AN ANALYSIS OF THE RELATIONSHIP BETWEEN REAL EXCHANGE RATE AND DOMESTIC CONSUMPTION IN NIGERIA (1981-2016)

By

Jamilu Said BABANGIDA
(P16SSEC8007)

A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER'S DEGREE IN ECONOMICS

DEPARTMENT OF ECONOMICS,
FACULTY OF SOCIAL SCIENCES
AHMADU BELLO UNIVERSITY, ZARIA
NIGERIA

MARCH, 2021

DECLARATION

I hereby declare that this dissertation titled, *"An Analysis of the Relationship Between Real Exchange Rate and Domestic Consumption in Nigeria"* has been undertaken fully by me in the Department of Economics under the supervision of Professor Aliyu Rafindadi Sanusi and Dr. Yusuf I. Maikudi. All sources used in the work have been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diploma at this or any other institution.

_____	_____	_____
Name of Student	Signature	Date

CERTIFICATION

This dissertation titled, "AN ANALYSIS OF THE RELATIONSHIP BETWEEN REAL EXCHANGE RATE AND DOMESTIC CONSUMPTION IN NIGERIA" by Jamilu Said, BABANGIDA meets the regulations governing the award of the degree of MSc. Economics of Ahmadu Bello University and is approved for its contribution to knowledge and literary presentation.

Professor Aliyu Rafindadi. Sanusi Chairman, Supervisory Committee	_____ Signature	_____ Date
Dr. Yusuf I. Maikudi Member, Supervisory Committee	_____ Signature	_____ Date
Professor Aliyu Rafindadi. Sanusi Head of Department,	_____ Signature	_____ Date
Prof. Abdullahi Sani Rabah Dean, School of Postgraduate Studies	_____ Signature	_____ Date

DEDICATION

This Dissertation is dedicated to Almighty Allah for His infinite and unfettered mercy and favour to complete this research work in good health and state of mind.

ACKNOWLEDGEMENT

A debt of praise to Almighty Allah who turns the shadow of death into the life of a new bright day. A lot of effort has gone into the preparation of this work with constructive criticism, support and advice from various individuals. Special and profound appreciation to my Supervisors, Professor Aliyu Rafindadi Sanusi and Dr. Yusuf I. Maikudi whose immeasurable advice and blend of thoroughness was the force behind the completion of my programme. They showed so much patience and tolerated my imperfections; who out of no time created time for me. I thank them for their careful supervision, provision of materials where necessary and whose useful comments and constructive criticisms have helped me to produce this research work.

I also thank my lecturers for their contributions in writing this dissertation and who have also imparted on me knowledge that made me rise brilliantly to my impossible challenges. I would be remiss if I don't acknowledge the unwearying effort of my colleagues, Mr. Usman Bello, Mamman Suleiman and Salisu Mudi. It is based on their inputs and contributions that this research work is completed.

I owe a debt of gratitude to my family for their financial and moral support and prayers that has been keeping me going in the journey called life and who also laid the basis for me to achieve this feat. Thank you all for your enthusiasm and unflagging effort towards making me what I am today. I also owe a debt of gratitude to my love, Zara Abdullahi who always wants me to do better. A person who gives me such feelings of love and happiness to see this work to completion. Lastly, I would like to thank my friends, and P16 course mates Ibrahim Suleiman, Jubril Luqman, Halliru Muhammad, Fureira Muhammed, who indeed have made an indelible impact towards the completion of this work.

ABSTRACT

This dissertation analyses the real exchange rate-domestic consumption relationship in Nigeria using the Smooth Transition Autoregressive (STAR) model from 1981 to 2016. Findings shows that domestic consumption determines the regime shift in real exchange rate suggesting a nonlinear linkage of real exchange rate and domestic consumption with clearly distinct regimes. Exchange rate is shown to have significant linear effect from previous exchange rate. On the other hand, current foreign consumption is positive but has no significant impact on the exchange rate in the linear part of the model. In the nonlinear part of the model, we found evidence of a significant negative relationship between real exchange rate and domestic consumption, thus supporting the proposition by standard International Real Business Cycle (IRBC) Model. In the face of the wide disparity in literature trying to establish the prediction of IRBC model, we found evidence of bi-directional nonlinear granger causality between real exchange rate and domestic consumption. The study concludes that the relationship between real exchange rate and domestic consumption is indeed nonlinear and that fiscal and monetary authorities should develop policies that will help strengthen domestic production to further reduce import component in domestic consumption.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Over the last few decades, issues relating to exchange rate and macroeconomic fundamentals have posed a number of questions and challenges across the globe. Trade among economies is facilitated by exchange rate as a measuring tool for valuing goods and services internationally. Globally, exchange rate instability is seen as a common issue, which has implications for domestic consumption through the prices of consumer goods and services. Therefore, changes in exchange rate could impede or distort the movement of goods and services globally. Besides, one of the fundamental concerns in international macroeconomics is the effect of high volatility of the real exchange rate on macroeconomic fundamentals. Hence, there has been growth in literature on the factors determining exchange rate instability in international business cycle models (Tretvoll, 2018).

Exchange rate volatility has also been seen to have effect on domestic economic performance in many developing countries, including Nigeria. It has implications for virtually most economic activities in both home and abroad. Most developed and developing economies of the world have experienced different episodes of exchange rate volatility translating to high degree of uncertainty which serves as an impediment to the attainment of macroeconomic objectives. The incidence of large fluctuations in exchange rates has informed the need for a better understanding of its pass through into import and domestic prices; and consumption (Aliyu, Yakub, Sanni & Duke, 2009). Exchange rate is one of the economic indicators that affects consumption directly through prices of consumer goods and indirectly through the prices of intermediate goods.

From the foregoing, there is also a wide acceptability that exchange rate affects domestic consumption (Alexander, 1952; Bahmani-Oskooee, Kutan & Xi, 2015; Bahmani-Oskooee & Xi, 2012; and Iyke & Ho, 2017) particularly in this age of globalization. As such, the role of exchange rate in the macroeconomic objectives of an economy cannot be overlooked. This gives justification public policy makers, investors and households to pay a lot of attention to the exchange rate management in the economy.

Owing to the fact consumption is an important variable in economies of the world, it is crucial to the apparatus that makes an economy run efficiently (Goodwin, Nelson, Ackerman, & Weisskopf, 2008) as well as crucial to exchange rate determination, particularly, a small open economy that depends on importation. Central to the issue of consumption is the welfare implications of exchange rate fluctuations on one hand, and the effect of consumption on exchange rate deviations from the "Purchasing Power Parity (PPP)" equilibrium on the other hand. Macroeconomists are interested in "aggregate consumption" because it determines aggregate saving that translate to capital through the financial markets (Ezeji & Ajudua, 2015). Hence, an economy's long-term productive capacity is significantly influenced by both aggregate consumption and saving behaviour accounting for most of the GDP. Therefore, it is imperative to study the dynamics of aggregate consumption expenditure not only for macroeconomic objective and the business cycle (Gerstberger & Yaneva, 2013), but also for determining the state of consumption favourable to optimal exchange rate determination. It is imperative to know the relationship between consumption and exchange rate as well as the extent to which an economy should consume imported products or nontraded goods to safeguard its domestic currency, since welfare depends partially, at least, upon household consumption. In developing countries like Ni-

geria, consumption is "the standard measure of material well-being because consumption standards were behind the original setting of the poverty line" (Meyer & Sullivan, 2003). Consequently, the welfare of household is linked to exchange rate in any given economy.

Exchange rate volatility "refers to a situation in which a country's actual exchange rate deviates from equilibrium" (Clement & Eze, 2017,p. 3). Therefore, exchange rate deviations from its equilibrium, a set-back to economies around the world is considered exchange rate misalignment especially in the form of exchange rate overvaluation. This has been identified as one of the obstacles to sustained economic growth (Ghura & Grennes, 1993). Exchange rate management is an important macroeconomic objective and an issue of serious concern in a developing economy (Essien, Uyaebo, & Omotosho, 2017). Indubitably, economists as well as policy makers are interested in exchange rate both in developed and developing economies. Exchange rate fluctuations or volatility affects trade among economies. These bilateral trades are threatened with the risks involved in exchange rate management, thereby passing through to domestic consumption and invariably to the welfare of households. Hence, consumption is affected by the fluctuations in the exchange rate through its inflation pass through i.e., the consumer prices channel. It also affects the price level that determines the level of household consumption as well as promotes local and foreign consumption, the value of which is determined in the foreign exchange market. Conversely, the pattern of consumption also poses a threat to the exchange rate especially when skewed to excessive consumption of imported goods, thereby, causing persistent Balance of Payment disequilibrium. For example, in a bid by the CBN to avert the consequences of our consumption on the exchange rate introduced additional trade and exchange restrictions, including a ban on supply of foreign exchange at the official rate for the import of about 41 items which constitute major consumption goods of households.

1.2 Statement of Research Problem

Many factors have exerted some influence the evolution of foreign exchange market in Nigeria. A sample of such factors include, "pattern of international trade, institutional changes in the economy and structural shifts in production and consumption" (CBN, 2016). "Before the establishment of the Central Bank of Nigeria (CBN) in 1958 and the enactment of the Exchange Control Act of 1962, foreign exchange was earned by the private sector and held in balances abroad by commercial banks which acted as agents for local exporters" (CBN, 2011). At that time, agricultural production and exports contributed the bulk of foreign exchange receipts. As a result of large volatility, there was introduction of reforms in the Foreign Exchange Market. However, Nigeria depends substantially on import with oil revenue serving as the pool of wealth for settling the trade balance in international market. For instance, many industries and households in the economy import their raw materials and finished goods for production and consumption respectively. This has made the economy vulnerable to the volatility of exchange rate through its impact on aggregate consumption stemming from its implications on consumer prices of imports. The foreign exchange rate of naira to the dollar and other major reserve currencies has deteriorated due to developments in the external sector which led to dwindling crude oil receipts as a result of both demand and supply factors[1]. Concerns have been raised on the implications of these developments on consumer prices[2] which is the major determinant of domestic consumption, and how it influences the exchange rate (Mamman, 2017).

[1] Speculation, hedging, investment, exchange rates, inflation, spare production capacity, geopolitical risks, inventories, weather, global economic growth and non-OPEC supply growth.

[2] With a pass-through effect from foreign prices to domestic and import prices as a result of exchange rate fluctuations.

The Nigerian exchange rate has been affected by numerous factors. This effect emanating from low production base of the country and undiversified structure of the economy; import dependent production and consumption structure; and excessive demand for foreign exchange in settlement for import bills (Obadan, 2006). Nigeria consumes more than it produces locally, which implies that there is spare production capacity that could be consumed domestically. This translates to a decrease in the domestic currency value of Naira. The economics of supply and demand state that when demand is high, prices tend to increase, thereby leading to the currency appreciation. On the other hand, when a country has consumption than it produces, their currency is demanded less, so prices should decline. An economy with a large demand for its goods tends to produce and export more than it consumes and imports, which increases the demand for its currency.

There are theoretical and empirical basis for nonlinearities in the exchange rate-consumption relationship. Studies on the exchange rate volatility and persistence have shown an evidence that high volatility regimes with bigger deviations from equilibrium adjust faster in speed than smaller deviations due to nonlinearity (Pavlidis, Paya, & Peel, 2017). In the same view, economic agents react to the abrupt fluctuations in exchange rate differently. Overall, the economy reacts to sudden deviations in different manner. This indicated that a negative shock to exchange rates in Nigeria overtime could trigger a higher uncertainty associated with heightened expectations. This uncertainty can take a nonlinear path in reverting back to the equilibrium (Akpan & Atan, 2012). In other words, the behavior of exchange rate may capture asymmetry. Exchange rate in Nigeria captures asymmetries related to both positive and negative shocks. Hence, this might be the effects of exchange rate asymmetric uncertainty imposed upon by the pattern of consumption.

1.3 Research Questions

In line with the above problems, the study seeks to answer the following questions

i. Is there evidence of linear or nonlinear relationship between domestic consumption and real exchange rate in Nigeria?
ii. How does domestic consumption affect real exchange rate in Nigeria?
iii. Is there presence of nonlinear granger causality between domestic consumption and real exchange rate in Nigeria?

1.4 Research Objectives

The broad objective of the study is to analyse the linear or nonlinear relationship between real exchange rate and domestic consumption in Nigeria from 1981Q1 to 2016Q4. Specifically, the study seeks to

i) Ascertain whether there is evidence of nonlinearity in the relationship between domestic consumption and real exchange rate in Nigeria;
ii) Based on question one above, analyze the effect of domestic consumption on real exchange rate in Nigeria; and
iii) Examine the direction of linear or nonlinear granger causal relationship between real exchange rate and domestic consumption in Nigeria.

1.5 Research Hypothesis

For the purpose of analysing the above objectives, the hypotheses of this study are formulated thus:

$H_0 : \alpha_0 = 0$: There is no evidence of nonlinear relationship between real exchange rate and consumption in Nigeria.

