Determinants of Exchange Rate in Tanzania

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Abstract

In this thesis I develop a theoretical model to capture Tanzania’s unique structure of imports and exports. The model implies that the value of real exchange rate, measured as the relative price of foreign goods, should be positively related to tax, negatively related to government consumption, positively related to the expenditure on imports of oil, negatively related to the earnings from gold exports, negatively related to foreign income and positively related to natural or long run output. The empirical analysis of the model was conducted based on data from Tanzania and major trading partners focusing on flexible exchange rate regime period from 1987 to 2012. Graphical analysis reveals that a large component of real exchange rate fluctuations are nominal exchange rate fluctuations. Although unit root and cointegration tests show theoretical implications do not hold empirically in the long run, short run co-movements of taxes and real exchange rate were in line with the predictions of the theoretical model. The theoretical discussion backed by both graphical analysis and granger-causality test results identifies taxation as significant determinant of changes in real exchange rate in Tanzania; at least in the short run. Therefore, a fiscal policy based on tax smoothing and stabilization of nominal exchange rate fluctuations can stabilize real exchange rate fluctuations.
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Contents

Abstract i

Acknowledgements ii

Contents iv

List of Figures v

List of Tables v

1 Introduction 1

2 Macroeconomic Developments in Tanzania 3
   2.1 The external sector .................................................. 3
   2.2 Institutional Developments ........................................ 5

3 Brief review of the literature 6

4 The model 8
   4.1 Set-up ................................................................. 8
   4.2 Preferences ........................................................... 9
   4.3 Equilibrium ............................................................ 10
   4.4 Comparative statics ................................................ 11

5 Data and graphical analysis 12
   5.1 Data ................................................................. 12
   5.2 Components of Real exchange rate ................................ 14
   5.3 Graphical analysis of the real exchange rate and explanatory variables 16

6 Testing long run relationship 21
   6.1 Methodology ........................................................... 21
   6.2 Results ................................................................. 22

7 Tests for short run relationships 23
   7.1 Methodology ........................................................... 23
   7.2 Results ................................................................. 24
List of Figures

1 Exchange rate dynamics in Tanzania ................................................. 2
2 Tanzania’s Primary Goods Imports, as a share of Total Goods Imports, in 2011 ... 4
3 Tanzania’s Primary Exports, as a share of Total Exports, in 2010 and 2002 ... 4
4 Tanzania trade balance and current account ........................................... 5
5 Inflation Dynamics in Tanzania ..................................................... 6
6 Relating changes of real exchange rate to changes in nominal exchange rate ... 14
7 Relating changes of real exchange rate to domestic inflation ....................... 15
8 Relating changes of real exchange rate to foreign inflation ......................... 15
9 Relating the real exchange rate with the tax to GDP ratio .......................... 17
10 Relating the real exchange rate with the government consumption to GDP ratio 18
11 Relating the real exchange rate and the real world price of oil ................... 19
12 Relating real exchange rate with the real price of gold .......................... 19
13 Relating the real exchange rate with the ratio of foreign output to domestic output 20
14 Time series plot of residuals ...................................................... 35
15 Lag selection for real exchange rate ............................................... 36
16 Lag selection for Tax to GDP ratio .............................................. 36
17 Lag selection for Government consumption to GDP ratio ...................... 36
18 Lag selection for Real price of oil ................................................ 37
19 Lag selection for Real price of gold .............................................. 37
20 Lag selection for Foreign output to domestic output ratio ...................... 37
21 Lag selection for Natural output to actual output ratio .......................... 37

List of Tables

1 Estimation results ................................................................. 23
2 Estimation results ................................................................. 25
3 ADF unit root test results ...................................................... 34
4 PP unit root test results ......................................................... 35
5 Unit root test for residuals ....................................................... 35
1 Introduction

Developing countries like Tanzania desperately need to achieve and maintain higher growth rates in order to have any hope of overcoming poverty. One of the most important sources of growth is the external sector. A well-functioning external sector can enable Tanzania to have competitive exports and a favourable domestic investment climate to attract foreign capital and technology. The achievement of these conditions ultimately depends on the dynamics of prices in Tanzania relative to those of its trading partners and competitors or the real exchange rate.

Higher volatility in the real exchange rate has been found to reduce much needed foreign direct investment (FDI) in Africa (Suliman et al., 2015, p. 222). Higher real exchange rate misalignment has been found to cause disincentives to exporters of primary goods in Africa and reduced their ability to exploit new opportunities in the world market (Sekkat and Varoudakis, 1998, p. 7). Evidence show that growth and investment have had a tendency to increase after the improvement of terms of trade and eradication of real exchange rate overvaluation (Bleaney and Greenaway, 2001, p. 498). Real currency depreciation has been found to improve country’s balance of payments position (Kodongo and Ojah, 2013).

Therefore, it is very crucial that policy makers in Tanzania are equipped with knowledge of how and why the real exchange rate would move in particular direction overtime. Figure 1 shows both nominal exchange rate and real exchange rate have been highly unstable with a general trend of depreciation.

There is an extensive literature devoted to gaining insights into real exchange rate dynamics with theoretical frameworks formulated and, in most cases, tested in developed countries. Unfortunately, the literature offers mixed empirical results. For example, while several studies have found empirical evidence of the purchasing power parity (PPP) theory (Papell, 1997; Frankel and Rose, 1996), other studies have found evidence against the PPP theory (Mark, 1990; Pedroni, 2001). Another hypothesis popular among researchers of this topic, the Balassa-Samuelson (BS), has not been free of mixed empirical results. Studies like that of Hsieh (1982), Strauss (1999) and Candelon et al. (2007) have found strong evidence for the hypothesis; Canzoneri et al. (1999) find empirical evidence against fundamental assumptions of BS hypothesis whereas NBER-East Asia Seminar on Economics (1999) finds that BS only works for some few Asian countries.

Not only that there are few studies done in Tanzania but also the existing few studies derive their theoretical frameworks from studies that were not originally formulated to study the Tanzanian economy (e.g. Hobdari (2008) and Li and Rowe (2007)). Tanzania, unlike developed countries and most other developing nations, has a very skewed export-import structure. Oil
Figure 1: Exchange rate dynamics in Tanzania

(a) Nominal Effective exchange Rate (NEER) Index

(b) Real Effective Exchange Rate (REER) Index

Notes: Nominal (real) Effective exchange rate is the weighted average of bilateral nominal (real) exchange rates of all trading partners’ currencies with Tanzanian shilling. Both variables are scaled as indices with their values in 2010 set equal to 1. Higher values of both variables indicate currency depreciation and vice versa. Source: International Financial Statistics (IFS), OECD economic outlook database and author’s calculations.

Imports account for more than 30 percent of all imports. Tanzania does not produce oil and oil is a major source of energy in many economic activities. Therefore large increase in oil price may significantly affect the demand of locally produced goods leading to a decrease in their relative price and real depreciation of the currency. Exports of gold and travel (tourism) account for more than 50 percent of all exports (McGrath and Temu, 2012). An increase in export earnings from exports of natural resources like gold has been found cause a real appreciation of the currency; a phenomenon known in the literature as the Dutch disease (see for example Acosta (2009) and Fardmanesh (1991)). I argue that these features are important and should be taken into account if one wants to explain the evolution of the real exchange rate in Tanzania.

In this thesis, I study the determinants of Real exchange rate in Tanzania. I develop a small open economy model of Tanzania that captures Tanzania’s special import-export features. I model Tanzania imports as consisting of endogenous (substitutable imports) like imports of food and exogenous imports (non substitutable) like oil and other imported inputs. I divide Tanzanian exports into exogenous exports whose prices are determined in the world market like gold, and endogenous exports like tourism and other traditional exports. The model shows that the value of real exchange rate should be negatively related to tax revenue, negatively related to government consumption, positively related to expenditure on imports of oil, negatively related to the earnings from gold exports, negatively related to foreign income and positively related to...
natural or long run output.

The empirical analysis of the model was conducted based on data from Tanzania and major trading partners focusing on flexible exchange rate regime period from 1987 to 2012. Graphical analysis reveals that the large component of real exchange rate fluctuations are nominal exchange rate fluctuations. Although unit root and cointegration tests show theoretical implications do not hold empirically in the long run, short run co-movements of taxes and real exchange rate were in line with the predictions of the theoretical model. The theoretical discussion backed by both graphical analysis and granger-causality test results identifies taxation as a significant factor influencing changes in real exchange rate in Tanzania; at least in the short run.

