pattern in which on average seems to oscillate around an increasing trend from the mid-1990s.

**Exchange Rate versus Relative Prices**

Similar to the observed relationship between the nominal exchange rate and money stock differential in the top chart of figure 4.2, the nominal exchange rate and the price differential move together throughout the period. However, the relationship between the nominal exchange rate and relative prices is shown to be stronger than that of nominal exchange rate and money stock differential. This positive relationship between nominal exchange rate and relative prices is consistent with the prediction of the PPP condition; that is, an increase in the domestic price relative to foreign price is associated with depreciation of the exchange rate.
The graphical empirical evidence in figures 1 and 2 should be taken with caution, however. Pearce (1983) cautions that “graphical implications could be misleading, however, since the theories predict the effect of one variable holding all the others constant and the graphs allow other variables to change” (p. 28). Therefore, the reliable empirical evidence to be compared with the model prediction should come from regression parameters.

2.0 Literature Review

The monetary approach to the exchange rate determination dates back to the 1950s, taking the form of Balance of Payments analyses and later on took the form of exchange rate (Jimoh, 2004). From then the topic has been heavily researched, mostly in developed countries, (Fry, 1976; Odedokun, 1997). Odedokun (1997) associates this asymmetric distribution pattern of the literature with a small number of countries with floating exchange rates as well as inadequate data for developing countries. Another asymmetry facing the subject according to the literature is that most of the studies involve empirical analysis rather than theoretical analysis. What is common in the literature among the studies is the objective, which is naturally stated explicitly by the topic itself. That is, the common objective of the studies on the topic centers on what shapes the behavior of the nominal exchange rate under a flexible exchange rate regime.

Since this study is conducted for Tanzania which is one of the developing countries, the literature review focuses on the studies from developing countries. This approach ensures a fair comparison given that these countries have almost similar economic characteristics and hence provide similar circumstances under which the monetary approach to floating exchange rate is implemented. At different times, Edwards (1983) and Lyons (1992) list the
typical characteristics of Least Developed Countries (LDCs) for Peru in the 1950s under which they estimate the monetary approach to the exchange rate determination. Their list includes limited interventions in the exchange rate market; exports dependent on a few commodities; informal currency market; repressed domestic capital market; and significant share of export tax in government revenue. Considering the economic, monetary, fiscal, and financial conditions in the country, Tanzania belongs to this category although it stands better than the listed conditions following a battery of economic sector transformations as a result of the economic and structural adjustment programs of the mid-1980s and the financial sector reforms of the 1990s. The relevant studies comprising this literature review include Fry (1976) for Afghanistan; Edwards (1983) and Lyons (1992) for Peru; Chinn (1999) for South Africa; and Jimoh (2004) for Nigeria.

The structure or framework of this literature review is built on key issues related to data and methodology, estimation method and finally on the results.

Review of Methodologies

The methodology used in the literature of the monetary approach to exchange rate determination does not vary significantly. Most of the studies identify the monetary model in which the nominal exchange rate is a function of monetary, real income, and interest rate differentials between the domestic and foreign countries. While some of the studies construct the monetary model based on two main assumptions (stable money demand functions and the Purchasing Power Parity (PPP) condition (Jinoh, 2004), other studies extend the premises of the monetary model to four assumptions (Pearce, 1983). The key assumptions on the
derivation of the monetary model are the equilibrium in the money market (demand functions) and the PPP condition.

It has been common in the literature that studies apply constrained coefficients by invoking the simplifying assumption of identical coefficients of the money supplies, real incomes and interest rates. Although the early studies (early evidence) based on unconstrained coefficients seem to perform well when judged based on significance and signs of coefficients as well as explanatory power, they suffer from serial correlation which is an indication of misspecification (MacDonald, 2007). Constraining the coefficients along with the application of the cointegration method seems to be the best approach of testing the monetary model. MacDonald reviews the studies of the 1980s, grouped under the “second evidence,” that apply the simplifying assumption of identical elasticities without the cointegration technique. He argues that such studies suffer from the dangers of biased estimates and signs reversal, citing the case of the “mystery of multiplying currency” whereby the results from the monetary model predict that an increase in the money stock leads to currency appreciation. This study estimates both the constrained and unconstrained monetary models using the vector error correction method (VECM).

In his model specification, Fry (1976) uses only domestic variables. He considers the foreign element in the model through the Purchasing Power Parity (PPP) condition, which is just assumed because no empirical test is conducted to verify whether the condition holds. Although Fry’s estimates seem to perform very well when judged in terms of statistical significance, signs and sizes of the coefficients, the Dubbin Watson (DW) statistic, and its explanatory power, there is no reason that keeps someone from doubting such estimates
given that there is no empirical test on whether the PPP condition holds. In this study, we test the PPP condition for Tanzania as a pre-condition for estimating the monetary model in order to avoid the flaws of the early studies.

**Review of Estimation Methods**

Since the early studies categorized in MacDonald (2007), estimation techniques have been changing as a result of development in the field of econometrics. Developments in the estimation techniques have been changing the perception about the results. For instance, MacDonald (2007) argues that studies which comprise the early evidence in the 1970s involve simple models such as traditional static framework with some limited dynamics using OLS. Later on, cointegration studies came in and changed the perception about the previous results arguing that the early evidence (1970s) involve spurious regressions.

Chinn (1999) is among the few recent studies in the literature that uses cointegration techniques. Chinn uses the Vector Error Correction Model (VECM), arguing that one is not only interested in how the exchange rate adjusts, but also in how the other explanatory variables in the model adjust. Another advantage of this method is that it gives a full account of the sources and the magnitude of contribution to the adjustment in the exchange rate. Therefore, the VECM estimation method provides a set of information from a particular macroeconomic system which is relevant for policy analysis. For instance, this study takes advantage of the rich features of the VECM estimation technique to determine the speed of convergence of the nominal exchange rate once it is shocked away from its equilibrium path. Both of these features distinguish this study from the earlier studies in the literature, including Chinn (1999) who, despite using the VECM, does not explore its features that
determine how long it takes the South African Rand to converge back to its long run equilibrium once it is hit by a shock.

**Review of Data and Variables**

The literature shows that the specification of the variables used in most studies do not vary much. Exceptions do occur in the operational definition of the opportunity cost used in the money demand functions. While most studies use an interest rate as the opportunity cost of holding real money balances, Fry (1976) and Odedokun (1997) recommend the use of expected inflation as the opportunity cost of holding real money balances in developing countries because of the low level of development of the financial markets that causes interest rates fail to reflect the opportunity cost of holding money. While this approach is theoretically appealing, it requires proxying expected inflation. However, given the impact of the Tanzanian financial sector reforms implemented starting in the early 1990s, financial markets are working well such that to some degree, interest rates are believed to reflect the opportunity cost of holding money.

Real GDP is another variable which poses a challenge in the literature. For most of the emerging market economies, only annual real GDP data are available; therefore, studies which use quarterly or monthly data need to interpolate the GDP data from annual levels to the desired frequency. Fry (1976) also uses government expenditure as a proxy for nominal GDP due to non-availability of nominal GDP data in Afghanistan at the time. While government expenditure might be positively correlated with nominal GDP, it is not always true that expenditure is a good proxy for GDP. This may not hold for instance when the government runs fiscal deficits (accumulating debt) in which the magnitude of government
expenditure would not reflect the size of the GDP. The opposite is the case when the government is committed to cash budgeting. Government expenditure may not be a good proxy for the national income (GDP) under an inefficient tax system because government expenditure may not be proportional to GDP as it is limited by tax revenue collection.

Another problem related to GDP in the literature entails sample size and duration of policy monitoring. Studies like Edwards (1983), Lyons (1992) and Odedokun (1997) cover at most six years, which is very short for a thorough analysis of policy. To circumvent the problems associated with small sample sizes, they use monthly data through interpolation of GDP data from annual to monthly series. Data transformation from annual to such a very high frequency is likely to produce biased estimates unless such estimates are included just to supplement the main results. For such short period studies, there is a high possibility of missing the actual policy dynamics, thus leading to biased estimates. Although Jimoh (2004) also uses monthly data parallel with the annual data, the results associated with monthly series need to be interpreted with caution because of potential distortion of GDP caused by linear interpolation of GDP; however, his monthly results do not seem to be affected by the short period of policy observation as it covers about 13 years, which is long enough to capture the policy changes in the variables.

Review of the Empirical Results

Although the results from the various estimation methods seem to be satisfactory when examined in terms of how they compare with the predictions of the model

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40 While Edwards (1983) and Lyons (1992) do not describe how they interpolate their monthly GDP data from annual GDP, Odedokun (1997) and Jimoh (2004) interpolate monthly GDP data from annual GDP by spreading the annual GDP growth evenly among the twelve months of the year.
(significance, signs, and sizes of coefficients), a deep analysis in terms of how the conditions for the monetary model were met casts some doubts on some of the results. The literature suggests that the monetary model is built on two important assumptions of equilibrium money markets in both countries and that the PPP theory should hold at least in the long run. A preview of the empirical literature shows that many of the studies test the relative/weak version of PPP and obtain supportive evidence for the validity of the monetary model (Chinn, 1999; Edwards, 1983; Jimoh, 2004; Lyons, 1992; Odedokun, 1997). No study considers the absolute version of PPP theory because it is not supported by empirical evidence (Pearce, 1983), mainly due to the difficulty in fulfillment of the homogeneity and symmetry properties since countries differ in their consumption patterns and hence attach different weights to their consumption baskets. Further, countries’ consumption patterns and consumption weights change over time at different speeds due to differences in the level of development. However, none of these studies tests the stability of the money demand function. Why do studies in the literature not bother testing for the stability of the money demand function and just assume that it holds? One of the possibilities is that testing for parameter stability requires a sufficiently large sample size; therefore, small sample size is the major constraint among the studies in the literature for conducting stability tests. This study also does not test for the stability of the money demand function because of the short sample period. However, the sample period falls under the single regime (post-reform); therefore, it likely that the demand for money function during the period is stable.