$H_1 : \alpha_1 \neq 0$: There is evidence of nonlinear relationship between real exchange rate and consumption in Nigeria.

1.6 Justifications of the Study

There exist some level of ambiguity in the real exchange rates-consumption relationship (Head, Mattina, & Smith, 2004). Examining the linkage between real exchange rates and consumption

is very crucial for any economy in order to determine the level of domestic or foreign consumption that is optimal for exchange rate determination. Poor management of the exchange rate volatility could have an adverse effect on consumption and could breed other crises. To avoid this situation, it is important to review past events and put forth proper policy to forestall the effects of domestic consumption on the exchange rate as well as effect of exchange rate on consumption in Nigeria.

The adjustment process of exchange rate deviations to the equilibrium path follows a nonlinear reversion pattern which is one of the numerous reasons why research into the nonlinear relationship between exchange rate and consumption is important for developing economy (Pavlidis, Paya, & Peel, 2017). The exchange rate-consumption behaviour is appealing and the knowledge of exchange rate and consumption behaviour is important in appropriately adjusting exchange rates to ensure competitiveness in the international market and prepare an effective expenditure switching strategy (Aliyu, 2016). Despite, the form of behaviour, a large body of literature that exist on the exchange rate-consumption relationship depend on linear models (see Backus & Smith, 1993; Backus & Smith, 1993; Kollmann, 1995; Stockman & Tesar, 1995; Ravn, 2001; Chari, Kehoe, & McGrattan, 2002; Selaive & Tuesta, 2003; Head *et al*., 2004; Choi, 2005; Benigno & Thoenissen, 2008;Tuesta, 2013). Empirical evidence on some economies have shown that the relationship could be nonlinear (see Pavlidis, Paya, & Peel, 2015; Pavlidis, Paya, & Peel, 2017). However, the few studies that exists for Nigeria did not consider the nonlinear pattern of the relationship of exchange rate, and may have therefore missed on fundamental information of the behaviour of exchange rate (Aliyu, 2016). However, the studies of Pavlidis *et al*. (2015) and Pavlidis *et al*. (2017) on nonlinear relationship and granger causality of real exchange rates and consumption basically tested the theoretical

preposition of International Real Business Cycle model on OECD countries. This study focuses on the nonlinear linkage between real exchange rate and consumption in Nigeria, and test for the linear or nonlinear direction of causality. Considering the hypothesis that the relationship between the variables is nonlinear in reality, there may be potentially one challenge of the choice of linear or nonlinear models to be utilized in this study. The practice of capturing misalignment with the level of deviations from linear trends could result in misleading inferences (Mordi, 2014). In trying to resolve this issue, this study adopts the Smooth Transmission Autoregressive (STAR) Model estimation technique used by Pavlidis *et al*. (2017) and Pavlidis *et al*. (2015).

On a final note, the significance of this study emanates from the fact that exchange rate is an important tool used to maintain balance between internal and external sectors. As such, this study would guide the authorities on the right policy in managing consumption behaviour to prevent Nigeria from the excessive foreign exchange rate fluctuations for the welfare of the economy. In other words, it would also help in smoothening domestic or private consumption through its policy strategies as well as curtail the exchange rate uncertainty.

1.7 Scope of the Study

The study focus shall be on the relationship between real exchange rate and domestic consumption in Nigeria using quarterly data from 1981Q1 to 2016Q4. The choice of the sample period is underpinned by the fact that under this period, the economy transits between different episodes of exchange rate management and a period when Nigeria attained its independence which will give comprehensive information in analysing the relationship. The period of study is also chosen to overcome the model limitations as well as account for changes in volatility and a number of regimes switching within the period of study because the larger the sample size,

the better for the STAR model to identify the abrupt change in regimes and the transition from one regime to another.

1.8 Organization of the Study

This dissertation shall be structured in five chapters with the first chapter giving the general introduction comprising of the background to the study, statement of research problem, the research objectives among others. Chapter two comprises of conceptual issues, theoretical and empirical literature as well as the gap in the literature. The research methodology is explored in chapter three, while chapter four shall focus on presentation and discussion of results. Chapter five shall present the summary, conclusion and recommendation.

CHAPTER TWO

LITERATURE REVIEW

2.0. Introduction

The real exchange rate-consumption relationship has attracted significant attention over some decades. Several studies have examined the relationship between real exchange rate and consumption in both developed and developing countries in both linear and nonlinear form for time series and panel data. This section reviews key conceptual issues, theoretical issues, methodologies used and empirical results with a view to identifying literature gaps.

2.1. Conceptual Issues

Real exchange rate between the two countries is defined "as the relative price of one country's consumption basket in terms of the consumption basket of the other country" (Mussa, 1986, p.1). For some purposes, Aliyu (2012) defines real exchange rate "as the relative price of local goods to foreign goods". "It is the nominal exchange rate which has been adjusted for price level between countries" (Odusola, 2006). Mankiw (2004) also states that "real exchange rate measures the price of a basket of goods and services available domestically relative to a basket of goods and services available abroad". "Real exchange rate is the nominal exchange rate (domestic price of foreign currency) multiplied by the ratio of national price levels (domestic price level divided by foreign price level)" (Taylor & Taylor, 2004, p. 7). The external real exchange rate is "the ratio of aggregate foreign price or cost level to the home countries aggregate price or cost while the internal real exchange rate measures the relative prices of two broad categories of goods; ratio of domestic price of tradable goods to non-tradable goods within a country" (Viser, 2004). Real exchange rate is also defined "as the relative price of non-tradable goods produced and consumed in a country in terms of tradable goods produced and consumed in that

country". However, the latter definition of real exchange rate is irrelevant to the context and objectives of this study because it is fraught by an accurate measure of the non-tradable prices in terms of tradables in Nigeria.

Consumption is defined "as the process by which goods and services are, at last, put to final use by household. Consumption is at the end of the line of economic activities that starts with an evaluation of available resources and proceeds through production of goods and services and distribution of goods and services (or the means to acquire them) among people and groups" (Goodwin *et al*., 2008, p. 3). Household consumption spending is known to be one of the most important part of aggregate demand representing a large proportion of Gross Domestic Product (OECD, 2009). "Household final consumption expenditure (also known as private consumption) is the market value of all goods and services, including durable products (such as cars, washing machines and home computers), purchased by households, and also payments and fees to governments to obtain permits and licenses" (World Bank, 2015). Dernburg (1985) also defined consumption to be the act of putting goods and services to use for the sole aim of satisfying a number of needs. This study utilizes "the summation of final consumption expenditure of households and non-profit institutions serving households" in order to capture the chunk of domestic consumption in the economy and the consumption of US to proxy foreign consumption.

2.2. Overview of Exchange rate Management in Nigeria

The CBN carries out the operation in the foreign exchange market which comprises the choice of optimal foreign exchange rate regime that will equate internal and external balances in the economy. This involves "the sum total of the institutional framework and measures put in place to gravitate the exchange rate towards desired levels in order to stimulate the productive sectors, control inflation, ensure internal balance, improve the level of exports and attract direct foreign

investment and other capital flows" (Fapetu & Oloyede, 2014, p.3). Since inception of Central Bank of Nigeria in 1958, Nigeria has transited from one regime of foreign exchange rate management to another (i.e. from the fixed to flexible exchange rate). In between these two extreme regimes lies variants of exchange rate regimes in Nigeria. These changes have been dictated by prevailing economic condition and policy thrust of the monetary authority, with the quest to preserve Naira against persistent deviations and maintain the external reserves positions. Other considerations include ensuring external balance with the goal of macroeconomic stability (CBN, 2014).

Nigeria's fixed exchange rate system came into operation from 1960 to 1986. Prior to the introduction of the Nigerian naira in 1973, the Nigeria pound was at one time or another at par with British pound sterling (1959-1967). The CBN was responsible for the purchase and sales of foreign currency with the declaration of the Exchange Control Act of 1962, which grants approval on the foreign exchange transactions. In addition, the Act pegged the Nigerian pound to the gold standard, thus, empowering the Nigerian government to make decision on further adjustments (Obadan, 2016). In 1973, Nigerian pound was changed to Naira and pegged to the US Dollar. However, with the devaluation of the US dollar that affected the Naira, there was discontinuation of relationship between Naira with both British pound sterling and the US dollar. The Naira was pegged against a basket of currencies such as the Canadian dollar, the US dollar, the Japanese yen, the Deutsche mark, the Swiss franc, the Dutch guilder and the French franc (1971-1984). The US dollar was later adopted as the currency of intervention in 1985. This government decision, the developments in the global oil markets and foreign exchange inflows led to the progressive appreciation of the Naira in the 1974/1975 (CBN, 2014). The exchange rate generally mirrored movements in the price of crude oil in the international

markets. However, the dwindling oil prices in the early 1980s and the attendant economic problems brought about budget-tightening austerity measures in 1980 up to 1985 (Obadan, 2006). As the economy deepened into crisis, the structural challenges including crisis in the public finance and overblown public expenditure aggravated the economic situation. In response to the structural problems, the International Monetary Fund (IMF) in 1986 recommended the Structural Adjustment Program (Ukeje, 2017).

In 1986, following the exchange rate was determined by market forces with the naira showing the feature of persistent instability. The exchange rate policies included the adoption of First and Second-tier Foreign Exchange Market (SFEM) in 1986. Based on the exchange control system's inability to resolve allocation of foreign exchange and internal balance, the SFEM came into existence in September 1986. Market forces determines the value of Naira under the SFEM. A new structure of the SFEM was also introduced in April 1987. In this system, various pricing methods (such as "marginal, weighted average") and Dutch system were adopted. For instance, the official rate was determined on a fortnightly basis while the auction rate was the marginal bid at which the foreign exchange was offered for sale. To enlarge the scope of the Foreign Exchange Market, the first-tier and second-tier foreign exchange market were unified in July, 1987 which was expected to achieve a realistic exchange rate that would reduce demand for foreign exchange for importation of goods and services. Despite the effort put in place by the monetary authorities, there was increase in demand pressure and this as a result led to depreciation of the Naira. Bureau-de-Change was created to deal in foreign exchange that are sourced privately (CBN, 2011). In spite of these developments, the market experienced persistent increase in demand for foreign exchange against supply. The SFEM later metamorphosed into FEM, Autonomous Foreign Exchange Market (AFEM), DAS and WDAS.

The FEM came into existence when first-tier and second-tier market were merged in July, 1987. The first-tier was abolished leaving FEM with two components: "official foreign exchange market auction sessions and autonomous foreign exchange market". The AFEM was expected to be competitive with the parallel foreign exchange market and thus be attractive to exporters. It later became destabilising due to high arbitrage premium and accusations of round-tripping by authorised dealers. The Interbank Foreign Exchange Market (IFEM) was introduced in 1988 as a result of the merger between the official and autonomous market in January 1989. This was a daily bidding where the CBN was injecting funds. It ended in December, 1990 but reintroduced in 1999 (Obadan, 2006).

The Dutch Auction system was introduced in April 1987 and reintroduced in December 1990 and later in July 2002 as Retail Dutch Auction System (RDAS). It was introduced against the backdrop of wide premium in the parallel and official exchange rate markets. It was introduced to discourage outrageous high bidding rates leading to depreciation. Foreign exchange market entails WDAS might also contribute to strengthening of naira in the market (Obadan, 2006). AFEM was first introduced as part of the enlarged Foreign Exchange Market in 1987. The exchange rate in this market was market-determined with stability ensuring by CBN interventions. The AFEM also "metamorphosed into a daily, two-way quote Inter-Bank Foreign Exchange Market (IFEM) on October 25, 1999. The IFEM is expected to broaden and deepen the foreign exchange market on a daily basis and discourage speculative activities". Against the drawback of unstable exchange rate, the deregulated exchange rate system was introduced in a bid to reduce the wide gap between parallel market rate and official rate. The foreign exchange was floated to help this discontinuation of a system of predetermined quotas for banks with allocations determined by the market rates. Thus, the FEM was further deregulated tighten the

gap between official rate with parallel market rate. During this period, foreign exchange was bought and sold by CBN with the expectation to satisfy authorised dealers' request (CBN, 2003).