The rest of my thesis is organized as follows; section 2 gives a description of major macroeconomic and institutional developments pertaining to the external sector. Section 3 gives a brief review of theoretical and empirical literature. Section 4 gives a description of the assumptions and how I build the open macroeconomic model of Tanzania and how I derive empirical predictions about exchange rate. Section 5 gives a description and graphical analysis of time series data. Section 6 presents the methodology for long run empirical analysis and results. Section 7 describes the methodology and results for short run empirical analysis. Section 8 gives the summary and conclusion.

2 Macroeconomic Developments in Tanzania

2.1 The external sector

In this thesis, I develop a small open economy model of Tanzania taking into account the specific features of Tanzania’s external sector. These features correspond to the skewed distribution of exports and imports in Tanzania. Figures 2 and 3 taken from McGrath and Temu (2012, pp.14–15) show the distribution of imports and exports in Tanzania respectively. Imports of oil, machinery and vehicles accounted for more than 50 per cent of the total value imports in 2011. Tanzania does not produce oil and oil is a major source of energy in many economic activities. Therefore large increase in oil price may significantly affect the demand of locally produced goods leading to a decrease in their relative price and real depreciation of the currency. Exports of tourism and gold account for significant share of total exports and they are the major sources of foreign exchange earnings in Tanzania. An increase in export earnings from exports of natural resources like gold has been found cause a real appreciation of the currency; a phenomenon known in the literature as the Dutch disease (see for example Acosta (2009) and
My model is limited to explaining only the movements in real exchange rate and therefore does not attempt to explain other issues related to real exchange rate in Tanzania. For insistence, one major issue related to real exchange rate in Tanzania is the applicability of the marshar learner condition. Despite the fact that the Tanzanian currency has depreciated over the long run (as shown on figure 1), Tanzania has had a trend of increasing trade and current account deficits for the past couple of years. This might have been contributed by poor export promotion policies and external factors such as a rapid increase in oil prices. Figure 4 taken from Ndulu (2013a, pp.16) shows the dynamics of trade and current account deficits. The figure...
shows, for the past decades, Tanzania has been running current account and trade deficits.

**Figure 4: Tanzania trade balance and current account**

Source: Ndulu (2013a, pp.16)

### 2.2 Institutional Developments

In order to study the dynamics of real exchange rate in Tanzania it is important to focus on the time period in which Tanzania was under flexible exchange rate regime. Rutasitara (2004) gives a good review of the development of the exchange rate regimes in Tanzania. Tanzania was under socialist control with a fixed exchange rate regime from 1967 to 1986. From 1986 the Tanzanian government started liberalization programs which included changing to a flexible exchange rate regime. The effects of these changes are seen in figure 1. Before 1986, the nominal exchange rate was constant then after 1986 started to fluctuate with a general upward trend. Therefore, the empirical testing of the model focus on the period from 1987 to 2012.

In this thesis I attempt to explain the real exchange rate and not the nominal exchange rate. The monetary policy is important in explaining the nominal exchange rate. A good description of monetary policy developments in Tanzania is given in Massawe (2001). Tanzania has been under inflation targeting since 1995. Due to high and sustained inflation levels in the period immediately before 1995, there was a need to make price stability a priority in macroeconomic policies. The central bank of Tanzania believes in monetarist view of inflation, therefore, in order to achieve price stability, they target and control monetary aggregates (Massawe, 2001). For the period of 2012/13, for example, the bank of Tanzania targeted an annual growth of about 18% for M3 and an annual growth not exceeding 16% for the average reserve money (Ndulu, 2013b). In figure 5 we can see how the switch to inflation targeting was able to reduce inflation.
drastically from an average of 30 percent in 1980s and early 1990s to an average of 10 in the period after 1995

Figure 5: Inflation Dynamics in Tanzania

Source: International Financial Statistics (IFS) and author’s calculations

3 Brief review of the literature

Figure 1 shows that the real value of the Tanzanian currency has had a long run trend of depreciation. This means that there is an existence of fundamental or structural macroeconomic factors that have affected the real exchange rate in Tanzania over the past couple of decades. Therefore the purchasing power parity (PPP) theory does not hold in the case of Tanzania, at least in the medium run. This is because the PPP theory predicts that the real exchange rate would be constant or stationary in the long run (see Rogoff (1996) and Frenkel (1978) for details).

The existing empirical literature on PPP theory provides mixed results and there is no agreement on proper methodology and data that should be used. One option is to use time series data on real exchange rate spanning a long time horizon and the other option is to use panel data. Lothian and Taylor (1996) use time series annual data covering the period of 1791–1990 and find that dollar–sterling and franc–sterling are both significantly mean reverting. However, the use of time series data covering long time horizons may not be appropriate as such data may contain significant structural shifts (Frankel and Rose, 1996, p. 210). Therefore, most of the literature testing the existence of PPP theory use panel data and panel econometric methods (Mark, 1990; Frankel and Rose, 1996; Papell, 1997; Pedroni, 2001). While Frankel and Rose
(1996) and Papell (1997) find empirical evidence to support the hypothesis, Mark (1990) and Pedroni (2001) don’t find enough empirical evidence to support the hypothesis.

Due to the failure of PPP theory and the general tendency of exchange rates to vary in the long run, various structural factors have been identified as determinants of real exchange rate. The most researched structural determinant is productivity. In this thesis I don’t attempt to model and empirically test productivity as a potential determinant of real exchange rate in Tanzania. The main reason being the lack of data on productivity dynamics in key industries in the tradable sector such as manufacturing industry in Tanzania. In addition, there has been controversy in the empirical literature surrounding the the productivity argument.

The first and most popular analytical framework in the literature linking the long–run real exchange rate to productivity was proposed in the seminal works of Balassa (1964) and Samuelson (1964). According to Balassa-Samuelson hypothesis, changes in long run real exchange rate are influenced by changes in the productivity differential between tradable and non-tradable sectors; the higher the differential the higher the real exchange rate and vice versa.

The empirical literature on this Balassa-Samuelson hypothesis offers mixed results. One group of literature find strong evidence to support the hypothesis (e.g. Hsieh (1982), Strauss (1999) and Candelon et al. (2007)). Using panel cointegration methods and data covering the period of 1993–2003 of eight new EU member states(NMS), Candelon et al. (2007) find that an increase in productivity in the tradable sector of these new states relative to tradable sector productivity of the whole Euro area, leads to appreciation of real exchange rate in these new member states. Using granger–causality and variance decomposition techniques, Strauss (1999) finds a strong response of relative price of non-tradables to shocks in productivity differentials. Using data for some OECD countries and time series methodology using lagged productivity differentials as instruments, Hsieh (1982) finds “more favourable confirmation of the productivity differential model using cross section regressions”(p.361). However, other studies find empirical problems most of which involve the failure of key assumptions in the Balassa-Samuelson hypothesis. Using panel of OECD countries, Canzoneri et al. (1999) find no evidence of the PPP among tradable goods which is a key assumption in the Balassa-Samuelson hypothesis. Studying he relationship between growth and real exchange rates in the Asia-Pacific Economic Council (APEC) countries, NBER-East Asia Seminar on Economics (1999) finds that the Balassa-Samuelson hypothesis worked only in japan korea and Taiwan (p.126). The study asserts that the Balassa-Samuelson hypothesis is not applicable to countries that had just transitioned from being primary goods exporter to a high value–added manufactured goods exporter (e.g. China)
The most crucial component of the theoretical model is the government consumption. The government of Tanzania, as in most African countries, has been receiving significant amounts of foreign aid and has been net lender from abroad. Therefore changes in government consumption may capture the effect of some of the determinants that have been identified in the literature such as international capital movements and foreign aid. In the literature, the long-run real exchange rate has been hypothesized to move as an equilibrium adjustment to capital movements across countries (Calvo et al., 1993; Lartey, 2007; Jongwanich and Kohpaiboon, 2013). According to Calvo et al. (1993), a larger capital transfer from abroad “has to be associated with an increase in domestic absorption. If part of the increase in spending falls on nontraded goods, their relative price will increase—[i.e.] the real exchange rate appreciates” (p.110). All studies (at least those under review) conclude that inflow of capital into an economy causes a real appreciation of the currency. In addition, Jongwanich and Kohpaiboon (2013) breaks down capital inflow into components (including FDI and portfolio investment and bank loans) and concludes that “both portfolio investment and bank loans, generate a faster speed of real exchange rate appreciation than foreign direct investment (FDI)” (p.146). Foreign aid is another factor that has been used to explain real exchange rate especially in Africa (see for example, Lartey (2007), Li and Rowe (2007) and Adenauer and Vagassky (1998)). Both Lartey (2007) and Adenauer and Vagassky (1998) find that aid inflow is associated with real appreciation of the currency in line with underlying theoretical explanation. However, Li and Rowe (2007) finds that aid inflow is associated with real depreciation of the currency in Tanzania.