Chinn (2013) and Cerra and Saxena (2010) constitute the most recent relevant contributions in the literature of exchange rate determination. Chinn (2013) provides an
important contribution to the general literature of exchange rate determination that puts the exchange rate literature into perspective. The paper reviews macroeconomic models of exchange rate determination, particularly the monetary and portfolio balance models of the nominal exchange rate. Second, it provides a broader literature review on real exchange rate models, and also provides a brief review of the recent developments with regards to modeling both nominal and real exchange rate determination.

Cerra and Saxena (2010) reexamine the monetary model using a large panel data set covering 98 countries. Using the error correction model, the study finds robust long-run relationships between monetary fundamentals and exchange rates. This evidence rejects the early evidence on the failure of the monetary models in characterizing the behavior of nominal exchange rates during the flexible exchange rate regimes.

**Empirical Results from Selected Studies**

This section reviews the results from a few key papers in the literature. It recapitulates the above discussion of the literature review but focusses on results, particularly those from developing countries. In general, the results from developing countries do not provide solid and conclusive evidence on the effect of monetary, real income, and nominal interest rate differentials on the nominal exchange rate. This may be due to some flaws related to methodology (model specification), data availability, variable selection, or the theory may not be correct.

While Fry’s (1976) study seems to be promising for a developing country with a dearth of data since it provides consistent results as predicted by the monetary model, the empirical framework of his study is inadequate; therefore, such results should be taken
cautiously. As required, Fry (1976) specifies the empirical model from the two main assumptions of stable demand functions for Afghanistan and the U.S and that the PPP condition holds between Afghanistan and the U.S. He finds highly significant coefficients (based on t-statistics) with expected signs. His results also suggest a very high explanatory power of the model and some elements of negative autocorrelations as indicated by the Dubbin Watson test statistic (2.7). The study does not perform a pre-test to ascertain whether the PPP condition between Afghanistan and the U.S. actually holds. Therefore, there is no element of an open economy in the model because he uses only Afghan data instead of using the differentials between Afghan data and the U.S. The missing foreign element also can be seen in the mathematical structure of the model since it involves only domestic variables (money stock, real income, and nominal interest) instead of differentials or domestic and foreign monetary, real income and nominal interest aggregates in the case of the unconstrained model. Another weakness of these results comes from the use of government expenditure and lagged inflation values as proxies for income and the opportunity cost of holding money, respectively. The validity of these variables as proxies raises some doubts as explained above.

Edwards (1983), Lyons (1992), and Odedokun (1997) are all studies related to Fry (1976) for developing countries; they are subject to the same economic characteristics of the economy, with almost the same data constraints. While the results from these studies seem to be satisfactory in replicating the predictions of the monetary model, econometric considerations suggest that they need also to be taken with caution. Edwards (1983) and Lyons (1992) at different times use the sample of the Peruvian data covering the period
1950-54. While they circumvent the small-sample problem by using high frequency data (monthly) through interpolation of the GDP data, the five-year period of their analyses may not be adequate to provide reliable results due to concentration of policy analyses within a short period.

Unlike developed countries, developing countries are characterized by negative cycles around elections due to insecurity or uncertainty of business investment caused by the lack of free and fair elections. Such results might be biased due to the high chances of missing the actual policy changes. The results in Edwards and Lyons studies contradict each other despite drawing from the same sample data. Although Edwards finds evidence for the monetary model with partial adjustments, the same model does not hold for Lyons since all the coefficients are statistically insignificant, except the monetary term as shown in table 4.1.

The above problem of short periods of analysis with interpolation of income from annual to monthly series also faces Odedokun (1997). Odedokun studies five Sub-Saharan countries for a period of six years. Although he claims to resolve the short-sample problem by increasing the number of observations from the panel setting as well as from monthly series via interpolation of GDP data, there is a high chance also that such results are biased.

Jimoh (2004) provides interesting results as they seem to be free from the purported problem of distorted GDP impulses (from interpolation) on the nominal exchange rate. Jimoh uses both monthly (interpolated) and annual data, both providing results which are consistent with the monetary model’s predictions. Although his results seem to exhibit some robustness, the problem lies on the linear assumption imposed in interpolation of the data, particularly
spreading GDP evenly in all the twelve months of the year while production activities in year
are usually characterized by seasons, especially in development countries.

**Summary**

One of the key takeaways from this literature review is that the main blocks in the
construction of the monetary approach to floating exchange rate determination are the
assumptions of the PPP condition (at least in the long run) and the equilibrium money
markets in both countries. This literature review shows that no study tests the PPP condition
in absolute term. That is, most of the studies test the relative version of the PPP theory and
none of them attempts to test the monetary stability condition because it involves strong
conditions which are implausible irrespective of the country’s level of financial and
economic development (Chinn, 1999).

Among the contributions of this study is that it is the first empirical study for
tanzania based on the monetary approach to floating exchange rate determination.
Therefore, there are no coefficients to compare in the context of Tanzania; instead I gauge
the coefficients with the predictions of the model itself and some few studies from
developing countries, particularly those from Sub-Saharan Africa. A summary of the results
(coefficients) from the above reviewed literature for the emerging market economies is in
table 4.1.

A couple of important features of such economic studies have emerged from the
literature review. It has been an empirical regularity everywhere that exchange rate
liberalization is followed by continuous exchange rate depreciation (Chinn, 1999; Jimoh,
2004). This implies that exchange rate controls are characterized by exchange rate
distortions, specifically overvaluation of the domestic currency and hence loss of competitiveness and consequent external balance problems. This is one of the major problems that prompted most countries to abandon the fixed exchange rate regime in favor of the flexible exchange rate regime. Lee (2005) also describes how Asian countries switched from the fixed to floating exchange rate regimes following the 1997 Asian financial crisis. With exchange rate liberalization, asset market forces tend to drive the exchange rate to its perceived long run equilibrium path. This stylized fact arises in Chinn (1999) for the case of South Africa, Jimoh (2004) for Nigeria, and Lyons (1992) for Peru.

Another notable feature in the literature review is the scanty literature on the monetary model of exchange rate determination for developing countries. This can be due to the existence of few floaters in developing countries as well as the non-availability of data for the period prior to 1990. However, more countries switched to flexible exchange rate regimes in the 1990s and a substantial amount of data exists in emerging market economies. The current study takes advantage of this opportunity of testing the monetary approach to exchange rate determination using Tanzanian data during the flexible exchange rate regime starting from 1992. The year 1992 is chosen because of two reasons: first, it is the year when most of the financial sector reforms started (including liberalization of exchange rate); second, given the objective of the study, the literature suggests that the impact of economic fundamentals on exchange rates are higher under the freely floating rather than the fixed exchange rate regime because it is possible for exchange rates to respond to reflect those shocks (Lee, 2005).
3.0 Estimation Method of the Study

3.1 Introduction

The monetary model in equation (4.10) involves a set of domestic and foreign variables (i.e., s, m, y, and i). Since macroeconomic variables are interrelated, it is crucial to consider this model as a system of equations rather than a single equation. Although the primary goal of this study is to analyze the effects of relative money supplies, real incomes and interest rates on the nominal exchange rate, there is a possibility that some of these variables receive feedback from the nominal exchange rate. In other words, it is not certain what exactly the central bank does in conducting monetary policy. Given these variables in relation to monetary policy, one cannot rule out the possibility that the central bank manipulates the exchange rate through its participation in the Interbank Foreign Exchange Market (IFEM) to achieve monetary and interest rate goals. The VECM estimation technique is used to allow estimation of a system of equations in order to subject the above possibility to empirical investigation. The model allows all options in terms of whether the nominal exchange rate dances to the tune of these variables (i.e., our hypotheses) or at some periods, these variables respond to nominal exchange rate changes as suggested by the results in chapter three. The VECM serves this purpose because it assumes that all the variables are endogenous and hence allows determination of linear relationships that reveal all the existing possibilities in the form of cointegrating vectors. The VECM estimation technique estimates the exchange rate adjustment term from which we can calculate the duration it takes for the exchange rate to converge back once it is pushed away by shocks from its long run equilibrium path. The same method is also applied to investigate the long run relationship
between exchange rate and relative prices through testing whether the weak version of PPP condition holds.