The pegging of the naira at ₦22.00/$1 came into existence after the introduction of the fixed exchange regime in 1994 with forex earnings domiciliated in the CBN. The system was discarded in 1995 and the "guided deregulation" of the foreign exchange market was introduced. A dual exchange rate emerged with "the reintroduction of AFEM in addition to the official exchange rate". AFEM operation was based on market principles to achieve a stable exchange rate with the CBN intervening at its discretion (Obadan, 2006). One of the remarkable exchange rate reforms of 1995 was the declaration of foreign exchange (Monitoring and Miscellaneous) Act 17 of 1995 and establishment of autonomous foreign exchange rate market (AFEM). This continued until the introduction of interbank foreign exchange market (IFEM) in 1999. Subsequently, the RDAS was introduced on July 22, 2002 in order to conserve the external reserves, reduce the spread between the official rate, parallel market and BDC rates to the lowest ebb. However, the WDAS replaced the RDAS on February 20, 2006. During this period, the bank adopted policy to drive foreign exchange stability (Fapetu & Oloyede, 2014). The Dutch Auction System was introduced due to the persistent increase in foreign exchange that led to the abolishment of IFEM in 2002. The Retail Dutch Auction System was meant to eliminate the wide premium of official and parallel market; reduction of capital flight among others (Auwal, 2006). The RDAS was replaced with the WDAS in 2006 due to the fact that it could not achieve its objectives of reduction of demand pressure, foreign exchange distortion, and speculation among others (Musa, 2012). In order to ensure the success of the WDAS, the following complementary measures were adopted which included the special intervention foreign

exchange sales to DMBs, BDCs in April 2006 and further increase in Business Travel Allowances (BTA) from $2,500 to $5,000 and Personal Travel Allowances (PTA) from $2,000 to $4,000 per quarter (CBN, 2011). The high premium in 2002 saw some improvement with the rate falling from ₦16.3505/$1 to ₦6.8741/$1 by December 2004. The exchange rate became stable after DAS particularly in the year 2004 and the Naira further improved in December, 2005 (CBN, 2014). The WDAS was introduced in early 2006 to replace the RDAS. Since the emergence of WDAS in early 2006, the market witnessed unprecedented stability[3] in the year 2006, 2007 and 2008. At the global financial crisis, the naira had a sharp depreciation of 19.5% in 2009 as a result of fall in crude oil price which led to dwindling foreign reserve ameliorating serious pressure on the exchange rate (Ukeje, 2017).

In attempt to ease demand pressure at the foreign exchange markets, CBN reintroduced the retail Dutch Auction System as an alternative to Wholesale Dutch Auction System in October 2013 and this continued until February 18, 2015, when it closed the RDAS window and disallowed BDCs participation in the interbank foreign exchange market (Ukeje, 2017). In June 2015, the Central Bank of Nigeria tightened the foreign exchange measure to safeguard the domestic currency against persistent exchange rate volatility and/or deviations. They placed restriction on 41 import items from being financed with foreign exchange sourced from the official exchange market. The CBN announced it could not continue to support the import of these items implying that any importer who wants to continue importing these items should source his/her foreign exchange privately. CBN took bold step to discontinue sales of foreign exchange to Bureau-De-Change (BDCs) operators and removed the restrictions of Deposit Money Banks to accept foreign currency from their customers. To further liberalize the market,

[3] Unified exchange rates and facilitation of greater market determination of exchange rates as well as exchange rate appreciation.

revised guideline was issued to move its interventions in the operations of the Interbank markets in June 2016. Consequently, to deepen the market and enhance CBN efficacy in demand management, they adopted a more flexible exchange rate system in June 2016 to move the market away from the sticky exchange rate and also reduce the hardship experienced by end users of foreign exchange rate. This address the issue of foreign exchange sales for invisible transactions; PTA, BTA, medical needs and school fees (Ukeje, 2017). Also, to further increase the accessibility of foreign exchange in the economy, CBN reduced the tenure of its forward sales from maximum of 180 days to no more than 60 days from the date of transaction. This was done to increase foreign currency liquidity and introduced the Naira settled foreign exchange futures to be traded on the FMDQ platform. It also directed all banks to extend their foreign exchange retail outlets to ensure transactions are settled at much more competitive exchange rates. In the meantime, CBN opened a special Investors' & Exporters' (I&E) foreign exchange window using Nigerian Autonomous Foreign Exchange Rate Fixing (Nafex) among themselves. Currently, CBN intervenes in Foreign Exchange market through the injection of million dollars in the "Retail Secondary Market Intervention Sales (SMIS)" segment.

2.3. Theoretical Issues

Most approaches used to examine the relationship between real exchange rate pays tribute to the Classical's interest rate and Keynesian's disposable income as the determinants of consumption with some modifications of exchange rate inclusion and the standard International real business cycle as well as the Purchasing Power Parity (PPP). Other theories reviewed below include the monetary approach and the traditional approach model.

The traditional approach also known as the Balance of Payment Theory of exchange rate determination is focused on the condition of balance of payment equilibrium (i.e. difference

between the demand for and the supply of foreign exchange equals zero) as the determinant of exchange rate equilibrium. Common feature of models that adopt balance of payment approach is "the assumption that an increase in the relative price of a country's imports in terms of its exports (provided certain elasticity conditions are satisfied) and an increase in the net inflow of foreign exchange arising from current account transactions are as a result of an increase in the price of foreign exchange" (Mussa, 1984, p.3). It predicts that a rise in interest rate relative to foreign interest rate increases the relative supply of foreign currency, which culminates into appreciation of the domestic currency and vice versa (Mamman, 2017). Exchange rate is considered as prices that clears an economy's import in terms of its export with the foreign exchange markets as a process that simultaneously determines many other variables in the economy (Gandolfo, 1976).

The basis of the monetary approach is that monetary flows in the exchange market are a consequence of disequilibrium in stock demand and supply of money (Babangida, 2015). The theory stated that any distortion in the foreign exchange market is a consequence of disequilibrium in the money market which can be averted by effective monetary policy. This theory states that exchange rate is determined by the outstanding demands for holding the stock of money. Mussa (1984) stated that monetary approach is divided into two classes of models. The first class of model which is more empirical expresses that "current exchange rate depends on the current stocks of domestic and foreign money and the current determinants of the demands for these monies, including domestic and foreign income and interest rates. The second class of monetary models, which is theoretical focuses on the influence on the current exchange rate of the expected future path of money supplies and of factors affecting money demands". According to the models, a rise in money supply causes depreciation in exchange rate as a result

of inflationary pressure. Therefore, the increase in price level (inflation) consequently results to exchange rate depreciation and vice versa (Viser, 2004).

Purchasing Power Parity holds that "the nominal exchange rate of currencies for two countries should be equal to the ratio of aggregate price levels between the two countries, so that a unit of currency of one country will have the same purchasing power in a foreign country" (Taylor & Taylor, 2004, p.1). It is an extension of the Law of One Price (LOOP). The general idea behind purchasing power parity is that "a unit of currency should be able to buy the same consumption basket of goods in one country as the equivalent amount of foreign currency at the going exchange rate can buy in a foreign country, so that there is parity in the purchasing power of the unit of currency across the two economies". The real exchange rate measures the "purchasing power of an equivalent unit of foreign currency in the foreign economy relative to the purchasing power of an equivalent unit of domestic currency in the domestic economy". Inconsistencies from PPP is gauged by comparing the prices of similar goods from the consumption baskets of two countries. If discrepancy exists in the prices of similar goods, then there is evidence of either overvaluation or undervaluation in the currency (literarily implying deviation from the equilibrium path of exchange rate). Theoretically, PPP would imply a "real, relative-price-level-adjusted exchange rate". Transaction costs has been used as possible explanation for these deviations. Therefore, transaction cost models have often been explained to be possible sources of nonlinear adjustment, other sources of nonlinearities arise from "diverse opinion in the foreign exchange market concerning the equilibrium level of the nominal exchange rate" (Taylor & Taylor, 2004). Taylor (2004) argues that "exchange rate nonlinearity may also arise from the operations of Central Banks intervention in foreign exchange market, which is more likely to occur and be effective when the nominal and hence the real exchange

rate has been driven a long distance away from its PPP or fundamental equilibrium". The PPP exchange rate theory is "built on the concept that the exchange rate is based on actual buying power over a consumption basket of goods and so changes in the nominal exchange rate should reflect changes in the price of goods with the real exchange rate staying fixed. But a nation's equilibrium real exchange rate may not remain fixed forever" (Taylor & Taylor, 2004, p. 2).

IRBC models is an extended version of the RBC models into an international setting with transactions taking place in goods and financial markets. This model predicts a real exchange rate-consumption linkage. Benigno & Thoenissen (2008) stated "a relationship between the real exchange rate and consumption series exists even if the assumptions of standard IRBC models are relaxed, and other features introduced into the model, such as incomplete capital markets, sticky prices in local currency pricing, nontraded goods sectors and habit persistence". In spite of a powerful theoretical premise the IRBC model is built on, the studies supporting the real exchange-consumption linkage is only incomplete (Head *et al*., 2004). In this model, however, the functional nature of the relationship is silent. Indeed, a common characteristic of studies using IRBC model relied on the linear functions. With reference to particular form of nonlinear characteristics, recent econometric literature presents evidence of nonlinearity of real exchange rate with time varying equilibrium (see Lothian & Taylor, 2012).

2.4. Empirical Literature

The wide range of literature has tried to examine and demonstrate the linear and nonlinear real exchange rate-consumption relationship for developing and developed economies. Several studies have been conducted on the effect of exchange rate on consumption and real exchange rate-consumption puzzle. However, few studies were conducted to examine the nonlinear

relationship between the variables globally. Thus, the empirical results from the stack of literature will be reviewed according to the close relation with the objective of this study.

With a common objective of examining the nonlinear relationship and causality between real exchange rate and consumption, Pavlidis et al. (2017) re-examined the real exchange rate-consumption relationship for 14 OECD countries with varying time periods. This study was based on their findings of the nonlinear causality running from real consumption to exchange rate and vice versa (Pavlidis et al., 2015). They allowed for smooth transition, extended sample period to overcome linear model limitations as well accounted for changes in volatility. Their finding was in line with Backus and Smith Puzzle that correlation among the variables vary widely with the presence of consumption-real exchange rate anomaly. They also found a powerful evidence in favour of nonlinear dynamics and the presence of long run consumption-real exchange rate relationship which is in support of the IRBC models with a volatility shift that increases due to Bretton Wood system collapse implying that "volatility shifts and economic fundamentals" play important role in explaining the behaviour of real exchange rates. In light of this relationship, an earlier study by Pavlidis et al. (2015) extended the IRBC empirical literature to test for nonlinear causality between real exchange rate and real consumption with time varying real exchange rate equilibrium for OECD countries using USA as a reference country and found that causal relationship exists between the variables. They also detected nonlinear causality for some countries which substantially consolidated for the existence of causality and nonlinearities in the data generating process.

Other stacks of literature also examine the correlation puzzle between real exchange rate and consumption with varying restrictions. In their study, Backus & Smith (1993) with "complete market assumption", document failure of international macroeconomic models to display the

lack of correlation between growth rate of real consumption and real exchange rate. Similarly, Corsetti, Dedola, & Leduc (2008) show that there is evidence of small and negative cross correlations between real exchange rate for a selection of OECD countries from 1971 to 1990. Using SVAR, they found that positive shock from productivity leads to improvement in terms of trade, stimulate exchange rate appreciation and lead to an rise in domestic consumption in relation to foreign consumption. Moreover, Benigno & Thoenissen (2008) examined the exchange rate-consumption behaviour with incomplete financial market and non-traded goods assumption using annual data from 1970 to 2000. Their results suggest that the combination of incomplete financial market and nontraded goods feature is a promising path for explaining the behaviour of consumption across countries and the real exchange rate. They found evidence of cross-correlations between the real exchange rate and relative consumption. They concluded that this is attributed to non-traded production sector and incomplete financial markets.

In the spirit of testing the empirical evidence between exchange rate and consumption with a wide range of versions on Backus and Smith model, Head *et al*. (2004) used data for some selected OECD countries between 1961 and 2001 to investigate the relationship between real exchange rate and relative consumption by introducing "money, habit persistence, asset market frictions and alternative specification for aggregate consumption". They found a negative relationship between the variables which shows that the model did not perform well empirically. Introducing the asset market frictions and preference shocks improves the performance of the model but the model remains empirically weak. The results conform to literature showing taste shocks or asset market frictions explaining the real exchange rate-consumption puzzle. Chari et al. (2002) on the other hand calibrated a "two-country general equilibrium model with production, nominal rigidities and monetary shocks under two environments" for the period

1973 to 2000. They found that real exchange rate is "perfectly correlated with relative consumption under both complete and incomplete markets for US and European countries". Their calibrated models lead to the conclusion that theory and empirical evidence on the correlation between consumption and real exchange rate could be reconciled by demand shocks or asset market frictions. Moreover, Nuntramas (2011) revisited the consumption and real exchange rate puzzle with the inclusion of non-traded goods in the model for some selected OECD countries and found evidence of weak relationship between relative consumption and the real exchange rate.

Other studies have equally challenged the assumption of financial market completeness: in particular, Selaive & Tuesta (2003) consider a richer structure by modelling monetary policy through interest rate feedback rules and assuming prices to be sticky. They showed evidence of cross correlation for some selected OECD countries to be zero or small and often negative. This has the ability to replicate the empirical facts based on the assumption of distribution services and asset market incompleteness. They also emphasized the significance of net foreign assets. Choi (2005) was the first to present an empirical study with impressive results by examining the relationship between real exchange rates and relative consumption by augmenting the standard consumption specification with relative trade flows and traded goods consumption. He assumes incomplete market and finds a correlation in excess of 0.8 for the real exchange rate and consumption. However, other studies demonstrate how exchange rate volatility can also affect domestic consumption in the short run and whether it lasts through to the long run even as the previous literature dwell on exchange rate determination. (e.g., Bahmani-Oskooee & Xi, 2012 and Iyke & Ho, 2017). They revealed that exchange rate volatility has differential impact on domestic consumption in the short run lasting into the long run.