Therefore, my thesis attempts to add both theoretical and empirical knowledge to the existing literature in the following ways. Firstly, it builds a theoretical framework tailored Tanzanian economy. Secondly, the thesis takes into account factors that have been ignored in the previous studies in Tanzania and Africa for that matter; that is, the effects of prices of oil and gold.

4 The model

4.1 Set-up

This model follows some aspects of the open economy macroeconomic model of Gottries (2013). I assume that the Tanzanian economy can be described as having two economic agents; the private sector\(^1\) and the government. To account for the special features of the Tanzanian economy, I include several types of goods. There are domestically produced consumption goods

\(^1\)Private sector in this model is the representative consumer-firm combined
and services $C$, which are also exported, at price $P$. Consumption is endogenous in the model as it is optimally chosen by the private sector. There are exports of consumption goods $X$ whose demand is a function of foreign nominal spending or income $Y^*P^*$, the proportion that is spent on Tanzanian exports $\alpha^*$ and the price paid by foreigners for these exports $P/s$; where $s$ is the domestic currency price of a unit of foreign currency.

$$X = \frac{\alpha^* Y^* P^*}{P/s}$$

There are exogenous exports of gold $Q$, whose price is $P^*_q$ where $P^*_q$ is exogenous. There are endogenous imports $Z$ (substitutable) which are chosen optimally by the private sector whose price is $P^*$. Finally, there are exogenous (non substitutable) imports of oil $V$ whose price is $P^*_o$

### 4.2 Preferences

The private sector has the following Cobb-Douglas type preferences over Consumption of domestically produced goods $C$ and imported goods $Z$

$$U(C, Z) = \frac{C^{1-\alpha} Z^\alpha}{(1-\alpha)^{1-\alpha} \alpha^\alpha}$$

Where $C$ is real consumption of home produced goods, $Z$ is the real consumption of foreign produced goods (imports), finally $\alpha$ is the proportion of private sector income spent on imports.

The private sector faces a budget constraint described by equation 2

$$PC + VsP^*_o + sP^*Z = PY + QsP^*_q - T$$

Where $P$ is the price of home produced goods in domestic currency units, $P^*_o$ is the foreign currency price of oil imports, $s$ is the value of foreign currency in terms of domestic currency, $Y$ is the total quantity consumption goods produced domestically. Furthermore, $Q$ is the quantity of exogenous exports of gold, $P^*_q$ is the foreign currency price of gold determined exogenously in the world market for gold, and $T$ is a lump-sum tax levied by the government on the private sector. The lagrangian for this private sector problem is:

$$L = U(C, Z) + \lambda(PY + QsP^*_q - T - PC - VsP^*_o - sP^*Z)$$
The first order conditions with respect to \( C \) and \( Z \) are

\[
\frac{\partial L}{\partial C} = U_c(C, Z) - \lambda P = 0 \tag{3}
\]

\[
\frac{\partial L}{\partial Z} = U_z(C, Z) - \lambda s P^* = 0 \tag{4}
\]

\[
\frac{\partial L}{\partial \lambda} = PY + Qs P_q^* - T - PC - sP_o^* V - sP_o Z = 0 \tag{5}
\]

Dividing 4 by 3 we have

\[
\frac{\alpha}{Z} \frac{1}{(1 - \alpha)/C} = \frac{sP^*}{P} \Rightarrow \frac{\alpha}{1 - \alpha} = \frac{sP^* Z}{PC} \tag{6}
\]

Substituting equation 6 into 5 we have

\[
C = (1 - \alpha) \left( \frac{PY + Qs P_q^* - T - sP_o^* V}{P} \right) \tag{7}
\]

Equation 7 shows that the demand for domestically produced consumption goods depends on disposable income less exogenous expenditure on imports of oil, domestic price level, and a share of income spent on domestically produced goods. An increase in price of gold will increase disposable income leading to an increase in demand for domestically produced goods. However, since domestic residents can not substitute imports of oil for domestic goods, an increase in the price of oil leads to a reduction in disposable income and a fall in demand for domestic goods.

Substituting 7 into 6 and solving for \( Z \) we have

\[
Z = \alpha \left( \frac{PY + Qs P_q^* - T - sP_o^* V}{sP_o^*} \right) \tag{8}
\]

Equation 8 describes the demand for substitutable imports such as imports of food. The demand for substitutable imports depends positively on disposable income and negatively on domestic price of these imports. An increase in foreign price or nominal currency depreciation will, through the substitution effect, decrease the demand for these imports. An increase in gold exports will increase disposable income leading to increase in imports while an increase in oil imports will, through income effect, cause a decrease in demand for substitutable imports.

4.3 Equilibrium

In the long–run, I assume that production \( Y \) is exogenous and its value is given by the natural level of production \( Y^n \). The domestic goods market equilibrium condition \(^2\) is given by

\(^2\)In this mode C and G do not include imports, so we don’t subtract imports here
Substituting the derived behavioural demand function for $C$ and the assumed demand for exports $X$ and multiplying by $P$ throughout we have

$$PY^n = (1 - \alpha) (PY^n + QsP_o^* - T - sP_o^*V) + s\alpha^*Y^*P^* + PG$$

$$\alpha PY^n = (1 - \alpha)s(QP^*_q - P_o^*V) - (1 - \alpha)T + s\alpha^*Y^*P^* + PG$$

$$\xi = \frac{sP^*}{P} = \frac{\alpha Y^n + (1 - \alpha)T/P - G}{(1 - \alpha)(QP^*_q - P_o^*V)/P^* + \alpha^*Y^*}$$

Equation 10 gives predictions for the real exchange rate. The real exchange rate is determined by real variables including long–run natural output $Y^n$, real taxes $T/P$, real government spending $G$, real export earnings from exogenous exports of gold $sP_o^*/P^*$, real spending on exogenous imports of oil $sP_o^*/P^*$, and foreign exogenous real income $Y^*$.

### 4.4 Comparative statics

Because I have defined the real exchange rate as the relative price of foreign goods, an increase (decrease) in the value of real exchange rate means real depreciation (appreciation) of a currency.

An increase in long run output leads to a real depreciation of the currency. This is equivalent to a decrease in the relative price of domestically produced goods or an increase in competitiveness. As the productive capacity increases, the relative supply of domestic goods increases, so their prices will fall relative to goods produced overseas. The long run natural output may increase due to factors such as an increase in labour force, human capital accumulation and advances in technology that improve productivity of capital and labour.

An increase in real taxes reduces private sector spending on home-produced goods which in turn reduces the relative price of domestic goods so we have a real depreciation of the currency, ceteris paribus.

An increase in government consumption, which for given taxes must be financed by non tax resources such as aid or increased sovereign debt (a capital inflow), will increase demand for home-produced goods leading to a real appreciation of the currency, ceteris paribus. Therefore, this model encompasses many mechanisms of real exchange rate dynamics proposed in the literature. For example, Calvo et al. (1993, p.110) argue that, as a result of increased domestic absorption, a large capital transfer from abroad causes expenditure on non–tradable goods to increase casing an increase in the real exchange rate. Empirical evidence also suggests that inflow
of capital into an economy causes a real appreciation of the currency (Calvo et al., 1993; Lartey, 2007; Jongwanich and Kohpaiboon, 2013). Both Lartey (2007) and Adenauer and Vagassky (1998) find that aid inflow is associated with real appreciation of the currency.

An increase in gold earnings will increase spending on home produced goods leading to an increase in relative price of these goods and real appreciation of the currency.

An increase in foreign income will increase the demand for home-produced goods leading to an increase in their relative price, i.e. a real appreciation of the currency, ceteris paribus. The magnitude of the effect of foreign income depends on the proportion of income spent by foreigners on domestically produced goods. The lower this proportion is, the weaker will be the effect.

The assumption that domestic residents can not substitute imports of oil for domestic goods implies an increase in price of oil leads to a reduction in disposable income and a fall in demand for domestic goods. This fall in demand leads to a fall in domestic price level and a real depreciation of the currency. I assume that the supply side effect of oil price is negligible in the case of Tanzania.