3.2 Description of the VECM Estimation Technique

Suppose that the variables in the monetary model in equation (4.10) are integrated of order one (I(1)); there is a possibility that they follow a common long-run path such that their linear combination(s) is(are) stationary I(0)) (Engle and Granger, 1987). If this happens, the variables are said to exhibit a long run relationship or cointegration. In economics, spurious regression is a problem that results from regression of non-stationary time series. The problem is pervasive in macroeconomics because most macroeconomic time series are generally non-stationary. Before advances in time series techniques, the solution to spurious regression problem was solved by estimating economic models using difference-stationary time series. However, differencing the time series eliminates the long run characteristics of the data (Hafer & Jansen, 1991). Later on, advancement in econometric techniques established that such long run characteristics of data are important in economic model estimations as they contain the long run information of the data. If several time series are independently non-stationary but their linear combination is stationary, then they are said to be cointegrated. This means that they tend to have a long run relationship, the information which would be lost when the series are estimated in their difference-stationary form. Therefore we need to test for the existence of cointegration among the variables.
The single equation method⁴¹ and the multiple equation method of Johansen (1988) and Johansen and Juselius (1990) constitute the key tests for cointegration. In this study, the question is not only how the nominal exchange rate adjusts, but also how other macroeconomic variables in the system adjust (Chinn, 1999). That is, while the primary objective is to learn how the exchange rate adjusts in relation to the execution of monetary policy, it is likely that the Bank of Tanzania, either directly or indirectly, manages the exchange rate by influencing some of its instruments. Although both tests serve the same goal, the multivariate test seems to be superior to the single equation method for the following reasons: it allows testing for the number of existing cointegrating vectors in the system of variables; it provides the maximum likelihood estimates of the unconstrained cointegrating vectors while the two-step procedure relies on convergence results from OLS to obtain parameter estimates of the cointegrating vectors; and the method allows testing for the predictions of economic theory (signs and sizes of estimated elasticities). Therefore, the multiple equation approach (Johansen, 1988; Johansen & Juselius, 1990) is appropriate for this exercise given the relevance of its features in this study. For details in the derivation of the VECM, see appendix 4.1.

4.0 Empirical Results

Introduction

It should be noted that the post-reform sample period of 1992-2011 is short such that it can be a constraint towards the expected results. To resolve this problem, this study expands the sample size by considering the pooled sample period of 1973-2011 that merges

⁴¹ Alternatively called the Engle and Granger (1987) two-step procedure
the pre- and post-reform periods. The *operational nominal exchange rate* in this sample period is obtained by merging the black market exchange rate\(^{42}\) during the pre-reform period and the flexible exchange rate during the post-reform period. Estimation of the models is done for three samples periods: the pre-reform sample (1973q1-1991q4); post-reform sample (1992q1-2011q4); and the pooled sample (1973q1-2011q4).

Given the possibility of a structural break in the pooled sample which includes the mid-1980s, economic and structural adjustment programs and the early 1990s’ financial sector reforms, the Gregory and Hansen (1996) test for cointegration with regime shifts (or structural break) is conducted to supplement the conventional tests for cointegration. Both tests show the presence of a long-run relationship in the monetary model with the Gregory-Hansen test showing the long-run relationship along a broken trend with the breakpoint in 1984q4. The Gregory and Hansen test proves the suspicion that the pooled sample period includes a structural break. From this evidence, the VECM is estimated using the pre-reform period (1973q1-1991q4), post reform period (1992q1-2011q4) and the pooled sample period (1973q1-2011q4).

The VECM results for the pre-reform and the pooled sample periods are not satisfactory and therefore do not achieve the envisaged objective of improvement in estimates via sample expansion. While some of the coefficients are statistically insignificant, others have the wrong signs leading to poor performance of the model in both samples. Therefore, the results using the pooled and pre-reform sample periods are not reported.

\(^{42}\) Cowitt (1986-1987, p.7) defines the black market exchange rate as “unofficial, usually illegal, price of particular currency, mostly in terms of U.S. Dollar. Reflects unrestricted supply and demand and therefore, represents true or real worth of a monetary unit.”
The possible reason for the unsatisfactory performance of the estimates from the pre- and pooled sample periods is that the domestic interest rate (lending rate) might not be a good proxy for the opportunity cost for holding money since interest rates were controlled by government. Before the financial sector reforms in the early 1990s, interest rates were determined administratively by the government and were deliberately kept low for prolonged periods in favor of bank borrowers, particularly the government and other government parastatals such as Cooperative Unions, Regional Trading Companies (RTCs), National Milling Corporations (NMCs), and more. Some studies in the literature (Edwards, 1976) suggest expected inflation as the best opportunity cost for holding money for developing countries where financial markets are not well developed; however, in my estimation, I could not use this option given that inflation is generated from price changes while prices were also controlled. Until the mid-1980s’ economic reforms, prices in Tanzania were strictly controlled by government, particularly by the National Price Commission, which was mandated to regulate prices by setting price ceilings and floors regardless of the costs incurred in the production of goods and services. The results for the pre-reform and the pooled sample periods are not reported; instead, the study focuses on the post-reform period, the results of which are reported in this section.

4.1 Unit Roots Test Results

To ascertain the time series characteristics of the data, I tested for unit roots using three methods: the Zivot-Andrews Unit Root (ZAURoot), Augmented Dickey Fuller (ADF), and the Phillips Perron (PP) tests. The Phillips Perron test has a significant advantage when the time series involve some moving average components; therefore, it offers a good
alternative to the ADF (Phillips and Perron, 1988). The ZAURoot test results are reported along with the ADF and PP tests. The tests for unit roots in table 4.2 show that all the variables become stationary after first differencing. This suggests that the variables are integrated of order one (I(1)).

4.2 Cointegration Test Results

Having established that the series are integrated of order one, I proceed with the test for cointegration. As pointed out in the estimation section, the study uses the Johansen procedure. The procedure basically tests for the rank of the matrix $\Pi$ using the trace statistic as described in appendix 4.1. The results reported in table 4.3 suggest the presence of one cointegrating vector as indicated by the single rank ($r=1$). This implies that there is evidence of a long-run relationship among the exchange rate, domestic and foreign inflation rates in the model.

The cointegration test for the variables in the monetary model exhibits a vector rank of one, meaning that there is only one long run relationship among the variables that constitute the monetary model. The evidence from the maximum rank test shown in table 4.3 suggests an estimate for both the long run and short run relationships for the PPP and monetary models.

Based on the long-run relationship evidence shown in table 4.3, a vector error correction model (VECM) is estimated to determine the long-run equilibrium and the short-run dynamics for the PPP condition and the monetary model.
4.3 Estimation of the Purchasing Power Parity Condition

It is stated in the model section that the absolute version of the PPP condition is not supported by empirical data in the literature. Therefore, this study is interested in investigating the presence of the weak version of the PPP condition. This would serve two purposes: first, it would provide evidence on the validity of estimating the monetary model for exchange rate determination; second, on the basis of the significant estimates of the PPP condition, it would be possible to characterize the behavior of the nominal exchange rate in relation to movements in the relative prices. From the weak version of the PPP, unit coefficients on the relative prices are not expected as predicted in the absolute version of PPP (unity). Nevertheless, for the weak version of PPP condition to hold, it requires the nominal exchange rate and the relative prices to exhibit a long-run relationship; it also requires that the coefficients on the relative prices be statistically significant. The coefficients on the domestic and foreign prices are predicted to be positive and negative, respectively.

Having established a long-run relationship among the variables in the PPP model in table (4.2), the PPP condition was estimated using a VECM approach. The long-run and short-run estimates are reported in panels A and B of table 4.4.

**Long Run Equilibrium Estimates of the PPP Condition**

The PPP equation is the sole long run relationship as established in table 4.3 and 4.4 by the rank test for cointegration and the estimates of the PPP model, respectively. All the long-run coefficients including the adjustment term are statistically significant with the expected signs.
The long run estimates for the PPP model (table 4.4) suggest that a 10% increase in
the domestic price is associated with 0.1% depreciation in the nominal exchange rate, while
the same 10% increase in the foreign price (holding domestic price constant) is associated
with a 0.2% appreciation in the nominal exchange rate.

Short Run Dynamics of the PPP Condition

The PPP condition estimates show that the changes in the domestic price tend to
influence the nominal exchange rate after the second and third lags. Although it is
statistically significant, the effect of the domestic price on the nominal exchange rate is even
smaller in the short run. The lags of the nominal exchange rate are not statistically
significant, suggesting that the exchange rate is not autoregressive, which means that the past
short-term changes in the exchange rate do not explain the current changes in the exchange
rate.

Overall Results of the PPP Condition

The results for the PPP condition in table (4.4) show that the coefficients on the
domestic and foreign prices are statistically significant at the 1% and 5% levels, respectively,
with the predicted signs. Based on statistical significance of the parameter estimates and
signs of the coefficients, the estimates are relevant to the prediction of the PPP condition.
These results adequately satisfy the weak version of the PPP condition. Satisfaction of the
weak version of PPP condition justifies estimation of the monetary model, which follows in
the subsequent section.