In summary, there has been a lot of authors that have provided theoretical explanation for the anomaly behaviour between consumption and real exchange rate by relaxing the assumptions of the IRBC and introducing "incomplete asset markets, limited enforcement of international financial contracts, sticky prices in local currency pricing, nontraded goods production sectors and distribution services, hand-to-mouth agents, and habit persistence" (see, Pavlidis et al., 2017; Benigno & Thoenissen, 2008; Head *et al*., 2004; and Chari et al., 2002). The empirical findings demonstrated "some series of ambiguity in the nature of the underlying relationship with the magnitude of the theoretical contemporaneous correlation taking a wide range of values (from large positive to negative) depending on model assumptions". However, the crux of this study is to analyse the relationship between domestic consumption and exchange rate's deviations as well as the pattern of reverting to the equilibrium. It is evident that there are numerous studies on the relationship between consumption and real exchange rate but only few examined the relationship in a nonlinear form (e.g., Pavlidis et al., 2017).

2.4.1. Gap in the Literature

It is clear from the literature reviewed, that previous studies relied heavily on linear models. However, studies from Pavlidis et al. (2015, 2017) show that the relationship could be nonlinear. There is much information to be derived by allowing nonlinear specification because economic variables switch regimes in a frequent manner especially if they are policy variables like the exchange rate. Therefore, not accounting for the nonlinearity can be misleading. The idea of a switching regime switch indicates an abrupt change depicting how economic variables from one regime to another in a smooth manner within a particular period. It is evident from other countries that nonlinear deviation from the equilibrium exchange rate best explains the

behaviour of exchange rate due to the excessive interventions in foreign exchange market, over reliance on imports for consumption and production among other factors. Moreover, most of the studies utilised correlation, VAR, SVAR, GMM, Three-stage Least Square, ARDL to analyse the real exchange rate-consumption relationship as predicted by the standard International Real Business Cycle. However, this study will utilise the STAR model to analyse the nonlinear relationship between real exchange rate and domestic consumption using Nigeria data.

CHAPTER THREE

METHODOLOGY

3.0. Introduction

This chapter consists of the theoretical framework, model specification, estimation techniques and description of data that will aid in analysing real exchange rate-domestic consumption relationship.

3.1. Theoretical Framework

There have been numerous theoretical models linking real exchange rate and consumption (e.g., Pavlidis et al., 2017; Benigno & Thoenissen, 2008; Head *et al*., 2004; and Chari et al., 2002). The specific aim of this study is to analyse the generic relationship between these two variables in a nonlinear form and the causality between the variables. Although the study does not place any restriction to a specific theoretical background. Under this subsection, the study briefly synthesizes and outlines the Standard IRBC and Purchasing Power Parity models to provide a premise for results interpretation. The PPP links the exchange rate and consumer prices while the standard "International Real Business Cycle models connects relative prices to the ratio of consumption in home and foreign country" (Backus & Smith, 1993). The literature is extended in two directions. Firstly, by employing the macroeconomic fundamentals suggested by the standard IRBC Model in a nonlinear context which may help in explaining the misleading results found by related studies. Standard International Real Business Cycle predicts a long run linkage between real exchange rates and consumption without making predictions in regards the functional form of its adjustment process (Pavlidis *et al*., 2017). The IRBC applied to a two-country exchange economy (home and foreign) is expressed:

$$U_k = E\left[\sum_{t=0}^{\infty} \beta_k^t u_{k,t}\left(C_{k,t}\right)\right] \qquad k = 2 \ \ldots\ldots\ldots\ldots\ldots 1$$

Where E[.] and $\beta_k \in (0,1)$ are the expectations operator and country k's subjective "discount factor" respectively. K is country *i* and *j*, $u_{k,t}(.)$ and $C_{k,t}$ are "country k's instantaneous utility function in period t and consumption in country k respectively". Each representative agent lifespan is infinite starting with period 0 (i.e., t = 0,1, …., ∞). This benchmark model highlights the key characteristics of individuals that lead to the relationship between real exchange rate and consumption. According to Backus and Smith (1993), each country as an agent with iso-elastic preferences maximises utility over consumption of multiple goods. The iso-elastic preference is specified as

$$U(C_k) = \frac{C_k^{1-\eta}}{1-\eta} \ldots\ldots\ldots 2$$

The iso-elastic utility function displays a constant relative risk aversion. The condition for the risk sharing for the country pair (*i, j*) for all periods and states is given as

$$RER_t = e_t \frac{p_{i,t}}{p_{j,t}} = \Lambda_{i,j} \frac{\beta_i^t m_{i,t}}{\beta_j^t m_{j,t}} \ldots\ldots\ldots 3$$

Where RER_t is the real exchange rate, e is the nominal exchange rate (expressed in units of home country i's currency per unit of country j's currency, say Nigeria ₦/ US $). $p_{k,t}$ is consumer price level for country k (*i, j*). The price level will be denoted with P* for country j (i.e., foreign country) and P for country i (i.e., domestic). Common measure of the price level is the consumer price index or the consumption price deflator serving as a measure of price level

(Volberg, 2005). $m_{k,t}$ is the marginal utility for country k=i, j. The marginal utilities are equal across countries in equilibrium which give a direct theoretical linkage between "the cross-country ratio of consumption to their bilateral real exchange rate". Thus, Backus and Smith (1993) further show the linkage between real exchange rate and relative consumption under complete market via the following relation.

$$RER_t = \lambda\left(\frac{C_t}{C_t^*}\right)^{\gamma} \quad \text{---------- 4}$$

Where λ is constant, γ is the risk aversion parameter, C_t is the home consumption at time t and C^* is the foreign country's consumption denoting a two-country model. This relationship holds in the presence of labour market frictions, sticky prices and sticky wages.

Following the extension of Purchasing Power Parity (PPP) puzzle by Pavlidis *et al.* (2017) regarding the weak mean reversion of real exchange rate, they established a link between volatility shifts and speed of adjustment.

$$RER_t = e_t \frac{p_t}{P_t^*} \quad \text{.....5}$$

Real exchange rates typically feature large and persistent deviations from the PPP. Indeed, under standard theory, where PPP holds, relative price movements are offset directly by nominal exchange rate, resulting in unitary real exchange rates. In developing economies like Nigeria, which is the focus of this study, where two-digit inflation abounds, nominal exchange rate would make up only a modest part of real exchange rate fluctuations suggesting that deviations from PPP in Nigeria could be large and persistent.

In terms of equation 4 and 5, therefore, the implication of the IRBC on bilateral relationship between Nigeria's real exchange rate and consumption can be approximated as:

$$RER_t = e_t \frac{p_t}{P_t^*} = \lambda \left[\frac{C_t}{C_t^*}\right]^{\gamma} \ldots\ldots\ldots\ldots\ldots\ldots 6$$

From equation 3, the risk sharing equilibrium condition for home and foreign countries for all periods and for all states can be derived by equating the real exchange rate to a factor of the ratio of the marginal utilities of the two countries (Pavlidis *et al*., 2017). So that

$$RER_t = e_t \frac{p_t}{P_t^*} = \lambda \left[\frac{\beta C_t}{\beta^* C_t^*}\right]^{\gamma} \ldots\ldots\ldots\ldots\ldots\ldots 7$$

The log of 7 and the assumption of iso-elasticity in equation 2 with an exponent $1 - \eta$ gives

$$rer_t = \lambda + ln(\beta/\beta *)t - \eta c_t + \eta * c_t^* \ldots\ldots\ldots\ldots\ldots\ldots 8$$

Where $rer_t, \lambda,\ c_t$ and c_t^* are all logs of their respective identities in equation 7 and η is the coefficient of risk aversion. Equation 8 implies that a fall in domestic consumption should lead to a rise in home currency that is, domestic currency depreciation. While and a rise in foreign consumption will result in the home currency depreciation. The implications of this theory are that "the growth rates of consumption ratios and of real exchange rate should have identical dynamics and should perfectly correlate" (Backus & Smith, 1993).

3.2. Model Specification

In order to ascertain the form of relationship that exists between real exchange rate and domestic consumption, the study utilizes a STAR model in line with Pavlidis *et al*. (2017) but extended it to include domestic consumption in a multivariate context. As argued in Pavlidis *et al.* (2017),

STAR is the widely used nonlinear model in analysing exchange rate behaviour due to its capability to parsimoniously fit a number of real exchange rate regimes (see Taylor & Kilian, 2003). The model differs from linear models because it establishes nonlinear relationship.

The generic form of the STAR model is specified as

$$y_t = \beta_1' w_t + (\varphi_0 + \varphi_1' w_t) G\left(s_{t-p}, \gamma, \mu_{t-\bar{p}}\right) + \varepsilon_t \ldots\ldots\ldots\ldots 9$$

Where:

$w_t = (z_t', x_t')'$ is an $(m+1) \times 1$ vector of explanatory variables,

with $z' = (1, y_{t-1}, \ldots\ldots y_{t-p})'$ and $x_t' = (x_t, \ldots\ldots\ldots x_{kt})'$. m is the number of explanatory variables. $\beta \; and \; \varphi$ are "the parameter vectors of the linear and nonlinear parts, respectively". ε_t is *iid* $(0, \delta^2)$; and $G\left(s_{t-p}, \gamma, \mu_{t-\bar{p}}\right)$ is a transition function and p is the delay parameter. The transition function $G\left(s_{t-p}, \gamma, \mu_{t-\bar{p}}\right)$ is bounded between *0* and *1* where extreme values represent two different regimes with gradual transition and a value close to zero represent linearity.

Note that equation 7 to 8 imply that equilibrium real exchange rate depends on consumption. Then the representation of the process is as given in Pavlidis *et al*. (2017) as;

$$rer_t - \mu_t = \sum_{p=1}^{\bar{p}} \psi_p\left(rer_{t-p} - \mu_{t-p}\right) G\left(rer_{t-\bar{p}}, \gamma, \mu_{t-\bar{p}}\right) + u_t \ldots\ldots\ldots\ldots 10$$

$$\vartheta_t = \sum_{p=1}^{\bar{p}} \psi_p\left(rer_{t-p} - \mu_{t-p}\right) G\left(rer_{t-\bar{p}}, \gamma, \mu_{t-\bar{p}}\right) + u_t \ldots\ldots\ldots\ldots 11$$

where:

$\vartheta_t = rer_t - \mu_t; u_t \sim NIID(0, \delta^2)$ and $\mu_t = \lambda + \ln(\beta/\beta^*)t - \eta c_t + \eta^* c_t^*$ being the long run IRBC equilibrium or the equilibrium exchange rate which depends on consumption as the threshold, p is the delay parameter and *G* is the transition function. If deviations from the equilibrium follows an Exponential Smooth Transition Autoregressive (ESTAR) process. The transition function, G is expressed as:

$$G(rer_{t-\bar{p}}, \gamma, \mu_{t-\bar{p}}) = \left[1 + \exp\{-\gamma(rer_{t-\bar{p}} - \mu_{t-\bar{p}})\}\right]^2 \text{ for ESTAR with } \gamma > 0 \text{ ---- 12}$$

And if it does not follow the ESTAR process, the transition variable will either take an LSTAR process or linear process.

$$G(rer_{t-\bar{p}}, \gamma, \mu_{t-\bar{p}}) = \left[1 + \exp\{-\gamma(rer_{t-\bar{p}} - \mu_{t-\bar{p}})\}\right]^{-1} \text{ for LSTAR with } \gamma > 0 \text{ ---- 13}$$

Where the transition function G is "a continuous function that is bounded between 0 to 1".[4] and $\gamma \in (0, \infty)$ is "the slope parameter, it determines the smoothness of the transition speed towards equilibrium. (i.e., speed of transition from one regime to the other)" and d is "the delay parameter". Furthermore, a test is to be carried out on two transition functions (i.e., LSTAR or ESTAR) in order to yield the accurate model for the study. Following Terasvirta (1994), a series of tests is conducted to choose between ESTAR and LSTAR within equation 8. The sequence of hypotheses to be tested is as follows:

Corresponding p-value of the F-statistics of the null hypothesis H_{04}, H_{03}, H_{02} are denoted by F_4, F_3, F_2 with the chosen model explicitly stated (see, Teräsvirta, 1994). The justification behind the sequence is based on interpreting the coefficients β_{ij} which determine the parameters of the

[4] This realizes the smooth transition between regimes dynamically.

STAR model in 11, with either 12 or 13. The implication for not rejecting the null hypotheses suggest that the relationship is linear in nature.