5 Data and graphical analysis

5.1 Data

Due to data availability constraints, equation 10 was modified to a more empirically testable version as given by eqation 11

$$\xi = \frac{sP^*}{P} = \frac{\alpha(Y^n/Y) + (1 - \alpha)(T/PY) - PG/PY}{(1 - \alpha)\left[(Q/Y)(P^*_q/P^*) - (V/Y)(P^*_o/P^*)\right] + \alpha(Y^*/Y)} \quad (11)$$

In the long run, the natural output to actual output ratio ($Y^n/Y$) is equal to unity and will not affect the real exchange rate. Both ratios of the quantity of gold ($Q/Y$) and oil ($V/Y$) to output are assumed to be constant. This assumption means that the variation of the nominal values of both gold exports and oil imports for Tanzania can be represented only by changes in world prices of oil and gold. Therefore the variables considered for empirical study include: real exchange rate ($\xi$), ratio of tax to nominal output ($T/PY$), the ratio of government consumption to nominal output ($PG/PY$), the real price of gold ($P^*_q/P^*$), the real price of oil ($P^*_o/P^*$), and the ratio of foreign output to domestic output ($Y^*/Y$).

Due to the fact that Tanzania trades with many countries, the foreign country is formulated as a combination of major trading partners weighted by their respective trade volumes.
(the sum of exports and imports) with Tanzania. Data on imports and exports of all countries that traded with Tanzania in 1991\(^3\) was taken from Direction of Trade Statistics (DOS) database of the IMF. 15 countries\(^4\) are identified as major trading partners with Tanzania based their respective trade volumes with Tanzania. Trade weight of a particular trading partner was calculated as a proportion of country’s trade volume with Tanzania to the total trade volume for the 14 countries (see the appendix A for further details).

The nominal exchange rate is calculated as a weighted average of the bilateral exchange rates of all trading partners’ currencies with Tanzanian shilling. The bilateral exchange rates are obtained by multiplying the exchange rate of trading partner’s currency with the dollar (us dollar per unit of trading partner’s currency) by the exchange rate of Tanzania shillings with the dollar (Tanzanian shillings per 1 dollar). All bilateral exchange rate data is obtained from IMF’s IFS database except for Euro zone countries in the trading partners list. The exchange rates for these countries are obtained from OECD economic outlook database.

The foreign price level is calculated as a geometric weighed average of CPIs of all 14 trading partners. Domestic price level is the Tanzania CPI. The tax variable is proxied by Tanzania total government revenue divided by the nominal GDP for Tanzania. Government expenditure is the nominal government consumption expenditure divided by the nominal GDP for Tanzania. The data for CPI, total government revenue, nominal GDP and nominal government consumption expenditure comes from the same IFS database\(^5\).

The real price of oil is calculated as the ratio of nominal world dollar price of oil to the price level in the United States. Price level in the US is the US CPI and data is taken from IFS. The dollar price of oil (USD per barrel) was obtained from BP statistical review of world energy (2013). This is the ratio of world dollar price of gold to the price level in the United States. The nominal price of gold is US–dollars per troy ounce\(^6\) sourced from Global Economic Monitor (GEM) for commodities database of the World Bank.

Foreign output is calculated as a geometrically weighted average of real gross national products (GDP) of 14 major trading partners with Tanzania. Domestic output is Tanzanian real GDP. The natural or long-run output is estimated by the quadratic time trend of Tanzanian

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\(^{3}\)The motivation for using year 1991 is the fact that this year lies at the center of the study period 1968-2012. The trade volumes for the entire period are assumed to be the same as they were in 1991

\(^{4}\)Countries include United Kingdom, Germany, Japan, Saudi Arabia, Italy, Netherlands, India, Belgium, United States, Kenya, United Arab Emirates, Singapore, Pakistan, France and Sweden. Due to data constraints, the United Arab Emirates was dropped from the list before the weights were calculated and 14 countries made the final list

\(^{5}\)However, the observation of total government revenue for the year 1996 is missing in this database therefore it is assumed to be equal to the previous year’s value. I replaced the missing observation with the value in the previous year.

\(^{6}\)One troy ounce is 31.1034768 grams, or 0.0311034768 kilograms
real GDP. All the data on GDP were taken from IFS database of the IMF.

5.2 Components of Real exchange rate

The real exchange rate is constructed from data on the nominal exchange rate, the foreign price level and the domestic price level. We first decompose the real exchange rate into its components and examine how these components evolve in relation to the real exchange rate. Figures 6, 8 and 7 display time series graphs of the yearly percentage changes in real exchange rate against the yearly percentage changes in the nominal exchange rate, foreign inflation and domestic inflation respectively. In all three figures, the dotted vertical lines mark Tanzania’s major macroeconomic events. The first dotted line marks the year 1986 when Tanzania abolished fixed exchange rate system while the later dotted line marks the year 1995 corresponding to the adoption of inflation targeting and strict control of money growth.

Figure 6: Relating changes of real exchange rate to changes in nominal exchange rate

![Image of Figure 6](image-url)

Notes: The first vertical line marks the year 1986 when Tanzania abolished fixed exchange rate system while the later vertical line marks the year 1995 corresponding to the adoption of inflation targeting and strict control of money growth. Source: International Financial Statistics (IFS), OECD economic outlook database and author’s calculations

Figure 6 shows that changes in nominal exchange rate are the major component of yearly changes in real exchange rate, at least in the short run. Almost all movements in the nominal exchange rate are replicated by movements in the real exchange rate.

Figure 7 shows that during the period of fixed exchange rate regime, Domestic inflation moves in opposite direction with the real exchange rate in line with expectations. For example, in the early 80s, high levels of inflation of more than 20% were accompanied by appreciations of

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7This is not a test of the model but just a descriptive decomposition of the real exchange rate
Figure 7: Relating changes of real exchange rate to domestic inflation

Notes: The first vertical line marks the year 1986 when Tanzania abolished fixed exchange rate system while the later vertical line marks the year 1995 corresponding to the adoption of inflation targeting and strict control of money growth. Source: International Financial Statistics (IFS), OECD economic outlook database and author’s calculations.

Figure 8: Relating changes of real exchange rate to foreign inflation

Notes: The first vertical line marks the year 1986 when Tanzania abolished fixed exchange rate system while the later vertical line marks the year 1995 corresponding to the adoption of inflation targeting and strict control of money growth. Source: International Financial Statistics (IFS), OECD economic outlook database and author’s calculations.
more than 20%. The relationship is weak in the years 1985 and 1986 due to real exchange rate devaluation associated with the transition to a flexible exchange rate. The negative relationship is again evident in post transition period from 1987 to the late 90’s where high sustained levels of inflation likely caused the trend of real exchange rate to decrease until late 90s. In the period after 1995, the relationship is generally weak. After the shift to “inflation targeting” in 1995, domestic inflation was stable while the real exchange rate continued to fluctuate.

In figure 8, Foreign inflation appears to be stable and does not move together with the real exchange rate.

5.3 Graphical analysis of the real exchange rate and explanatory variables

In order to assess the theoretical implications of the model developed in section 4, the real exchange rate is plotted against each of its equilibrium determinants identified in the theoretical model. We focus on the period after 1986 when the nominal exchange rate in Tanzania was allowed to fluctuate in response to foreign exchange market conditions. One reason for limiting the sample in this manner is to avoid possible structural break in the time series caused by devaluations associated with the transition from fixed to a flexible exchange rate regime. In figure 1, we can see the significant jump in the real exchange rate time series in the year 1986 in which the exchange rate reform program was implemented. The visual inspection of the plots is used to identify the presence of trend movements in the real exchange rate and these movements are compared with corresponding movements of the empirical measures of the theoretical determinants. We expect, for example, if the real exchange rate has a tendency to increase\(^8\), then the corresponding equilibrium determinant should show an appropriate movement as predicted by the theoretical model. In each of Figures 9, 10, 11, 12 and 13, the real exchange rate is plotted along one of the structural determinants. in each graph, the vertical dotted line at the year 1986 marks the transition form fixed to flexible exchange rate in Tanzania. For comparison purposes, each variable is normalized in such a way that its value in 2010 is equal to 1\(^9\).

**Tax revenue**

The theoretical model predicts a positive relationship between tax revenue and the real exchange rate. An increase in real tax revenue reduces private sector spending which in turn

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\(^8\) The way exchange rate is defined here, increase in numerical value of the real exchange rate means depreciation of the real value of the Tanzanian shilling. To keep things simple, when I say a determinant has a positive relationship with the real exchange rate this means that increase in value of that determinant leads to increase in the numerical value of the real exchange rate and vice versa. In the literature this is usually interpreted as a negative relationship because increases in the determinant’s value leads to the actual depreciation of the currency.