Although the PPP condition is a pre-requisite to estimation of the monetary model in
determining the drivers of the nominal exchange rate, the PPP model by itself determines
how changes in the exchange rate are explained by relative prices. From the long run results of the PPP model, the results seem to characterize the behavior of the Tanzanian exchange rate during the flexible exchange rate regime. The coefficient on the adjustment (error) term satisfies the two crucial properties of negativity and statistical significance, since it is negative and statistically significant at the 5% level. Based on the size of the adjustment term (-0.123), it can be estimated how long it takes for the exchange rate to converge back to the perceived long-run equilibrium path once it is struck by a shock. The half-life formula as defined in the panel A of table 4.4, suggests that once the exchange rate deviates from its long run equilibrium path following a shock, it takes about 1.5 years (or six quarters) to converge back by 50%. As the name suggests, the method estimates just one half rather than the full period required for a variable to converge back because the speed of convergence is nonlinear (it is faster the closer to the shock and gets slower as time goes on (see table 4.8 and figure 4.3)). Therefore, in the long run, adjustments in the nominal exchange rate emanate from both domestic and foreign prices.

The results from the short-run estimates of the PPP condition in table 4.4 (panel B) suggest that adjustments in the nominal exchange rate originate from domestic price alone. The change in the foreign price term does not have any effect on the nominal exchange rate. Although the PPP estimates do not exhibit a one-to-one relationship between domestic inflation and the nominal exchange rate as indicated by the small coefficient on the domestic price, the positive relationship between inflation and the exchange rate is consistent with economic intuition.

43 See MacDonald and Racci (2005).
4.4 Estimation of the Constrained Monetary Model

One requirement in estimating the monetary model as mentioned in the model section of this chapter is the assumption of a stable money demand function. The partial empirical evidence from chapter two of this study based on the individual macroeconomic variables suggest some structural breaks following the early 1990s financial sector reforms in Tanzania. This is likely to have effects on the stability of the demand for money function when a pooled sample period is considered. However, with the early financial sector reforms which place the post-reform sample period (1992q1-2011q4) in the same regime in addition to inadequate sample size for the purpose of structural break test, this study, like other studies in the literature, does not test the structural break.

Based on the weak PPP condition results (table 4.4) and cointegration (maximum rank) test results in table 4.3, the constrained monetary model is estimated using the VECM approach. In estimating the monetary model in the context of Tanzania, I consider the lending rate as the best available proxy for the opportunity of holding money. Other interest rates (such as the Treasury bill rate) do not provide better results than the lending rate when considered in the model; hence, the results are not reported. I estimate each model with a time trend in order to capture the plausible impact of the continuous improvement in the financial sector following a series of reforms in the financial sector starting from early 1990s.

Long Run Equilibrium Estimates of the Constrained Monetary Model

The results of the cointegration test in table 4.3 suggest that the equation (vector) of the monetary model is the sole long-run relationship in which the nominal exchange rate is determined by differentials in the money stocks, real incomes and the interest rates. From this
result, there is no evidence to suggest that the Bank of Tanzania has been using the exchange rate as a tool to achieve monetary, output, or interest rate goals (at least during the post-reform period). Examining whether the central bank uses the exchange rate to achieve other goals (contrary to the stipulated exchange rate policy) has been an implicit objective of this study as explained in the model section in justifying the use of the VECM technique.

The results in general are satisfactory. The coefficients associated with the monetary, real income and the interest rate terms are statistically significant at the 5%, 1% and 10% levels, respectively. The coefficients on the monetary and real income terms have the predicted positive and negative signs, respectively. However, the coefficient on the interest rate term has a negative sign, which is contrary to the prediction of the monetary model.

These results suggest that a 1% increase in the domestic money stock leads to a 0.62% depreciation of the nominal exchange rate. Also, a 1% increase in the domestic real income relative to foreign real income leads to a 1.26% appreciation in the nominal exchange rate, while a 100 basis point increase in the domestic interest rate relative to foreign interest rate is associated with a 1 basis point appreciation in the nominal exchange rate. The coefficient on the interest rate differential is small (-0.011) with the wrong sign. This can be explained by the low level of development of the financial sector in Tanzania.

**Short Run Dynamic Estimates of the Constrained Monetary Model**

The results of the short-run dynamics are reported in panel B of table (4.4). Most of the coefficients are not statistically significant and hence are not reported. Only the first lags of the changes in income differentials and interest rate differentials are statistically significant at the 5% and 1% levels, respectively, but with the wrong signs. These results
suggest that the exchange rate is not autoregressive, at least in the short run, as suggested by the statistically insignificant coefficients on the lagged changes in the exchange rate.

4.5 Estimation of the Unconstrained Monetary Model

Correspondingly, we estimate the monetary model in unconstrained form by relaxing the assumption of identical coefficients between Tanzania and the U.S. This helps in gauging whether the results from the constrained monetary model are robust. To serve this purpose, the model in equation (4.10) is specified with separate coefficients as

\[ s_t = \beta_0 + \beta_1 m_t + \beta_2 m_t^* + \beta_2 y_t + \beta_3 i_t + \beta_3 i_t^* + u_t \]  

(4.12)

The variables and the coefficients are as defined before. The foreign variables are expected to have an opposite sign from the predicted differential terms (see predictions in table 4.6). Table 4.5 shows the long run estimates of the constrained monetary model.

All the coefficients on the domestic variables are statistically significant (at the 1% level) with the expected signs. With regards to the foreign variables, only the coefficient on the monetary term is statistically significant (at the 1% level) but with the wrong sign. The coefficients on the foreign income and the interest rate terms are not only statistically insignificant but also exhibit the wrong signs. The coefficients on the monetary terms for the domestic and foreign are 0.67 and 3.27, respectively. The latter is considerably different from the predicted unity value. The adjustment term is statistically significant at the 1% level with the expected negative sign (i.e., -0.184), which suggests that once the exchange rate deviates from the perceived long run equilibrium path, it takes about one year (or four quarters) to converge back by 50% according to the half-life calculations.
The F statistics based on the Wald tests as to whether the coefficients on the domestic and foreign money and real income variables are equal are statistically significant. This provides evidence that the corresponding variables between the two countries have different effects on the nominal exchange rate. With regards to interest rate coefficients, the F statistic is not significant, which means that we do not reject the null hypothesis that the effects of the domestic and foreign interest rates are equal.

4.6 Comparison between the Constrained and Unconstrained Monetary Models

This section provides a brief comparison between the constrained and unconstrained results of the monetary models. Table 4.7 summarizes the coefficients against predictions of the respective models.

The coefficient on the unconstrained domestic monetary term (0.67) is approximately equal to the one from the constrained model (0.62). Also, the coefficient on the unconstrained domestic interest rate term is identical to that of the constrained model (0.01) except that they have different signs. In terms of sizes, the coefficients on the interest rate in the unconstrained model tend to justify the assumption of identical elasticity imposed in the derivation of the constrained model although the coefficient on the foreign interest rate is statistically insignificant. However, the diverse coefficients on money stocks and real incomes in the unconstrained model tend to refute this assumption. Nevertheless, this outcome is not surprising given the high chances of errors in the Tanzanian data and the distortions related to data interpolation from annual to quarterly series.
4.7 Overall Monetary Model Estimates

Given the low level of development of the Tanzanian financial sector, the interest rate (lending rate) might not be perfect in playing the role of the opportunity cost for holding real money balances although it is relatively better than any substitute. The model suggests moderate and hence reasonable speed of adjustment of the exchange rate. That is, once the exchange rate is shocked away from its long-run equilibrium path, it takes about 1.3 years for the constrained monetary model and 1.03 years for the unconstrained monetary model to converge back by 50%.

The size of the income elasticity is reasonable (-1.26) compared to other studies in the literature for developing countries (for example, Jimoh (2004) obtains approximately -4.0 using the OLS and AR(1) GLS). The coefficient of the relative income is relatively closer to what exists in other studies in the literature. For instance, Chinn (1999) obtains -2.4 for South Africa; Edwards (1983) obtains -2.9 for Peru; and Odudekun’s (1997) finds -2.0 for Sub-Saharan Africa. Table 4.1 summarizes some selected empirical results from the literature in emerging market economies. Although the coefficient on the interest rate has the wrong sign, its size accords with those from other studies in the literature (for example, Jimoh (2004) obtains 0.07), implying the small effect of the interest rate on the nominal exchange rate in developing countries. This small effect also makes sense because under the monetary model, the impact of the interest rate is not direct as it has to go through money stock and prices.

44 Nevertheless, the estimates show that the lending rate provides the best alternative among the available options for opportunity for holding real money balances. The estimates based on other interest rate alternatives are not impressive and therefore are not reported.
unlike in the case of the traditional model where the interest rate has a direct impact through its effect on the net flow of assets.

In general, the results of the constrained monetary model do not seriously suffer from the problem of signs reversal as a result of imposing the assumption of identical coefficients apart from the interest rate differential term which takes a wrong sign. Synonymously, the estimates from the unconstrained monetary model do not seriously suffer from the potential dangers of not constraining the model as described in the literature review regarding the evidence from the early studies. Perhaps this can be the advantage of using the VECM estimation approach instead of the simple OLS, the results of which are associated with signs reversal in the early studies.