Furthermore, the study, following Pavlidis *et al*. (2015) examines the existence of a linear and nonlinear Granger causal relationship between real exchange rate and domestic consumption in Nigeria. The model is mathematically expressed thus;

$$Y_t = f\left(Y_{t-1},.....,Y_{t-p1},X_{t-1},.....,X_{t-q1};\theta\right)+e_t \qquad \text{---------- 14}$$

Where "θ is a vector of parameters, e is a vector of serially uncorrelated and homoscedastic normal errors and *f(.)* is a continuously differentiable function". By taking K[th]-order Taylor series expansion of equation 14, the equation yields:

$$Y_t = \alpha_0 + \sum_{j=1}^{p_1}\alpha_j y_{t-j} + \sum_{j=1}^{q_1}\phi_j x_{t-j} + \sum_{j_1=1}^{p_1}\sum_{j_2=j_1}^{p_1}\alpha_{j_1 j_2} y_{t-j_1} y_{t-j_2} + \sum_{j_1=1}^{p_1}\sum_{j_2=j_1}^{q_1}\varphi_{j_1 j_2} y_{t-j_1} x_{t-j_2}$$

$$+ \sum_{j_1=1}^{q_1}\sum_{j_2=j_1}^{q_1}\phi_{j_1 j_2} x_{t-j_1} x_{t-j_2} + ... + \sum_{j_1=1}^{p_1}\sum_{j_2=j_1}^{p_1}..... \sum_{j_k=j_{k-1}}^{p_1}\varphi_{j_1.....j_k} y_{t-j_1}.....y_{t-j_k}$$

$$+ \sum_{j_1=1}^{q_1}\sum_{j_2=j_1}^{q_1}..... \sum_{j_k=j_{k-1}}^{q_1}\phi_{j_1.....j_k} x_{t-j_1.....}x_{t-j_k} + u_t \qquad \text{--------- 15}$$

Where $u_t = e_t + R_k\left(y_t, x_t\right)$ with $R_k(.)$ which denotes the remainder term of the Taylor series expansion. The specified function is appealing as "it is an approximation of quite a number of nonlinear models, such as smooth transition and bilinear models as well as nests the equation for its linear counterpart" (Pavlidis *et al.*, 2015). The equation includes all combinations between lagged *y's* and *x's.* Both *x's* and *y's* representing both real exchange rate and consumption respectively. Under the null hypothesis that *x* fails to Granger cause *y*, the coefficients including lagged x's are equated to zero. This means:

$$H_0 = \begin{cases} \phi_j = 0, & j = 1,....q_1 \\ \varphi_{j_1 j_2} = 0, & j_1 = 1,.....p_1; j_2 = 1,.....q_1 \\ \phi_{j_1 j_2} = 0 & j_1 = 1,.....q_1; j_2 = j_1,....., q_1 \\ \\ \phi_{j_1 ..... j_2} = 0 & j_1 = 1,....., q_1; j_2 = j_1,....., q_1,....., j_k = j_{k-1},.....q_1 \end{cases}$$

The study shall run both linear and nonlinear Granger causality on the time series in order to confirm the existence of causality between the variables under study. The traditional Granger causality test neglects the nonlinearity observed in time series dynamics. Therefore, neglecting the nonlinear dynamics may reduce the estimation power of the test. This as a result leads to the introduction of nonlinear Granger causality test by using nonparametric estimators of temporal relations within and across time series (Baek & Brock, 1992). To overcome this drawback, the study employs the nonparametric statistical method to detect nonlinear Granger causality between the real exchange rate and consumption.

3.3. Estimation Strategy and Techniques

Two preliminary tests shall be conducted prior to the estimation of the model. The first test is the stationary test which allows checking for the presence of unit root. The study adopts two variant tests of the stationarity test i.e., the Augmented Dickey Fuller (ADF) and Philip Perron (PP). The use of two variant stationarity tests was necessary in order to provide a consolidation or confirmation to the result provided by a single type of test. The second preliminary test is the model selection criteria test which will be important in determining the number of lags to be included in the model. Johansen cointegration test shall also be examined to check the existence of a long run relationship between the variables. The existence of cointegration is a precondition for adopting the smooth transition model.

From recent studies of various forms of models, there are comprehensive information to be derived from nonlinear specification. Moreover, economic variables are frequently subject to switching regimes. The STAR models came into existence to handle this switch in regime. The study presents the STAR methodology, including specification, estimation and evaluation of STAR models to choose between ESTAR or LSTAR model in order to analyse the relationship between real exchange rate and domestic consumption for Nigeria covering the period between the different nominal exchange rate.

In contrast to discrete switching models, "STAR models switch as a continuous process dependent on the transition variable. This allows for incorporating regime switching behaviour both when the exact time of the regime change is not known with certainty and when there is a short transition period to a new regime" (Kavkler, Mikek, Böhm, & Boršič, 2007, p.5). Therefore, STAR models comprehensive information on the dynamism of variables showing their value even during the transition period. It captures nonlinearities and regime switching analysis of numerous economic variables[5]. Conceptually, "it is straightforward to extend the existing univariate regime-switching models to a multivariate context. However, the interest in multivariate nonlinear modelling has started to develop only very recently and, therefore, the relevant statistical theory is not yet fully developed". (van Dijk, Terasvirta, & Franses, 2000. p. 2).

The Granger causality test shall be utilised in this study to examine the direction of causality between real exchange rate and domestic consumption. The reason to employ the two different empirical method is to compare the determination power of both linear and nonlinear causality

[5] It models and studies "transition economies characterised by many structural breaks in the early part of transition and provides evidence of asymmetries in the dynamics of economic variables, depending on the magnitudes of parameters, in established market economies. It is therefore, extended recently to VAR and panel data which allows for a whole spectrum of new applications modelling several variables and incorporating heterogeneity in disaggregated data".

tests and to discuss the evidence of significant linear or nonlinear relationship between these two variables. This nonlinear Granger causality test gives rich information about the causal relationships existing among variables (Rahimi, Lavoie, & Chu, 2016).

3.4. Robustness Tests

We then proceed to subject the results of the study to some robustness checks in order to validate the findings to support the hypothesis. Firstly, we examine the long run relationship as a pre-condition for testing the nonlinear relationship between the variables of interest and also test causality between real exchange rate and consumption. Secondly, as a measure of performance after estimating the STAR model, we compare both (non) linear and examine which model performs better and test for error autocorrelation, no additive Nonlinearity and parameter constancy of the model. **3.5. Data and Sources of Data**

The study considers quarterly data for the period 1981Q1-2016Q4 to analyse the nonlinear relationship between real exchange rate and consumption. This yields a sample of 144 observations. The data for Real exchange and domestic consumption were obtained from the Central Bank of Nigeria (CBN) Statistical Bulletin 2019 edition. The US consumption, proxy foreign consumption was obtained from the US Bureau of Economic Analysis (https://www.bea.gov/data/consumer-spending/main). All the series were log-transformed as prescribed by the methodology.

3.6. Apriori Expectations

From the above models, the target coefficients from equation 3.5 and 3.6 are $\lambda, \beta, \beta^*, \eta$ and η^* where λ denotes the intercept of the model, β, β^*, η and η^* are the coefficients of home/domestic and foreign consumption affecting the dependent variable (i.e. real exchange rate). These coefficients help in analysing the relationship of the respective variable on real

exchange rate determination. In this case, it implies, given that the coefficients of risk aversion take a negative value, growth in domestic consumption would lead to a fall in exchange rate (appreciation); while fall in domestic consumption should increase the exchange rate of Naira (depreciation). In other words, there is a positive relationship between consumption and real exchange rate depreciation. When "the currency depreciates, it results in higher import prices which are more likely to be passed on to consumer prices and then consumption. Currency depreciation also causes a rise in the prices of imported inputs which may result in an increase in the marginal cost of production. Thus, this results in higher prices for domestically produced goods" (Mohammed, 2013).

CHAPTER FOUR

PRESENTATION OF RESULTS, ANALYSIS AND DISCUSSION

This chapter presents and discusses the results of the estimation using the econometric frameworks described in the previous chapter and justification. First, the result of the preliminary test is presented. Secondly, the result of cointegration is presented as a condition for estimation of the nonlinear relationship between real exchange rate and consumption. Then the transition model result is presented. Finally, the chapter closes with the presentation and analysis of the nonlinear Granger causality test between the variables.

4.1. Test for Stationarity and Lag Length Selection

In analysing time series data, testing for stationarity is an important element and condition for estimating the parameters for the first model of the study. This is so because the use of nonstationary series produces results that are spurious indicating a relationship that is inexistent. Obtaining consistent and reliable results, the non-stationary data have to undergo a transformation by differencing into stationary data. Table 1 shows the result of the unit root tests as the first step of the analysis.

Table 1. Result for Unit Root Tests

Variable	ADF			PP		
	Level	1st Difference	Remark	Level	1st Difference	Remark
Rer	-2.0040 -0.5939	-12.4396*** 0.0000	I(1)	-2.1867 -0.493	-12.4348*** 0.0000	I(1)
Dc	-3.1228 0.1367	-11.7496*** 0.0000	I(1)	-3.0638 0.2368	-11.7503*** 0.0000	I(1)
Fc	-2.3612 -0.3982	-4.0759*** 0.0086	I(1)	-0.9345 -0.9483	-9.0388*** 0.0000	I(1)

Source: Author's Computation using Eviews 9

The unit root test was carried out using the ADF and the PP which were used to determine stationarity in the study. The lag selection criteria were applied to determine the appropriate number of lags to be used in the model. Both the ADF and PP indicated the presence of unit

root for Domestic consumption (Dc) at both 5% and 10% level of significance. That is, domestic consumption is integrated at levels I(1). There is also evidence of unit root at levels for both real exchange rate (rer) and Foreign consumption (Fc) data at all levels of significance (i.e., 1%, 5% and 10%). However, real exchange rate and foreign consumption indicates stationarity at first difference at all levels of significance for both ADF and PP that is, real exchange rate and foreign consumption are integrated of order one I(1). Both ADF and PP results present stationarity in the series.

Table 2 shows the results of the lag order selection process which is critical for the determination of the order of the AR process for equation 7. From the result shown in Table 2, it can be seen that the lag length of one (1) period is the optimal lag as jointly suggested by AIC, SC, HQ, LR, and FPE criteria.

Table 2. Optimal Lag Order Selection Result

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-80.97497	NA	0.000690	1.234926	1.299176	1.261035
1	727.8997	1570.169*	5.37e-09*	-10.52794*	-10.27094*	-10.42350*
2	735.6031	14.61384	5.48e-09	-10.50887	-10.05912	-10.3261
3	743.3652	14.38269	5.58e-09	-10.49067	-9.848168	-10.22957
4	752.3981	16.33893	5.59e-09	-10.49115	-9.655902	-10.15173
5	758.9039	11.48082	5.80e-09	-10.45447	-9.426474	-10.03672
6	767.0843	14.07514	5.89e-09	-10.44242	-9.221672	-9.946337
7	772.4248	8.953034	6.23e-09	-10.3886	-8.975105	-9.814191
8	776.0503	5.918107	6.77e-09	-10.30956	-8.703319	-9.656826

4.2. Results of Cointegration Test

Table 3. Cointegration Result

Hypotheses	Trace Statistic	Critical Values	Max Values	Critical Values
r≤ r = 0	32.45053 (0.0242)*	29.79707	20.45546 (0.0619)	21.13162
r ≤ r >1	11.99507 (0.1572)	15.49471	10.67555 (0.1712)	14.26460
r ≤ r > 2	1.319520 (0.2507)	3.841466	1.319520 (0.2507)	3.841466

Source: Authors Computation using Eviews 9.

The Johansen cointegration test result is presented in table 3. The ***Trace*** statistics indicates one (1) cointegrating equation implying that there exists a long-run equilibrium relationship between real exchange rate and consumption. The result confirms that there is an empirical relationship between real exchange rate and consumption and the assumption that equilibrium real exchange rate depends on consumption. This existence of a long run relationship between the variables meets the precondition for adopting the smooth transition model of the adjustment process which the study proposes. This is done in the next subsection. The deviations from the long-run equilibrium follows either a ESTAR or LSTAR process. This long run relationship is in line with the study of Pavlidis *et al.* (2017) which supports the predictions of the standard IRBC models. This result is however in contrast with the result found by Kollman (1995) which shows that there is no evidence of long-run relationship between exchange rate, domestic consumption and foreign consumption.

4.3. Results for the Smooth Transition Autoregression (STAR)

Table 4. Linearity vs Nonlinearity Test.