\(^9\) The normalized variable is essentially an index and its actual value is meaningless but the focus of this analysis is on relative changes which are effectively captured by the index.
reduces the price of domestic goods relative to foreign goods, i.e. the value of real exchange rate increases. In figure 9, focusing on the period from 1987, Tax to GDP ratio shows a strong positive relationship with the numerical value of the real exchange rate. During the period from 1987 to 1994, on average, Tax to GDP ratio increased from 0.5 to 0.8 while the value of the real exchange rate increased from 0.5 to 1. Both Tax to GDP ratio and the real exchange rate increased from 0.8 to 1 during the period from 2000 to 2010. However, the strong relationship between the two variables does not hold in a brief period from 1994 to 2000. In this period, Tax to GDP ratio remained fairly constant while the real exchange rate decreased from 1 to 0.8.

**Government consumption**

According to the theoretical model, government consumption expenditure should have a negative relationship with the value of the real exchange rate. For given tax revenue, an increase in government consumption expenditure increases demand for home produced goods leading to a decrease in domestic price level and a decrease in the value of the real exchange rate. In figure 10, Government consumption to GDP ratio appears to be stationary which means its underlying long run value is constant throughout the study period. However, focusing on the period after 1987, this variable appears to have huge cyclical or short run variations which appear to have strong positive correlation with short run real exchange rate movements contrary to predictions of the theoretical model. Government consumption to GDP ratio appears to be more volatile.
Figure 10: Relating the real exchange rate with the government consumption to GDP ratio

Notes: Both variables are scaled as indices with their values in 2010 set equal to 1. Higher values of the real exchange rate indicate currency depreciation and vice versa. The vertical line marks the year 1986 when Tanzania transitioned to flexible exchange rate regime. Source: International Financial Statistics (IFS), OECD economic outlook database and author’s calculations

than the real exchange rate. In the period from 1993 to 2000, Government consumption to GDP ratio decreased dramatically 66.7% from 1.2 to 0.4 while the real exchange rate decreased by only by 30% from 1 to 0.7.

Real price of oil

Theoretically, the real price of oil and the value of real exchange rate should have a positive correlation. Since domestic residents can not substitute oil imports for a domestically produced energy source, an increase in the real price of oil reduces the disposable income, a fall in demand for domestic goods, a fall in the price level and an increase in the value of the real exchange rate. In figure 11, the Real price of oil appears to have non-stationary properties with high levels of persistence. During the period from 1987, both Real price of oil and the real exchange rate show an increasing trend in line with the predictions of the theoretical model. In the short run, however, the relationship between Real price of oil and the real exchange rate is generally weak. During the period from 1987 to 2003, Real price of oil was fairly constant around 0.4 while the real exchange rate increased from 0.4 to 1.1 during period from 1987 to 1995 and then decreased from 1.1 to 0.8 during the period from 1995 to 2003. For a short period from 2003 to 2008, both variables appear to be increasing but during the period after 2008, Real price of oil fluctuated greatly while the real exchange rate remained constant.
Figure 11: Relating the real exchange rate and the real world price of oil

Notes: Both variables are scaled as indices with their values in 2010 set equal to 1. Higher values of the real exchange rate indicate currency depreciation and vice versa. The vertical line marks the year 1986 when Tanzania transitioned to flexible exchange rate regime. Source: International Financial Statistics (IFS), OECD economic outlook database, BP statistical review of world energy (2013) and author’s calculations

Figure 12: Relating real exchange rate with the real price of gold

Notes: Both variables are scaled as indices with their values in 2010 set equal to 1. Higher values of the real exchange rate indicate currency depreciation and vice versa. The vertical line marks the year 1986 when Tanzania transitioned to flexible exchange rate regime. Source: International Financial Statistics (IFS), OECD economic outlook database, Global Economic Monitor (GEM) for commodities database of the World Bank and author’s calculations
**Real price of gold**

The theoretical model predicts a negative relationship between the value of the real exchange rate and the real price of gold. An increase in gold earnings will increase spending on home produced goods leading to an increase in the relative price of these goods and a decrease in the value of the real exchange rate. In figure 12, focusing on the period after 1986, the relationship between the real exchange rate and *real price of gold* appears to be ambiguous. During period of from 1987 to 1995, the *real price of gold* decreased from 0.6 to 0.5 while the real exchange rate increased from 0.5 to 1. Both variables increased during the period from 2000 to 2010 with *real price of gold* increasing from 0.3 to 1 and the real exchange rate increasing from 0.7 to 1.

Figure 13: Relating the real exchange rate with the ratio of foreign output to domestic output

![Graph showing relationship between real exchange rate and foreign output to domestic output ratio]

**Notes:** Both variables are scaled as indices with their values in 2010 set equal to 1. Higher values of the real exchange rate indicate currency depreciation and vice versa. The vertical line marks the year 1986 when Tanzania transitioned to flexible exchange rate regime. *Source:* International Financial Statistics (IFS), OECD economic outlook database and author’s calculations

**Foreign income**

A negative relationship is predicted to exist between the value of the real exchange rate and foreign income relative to domestic income. An increase in foreign income increases the relative demand of domestic goods. This leads to an increase in the relative price of domestic goods and a decrease in the value of the real exchange rate. In figure 13, focusing on the period from 1987, *Foreign output to domestic output ratio*\(^{10}\) shows a decreasing trend while the real exchange rate shows an increasing trend as predicted by the theoretical model. The relationship

\(^{10}\)Here output is considered as synonymous to income
in the short run is difficult to determine and perhaps ambiguous. During the period from 1987 to 1995, both variables increased slightly. During the period from 1995 to 2010, Foreign output to domestic output ratio decreased consistently while the real exchange rate first decreased in the period from 1995 to 1998, stayed constant until 2002, then increased in the period after 2002.

According to the above graphical analysis, there is weak empirical evidence that the theoretical implications hold in the long run. However in the short run, tax revenue shows a positive relationship with the value of real exchange rate which is consistent with the prediction of the model. In the text sections, we test formally, through regression techniques, the predictions of the theoretical model.

6 Testing long run relationship

In this section I test the existence of the long-run equilibrium relationship between the real exchange rate and its structural determinants. I use the technique developed by Engle and Granger (1987). The absence of statistical evidence to support the existence of equilibrium relationship would indicate that the real exchange rate in Tanzania permanently deviates from its proposed long run equilibrium value.

6.1 Methodology

We test the long run relationship in the sample limited to the floating exchange rate regime (i.e period from 1987 to 2012). The static equation to estimate the long run equilibrium relation between RER and its determinants is specified by equation 12

\[ r_t = \alpha + \beta_1 x_t + \beta_2 e_t + \beta_3 o_t + \beta_4 g_t + \beta_5 f_t + \epsilon_t \]  

(12)

Where \( r_t \) is the real exchange rate, \( x_t \) is the tax to GDP ratio, \( e_t \) is the government consumption to GDP ratio, \( o_t \) is the real price of oil, \( g_t \) is the real price of gold, \( f_t \) is the foreign output to domestic output ratio, \( \epsilon_t \) is the error term capturing other factors not included in the regression, \( \alpha \) is the intercept. \( \beta_1, \beta_2, \beta_3, \beta_4 \) and \( \beta_5 \) are population coefficients on, tax to GDP ratio, government consumption to GDP ratio, real price of oil, real price of gold and foreign output to domestic output ratio respectively.

Regressions based on specifications described by equation 12 are prone to spurious regression results if the variables involved are non–stationary (Stock and Watson, 2011). However, Engle and Granger (1987) show if the variables involved in the regression are integrated of the
same order and residuals are stationary, then the results from regression based on equation 12 may not be spurious. Following Engle and Granger (1987), I first test all variables for existence of unit roots. Unit root tests are conducted in line with procedures described by Phillips and Perron (1988) and Dickey and Fuller (1979) (see appendix B for explanation of the two tests). Secondly, in order to test for cointegration between real exchange rate and its determinants, the residuals from equation 12 are tested for unit root based on Dickey and Fuller (1979). The appropriate critical values taken from Davidson and MacKinnon (1993).