This study is closely related to the study by Chinn (1999) in terms of methodology, particularly on the estimation method. Despite the existence of some elements of controls in the South African financial market, the South African financial market is relatively more developed compared to the Tanzanian financial market. However, given that both countries are grouped under emerging market economies, the two results can still be compared. Comparison of our results with Chinn’s (1999) results shows that the two sets of results exhibit some similarities. The coefficients on the monetary, real income and the interest rate differentials are statistically significant in each study with the coefficient on the monetary and real income terms having the expected signs, while the coefficient on the interest rate terms exhibit the wrong signs. One can argue that interest rates are still inadequate measures of the opportunity for holding real balances in developing countries because of some remaining elements of financial repressions despite the ongoing financial sector reforms.
Regarding robustness of the results, the estimates from the unconstrained model in general corroborate those in the constrained model. That is, the estimates of the unconstrained model tend to reinforce the results of the constrained model as indicated by the significant coefficients with the predicted signs at least for the domestic variables. The two models (constrained and unconstrained) also suggest an approximately equal convergence speed of the nominal exchange rate; that is, once the exchange rate deviates from the long run equilibrium, it takes about five and four quarters for the constrained and unconstrained models, respectively, to converge back by 50%. This value is also close to the convergence speed of 1.5 years (or six quarters) predicted in the PPP model.

Tanzania trades mostly with European countries and Japan, with the UK taking the lead. However, the US dollar is the vehicle currency since most of the transactions with regards to import and exports take place in US dollars. This study also estimates the monetary model using the Tanzanian shilling per UK pound and UK data in place of US data.

4.8 Review of Empirical Evidence on the Exchange Rate Adjustment Speed

In the literature, Rogoff (1996) provides what is considered as the consensus in which the nominal exchange rate convergence is slower than price convergence. This is contrary to

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45 With regards to the PPP model, the coefficients of the domestic and foreign prices are statistically significant but with the wrong signs. Comparing these estimates with those based on US data, the estimates show larger effects of the domestic and foreign prices on the exchange rate except that the signs are wrong. While all the estimates of the constrained monetary model are statistically significant with the predicted signs, all the coefficients in the unconstrained monetary model are statistically significant but with the opposite signs. These results suggest that neither of the two data sets (US nor UK) is perfect regarding the performance of the PPP and the unconstrained monetary models. However, given that the results on the constrained monetary models in both cases are satisfactory and the fact that the US dollar is the vehicle of most of the transactions, the conclusion of this study is based on the results from the Tanzania-US dataset.
the prediction of the PPP theory. Rogoff (1996) suggests that the nominal exchange rate convergence falls in the range of 3-5 years, which is longer than the price convergence. This is viewed as a “puzzle” or surprising behavior of the nominal exchange rate. Studies in the literature provide explanations behind this puzzle. Cheung et al. (2004) argue that a number of studies reporting half-life use models involving trade (transaction costs and tariffs). Frictions in the goods market are deemed to be the potential cause of sluggish convergence in the nominal exchange rate. Crowder (2004) also claims that “the majority of studies that examine half-lives of PPP deviations focus on the individual variables that comprise real exchange rates” (p.1). This argument is reinforced by Kim et al. (2001) who contend that “half-life estimates from the system method tend to be shorter than the 3-5 years explained by Rogoff (1996)” (p. 31). From these views, the half-lives in this study are shorter than the 3-5 years range because the exchange rate model (monetary model) does not involve trade; therefore, it is free from the trade-related frictions which are said to slow the exchange rate adjustment. Second, this study’s model is a system rather than a single equation; therefore, as Kim et al. (2001) suggests, it is evident that our half-lives are shorter than the Rogoff’s (1996) 3-5 years consensus range in the literature.

5.0 Summary and Conclusions

The results of this study answer the hypotheses raised in this study and also prove the assertion that the monetary model holds for Tanzania during the post-reform period. Based on the statistical significance, signs and sizes, especially on the relative money stocks and the real income terms, the estimates are consistent with the predictions of the monetary model. What is interesting is the consistence in the adjustment speed suggested by the PPP and
monetary models during the post-reform period: The PPP model suggests a half-life of 1.5 years, while the constrained and unconstrained monetary models suggest half-lives of 1.3 and 1.03 years, respectively. The adjustment speeds suggested by the PPP model and the monetary models ranges between 1.0 and 1.5 years, which do not vary significantly.

Given the performance of the model, the monetary model adequately explains the exchange rate changes in Tanzania during the post-reform period and therefore forms the bases of the conclusion of this chapter. The results are quite satisfactory and adequately support our assertion that the changes in the nominal exchange rate under the flexible exchange rate regime in Tanzania are best explained by the monetary model of exchange rate determination. Therefore, I conclude that the monetary model is relevant in explaining the nominal exchange rate changes under the flexible exchange rate regime in Tanzania.
Table 4.1: Summary Results on Performance of Monetary Models of Exchange Rates in Selected Studies from Developing Countries (from reviewed studies)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pred OLS OLS &amp; AR(1) GLS</td>
<td>Pred OLS OLS &amp; AR(1) GLS</td>
<td>Pred OLS OLS &amp; AR(1) GLS</td>
<td>Pred OLS OLS &amp; AR(1) GLS</td>
<td>Pred OLS OLS &amp; AR(1) GLS</td>
<td>Pred OLS OLS &amp; AR(1) GLS</td>
<td></td>
</tr>
<tr>
<td>$(m - m^*)_t$</td>
<td>(+)</td>
<td>1.053*</td>
<td>0.32*</td>
<td>0.673*</td>
<td>0.544*</td>
<td>0.92*</td>
</tr>
<tr>
<td>$(y - y^*)_t$</td>
<td>(-)</td>
<td>-2.901*</td>
<td>0.07</td>
<td>-1.82*</td>
<td>-2.445*</td>
<td>-3.9*</td>
</tr>
<tr>
<td>$(i - i^*)_t$</td>
<td>(+)</td>
<td>0.267*</td>
<td>0.13</td>
<td>-0.348</td>
<td>0.08*</td>
<td>0.07*</td>
</tr>
<tr>
<td>$(p - p^*)_t$</td>
<td>(+)</td>
<td>7.248*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$(y - y^*)_{t-1}$</td>
<td>(-)</td>
<td></td>
<td></td>
<td></td>
<td>-1.2*</td>
<td></td>
</tr>
<tr>
<td>$(i - i^*)_{t-1}$</td>
<td>(+)</td>
<td></td>
<td></td>
<td></td>
<td>0.02*</td>
<td></td>
</tr>
<tr>
<td>$m_t$</td>
<td>(+)</td>
<td>1.101*</td>
<td></td>
<td></td>
<td>0.917*</td>
<td></td>
</tr>
<tr>
<td>$y_t$</td>
<td>(-)</td>
<td></td>
<td></td>
<td></td>
<td>0.441*</td>
<td></td>
</tr>
<tr>
<td>$i_t$</td>
<td>(+)</td>
<td></td>
<td></td>
<td></td>
<td>1.82*</td>
<td></td>
</tr>
</tbody>
</table>

46 Estimate two models, i.e., partial adjustment and complete adjustment. Reported in the table is the model with complete adjustment

47 Estimates Four models, i.e., FLMA and SPMA each with full and Quasi-interest elasticity. In this table, only the quasi-interest-elasticity models are reported
<table>
<thead>
<tr>
<th></th>
<th>Pred</th>
<th>OLS</th>
<th>OLS&lt;sup&gt;48&lt;/sup&gt;</th>
<th>OLS &amp; AR(1) GLS</th>
<th>VECM</th>
<th>OLS &amp; AR(1) GLS&lt;sup&gt;49&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>( m_{t-1} )</td>
<td>(+)</td>
<td>-</td>
<td>2.996*</td>
<td>0.243*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( d_{t-1} )</td>
<td>(+)</td>
<td>0.21</td>
<td>0.3*</td>
<td>0.3*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta s_t )</td>
<td></td>
<td></td>
<td></td>
<td>-0.004</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta (m - m^*)_t )</td>
<td></td>
<td></td>
<td></td>
<td>0.004</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta (y - y^*)_t )</td>
<td></td>
<td></td>
<td></td>
<td>0.011*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta (i - i^*)_t )</td>
<td></td>
<td></td>
<td></td>
<td>0.005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta (p - p^*)_t )</td>
<td></td>
<td></td>
<td></td>
<td>0.102*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adj R-square</td>
<td></td>
<td></td>
<td></td>
<td>0.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. Observ.</td>
<td></td>
<td></td>
<td></td>
<td>227</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: * indicates that the coefficient is statistically significant at the conventional levels.

---

<sup>48</sup> Estimate two models, i.e., partial adjustment and complete adjustment. Reported in the table is the model with complete adjustment.