Transition variable	F	F4	F3	F2	Remark
rer(t-1)	1.55E-04	6.13E-04	7.12E-02	5.40E-02	LSTR1
Dc(t)*	**1.41E-56**	**3.79E-61**	**7.10E-01**	**7.27E-01**	**LSTR1**
Fc(t)	NaN	NaN	8.81E-01	8.36E-01	Linear
variables in AR part:	CONST rer(t-1) Dc(t) Fc(t) Dc(t-1) Fc(t-1)				

Table 5. Smooth Transition Autoregressive Test Result

Linear Component			Nonlinear Component		
Variables	**estimates**	**P-Value**	**Variables**	**estimates**	**P-Value**
Constant	-32.10421	0.0000***	**Constant**	32.01522	0.0000***
Rer(-1)	**0.67433**	**0.0000*** **	**Rer(-1)**	**0.26967**	**0.003*** **
Dc	**0.99043**	**0.0001*** **	**Dc**	**-0.64778**	**0.0056*** **
Fc	0.37441	0.8944	**Gamma**	**0.780977**	**0.0001*** **
Dc(-1)	**-0.86686**	**0.0000*** **	**C1**	**2827**	**0.1779**
Fc(-1)	-0.34408	0.9036			

Notes: This table provides the results following Pavlidis et al. (2017) and applying the test procedures of Terasvirta (1994) to examine the relationship between real exchange rate dynamics and domestic consumption using the inbuilt mechanism on JMULTi.

Results in the Table 4 shows that domestic consumption is the transition variable because it has the lowest p-value. This suggests that the null hypothesis of linearity is rejected and LSTR1(that is, Logistic Smooth Transition Autoregressive model) is accepted for real exchange rate and domestic consumption respectively. In the next step, a grid search is performed since the hypothesis of linearity was rejected against STAR nonlinearity. The use of a good starting values for the algorithm is very important in computing the nonlinear estimates (Teräsvirta, 1994). To do this, "the grid search creates a linear grid in ***c1*** **(**that is, $\boldsymbol{\mu}$ in the model***)*** and a log-

linear grid in ***gamma (γ)***. For any value of ***gamma*** and ***c1,*** a residual sum of squares is computed. The set of values that correspond to the minimum sum of squares is taken as starting values". To ensure that the initial values used for the estimation are scale-free, the study followed the traditional rule to divide ***gamma*** by the "***Kth*** power of the sample standard deviation of the transition variable (that is, domestic consumption)". The result of the grid search and the plot of the residual sum of squares as a function of ***gamma*** and ***c1*** are shown in the appendix FII.

Overall, the results of the nonlinearity tests, thus far, suggest that the relationship between exchange rate and consumption in Nigeria follows a non-linear adjustment process with clearly distinct regimes. These regimes are demarcated by the level of domestic consumption relative to foreign consumption.

4.3.1. Linear Part (Low Exchange rate regime)

The first regime in this study is captured by an Autoregressive (AR) process of the relationship between exchange rate and domestic consumption. As the results showed, at low exchange rate variation environment that is, the lower regime, the lagged exchange rate is shown to have significant influence on the current exchange rate. That is, about 67% of the variation in the exchange rate is accounted for by its previous value. Hence, this indicates that there are situations the economy reacts to exchange rate fluctuations with a substantial time lag. On the other hand, both current and past foreign consumption have positive insignificant influence on the exchange rate with a value of 37% while the lagged foreign consumption has a negative insignificant effect of -34% on the exchange rate in the linear part of this study. This is a robust result indicating that foreign consumption is insignificant in the relationships in Nigeria, there is a significant role for domestic consumption in determining the real exchange rate of the Naira.

Since the variable of concern in this study is the domestic consumption, the rest of the analysis would be focused on the relationship between domestic consumption and exchange rate dynamics. The coefficient of domestic consumption in the linear part is positive and statistically significant at the 1% critical level. It specifically indicates that a one percent rise in domestic consumption causes the real exchange to depreciate by 0.99%. this implies that the real value of the naira falls with real consumption at home. This result is contrary the conventional view that consumption moves in a orderly way with its relative price (that is, real exchange rate). The results for domestic consumption in the linear part (i.e. the lower regime) is overall, not supportive of the predictions of IRBC models that suggest a long-run negative relationship. In other words, since the coefficient has a positive value, it implies that a rise in domestic consumption would lead to higher exchange rate, that is the domestic currency depreciation and vice versa. The result also shows evidence of a negative significant relationship between lagged domestic consumption and exchange rate. The combination of both positive (negative) coefficient of current domestic consumption (lagged domestic consumption) indicates the tendency of domestic consumption to trigger adjustment to equilibrium for real exchange rate dynamics.

4.3.2. Nonlinear Part (High Exchange Rate Regime)

In switching from low regime to high exchange rate regime, the results indicates that the relationship between exchange rate and domestic consumption switches smoothly following a logistic transition shape. The result presented in Table 5 shows that exchange rate switches to a higher regime at certain threshold value of domestic consumption, that is, ***C1***. This threshold value represents a specific level of domestic consumption that is capable of triggering a shift

from the low exchange rate regime to a high regime. The threshold domestic consumption (***C1***) is found to be about ₦2,827 billion Naira. This means that a rise in domestic consumption as much as the threshold value would trigger a regime switch from low to high exchange rate deviation regime. Although the threshold value that could trigger the regimes shift is statistically not significant. This signifies the existence of not only consumption goods that are not traded internationally but the presence of large imported goods in the consumption basket of the economy.

Recall from Table 4, domestic consumption was found to be the transition variable which causes the change in regime. Furthermore, the result in Table 6 indicates that the speed (***gamma***) with which the threshold value can trigger a shift to higher exchange rate regime was found to be about 78% per quarter. This means that a rise in relative value of the consumption would cause exchange rate's transition to a higher deviation level with a speed of 78% quarterly. Hence domestic consumption is shown to be critical in explaining exchange rate dynamics in Nigeria. In other words, this result suggests that the shocks that could trigger a regime change at the estimated threshold value stem absolutely from domestic consumption relative to foreign consumption. More so, empirical evidence from the result show that domestic consumption is the major determinant of exchange rate dynamics in a high exchange rate regime.

The exchange rate switches to high (low) regime when the domestic consumption marginally increases (reduces). The result reveals that the speed of adjustment (transiting between regimes) is 78% in a quarter. This is relatively a fast transition. This high speed can be attributed to the direct impact that domestic consumption has on exchange rate as a result of the excessive de-pendence on importation for consumption in the economy. From Table 5, the coefficient of

domestic consumption in the nonlinear part is shown to have a negative value of 0.65 and statistically significant at all conventional level of significance. This evidence suggests that the domestic consumption have an inverse relationship with real exchange rate in upper regime. This implies that a fall in domestic consumption leads to a fall in the value of naira (depreciation). The empirical finding is interesting for it conforms to the standard IRBC model and conventional wisdom. This finding can be interpreted as evidence of nontraded goods effect on the economy which causes naira to increase in real value with consumption abroad and fall with domestic consumption. In other words, since the coefficient of domestic consumption has a negative value, a rise in domestic consumption strengthens the value of naira, while decrease in domestic consumption weakens the value of naira.

The results show that domestic consumption which is the most important variable among the explanatory variables has the most significant influence on exchange rate dynamics in Nigeria. Compared to the first regime, the high exchange rate regime is characterized by a negative relationship between the variables of concern unlike the first regime where there was evidence of both positive and negative signs for current and past values of domestic consumption respectively. Furthermore, the coefficient of domestic consumption is relatively high in the upper regime and there is no evidence that an increase in domestic consumption would decrease the value of domestic currency on one hand and a decrease in domestic consumption would as well increase the value of domestic currency on the other hand. This suggests that depreciation in the value of naira is as a result of high consumption of imported goods as well as non-tradable good in the economy.

4.4. Linear and Nonlinear Granger Causality Test Results

Table 6 shows the result of the linear and nonlinear Granger causality tests. It suggests that there is no causality in linear manner between real exchange rate and consumption in Nigeria. In other words, real exchange rate does not linearly Granger cause consumption and consumption does not also linearly Granger cause real exchange rate in Nigeria. As noted in table 6 below, the p-value of causality running from real exchange rate to domestic consumption is 0.86; implying that the null hypothesis is failed to be rejected. Similarly, the p-value of 0.94 for causality running from consumption to real exchange rate is failed to be rejected because it is above the significance level of 1%, 5% and 10% respectively. The traditional linear Granger causality "does not take into account the nonlinearity observed in the time series dynamics in the Nigerian economy". The study then took a step further to examine nonlinear causality because Nigeria is an economy which is almost certainly nonlinear. Therefore, it is unsatisfactory to rely on only exploring the linear causality between real exchange rate and consumption. The reason to employ the two different empirical approaches "is to compare the determination power of both linear and nonlinear causality tests and to present whether there is evidence of significant nonlinear relationship between these two variables in Nigeria".

The results shows that real exchange rate nonlinear Granger causes domestic consumption at 1%, 5% and 10% percent significance level for Nigeria at 1 lag. The F-statistics for the null hypothesis of nonlinear granger causality running from real exchange rate to consumption is 5.52 with a p-value of 0.0000; implying that the null hypothesis of no nonlinear granger causality is rejected at all levels of significance. On the other hand, the F-statistics for the nonlinear causality running from domestic consumption to real exchange is 8.16 with a p-value of 0.0000. This result shows evidence of bi-directional nonlinear causality between exchnage

rate and consumption. Therefore, it is concluded that at the optimal lag of 1, there is bi-directional relationship between these variables, contrary to the result of linear models. The result supports the claim that the attitude of depending excessively on import places pressure on the local currency, thereby, leading to persistent exchange rate deviations from the market rate or equilibrium (Obadan, 2016). This is plausible given that exchange rate is one of the economic indicators that affects consumption directly through prices of consumer goods and indirectly through the prices of intermediate goods.

Table 6. Linear and Nonlinear Granger Causality Test Results

Linear Granger			Nonlinear Granger		
Null Hypothesis	**F-Stat**	**P-Value**	**Null Hypothesis**	**F-Stat**	**P-Value**
$rer \overset{GC}{\neq\triangleright} \ln cons$	**0.02913**	**0.8646**	$rer \overset{NGC}{\neq\triangleright} \ln cons$	**5.51994**	**0.0000*** **
$\ln cons \overset{GC}{\neq\triangleright} rer$	**0.00614**	**0.9376**	$\ln cons \overset{NGC}{\neq\triangleright} rer$	**8.16396**	**0.0000*** **
Notes: This table provides the results following Diks and Pachenko test statistics applied for the real exchange rate and domestic consumption using R 3.5.2 version. *,**,*** denote "rejections of the null hypothesis at 10%, 5%, and 1% significance levels, respectively".					

Source: Author's Computation using R 3.5.2.

4.5. Nonlinearity in Nigeria

According to the above estimated results, there is nonlinearity in the relationship between real exchange rate and domestic consumption in Nigeria from both smooth transition and Granger causality test. For the STAR model result, this is evident by the successive regime switches in the model. There is evidence of one regime switch across the period under review showing the nonlinear behaviour of the real exchange rate and domestic consumption in Nigeria. For the Granger causality, there was no evidence of linear Granger causality between real exchange rate and domestic consumption. But when we tested using the nonlinear Granger causality test, we

found an evidence of bi-directional causality between the variables following a nonlinear path. It should also be noted that exchange rate in Nigeria has witnessed a long period of successive depreciation of about 20 years since the introduction of the SAP of 1986, before it witnessed a slight appreciation around 2005/2006 and few insignificant others before 2016. Thus, ascertaining asymmetry with respect to the relationship between real exchange rate and domestic consumption in Nigeria may not be easily established due to the absence of substantial appreciation or persistent exchange rate dynamics within the period under review. This study finds the critical role domestic consumption plays in exchange rate. First, the domestic consumption being the transition variable, determines whether the economy is in high or low exchange rate regime. The monetary policy authority cannot achieve exchange rate stability with all its available measure alone as long as the economy continues to import goods for its consumption. The economy should take measures that could help in domestic production in order to reduce the effect of import demand and relief the pressure on domestic currency.