6.2 Results

Unit root test was done based on Dickey and Fuller (1979). In this test the null hypothesis is that the variable has a unit root against the alternative that it is stationary (see Appendix for details). Results show the null hypothesis can’t be rejected for all variables in their levels except for Natural output to actual output ratio. This indicates that all variables have trending behaviour except Natural output to actual output ratio which appears to be stationary. To determine the order of integration, all variables were tested for unit roots in first difference form. The results show we can reject the null hypothesis for Real exchange rate, tax to GDP ratio and foreign output to domestic output ratio at 10%. The null hypothesis was also rejected at 1% level for real price of oil. However, the null hypothesis could not be rejected for government consumption to GDP ratio and real price of gold. Therefore, the test according to Dickey and Fuller (1979) concludes that Natural output to actual output ratio is $I(0)$; Real exchange rate, tax to GDP ratio, foreign output to domestic output ratio and real price of oil are $I(1)$ while government consumption to GDP ratio and real price of gold are integrated with order greater than one.

Another test for unit root known as Philips-perron test was used (see Phillips and Perron (1988) for details of the test). The null hypothesis is that the variable has a unit root against the alternative that it is stationary. For level variables the test fails to reject the null hypothesis for all variables except Real exchange rate. Tests on first difference indicate we can reject the null hypothesis for all variables. The conclusion from this test is that all variables in the model are $I(1)$ except Real exchange rate which is $I(0)$.

The foregoing unit root analysis indicate that all variables are $I(1)$. Therefore, the static specification in equation 12 was estimated using ordinary least squares method. The simple OLS results are presented in table 1. The results show tax, government consumption,

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11Residuals are not observed and are therefore estimated. To account for uncertainty associated with estimation, Davidson and MacKinnon (1993) recommend appropriate critical values that take into account the uncertainty involved in the estimation of residuals. Therefore, the Davidson and MacKinnon (1993) critical values are significantly larger than usual ADF critical values.
and real price of gold have significant effects on the long run real exchange rate. However, Engle and Granger (1987) show that these results are spurious if the errors from the ols regression contain unit roots. To this end, I conducted unit root test on the residuals of the regression. The results show that we cannot reject the null hypothesis of a unit root using both the usual dickey fuller critical values and the Davidson and MacKinnon (1993) critical values (see the appendix B for details).

The conclusion from this long-run analysis is that the real exchange rate permanently deviates from its proposed long run equilibrium value; that is there is no long run equilibrium relationship between the real exchange rate and the structural determinants.

Table 1: Estimation results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient (Std. Err.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxes</td>
<td>0.737*** (0.153)</td>
</tr>
<tr>
<td>Government consumption</td>
<td>0.407*** (0.0520)</td>
</tr>
<tr>
<td>Real price of oil</td>
<td>-0.0732 (0.0653)</td>
</tr>
<tr>
<td>Real price of gold</td>
<td>-0.127** (0.0567)</td>
</tr>
<tr>
<td>Foreign output</td>
<td>0.149 (0.117)</td>
</tr>
<tr>
<td>Intercept</td>
<td>-0.0910** (0.0320)</td>
</tr>
<tr>
<td>Observations</td>
<td>25</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.788</td>
</tr>
</tbody>
</table>

Standard errors in parentheses. The sample limited to the floating exchange rate regime (i.e period from 1987 to 2012). All variables are in logarithms. The dependent variable is the real effective exchange rate. Taxes stands for tax to GDP ratio whereas government consumption stands for government consumption to GDP ratio. Foreign output stands for foreign output to domestic output ratio.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

7 Tests for short run relationships

We have found, in section 6, that there is no equilibrium relationship between the real exchange rate and its structural determinants. However there may still be a short run relationship in the sense Granger (1969). More often than not, past changes in values of determinants may precede changes in the real exchange rate. In this section we test for possible granger-causal relationship running from the structural determinants to the real exchange rate.

7.1 Methodology

We test the short–run relationship in the sample limited to the floating exchange rate regime (i.e period from 1987 to 2012). We consider a simple causality test in the spirit of Granger (1969). According to Granger, a variable (say real price of oil), is said to Granger–cause another
variable (in this case, Real exchange rate) if, given the past values of Real exchange rate, past values of real price of oil are useful for predicting Real exchange rate. Therefore, I specified a simple linear regression model where Real exchange rate is regressed on its own lags and lags of all the structural determinants. This specification is described by equation 13 in which two lags are considered. According to Granger (1969), the variables used in the test must be stationary therefore equation 13 specify variables in their first differences denoted by hat symbol.

\[
\hat{r}_t = \delta + \alpha_r \hat{r}_{t-1} + \alpha_x \hat{x}_{t-1} + \alpha_e \hat{e}_{t-1} + \alpha_o \hat{o}_{t-1} + \alpha_g \hat{g}_{t-1} + \alpha_f \hat{f}_{t-1} + \alpha_y \hat{y}_{t-1}
+ \beta_r \hat{r}_{t-2} + \beta_x \hat{x}_{t-2} + \beta_e \hat{e}_{t-2} + \beta_o \hat{o}_{t-2} + \beta_g \hat{g}_{t-2} + \beta_f \hat{f}_{t-2} + \beta_y \hat{y}_{t-2} + \epsilon_t
\]  

(13)

Where \( \hat{r}_t \) is the first difference of the real exchange rate, \( \hat{x}_t \) is the first difference of tax to GDP ratio, \( \hat{e}_t \) is the first difference of government consumption to GDP ratio, \( \hat{o}_t \) is the first difference of real price of oil, \( \hat{g}_t \) is the first difference of real price of gold, \( \hat{f}_t \) is the first difference of foreign output to domestic output ratio, \( \hat{y}_t \) is the first difference of natural output to actual output ratio\(^{12} \), \( \epsilon_t \) is the error term capturing other factors not included in the regression, \( \alpha_j \) and \( \beta_j \), for \( j = r, x, e, o, g, f, y \) are coefficients and \( \delta \) is the intercept.

The granger–causality is tested by t–test for individual lags and the F–test for joint significance of both lags. For example, a test of whether tax to GDP ratio granger-cause real exchange rate is the F–test with null hypothesis that both lags of tax to GDP ratio have no explanatory powers (i.e. \( H_0 : \alpha_x = 0, \beta_x = 0 \)). A rejection of the null hypothesis in the F–test means that the variable in question granger–causes real exchange rate

### 7.2 Results

Granger–causality test results are presented in table 2. Column 5 describes the null hypothesis of the F–test and reports the F–statistic.

The results show that the lags on tax to GDP ratio, government consumption to GDP ratio, and real price of gold have predictive effects that are consistent with the predictions of the model derived in section 4. real price of gold has significant and negative estimated coefficients for both lags. The first lag of tax to GDP ratio is positive and significant. The first lag of the government consumption to GDP ratio is negative and significant.

\(^{12}\)In the short run actual output may differ from its natural level and may potentially affect the real exchange rate. Therefore, natural output to actual output ratio is included in the regression as a control variable.
Table 2: Estimation results

<table>
<thead>
<tr>
<th>Variable</th>
<th>lag</th>
<th>Coefficient</th>
<th>(Std. Err.)</th>
<th>(F. Test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real exchange rate</td>
<td>( \hat{r}_{t-1} )</td>
<td>0.269</td>
<td>(0.281)</td>
<td>0.99</td>
</tr>
<tr>
<td></td>
<td>( \hat{r}_{t-2} )</td>
<td>0.303</td>
<td>(0.216)</td>
<td></td>
</tr>
<tr>
<td>Taxes</td>
<td>( x_{t-1} )</td>
<td>0.381*</td>
<td>(0.195)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( x_{t-2} )</td>
<td>0.190</td>
<td>(0.231)</td>
<td>1.98</td>
</tr>
<tr>
<td>Govt. consumption</td>
<td>( \hat{e}_{t-1} )</td>
<td>-0.605***</td>
<td>(0.246)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( \hat{e}_{t-2} )</td>
<td>0.209</td>
<td>(0.109)</td>
<td>3.21</td>
</tr>
<tr>
<td>Real price of oil</td>
<td>( \hat{o}_{t-1} )</td>
<td>-0.604***</td>
<td>(0.146)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( \hat{o}_{t-2} )</td>
<td>0.201*</td>
<td>(0.093)</td>
<td>8.70*</td>
</tr>
<tr>
<td>Real price of gold</td>
<td>( \hat{g}_{t-1} )</td>
<td>-0.344*</td>
<td>(0.149)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( \hat{g}_{t-2} )</td>
<td>-0.539*</td>
<td>(0.223)</td>
<td>5.94*</td>
</tr>
<tr>
<td>Foreign output</td>
<td>( \hat{f}_{t-1} )</td>
<td>3.266***</td>
<td>(1.171)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( \hat{f}_{t-2} )</td>
<td>-0.620</td>
<td>(1.016)</td>
<td>7.06*</td>
</tr>
<tr>
<td>Natural output</td>
<td>( \hat{y}_{t-1} )</td>
<td>-5.414***</td>
<td>(1.376)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( \hat{y}_{t-2} )</td>
<td>0.173</td>
<td>(1.236)</td>
<td>9.04*</td>
</tr>
</tbody>
</table>