<sup>49</sup> Estimates Four models, i.e., FLMA and SPMA each with full and Quasi-interest elasticity. In this table, only the quasi-interest-elasticity models are reported.
### Table 4.2: Unit Roots Test Results (1992q1-2011q4)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Level/ change</th>
<th>No. lags</th>
<th>ZAURoot Min t-stat.</th>
<th>ADF (p-value)</th>
<th>PP p-value</th>
<th>Order of integ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchange rate ($s_t$)</td>
<td>Level</td>
<td>3</td>
<td>-4.424</td>
<td>0.4857</td>
<td>0.8037</td>
<td>I(1)</td>
</tr>
<tr>
<td></td>
<td>Diff.</td>
<td>3</td>
<td>-7.519</td>
<td>0.0000</td>
<td>0.0000</td>
<td>I(0)</td>
</tr>
<tr>
<td>Money. $(m - m^*)_t$</td>
<td>Level</td>
<td>3</td>
<td>-3.120</td>
<td>0.9853</td>
<td>0.9348</td>
<td>I(1)</td>
</tr>
<tr>
<td></td>
<td>Diff.</td>
<td>3</td>
<td>-10.619</td>
<td>0.0822</td>
<td>0.0000</td>
<td>I(0)</td>
</tr>
<tr>
<td>Income. $(y - y^*)_t$</td>
<td>Level</td>
<td>3</td>
<td>-5.838</td>
<td>1.0000</td>
<td>1.0000</td>
<td>I(1)</td>
</tr>
<tr>
<td></td>
<td>Diff.</td>
<td>3</td>
<td>-10.227</td>
<td>0.0860</td>
<td>0.0000</td>
<td>I(0)</td>
</tr>
<tr>
<td>Interest. $(i - i^*)_t$</td>
<td>Level</td>
<td>3</td>
<td>-6.989</td>
<td>0.6066</td>
<td>0.0281</td>
<td>I(1)</td>
</tr>
<tr>
<td></td>
<td>Diff.</td>
<td>3</td>
<td>-9.472</td>
<td>0.0000</td>
<td>0.0000</td>
<td>I(0)</td>
</tr>
<tr>
<td>Domestic. price $(p_t)$</td>
<td>Level</td>
<td>3</td>
<td>-0.467</td>
<td>1.0000</td>
<td>0.9991</td>
<td>I(1)</td>
</tr>
<tr>
<td></td>
<td>Diff.</td>
<td>3</td>
<td>-11.108</td>
<td>0.1316</td>
<td>0.0000</td>
<td>I(0)</td>
</tr>
<tr>
<td>Foreign price $(p_t^e)$</td>
<td>Level</td>
<td>3</td>
<td>-3.700</td>
<td>0.9852</td>
<td>0.9974</td>
<td>I(1)</td>
</tr>
<tr>
<td></td>
<td>Diff.</td>
<td>3</td>
<td>-5.019</td>
<td>0.1197</td>
<td>0.0000</td>
<td>I(0)</td>
</tr>
</tbody>
</table>

Critical values: Minimum test statistic 1% : -5.53, 5%: -4.80; p-values are p<0.01=significant at 1% level, p<0.05=significant at 5% level, and p<0.1 =significant at 10% level
Table 4.3: Johansen Tests for Cointegration of PPP and Monetary Model

<table>
<thead>
<tr>
<th>Maximum Rank (r)</th>
<th>Model: $[s_t, p_t, p_t^*]$</th>
<th>Model: $[s_t (m - m^<em>_t), (y - y_t^</em>)_t, (i - i_t^*)_t]$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1992q1-2011q4</td>
<td>5% Critical Value</td>
</tr>
<tr>
<td>0</td>
<td>34.4909</td>
<td>29.68</td>
</tr>
<tr>
<td>1</td>
<td>12.6824*</td>
<td>15.41</td>
</tr>
<tr>
<td>2</td>
<td>4.6659</td>
<td>3.76</td>
</tr>
<tr>
<td>3</td>
<td>1.2205</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>75</td>
<td>79</td>
</tr>
<tr>
<td>Lags</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: The number of lags refers to the optimal lags based on information criteria (i.e., FPE, AIC, HQIC, and SBIC)
Table 4.4: Long Run and Short Run Estimates of the PPP Model

Panel A: Long Run Model: \[ s_t = \delta_0 + \delta_1 p_t + \delta_2 p^*_t \]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Prediction</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>(p_t)</td>
<td>(+)</td>
<td>0.010***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.000]</td>
</tr>
<tr>
<td>(p_t^*)</td>
<td>(-)</td>
<td>-0.018**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.040]</td>
</tr>
<tr>
<td>Adj’ coeff ((\alpha))</td>
<td>(-)</td>
<td>-0.123**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.022]</td>
</tr>
<tr>
<td>Constant</td>
<td>(±)</td>
<td>6.84</td>
</tr>
<tr>
<td>Half-Life[(\frac{\ln(2)}{\ln(1+</td>
<td>\alpha</td>
<td>)})]</td>
</tr>
<tr>
<td>Lags</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Observations</td>
<td></td>
<td>76</td>
</tr>
</tbody>
</table>

Panel B: Short Run Model\(^{50}\): \[ \Delta s_t = \delta_0 + \delta_1 \Delta p_t + \delta_2 \Delta p^*_t \]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Prediction</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\Delta p_{t-2})</td>
<td>(+)</td>
<td>-0.002**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.013]</td>
</tr>
<tr>
<td>(\Delta p_{t-3})</td>
<td>(+)</td>
<td>0.001*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.079]</td>
</tr>
<tr>
<td>Observations</td>
<td></td>
<td>76</td>
</tr>
</tbody>
</table>

Note: p-values in brackets (*** p<0.01, ** p<0.05, * p<0.1)

\(^{50}\) Only statistically significant coefficients are reported for the short run PPP and Monetary models.
Table 4.5: Long Run and Short Run Estimates of the Constrained Monetary Model (VECM)

Panel A: Long Run Model:  (equation4.10)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Prediction</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m-m^*$</td>
<td>(≈1)</td>
<td>0.622**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.049]</td>
</tr>
<tr>
<td>$y-y^*$</td>
<td>(-)</td>
<td>-1.263***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.000]</td>
</tr>
<tr>
<td>$i-i^*$</td>
<td>(+)</td>
<td>-0.011*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.072]</td>
</tr>
<tr>
<td>Trend</td>
<td>(+)</td>
<td>0.022***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.000]</td>
</tr>
<tr>
<td>Adj’ coeff ($\alpha$)</td>
<td>(-)</td>
<td>-0.145***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.005]</td>
</tr>
<tr>
<td>Constant</td>
<td>(±)</td>
<td>6.179</td>
</tr>
<tr>
<td>Half-Life $\left[\frac{\ln(2)}{\ln(1+</td>
<td>\alpha</td>
<td>)}\right]$</td>
</tr>
</tbody>
</table>

Lags  Observations  3  77

Panel B: Short Run Model:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Prediction</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta(y - y^*)_{t-1}$</td>
<td>(-)</td>
<td>0.399**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.038]</td>
</tr>
<tr>
<td>$\Delta(i - i^*)_{t-1}$</td>
<td>(+)</td>
<td>-0.003***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.001]</td>
</tr>
</tbody>
</table>

Observations. 77

Note: p-values in brackets (*** p<0.01, ** p<0.05, * p<0.1)
Table 4.6: Long Run Estimates of the Unconstrained Monetary Model (VECM)

<table>
<thead>
<tr>
<th>Variable/coeff</th>
<th>Prediction</th>
<th>Estimate</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$m_t: \beta_1$</td>
<td>(+)</td>
<td>0.67***</td>
<td>[0.001]</td>
</tr>
<tr>
<td>$m_t: \beta_1^*$</td>
<td>(-)</td>
<td>3.27***</td>
<td>[0.000]</td>
</tr>
<tr>
<td>$y_t: \beta_2$</td>
<td>(-)</td>
<td>-2.46***</td>
<td>[0.000]</td>
</tr>
<tr>
<td>$y_t: \beta_2^*$</td>
<td>(+)</td>
<td>-0.15</td>
<td>[0.788]</td>
</tr>
<tr>
<td>$i_t: \beta_3$</td>
<td>(+)</td>
<td>0.01***</td>
<td>[0.000]</td>
</tr>
<tr>
<td>$i_t: \beta_3^*$</td>
<td>(-)</td>
<td>0.01</td>
<td>[0.278]</td>
</tr>
<tr>
<td>Const: $\beta_0$</td>
<td>(±)</td>
<td>1.54</td>
<td></td>
</tr>
<tr>
<td>Adj' coeff ($\alpha$)</td>
<td>(-)</td>
<td>-0.184***</td>
<td>[0.000]</td>
</tr>
</tbody>
</table>

Half-Life\[\frac{\ln(2)}{\ln(1+\mid\alpha\mid)}\] 1.03 years

Lags 1
Observations 79

Note: p-values in brackets (*** p<0.01, ** p<0.05, * p<0.1). Stared are U.S variables

51 Most of the short run model estimates are not statistically significant. This is the feature of the short run estimates from vector models, Canova (2007). So the main focus is on the long run estimates.
Table 4.7: Summary of the Constrained and Unconstrained Estimates of the Monetary Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model</th>
<th>Prediction</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monetary</td>
<td>Constrained</td>
<td>(m-m*) ≈ +1</td>
<td>0.62**</td>
</tr>
<tr>
<td></td>
<td>Unconstrained</td>
<td>(m) ≈ +1</td>
<td>0.67***</td>
</tr>
<tr>
<td></td>
<td>Constrained</td>
<td>(m*) ≈ −1</td>
<td>3.27***</td>
</tr>
<tr>
<td>Monetary</td>
<td>Unconstrained</td>
<td>(y-y*) (−)</td>
<td>-1.26***</td>
</tr>
<tr>
<td>Real Income</td>
<td>Constrained</td>
<td>(y) (−)</td>
<td>-2.46***</td>
</tr>
<tr>
<td></td>
<td>Unconstrained</td>
<td>(y*) (+)</td>
<td>-0.15</td>
</tr>
<tr>
<td>Interest rate</td>
<td>Constrained</td>
<td>(i-i*) (+)</td>
<td>-0.01*</td>
</tr>
<tr>
<td></td>
<td>Unconstrained</td>
<td>(i) (+)</td>
<td>0.01***</td>
</tr>
<tr>
<td>Adjustment term</td>
<td>Unconstrained</td>
<td>(i*) (−)</td>
<td>-0.145***</td>
</tr>
</tbody>
</table>