However, while the findings of significant nonlinearity and estimation of the appropriate non-linear form are in themselves important, a further issue relates to checking the robustness of the nonlinear model against misspecification. From the model specification test, test of no autocorrelation, test of no remaining nonlinearity and parameter constancy test in the Appendix, the various test statistics show that the models are robust and significant. The results reported that there is no existence of autocorrelation in the model. The p-values are above the conventional level for all the number of lags which makes it necessary to accept the null hypothesis of no autocorrelation in the model. The F-statistics and P-values for both parameter constancy test and test of no remaining nonlinearity were also significant in the models.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1. Summary

This study investigated the nature of the relationship between real exchange rate and domestic consumption in Nigeria. There are broadly a number of theoretical studies laid on some premises as a necessary condition for explaining the observed evidence of the relationship between the variables. The theoretical channels through which domestic consumption affect the dynamics of exchange rate is the Standard International Real Business Cycle model. The study utilised quarterly nominal exchange rate deflated by the ratio of foreign to domestic prices for the period 1981-2016 to estimate Granger causality and Smooth Transition Autoregressive Model. The study attempts to address three empirical issues on the relationship between real exchange rate dynamic and domestic consumption in Nigeria. The first part relates to showing an evidence of nonlinear relationship between domestic consumption and real exchange rate in Nigeria. The second empirical issue relates to the identification of the significant empirical determinants or the extent of the relationship between the variables of concern in the study during the sample periods. The final empirical issue examined in this study is ascertaining the direction of causality between the variables in both linear and nonlinear form. In Chapter One, the study provided the justification for the study while establishing the premise on which the study must be explored by the nonlinear process in Nigeria. Chapter Two provided the overview of foreign exchange management in Nigeria and the various strategies and regimes adopted the Central Bank of Nigeria to manage the foreign exchange market pressure in the country. This chapter also provided the conceptual and definitional issues for the exchange rate and domestic consumption as well as the existing theories on exchange rate determination explaining the real

exchange rate-consumption relationship. It also reviewed critically the available studies related to the subject matter. Chapter three presents the techniques used to achieve the objective of the study and presents a model to establish the relationships for both smooth transition autoregressive model and Granger causality. In order to avoid the potential issues of autocorrelation, parameter constancy and remaining nonlinearity, the study chooses to subject the model to some robustness checks relating to the aforementioned potential issues. In Chapter Four, the study presented the estimated STAR model and Granger causality test results of the relationship between exchange rate and domestic consumption. It was found that domestic consumption has significant effect on real exchange rate. The study reveals that there is an evidence of nonlinear behaviour showing a negative relationship between the real exchange rate and domestic consumption in Nigeria for the STAR result with a fast switch from the linear regime to the nonlinear regime which is triggered by domestic consumption variable. For the nonlinear granger causality result, it has indeed shown that there is a bi-directional causality between real exchange rate and domestic consumption in Nigeria. This implies that domestic consumption is one of the most significant variables in determining an optimum level of exchange rate in the economy. On the external factors, foreign consumption was found to have insignificant effect on real exchange rate in Nigeria. However, the lagged domestic consumption also has significant effect in the lower regime. This was against the theoretical propositions of the standard IRBC. The findings were consistent with many of the previous studies (see e.g., Ravn, 2001; Benigno & Thoenissen, 2005, 2008; Pavlidis et al., 2017; etc.).

5.2. Conclusion

Based on the findings, the study has shown that the relationship between real exchange rate and domestic consumption is indeed nonlinear having indicated the presence of nonlinearity in the result. This then motivated the study to conclude that domestic consumption determines the real exchange rate dynamics. The effect from the domestic consumption dissipates along the transmission thereby passing large pressure on real exchange rate at a threshold value. Foreign consumption is insignificant in determining exchange rate dynamics in Nigeria. The nonlinearity gives a more comprehensive information about the relationship showing distinct real exchange rate regimes and the role of domestic consumption in determining the changes in regimes.

5.3. Policy Recommendations

Based on the findings of the study, some recommendations were made. One of the important policy recommendations is that fiscal authorities should come up with policies that will help in strengthening domestic production which would assist in reducing the level of the import components thereby reducing the exchange rate pressure on the naira. Since the increasing level of domestic consumption relative to foreign consumption poses a challenge to the domestic currency, the behaviour of domestic consumption should strictly be monitored in order not to reach the threshold level that could trigger a shift from low exchange rate regime to a high exchange rate regime. This adjustment could help not to endanger the macroeconomic goal of achieving exchange rate stability in the economy. There is also a need to strengthen domestic production for tradable sectors. However, this requires the incentives of the production of commodities the economy has competitive advantage over and increase in massive requisite infrastructural development or social overhead capitals such as electricity, health care,

education etc. and other investment incentives that would boost the economy through broad-based policies to improve domestic production for consumption and export. Corsetti et al. (2004) suggests that a positive productivity shock will lead to improvement in terms of trade, real exchange rate and domestic consumption. Therefore, firms should be able produce more output for the tradable sector and hence help in reducing the effect of import demand for the domestic currency to become stable. Unlike in the low exchange rate regime, the monetary policy authority cannot achieve the objective of exchange rate stability as long as the economy continues to depend on imports for consumption. This depicts the critical role the government should play in boosting domestic output for domestic consumption and exports in the economy for the naira to retains its value.

It is further recommended that the Central Bank of Nigeria in its mandate, should also place forex and trade restrictions on food importation as a means to stabilize the currency. In addition, since the relationship is nonlinear, there is a need for monetary authorities to closely monitor the pattern of movement of exchange rate in order to provide the appropriate monetary policy responses in different regimes. Finally, this study recommends that fiscal and monetary authorities should develop policies that will help strengthen domestic production which would further reduce import component in domestic consumption basket that puts pressure on the exchange rate.

REFERENCES

Akpan, E. O., & Atan, J. A. (2012). Effects of Exchange Rate Movements On Economic Growth in Nigeria. *CBN Journal of Applied Statistics*, *2*(2).

Alexander, S. S. (1952). Effects of Devaluatio on a Trade Balance. *International Monetary Fund Staff Papers*, *2*(2), 263–278.

Aliyu, B. (2016). Exchange Rate Pass-Through to Import and Consumer Prices in Nigeria: Evidence from Threshold Regression Models. Ahmadu Bello University, Zaria.

Aliyu, M. (2012). An Evaluation of Retail and Wholesale Dutch Auction Systems of Foreign Exchange Rate in Nigeria 2000-2010. Ahmadu Bello University, Zaria.

Aliyu, S. U. R., Yakub, M. U., Sanni, G. K., & Duke, O. . (2009). Exchange Rate Pass-Through in Nigeria: Evidence from a Vector Error Correction Model. In *Paper presented at the CSAE conference, Oxford University, UK.*

Auwal, U. (2006). An Evaluation of the Re-introduced Dutch Auction System as a Means of Determining a Realistic and Stable Value of the Naira. Ahmadu Bello Univerisity, Zaria.

Babangida, J. S. (2015). The Impact of Exchange Rate Volatility on Macroeconomic Stability in Nigeria (1986-2013). *Unpubblished BSc Project, Department of Economics.*

Backus, D. K., & Smith, G. W. (1993). Consumption and Real Exchange Rates in Dynamic Economies with Non-Traded Goods. *Journal of International Economics*, *35*, 297–316.

Baek, E., & Brock, W. (1992). *A General Test for Non-linear Granger Causality: Bivariate Model*. Madison, WI.

Bahmani-Oskooee, M., Kutan, A. M., & Xi, D. (2015). Does exchange rate volatility Hurt domestic consumption? Evidence from Emerging Economies. *International Economics*, *144*(4), 53–65. Retrieved from http://dx.doi.org/10.1016/j.inteco.2015.05.002

Bahmani-Oskooee, M., & Xi, D. (2012). Exchange rate volatility and domestic consumption: Evidence from Japan. *Economic Systems*, *36*, 326–335. https://doi.org/10.1016/j.ecosys.2011.10.004

Benigno, G., & Thoenissen, C. (2005). On the consumption-real exchange rate anomaly. *Bank of England Quarterly Bulletin*.

Benigno, G., & Thoenissen, C. (2008). Consumption and real exchange rates with incomplete markets and non-traded goods. *Journal of International Money and Finance*, *27*, 926–948. https://doi.org/10.1016/j.jimonfin.2008.04.008

CBN. (2003). *Contemporary Economic Policy Issues*. Abuja.

CBN. (2011). Exchange Rate Management Management in Nigeria. *Understanding Monetary Policy Series*, *No. 8*.

CBN. (2014). Economic and Financial Review. *Exchange Rate Policy and Economic Management in Nigeria- Is There a Need for Paradigm Shift?*

CBN. (2016). External Sector Developments: Opportunities, Gains and Challenges. *Central Bank of Nigeria Bullion*, *1–40*, 77–88.

Chari, V. V., Kehoe, P. J., & McGrattan, E. R. (2002). Can Sticky Price Models Generate Volatile and Persistent Real Exchange Rates? *Review of Economic Studies*, *69*(3), 533–563. https://doi.org/10.1111/1467-937X.00216

Choi, W. W.-Y. (2005). Real Exchange Rates, International Trade and Macroeconomic Fundamentals. Stanford University.

Clement, I. I., & Eze, A. E. (2017). Modeling the Real Naira Exchange Rate: The Beer Approach. *International Journal of Research in Engineering and Social Sciences*, *7*(7),

51–64.
Corsetti, G., Dedola, L., & Leduc, S. (2008). International risk-sharing and the transmission of productivity shocks. *Review of Economic Studies*, *75*, 443–473.
Corsetti, G., Dedola, L., & Sylvain, L. (2004). International risk- sharing and the transmission of productivity shocks. *Mimeo*.
Dernburg, T. F. (1985). *Macroeconomics Concept, Theories and Policies*. Singapore: McGraw- Hill Co.
Essien, S. N., Uyaebo, S. O. U., & Omotosho, B. S. (2017). Exchange Rate Misalignment under Different Exchange Rate Regimes in Nigeria. *CBN Journal of Applied Statistics*, *8*(1).
Ezeji, C. E., & Ajudua, E. I. (2015). Determinants of aggregate consumption expenditure in Nigeria. *Journal of Economics and Sustainable Development*, *6*(5), 164–168.
Fapetu, O., & Oloyede, J. A. (2014). Foreign Exchange Management and the Nigerian Economic Growth (1960-2012). *European Journal of Business and Innovation Research*, *2*(2), 19–31.
Gerstberger, C., & Yaneva, D. (2013). Analysis of EU-27 Household Final Consumption Expenditure: Baltic Countries and Greece Still Suffering Most from the Economic and Financial Crisis. *Eurostat Statistics in Focus*, *2*. Retrieved from www.bit. ly/1n2s52l.
Ghura, D., & Grennes, T. J. (1993). The real exchange rate and macroeconomic performance in Sub-Saharan Africa. *Journal of Development Economics*, *42*(1), 155–174.
Goodwin, N., Nelson, J. A., Ackerman, F., & Weisskopf, T. (2008). Consumption and the Consumer Society. *Journal of Law and Society*. Retrieved from http://ase.tufts.edu/gdae
Head, A. C., Mattina, T. D., & Smith, G. W. (2004). Real exchange rates, preferences and incomplete markets: evidence, 1961-2001. *Cana*, *37*, 782–801.
Iyke, B. N., & Ho, S.-Y. (2017a). Real Exchange Rate Volatility and Domestic Consumption in Ghana. *Munich Personal RePEc Archive*. Retrieved from https://mpra.ub.uni-muenchen.de/78852
Iyke, B. N., & Ho, S. Y. (2017b). Exchange rate uncertainty and domestic investment in Ghana. *Cogent Economics and Finance*. https://doi.org/10.1080/23322039.2017.1362157
Kavkler, A., Mikek, P., Böhm, B., & Boršič, D. (2007). *Nonlinear Econometric Models: The Smooth Transition Regression Approach*.
Kollmann, R. (1995). Consumption, Real Exchange-Rates and The Structure of International Asset Markets. *Journal of International Money and Finance*, *14*(2), 191–211.
Kollmann, Robert. (1995). Consumption, real exchange rates and the structure of international asset markets. *Journal of International Money and Finance*. https://doi.org/10.1016/0261-5606(94)00011-O
Lothian, J. R., & Taylor, M. P. (2012). A Primer on Exchange Rate Behavior. In *Survey of International Finance*. Oxford University Press.
Mamman, S. O. (2017). An Evaluation of the Determinants of Foreign Exchange Market Pressure in Nigeria. Ahmadu Bello University, Zaria.
Mankiw, N. G. (2004). Principles of economics. In *Mason* (Third). Ohio: Macmillan.
Meyer, B. D., & Sullivan, J. X. (2003). Measuring the Well-Being of the Poor Using Income and Consumption. *Income Volatility and Implications for Food Assistance*. Washington, DC.
Mohammed, A. A. (2013). Exchange Rate Pass-Through to Domestic Consumer Prices in Nigeria: A Structural Var Approach.