Standard errors in parentheses. The sample limited to the floating exchange rate regime (i.e period from 1987 to 2012). All variables are in first difference of logarithm denoted by hat symbol. The dependent variable is the contemporaneous value of real exchange rate (i.e \( \hat{r}_t \)). Taxes denotes tax to GDP ratio while govt. consumption denotes government consumption to GDP ratio. Foreign output denotes the foreign output to domestic output ratio. Natural output denotes natural output to actual output ratio. The number of observations included in the regression is 21. The value of \( R^2 \) is 0.865

\* \( p < 0.10 \), \** \( p < 0.05 \), \*** \( p < 0.01 \)

The first lags of foreign output and natural output are highly significant but posses the signs that are inconsistent with the theoretical model predictions. The theoretical model predicted negative coefficient on the first lag of foreign output while the estimated coefficient is positive. The sign of the estimated coefficient on the first lag of natural output is negative while the theoretical model predicts a positive significant coefficient.

8 Summary and conclusion

In this thesis I build a general equilibrium model with micro foundations to capture Tanzania’s unique structure of imports and exports. The model hypothesizes the numerical value of the real exchange rate is positively related to tax, negatively related to government consumption, positively related to the expenditure on imports of oil, negatively related to the earnings from gold exports, negatively related to foreign income and positively related to natural or long run output.

The empirical analysis of the model was conducted based on data from Tanzania and major trading partners focusing on flexible exchange rate regime period from 1987 to 2012. Graphical analysis reveals that a large component of real exchange rate fluctuations is associated with nominal exchange rate fluctuations. Visual inspection of the data show weak evidence of the
existence of the implications of the theoretical model in the long run. Only the co-movements of taxes and real exchange rate were in line with the predictions of the theoretical model.

Unit root and cointegration tests confirm that the OLS regression results of a static linear specification of the theoretical model may be spurious. Therefore, cointegration tests confirm the graphical analysis results that shows absence of long run relationship between real exchange rate and its structural determinants. However, granger-causality tests show past changes in gold price, government consumption and taxes have effects on real exchange rate that are consistent with the predictions of the theoretical model.

The theoretical discussion backed by both graphical analysis and granger-causality test results identifies taxes as an important factor influencing the real exchange rate in Tanzania; at least in the short run. The policy implication emerging from this thesis is that, through the adoption of a fiscal policy whose main objective is to smooth tax revenue over time, Tanzanian government can stabilize the real exchange rate fluctuations. However any effort to stabilize the real exchange rate must be accompanied by central bank’s efforts to stabilize short run fluctuations of the nominal exchange rate.
References


Appendix A

Data

The weights were calculated using the following formula

\[ w_j = \frac{M_j + X_j}{\sum_{j=1}^{n} (M_j + X_j)} \]  \hspace{1cm} (14)

Where \( M_j \) is country \( j \) value of imports to Tanzania during during 1991 while \( X_j \) is the value of exports from Tanzania to country \( j \) during 1991. \( n \) is the total number of major trading partners.

Nominal exchange rate is constructed as geometrically weighted average price of major trading partners’ currencies in terms of the Tanzanian shilling using the following formula

\[ S_t = \prod_{j=1}^{n} S_{j,t}^w \]  \hspace{1cm} (15)

Where \( S_{j,t} \) is the value country \( j \) currency at time \( t \) in terms of Tanzania shillings. \( S_{j,t} \) is calculated in the way described by equation 16

\[ S_{j,t} = S_{u,t} \times S_{u,j,t} \]  \hspace{1cm} (16)

Where \( S_{u,t} \) the value of one US dollar in terms of Tanzanian shillings, while \( S_{u,j,t} \) is the bilateral exchange rate expressed as a value of one unit of country \( j \)’s currency in terms of US dollars. The data of these two variables comes from IFS database of IMF except bilateral exchange rates for European countries. The data for these countries comes from OECD economic outlook database.

Foreign price level is a geometrically weighted average of price levels of all major trading partners with Tanzania and it is calculated as follows

\[ P_t^* = \prod_{j=1}^{n} P_{j,t}^{w_j} \]  \hspace{1cm} (17)

Where \( P_{j,t} \) is the price level in country \( j \) at time \( t \) and it is proxied by the CPI in country \( j \) at time \( t \). The data of CPI for each trading partner comes from IFS database.

The real exchange rate is calculated by the following formula

\[ \varepsilon = \frac{S_t \times P_t^*}{P_t} \]  \hspace{1cm} (18)
Where $P_t$ is the Tanzania CPI at time $t$ the data for which comes from IFS database.

Foreign output is calculated as a geometrically weighted average of outputs of major trading partners with Tanzania and given by the formula expressed in equation 19

$$Y^*_t = \prod_{j=1}^{n} Y_{j,t}^{w_j}$$

Where, $Y_{j,t}$ is the real GDP of trade partner $j$ at time $t$ the data of which is taken from IFS database. Domestic output is Tanzania real GDP at time $t$ and is taken from IFS database. The natural output obtained by fitting a quadratic time trend model of actual real output in a way described equation 20

$$y_t = \delta + \alpha t + \beta t^2 + \epsilon$$

where $y_t$ is the real output, $t$ stands for time, $\epsilon$ is the error term, $\delta$ is the intercept, $\alpha$ and $\beta$ are coefficients on linear and quadratic time trends respectively.

The estimated coefficients from equation 20 are then used to generate the actual natural output data in a way expressed by equation 21

$$y^n = \hat{\delta} + \hat{\alpha} t + \hat{\beta} t^2$$

Where $y^n$ is the natural output, $t$ denotes time, $\hat{\delta}$, $\hat{\alpha}$ and $\hat{\beta}$ are ordinary least squares (OLS) estimates from the regression specified by equation 20

**Appendix B**

**Unit root tests**

Following Dickey and Fuller (1979), the following model is used to test for unit roots

$$\Delta x_t = \alpha + \beta x_{t-1} + \sum_{j=1}^{p} \delta_j \Delta x_{t-j} + \epsilon_t$$

Where $x$ is can be any variable that is tested for unit root. $\alpha$ is the intercept. $\beta$ and $\delta_j$ for $j = 1, \ldots, p$ are coefficients. The $\Delta$ sign indicate a variable in first difference form. The null hypothesis is based on the significance of the coefficient on $x_{t-1}$. The null hypothesis is that the stochastic process $x_t$ has a unit root (i.e. $H_o : \beta = 0$) against the alternative that the process is stationary (i.e. $H_o : \beta < 0$). $p$ is the number of lags included chosen based on final prediction error (FPE), Akaike’s information criterion (AIC), Schwarz’s Bayesian information
criterion (SBIC), the Hannan Quinn Information Criterion (HQIC), the log likelihood (LL) and likelihood-ratio (LR). The number of lags is actually selected on "majority rule" basis where by the lag leve suggested my most criteria is chosen. The estimates of these criteria are calculated by `varsoc` command of `stata`.

The results of the test by Dickey and Fuller (1979) depends on the number of lags included. Therefore and additional unit root test based on Phillips and Perron (1988) is used. The Phillips–Perron (PP) test is based on the estimation of equation 23

\[ x_t = \alpha + \rho x_{t-1} + \epsilon_t \]  \hspace{1cm} (23)

Where \( x_t \) can be any variable being tested for unit root. The difference between this test and the augmented dickey–fuller (ADF) test is the way serial correlation of the error term \( \epsilon_t \) is addressed. The ADF test uses more lagged values of the dependent variable while the PP uses non–parametrically corrected t–tests for testing the significance of the coefficient on \( x_{t-1} \). The null hypothesis in PP test is that the series has a unit root (i.e. \( H_0 : \rho = 1 \)) against the alternative hypothesis that the series is stationary (i.e. \( H_0 : \rho < 1 \)).

**Unit root test results**

Tables 3 and 4 report unit root tests done based on Dickey and Fuller (1979) and Phillips and Perron (1988) respectively.