Notes: ***, **, and * indicates that the coefficient is statistically significant at the 1%, 5%, and 10% level, respectively.
Table 4.8: Half Life (HL)

<table>
<thead>
<tr>
<th>Alpha (0≤α≤1)</th>
<th>Half Life (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothetical</td>
<td>( \frac{\ln(2)}{\left(\frac{\ln(2)}{\ln(1+</td>
</tr>
<tr>
<td>0.05</td>
<td>3.6</td>
</tr>
<tr>
<td>0.10</td>
<td>1.8</td>
</tr>
<tr>
<td>0.15</td>
<td>1.2</td>
</tr>
<tr>
<td>0.20</td>
<td>1.0</td>
</tr>
<tr>
<td>0.25</td>
<td>0.8</td>
</tr>
<tr>
<td>0.30</td>
<td>0.7</td>
</tr>
<tr>
<td>0.35</td>
<td>0.6</td>
</tr>
<tr>
<td>0.40</td>
<td>0.5</td>
</tr>
<tr>
<td>0.45</td>
<td>0.5</td>
</tr>
<tr>
<td>0.50</td>
<td>0.4</td>
</tr>
<tr>
<td>0.55</td>
<td>0.4</td>
</tr>
<tr>
<td>0.60</td>
<td>0.4</td>
</tr>
<tr>
<td>0.65</td>
<td>0.3</td>
</tr>
<tr>
<td>0.70</td>
<td>0.3</td>
</tr>
<tr>
<td>0.75</td>
<td>0.3</td>
</tr>
<tr>
<td>0.80</td>
<td>0.3</td>
</tr>
<tr>
<td>0.85</td>
<td>0.3</td>
</tr>
<tr>
<td>0.90</td>
<td>0.3</td>
</tr>
<tr>
<td>0.95</td>
<td>0.3</td>
</tr>
<tr>
<td>1.00</td>
<td>0.3</td>
</tr>
</tbody>
</table>
Table 4.9: Variable and Data Sources

<table>
<thead>
<tr>
<th>Variable</th>
<th>Source</th>
<th>Code</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A1: Tanzania</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPI</td>
<td>(IFS) IMF</td>
<td>73864...ZF...H A61</td>
<td>Index</td>
</tr>
<tr>
<td>CPI%</td>
<td>(IFS) IMF</td>
<td>73864..XZF...H %2</td>
<td>%/annum</td>
</tr>
<tr>
<td>Exchange rate</td>
<td>Global Insight</td>
<td>n.a</td>
<td>TZS/USD</td>
</tr>
<tr>
<td>Exchange rate</td>
<td>(IFS) IMF</td>
<td>738..AE.ZF...H SA3</td>
<td></td>
</tr>
<tr>
<td>RGDP at mp</td>
<td>NBS</td>
<td>n.a</td>
<td>Mn TZS</td>
</tr>
<tr>
<td>M0 (Monetary Base)</td>
<td>(IFS) IMF</td>
<td>73819MC.ZF...H S20</td>
<td>Mn TZS</td>
</tr>
<tr>
<td>M1</td>
<td>(IFS) IMF</td>
<td>73859MA.ZF...H S20</td>
<td>Mn TZS</td>
</tr>
<tr>
<td>M2</td>
<td>(IFS) IMF</td>
<td>73859MB.ZF...H S20</td>
<td>Mn TZS</td>
</tr>
<tr>
<td>M3</td>
<td>(IFS) IMF</td>
<td>73859MC.ZF...H S20</td>
<td>Mn TZS</td>
</tr>
<tr>
<td>Treasury Bill rate</td>
<td>(IFS) IMF</td>
<td>73860C..ZF...H A52</td>
<td>%/annum</td>
</tr>
<tr>
<td>Savings rate</td>
<td>(IFS) IMF</td>
<td>73860K..ZF...H A52</td>
<td>%/annum</td>
</tr>
<tr>
<td>Interest rate (3-6months)</td>
<td>(IFS) IMF</td>
<td>73860L..ZF...H A52</td>
<td>%/annum</td>
</tr>
<tr>
<td>Lending rate</td>
<td>(IFS) IMF</td>
<td>73860P..ZF...H A52</td>
<td>%/annum</td>
</tr>
<tr>
<td>CGO</td>
<td>(IFS) IMF</td>
<td>738cCSD.BA...H H42</td>
<td>Bn TZS</td>
</tr>
<tr>
<td><strong>B1: U.S.A.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPI total</td>
<td>OECD Main Econ Ind.</td>
<td></td>
<td>%/annum</td>
</tr>
<tr>
<td>RGDP</td>
<td>ECB</td>
<td></td>
<td>Mn USD</td>
</tr>
<tr>
<td>CPI</td>
<td>(IFS) IMF</td>
<td>11164...ZF...H A61</td>
<td>Index</td>
</tr>
<tr>
<td>CPI%</td>
<td>(IFS) IMF</td>
<td>11164..XZF...H %2</td>
<td>%/annum</td>
</tr>
<tr>
<td>GDP deflator</td>
<td>(IFS) IMF</td>
<td>11199BIRZF...H A61</td>
<td>Index</td>
</tr>
<tr>
<td><strong>B1: U.S.A.---Money and Interest Rate</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CB policy rate</td>
<td>(IFS) IMF</td>
<td>11160...ZF...H S52</td>
<td>%/annum</td>
</tr>
<tr>
<td>Federal Funds Rate</td>
<td>(IFS) IMF</td>
<td>11160B..ZF...H A52</td>
<td>%/annum</td>
</tr>
<tr>
<td>TB rate, 3months</td>
<td>(IFS) IMF</td>
<td>11160CS.ZF...H A52</td>
<td>%/annum</td>
</tr>
<tr>
<td>M2</td>
<td>(IFS) IMF</td>
<td>11159MB.ZF...H S31</td>
<td>Bn USD</td>
</tr>
</tbody>
</table>

---

52 Quarterly GDP data for Tanzania are interpolated from annual GDP (real and nominal) based on seasonality in the broad money supply (M2) on the assumption that in a year, the growth in GDP (real and nominal) is not evenly distributed due to concentration of production activities in some months. We assume further that production is backed by money supply and therefore use the patterns in money supply in interpolation of GDP data.
Table 4.9 Acronyms
CB:    Central Bank
CGO:   Central Government Operations
CPI:   Consumer Price Index
GDP:   Gross Domestic Product
M0:    Monetary Base
M1:    Narrow Money Supply
M2:    Broad Money Supply
M3:    Extended Broad Money Supply
NGDP:  Nominal Gross Domestic Product
RGDP:  Real Gross Domestic Product
TB:    Treasury Bill
Figure 4.1: Movements between Exchange Rate and Domestic Variables

Notes: so= log of the official exchange rate; sp= log of the parallel exchange rate; sosp= log of the official and parallel exchange rate (merged prior and post reform periods); mT= log of money supply (Tanzania); yT=log of real GDP (Tanzania); pde=log of the GDP deflator (Tanzania); and iT=interest rate (lending): Tanzania
Figure 4.2: Movements in Nominal Exchange Rate against Money, Income and Price Differentials
Figure 4.3: Half Life Curve

Notes: The numbers in the figure are calculated speeds of the nominal exchange rate adjustment using error terms in the PPP model, constrained and unconstrained monetary models reported in in the text.
REFERENCES

Bank of Tanzania (2010/11), Monetary Policy Statement.


Kim, J., Ogaki, M. and Yang, M.S. (2001), “Structural Error Correction Models: Instrumental Variables Methods and an Application to an Exchange Rate Model”, *Ohio State University, Department of Economics, WP. No. 01-01*.


CHAPTER 5: SUMMARY AND CONCLUSIONS

Tanzania’s monetary sector took a different path in the 1990s following a series of economic and financial sector reforms which started in the mid-1980s and the early 1990s. Implementation of the financial sector reforms in the early 1990s marked a structural change, which splits the period between the pre- and post-reform periods. This is indicated by the patterns of the key macroeconomic variables as suggested by the structural break outcomes in chapter two. The chapter lays a groundwork for the whole study by providing a picture of the evolution of the banking and financial sector in Tanzania since the establishment of the Bank of Tanzania in 1966. The notable outcome from the analysis in this chapter shows that the early 1990s financial sector reforms in Tanzania transformed the structure of the banking and financial sector from a small-government-owned industry into a large, private-owned and dynamically competitive industry. This transformation produced a more stable economy as shown by stable economic growth, low inflation, and market determined interest and exchange rates. For the past fifteen years, on average, real GDP growth has been reasonably stable, the rate of inflation has been in single digits while the interest rates and the exchange rate have continued to be determined by market forces. However, there is a need for some additional measures to be done on the interest rates given the small real returns on bank deposits, despite the low level of inflation.