---

\footnote{Please see Sukati (2013), for explanation on FPE, AIC, SBIC, HQIC, LL, LR and LR}
<table>
<thead>
<tr>
<th>variable</th>
<th>form</th>
<th>statistic</th>
<th>critical values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1%</td>
</tr>
<tr>
<td>Real Exchange rate</td>
<td>Level</td>
<td>-2.411</td>
<td>-3.750</td>
</tr>
<tr>
<td>Tax</td>
<td>Level</td>
<td>0.318</td>
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<td>First Difference</td>
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<td>-3.750</td>
</tr>
<tr>
<td>Govt. consumption</td>
<td>Level</td>
<td>-2.399</td>
<td>-3.750</td>
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<td>First Difference</td>
<td>-2.504</td>
<td>-3.750</td>
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<td>Level</td>
<td>-0.245</td>
<td>-3.750</td>
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<td>First Difference</td>
<td>-4.953***</td>
<td>-3.750</td>
</tr>
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<td>Real price of gold</td>
<td>Level</td>
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<td>-3.750</td>
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<td>First Difference</td>
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<tr>
<td>Foreign output</td>
<td>Level</td>
<td>-0.329</td>
<td>-3.750</td>
</tr>
<tr>
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<td>First Difference</td>
<td>-2.805*</td>
<td>-3.750</td>
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<tr>
<td>Natural output</td>
<td>Level</td>
<td>-2.901*</td>
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<tr>
<td></td>
<td>First Difference</td>
<td>-1.692</td>
<td>-3.750</td>
</tr>
</tbody>
</table>

* Tax stands for Tax to GDP ratio, Govt. consumption stands for Government consumption to GDP ratio, Foreign output stands for Foreign output to domestic output ratio and Natural output stands for Natural output to actual output ratio. Column 3 reports augmented dickey–fuller test statistic which is equivalent to t statistic of the coefficient on $x_{t-1}$ in equation 22. Columns 4 through 6 reports the interpolated augmented dickey–fuller critical values.

Cointegration test results

The time series plot of residuals from regression estimates based on equation 12 is displayed in figure 14. The unit root test of these residuals based on Dickey and Fuller (1979) with Davidson and MacKinnon (1993) critical values is presented in table 5.
Table 4: PP unit root test results

<table>
<thead>
<tr>
<th>Variable</th>
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<th>Statistic</th>
<th>Critical values</th>
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<td></td>
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<td>1%</td>
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<tr>
<td>REER</td>
<td>Level</td>
<td>-10.357*</td>
<td>-17.268</td>
</tr>
<tr>
<td></td>
<td>First Difference</td>
<td>-15.606***</td>
<td>-17.268</td>
</tr>
<tr>
<td>Tax</td>
<td>Level</td>
<td>-6.002</td>
<td>-17.200</td>
</tr>
<tr>
<td></td>
<td>First Difference</td>
<td>-30.978***</td>
<td>-17.200</td>
</tr>
<tr>
<td>Govt. consumption</td>
<td>Level</td>
<td>-5.419</td>
<td>-17.268</td>
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<tr>
<td></td>
<td>First Difference</td>
<td>-17.485***</td>
<td>-17.268</td>
</tr>
<tr>
<td>Real price of oil</td>
<td>Level</td>
<td>-0.039</td>
<td>-17.200</td>
</tr>
<tr>
<td></td>
<td>First Difference</td>
<td>-24.695***</td>
<td>-17.200</td>
</tr>
<tr>
<td>Real price of gold</td>
<td>Level</td>
<td>-1.101</td>
<td>-17.268</td>
</tr>
<tr>
<td></td>
<td>First Difference</td>
<td>-11.816*</td>
<td>-17.268</td>
</tr>
<tr>
<td>Foreign output</td>
<td>Level</td>
<td>0.082</td>
<td>-17.200</td>
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<tr>
<td></td>
<td>First Difference</td>
<td>-20.981***</td>
<td>-17.200</td>
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<td>Natural output</td>
<td>Level</td>
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<td>-17.268</td>
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<tr>
<td></td>
<td>First Difference</td>
<td>-19.630***</td>
<td>-17.200</td>
</tr>
</tbody>
</table>

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Unit root test for residuals

<table>
<thead>
<tr>
<th>Test statistic</th>
<th>DF critical values</th>
<th>Davidson &amp; MacKinnon (1993) critical values</th>
</tr>
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<td>-3.000</td>
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<tr>
<td></td>
<td>-2.630</td>
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<tr>
<td></td>
<td>-4.71</td>
<td>-4.43</td>
</tr>
</tbody>
</table>

Figure 14: Time series plot of residuals

Source: International Financial Statistics (IFS) and author’s calculations
Appendix C

Lag length selection for ADF tests

The lags used in Dickey and Fuller (1979) based unit root test were selected based on results presented in tables 15, 16, 17, 18, 19, 20 and 21.

Figure 15: Lag selection for real exchange rate

<table>
<thead>
<tr>
<th>Lag</th>
<th>LL</th>
<th>LR</th>
<th>df</th>
<th>p</th>
<th>FPE</th>
<th>AIC</th>
<th>HQIC</th>
<th>SBIC</th>
</tr>
</thead>
<tbody>
<tr>
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<td>11.3644</td>
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<td>1</td>
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<td>-.900834</td>
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<td></td>
</tr>
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<td>1</td>
<td>23.9335</td>
<td>25.139*</td>
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<td>.00000</td>
<td>.000498</td>
<td>-1.00026</td>
<td>-1.00024</td>
<td>-1.00059*</td>
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<tr>
<td>2</td>
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<td>2.8355</td>
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<td>.09200</td>
<td>.002196*</td>
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<td>-1.90639*</td>
<td>-1.78548</td>
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<tr>
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<td>1</td>
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<tr>
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<td>.009129</td>
<td>-1.53312</td>
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<td>-1.58622</td>
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</table>

Figure 16: Lag selection for Tax to GDP ratio

<table>
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<th>df</th>
<th>p</th>
<th>FPE</th>
<th>AIC</th>
<th>HQIC</th>
<th>SBIC</th>
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</thead>
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<td>1</td>
<td>-.270358</td>
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<td>.017405*</td>
<td>-1.21669*</td>
<td>-1.20207*</td>
<td>-1.06965*</td>
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<tr>
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</table>

Figure 17: Lag selection for Government consumption to GDP ratio

<table>
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<th>p</th>
<th>FPE</th>
<th>AIC</th>
<th>HQIC</th>
<th>SBIC</th>
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<td>.701884</td>
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</table>
### Figure 18: Lag selection for Real price of oil

<table>
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<th>FPE</th>
<th>AIC</th>
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<th>SBIC</th>
</tr>
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<td>0.65758*</td>
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<td>1.74957</td>
<td>1.78748</td>
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<tr>
<td>1</td>
<td>7.22821</td>
<td>37.69*</td>
<td>1</td>
<td>0.000</td>
<td>0.65758*</td>
<td>1.73789</td>
<td>1.74957</td>
<td>1.78748</td>
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<td>7.48728</td>
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<td>1</td>
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<td>0.65758*</td>
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<td>1.74957</td>
<td>1.78748</td>
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</tbody>
</table>

Sample: 1991 - 2012  
Number of obs = 22

### Figure 19: Lag selection for Real price of gold

<table>
<thead>
<tr>
<th>lags</th>
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<th>LR</th>
<th>df</th>
<th>p</th>
<th>FPE</th>
<th>AIC</th>
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<td>0.231057</td>
<td>0.28947</td>
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</tbody>
</table>

Sample: 1991 - 2013  
Number of obs = 23

### Figure 20: Lag selection for Foreign output to domestic output ratio

<table>
<thead>
<tr>
<th>lags</th>
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<th>LR</th>
<th>df</th>
<th>p</th>
<th>FPE</th>
<th>AIC</th>
<th>HQIC</th>
<th>SBIC</th>
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<td>0.63611</td>
<td>3.14983</td>
<td>3.26688</td>
<td>3.36576</td>
</tr>
<tr>
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<td>0.000</td>
<td>0.63611</td>
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</table>

Sample: 1991 - 2012  
Number of obs = 22

### Figure 21: Lag selection for Natural output to actual output ratio

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<th>AIC</th>
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<td>0.65461</td>
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<td>3.26688</td>
<td>3.36576</td>
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<td>1</td>
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<td>3.1693</td>
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</table>

Sample: 1991 - 2013  
Number of obs = 23

37