Chapter three investigates the rule-like behavior of the Bank of Tanzania in conducting monetary policy and whether monetary policy involves inertia. The study does this by addressing some of the flaws in the literature, particularly those related to estimation, variable choice etc. The main findings suggest that there has been a systematic relationship
between monetary policy targets and indicators. Further, there is evidence that the conduct of monetary policy involves partial adjustment to both monetary policy targets (monetary base and interest rate). These results are robust as they are consistent between two different estimation methods (GMM and SVAR). The observed systematic relationship between monetary policy targets and indicators implies that the central bank has been able to manage the economy via its execution of monetary policy. This, in turn, suggests that the monetary and financial sector is active and vibrant.

Chapter four analyzes the determinants of the changes in the nominal exchange rate by estimating a monetary model of exchange rate. Since the adoption of the flexible exchange rate regime in 1992, the nominal exchange rate has been depreciating continuously. The study finds empirical evidence that the changes in the nominal exchange rate following the adoption of the floating exchange rate regime in 1992 can be explained by the monetary model of exchange rate determination. That is, the exchange rate depreciates when the domestic money stock, price level and the interest rate are above the counterpart variables in the foreign country (i.e. U.S.). The same also happens when domestic real income grows at a rate lower than the one in the foreign country.

The empirical evidence that the monetary model of the floating exchange rate explains the behavior of the exchange rate implies a good sign for the monetary and financial sector. Specifically, it implies that domestic price and interest rates are freely determined by market forces, which in turn create a better environment for the monetary and financial sectors. The empirical evidence on the exchange rate convergence of 1.5 years, 1.3 years and 1.03 years as suggested by the PPP model, the constrained and unconstrained monetary
models, respectively, imply dynamic and well-functioning monetary and financial sectors. The fast convergence of the exchange rate in this study relative to Rogoff’s (1996) puzzle consensus of 3-5 years in the literature is justifiable because of the use of a system model (VECM) versus single equation model, which mostly leads to slow adjustment. The other reason is the fact that, unlike other studies which are associated with slow adjustment in the literature, the model of this study does not involve trade; therefore, the exchange rate convergence is free from trade (particularly transportation and tariff) frictions.

Consequently, the current stance of Tanzania’s monetary sector as suggested in the main three chapters (chapters two, three and four) of this study is the outcome of deliberate government measures that started gradually with the mid-1980s’ economic and structural adjustment programs and later on the early 1990s’ financial sector reforms. All these created a favorable environment for a market-based economic system and led to an increase in the central bank’s autonomy in the management of the banking and financial sector in form of regulations as well as execution of monetary policy.

This study underscores the importance of reliable high frequency data for monetary policy decisions. There is a need for the government through the National Bureau of Statistics (NBS) to ensure that the measures of economic activity (GDP and unemployment) are published at least at the quarterly frequency. This would enable well-informed monetary policy decisions and lead to improved monetary policy outcomes.

One potential area for future research is testing the traditional model of exchange rate determination to determine whether there exists an alternative way of explaining the nominal
exchange rate movements. Unlike the monetary model which takes into account stock of assets, the traditional model considers the flow of assets.
APPENDICES
APPENDIX 4.1: THE VAR MODEL

Consider a vector autoregressive (VAR) approach. Assuming X is vector variable which includes the log of nominal exchange rate (s_t), the relative money supplies term (m_t), relative real income term (y_t), and the interest differential term (i_t), i.e., \( X_t = [s_t \ m_t \ y_t \ i_t] \) the VAR model can be specified as follows:

\[
X_t = \theta + \Gamma_1 X_{t-1} + \Gamma_2 X_{t-2} + \cdots + \Gamma_p X_{t-p-1} + \epsilon_t
\]

\( X_t \) is a (4x1) column vector, i.e. \( X_t = (s_t, m_t, y_t, i_t) \); \( \theta \) is a constant term; \( \Gamma_i \) is a (4x4) parameter matrix with \( i=1, 2, \ldots, p \); and \( \epsilon_t \) is a (4x1) matrix of Gaussian errors. Assuming \( X_t \) is a vector of I(1) terms, then the VAR model can be written in a vector error correction model (VECM) as follows:

\[
\Delta X_t = \varphi_1 \Delta X_{t-1} + \varphi_2 \Delta X_{t-2} + \cdots + \varphi_{p-1} \Delta X_{t-p+1} + \Pi X_{t-p} + \epsilon_t
\]

where,

\[
\varphi_i = -(I - \Gamma_1 - \Gamma_2 - \cdots - \Gamma_i), \text{ and}
\]

\[
\Pi = -(I - \Gamma_1 - \Gamma_2 - \cdots - \Gamma_p),
\]

“1” is an identity matrix, and \( i=1, 2, \ldots, p-1 \). Let “r” be the rank of \( \Pi = a\beta' \), which also defines the number of cointegrating vectors in the system where \( \Pi \) is the long run equilibrium. In this case “r” defines the linearly independent columns which are less than the total number of variables in the vector \( X_t \), (k). The \( a \) and \( \beta \) are (kxr) matrices with \( \beta \) containing adjustment coefficients that define the long run equilibrium and \( a \) defining the convergence rate back to the long run equilibrium. We substitute the expression \( \Pi = a\beta' \) into the VECM model and obtain,
\[ \Delta X_t = \varphi_1 \Delta X_{t-1} + \varphi_2 \Delta X_{t-2} + \cdots + \varphi_{p-1} \Delta X_{t-p+1} + \alpha (\beta' X_{t-p}) + \epsilon_t \]

The term \( \beta X_{t-p} \) gives at most \( r=k-1 \) cointegrating relationships or vectors which guarantee that \( X_t \) converges to its long-run path. The adjustment speed is given by the error correction term \( (\alpha) \), which tells how fast the system responds once the exchange rate is out of equilibrium. This speed can be quantified by using the Half Life (HL) formula, defined as \( HL = \ln(0.5) / \ln(1 + \alpha) \) (MacDonald and Ricci, 2005). In some papers, half-life is defined as \( HL = \ln(0.5) / \alpha \) (Mello and Perrelli, 2003). However, the latter tends to understate the convergence speed. This is interpreted as the speed at which the exchange rate adjusts once it is kicked out of the equilibrium path by any shock. The error correction term or adjustment speed captures the long run effects and must have a negative sign.

I tested the rank of \( \Pi, (r) \) using the full information maximum likelihood ratio statistic which tests the null hypothesis that \( r \) is less than or equal to \( r_0 \) versus the alternative hypothesis that \( r \) is greater than \( r_0 \). This test is called the trace statistic and is denoted as

\[ Trace = -T \cdot \sum_{i=r+1}^{n} \log(1 - \lambda_i) \]

where \( \lambda_i \)'s are the correlations between \( \Delta X_t \) and \( X_{t-1} \). The same test can be accomplished using the maximum eigenvalue statistic, denoted as

Maximum eigenvalue = \(-T \cdot \log(1 - \lambda_{i+1}).\)

We reject the null in both tests if the test statistic is greater than the corresponding critical value.

---

53 The reason why it should be negative is illustrated in the derivation of the error correction model as demonstrated in appendix 4.2
APPENDIX 4.2: THE NEGATIVE ERROR CORRECTION TERM

Starting from a simple case of two variables $X$ and $Y$,

$$Y_t = \alpha_0 + \alpha_2 X_t + \epsilon_t \quad (A.1)$$

Subtract $Y_{t-1}$ on both sides of equation (A.1),

$$\Delta Y_t = \alpha_0 + \alpha_2 X_t - Y_{t-1} + \epsilon_t \quad (A.2)$$

Add and subtract $\alpha_2 X_{t-1}$ on the right hand side of equation (A.2)

$$\Delta Y_t = \alpha_0 - Y_{t-1} + \alpha_2 X_{t-1} + \alpha_2 X_t - \alpha_2 X_{t-1} + \epsilon_t$$

$$= \alpha_0 - (Y_{t-1} - \alpha_2 X_{t-1}) + \alpha_2 (X_t - X_{t-1}) + u_t$$

$$= \alpha_0 - Y_{t-1} + \alpha_2 X_{t-1} + \alpha_2 \Delta X_t + u_t$$

$$= -(Y_{t-1} - \alpha_0 - \alpha_2 X_{t-1}) + \alpha_2 \Delta X_t + u_t \quad (A.3)$$

From (A.1), $\hat{\epsilon}_{t-1} = Y_{t-1} - \alpha_0 - \alpha_2 X_{t-1} \quad (A.4)$

Substituting (A.4) into (A.3) yields

$$\Delta Y_t = -\hat{\epsilon}_{t-1} + \alpha_2 \Delta X_t + u_t \quad (A.5)$$

A significant lagged error term implies existence of long run equilibrium. Long equilibrium also implies presence partial adjustment, which means the coefficient of the lagged error term (i.e., $\hat{\epsilon}_{t-1}$) lies within a unity circle. To attain this requirement we assume that the coefficient of the lagged error term is not unity as in A.5, rather it is $\alpha_1$ such that $0 < \alpha_1 < 1$. With this condition, A.5 can be written,

$$\Delta Y_t = -\alpha_1 \hat{\epsilon}_{t-1} + \alpha_2 \Delta X_t + u_t \quad (A.6)$$

This proves that the coefficient of the error correction term is always negative. It can be generalized for any number of variables in the model.