Mordi, C. N. (2014). Exchange Rate and Inflation: Is there a Relationship in Nigeria? *Economic and FInancial Review, Central Bank of Nigeria.*, *52*(4), 103–123.
Musa, A. (2012). An Evaluation of Retail and Wholesale Dutch Auction Systems of Foreign Exchange Rate in Nigeria (2002-2010). Ahmadu Bello University, Zaria.
Mussa, M. (1984). The Theory of Exchange Rate Determination. In *Exchange Rate Theory and Practice* (pp. 13–78). Retrieved from http://www.nber.org/chapters/c6829
Mussa, M. (1986). Nominal Exchange Rate Regimes and the Behavior of Real Exchange Rates: Evidence and Implications. *Carnegie-Rochester Conference on Public Policy*, *25*, 117–214. https://doi.org/10.1016/0261-5606(95)00004-X
Nuntramas, P. (2011). Revisiting the consumption-real exchange rate anomaly in a model with non-traded goods. *Journal of International Money and Finance*, *30*, 428–447.
Obadan, M. I. (2006). Overview of Exchange rate Management in Nigeria from 1968 - date. *The Dynamics of Exchange Rate in Nigeria. Central Bank of Nigeria Bullion*, *30*(3), 1–9.
Obadan, M. I. (2016). Foreign Exchange Management and Stability of the Nigerian Economy, 1976-2016. *Central Bank of Nigeria Bullion*, *1–40*, 101–115.
Odusola, A. (2006). Economics of Exchange Rate Management. *Central Bank of Nigeria Bullion*, *30*(3), 38–44.
Pavlidis, E.G., Paya, I., & Peel, D. A. (2017). A Nonlinear Analysis of the Real Exchange Rate–Consumption Relationship. *Macroeconomic Dynamics*. https://doi.org/10.1017/S1365100516000894
Pavlidis, Efthymios G., Paya, I., & Peel, D. A. (2015a). Testing for linear and nonlinear Granger causality in the real exchange rate-consumption relation. *Economics Letters*. https://doi.org/10.1016/j.econlet.2015.04.008
Pavlidis, Efthymios G., Paya, I., & Peel, D. A. (2015b). Testing for linear and nonlinear Granger causality in the real exchange rate-consumption relation. *Economics Letters*, *132*, 13–17. https://doi.org/10.1016/j.econlet.2015.04.008
Rahimi, A., Lavoie, M., & Chu, B. (2016). Between, Linear and nonlinear Granger-causality short-term and long-term interest rates during business cycles. *International Review of Applied Economics*, *30*(6), 714–728.
Ravn, M. O. (2001). Consumption Dynamics and Real Exchange Rates. *Understading Europe's Role in Global Economy*. London.
Ravn, M. o., Schmitt-Grohe, S., & Uribe, M. (2012). Consumption, Government Spending, and the Real Exchange Rate. *Journal of Monetary Economics*, *59*, 215–234.
Selaive, J. D., & Tuesta, V. (2003). Net foreign assets and imperfect pass-through: the consumption–real exchange rate anomaly. In *Board of Governors of the Federal Reserve System, International Finance Discussion Papers* (No. 764). Retrieved from www.federalreserve.gov/pubs/ifdp/
Stockman, A. C., & Tesar, L. . (1995). Tastes and technology in a two-country model of the business cycle: explaining international comovements. *American Economic Review*, *85*(1), 168–185.
Taylor, A. M., & Taylor, M. P. (2004). The Purchasing Power Parity Debate. *Journal of Economic Perspectives*, *18*(4), 135–158.
Teräsvirta, T. (1994). Specification, estimation, and evaluation of smooth transition autoregressive models. *Journal of the American Statistical Association*, *89*(425), 208–218. https://doi.org/10.1080/01621459.1994.10476462
Tretvoll, H. (2018). Real exchange rate variability in a two-country business cycle model.

Review of Economic Dynamics, *27*, 123–145. https://doi.org/10.1016/j.red.2017.11.006
Tuesta, V. (2013). The consumption-real exchange rate anomaly: Nontraded goods and distribution services. *Applied Economics*. https://doi.org/10.1080/00036846.2011.597730
Ukeje, U. E. (2017). Exchange Rate Management in Period of Economic Uncertainty. *Central Bank of Nigeria Bullion*, *41*(1), 3–14.
van Dijk, D., Terasvirta, T., & Franses, P. H. (2000). Smooth Transition Autoregressive Models - A Survey of Recent Developments. *Econometric Institute Research Report EI2000-23*.
Viser, H. (2004). *International Monetary Economics* (3rd ed.). Cheltenham, United Kingdom: Edward Elgar Publishing Ltd.
Volberg, D. (2005). Consumption and Real Exchange Rates: A Correlation Puzzle. *Job Market Paper*.

APPENDICES

Appendix A

Episodes of Exchange Rate Policy in Nigeria, 1957-2016

S/N	Period	Regime	Major Developments
1	1957-1973	Fixed Exchange Rate	▪ Introduction of "Nigerian pound in parity with British pound sterling" in line with IMF exchange rate system. ▪ Parity maintained "to achieve balance of payments viability, maintain a stable exchange rate and preserve the external reserves". ▪ Exchange rate administration. ▪ Exchange rate "was later fixed in relation to a basket of seven currencies".
2	1973-1985	Fixed Exchange Rate	▪ Naira was introduced. ▪ Exchange rate control and budgeting were administered. ▪ Import licensing regime. ▪ Foreign exchange rationing. ▪ Pegging of Naira against a basket of currencies and later resort to import weighted basket approach of calculating the naira exchange rate.
3	September 1986-April 1987	Dual System of Exchange Rate	▪ Dual system of exchange rate: First-tier & Second-tier rates. ▪ Second-tier rate was determined through an auction system with market forces. ▪ CBN intervention in the FEM for the sale of forex weekly. ▪ Marginal pricing system. ▪ Problem of "Multiple bidding" in the system.
4	April 1987-July 1987	Dutch Auction System (DAS)	▪ DAS existed the same time with first-tier exchange rate ▪ Two weeks interval bidding. ▪ Auction system price determination. ▪ Marginal rate system. ▪ DAS was jettisoned due to deregulation.
5	July 1987-1988	Unified Exchange Rate System	▪ Merging of First-tier and second-tier market. ▪ Uniform rate achieved.

			▪ Demand pressure due to merger and expansionary fiscal policy. ▪ Excess depreciation.
6	1989	Interbank FEM	▪ CBN as sole supplier of foreign exchange. ▪ Characterised by "unbridled demand pressure on available foreign exchange". ▪ Misalignment of the naira rate. ▪ Multiple exchange rates. ▪ Foreign exchange "speculation and arbitrage".
7	1990	Dutch Auction System (DAS)	▪ Interbank procedure was modified. ▪ BDCs were introduced ▪ Naira exchange rate depreciation persisted.
8	March 1992-1994	Deregulated Exchange Rate System	▪ CBN supplied all foreign exchange. ▪ Parallel market premium reduced. ▪ Fixed at N21.9960 ▪ Characterised by large arbitrage.
9	1994	Fixed Exchange Rate	▪ Introduction of Foreign exchange committee. ▪ Fixed exchange rate system. ▪ Pegged at N21.9960/US$1. ▪ Allocation based on Pro-rata system ▪ Widening premium and depreciation due to Re-regulation of the economy.
10	1988	AFEM	▪ Selling of foreign exchange by banks. ▪ Sharp depreciation of rate and rent seeking behavior. ▪ Official rate became unrealistic building demand pressure on the CBN. ▪ Parallel market flourished with widening arbitrage premium with the official rate.
11	1994- January 1999	Re-introduction of the Dual Exchange Rate System	▪ Reintroduction of dual exchange rate system. ▪ Foreign exchange supplied to public at official rate ▪ Forces of demand and supply determined AFEM rate. ▪ BDCs traded in autonomous fund.

			▪ Abolishment of exchange control act and the enterprise promotion decree of 1989. ▪ Characterised by "demand pressure and round-tripping from fiscal rate".
12	October 1999-July2002	IFEM	▪ Daily trading of forex. ▪ CBN intervention as buyers/sellers based on market conditions. ▪ Characterised by demand pressure. ▪ CBN as "sole supplier of foreign exchange and round-tripping" continued and exchange rate budgeting was abolished in 2001.
13	August 2002-January 2006	Retail Dutch Auction System (RDAS)	▪ Twice a week trading in forex (Monday and Wednesday). ▪ Customer based biddings. ▪ Unbidded balance returned to CBN for repurchase.
14	February 2006-December 2008	Wholesale Dutch Auction System (WDAS)	▪ Banks sold to their customers from their own account. ▪ Existence of transfer of funds among banks. ▪ Trading done twice weekly. ▪ Unutilized balance was sold to CBN.
15	2009-February 2015	RDAS/WDAS	▪ Operated against the backdrop of liberalization of the foreign exchange market, fallen crude oil prices, large premium and RDAS window, speculative demand, rent seeking, etc. ▪ RDAS replace WDAS in order "to curb unwholesome practices by authorized dealers, stem exchange rate volatility and demand pressure in foreign exchange market".
16	February 2015-June 2016	Interbank Foreign Exchange Market	▪ IFEM handled all demand for foreign exchange. ▪ CBN continued to intervene in the market to meet genuine/legitimate demands.
16	June 2016-2018	Flexible Exchange Rate Interbank Market	▪ Introduced against the backdrop of collapsed crude oil which depleted foreign reserves. ▪ Inability of the managed exchange rate to adjust foreign exchange demand with supply.

			▪ Single market structure operation through the interbank/autonomous window. ▪ Market driven exchange rate. ▪ CBN periodic interventions in the market. ▪ Foreign exchange primary dealers introduced, which operates with other dealers in the interbank market. ▪ All foreign exchange spot purchased by authorized dealers are transferable in the interbank foreign exchange market. ▪ Existence of "special Investors' & Exporters' (I&E) foreign exchange window" using Nigerian Autonomous Foreign Exchange Rate Fixing (Nafex) among themselves. ▪ CBN intervention through Retail Secondary Market Intervention Sales (SMIS) segment.

Source: Adopted and modified from Obadan (2016); Ukeje (2017) and Central Bank of Nigeria.

Appendix B

Summary of Empirical Review

S/N	Author/Year	Area Covered	Objectives	Estimation Techniques	Summary of Findings/Conclusion
1	Backus and Smith, 1993	OECD Countries	To investigate the possibility of non-traded goods accounting for large and persistent deviations from PPP and imperfect correlations of consumption across countries.	Correlation	There is little support for no traded goods in accounting for the deviations of PPP and lack of correlation between relative consumption areal exchange rate.
2	Ravn, 2001	OECD Countries	To analyse the relationship between consumption growth and real exchange rate	Correlation and Three-Stage Least Square	Although foreign consumption is significant in the real exchange rate-consumption behaviour, it found out that there is little relationship between the two variables.
3	Chari, Kehoe, & McGrattan, 2002	United States and 11 European Countries	To examine the relationship between real exchange rate and relative consumption under both complete and incomplete markets	Correlation	Real exchange correlates with relative consumption under the two environment and that demand shocks or asset market frictions can reconcile theory and empirical evidence on correlation between consumption and real exchange rate. They found that devoid of substantial price-stickiness, consumption and real exchange rates will have no persistence.

4	Head, Mattina & Smith, 2004	OECD Countries	To test the relationship between exchange rate and utilities with money, habit persistence and asset market frictions assumptions.	Correlation and GMM	They found evidence of zero or negative correlation between the real exchange rate and relative consumption suggesting a weak empirical relationship between the variables pointing that taste shocks and asset market frictions can improve the relationship. This is explained that real exchange rates and consumption tend to be quite persistent and random walk respectively so as to have difficulty predicting their growth rates.
5	Selaive & Tuesta, 2003	OECD Countries	To empirically examine the real exchange rate dynamics and relative consumption relationship.	Correlation and GMM	They found evidence of zero and often negative cross correlation for some selected OECD countries based on the assumption of distribution services and asset market incompleteness.
6	Corsetti, Dedola, & Sylvain, 2004	OECD	To investigate the real exchange rate-consumption relationship with distributive trade and incomplete markets.	Correlation and SVAR	They found evidence of inverse correlation between real exchange rate and relative consumption and that positive shock will lead to improvement in terms of trade, real exchange rate and domestic consumption.
7	Choi, 2005	OECD	To examine the relationship between real exchange rate and	Correlation	They found that either taste shocks or limited commitment gives rise to the consistent

			consumption ratios		relationship between the variables.
8	Volberg, 2005	OECD Countries	To examine the links between real exchange rate and macroeconomic variables by allowing for default in securities market and trade frictions.	Correlation and VAR.	That limited commitment in asset markets breaks the tight link between consumption and real exchange rate pointing to assets market frictions as tool for modelling exchange rate behaviour.
9	Benigno & Thoenissen, 2008	OECD Countries	To investigate "the relationship between exchange rate and consumption with incomplete markets and non-traded goods".	Correlation	There is evidence of correlation between real exchange rate and consumption with the combination of incomplete market and non-traded goods.
10	Nuntramas, 2011	Some selected OECD Countries	Examine "the relationship between real exchange rate and consumption by accounting for non-traded goods".	Cross-country Correlation	There is weak relationship between relative consumption and the real exchange rate.
11	Bahmani-Oskooee & Xi, 2012	Japan	To examine the impacts of exchange rate volatility on consumption in Japan	ARDL	They revealed that exchange rate and its volatility exert impact on consumption in the short run which only exchange rate volatility last through the long run with positive relationship.
12	Pavlidis, Paya and Peel, 2015	OECD Countries	To test "nonlinear causality	Granger Causality Test	Causal relationship exists between variables but without clear

			between real exchange rate and real consumption"		pattern. For some countries there is evidence of nonlinear granger causality.
13	Pavlidis, Paya and Peel, 2017	OECD Countries	To analyse the relationship between real exchange rate and consumption by accounting for smooth transition and volatility shifts	Smooth Transition Dynamic Model, Monte Carlo Simulation and Generalised Impulse Response Function (GIRF)	There is evidence of "nonlinear dynamics and existence of a long run relationship between real exchange rate and consumption". They concluded that "volatility shifts and economic fundamentals play crucial role in explaining the behaviour of exchange rates".
14	Iyke & Ho, 2017	Ghana	To examine the impact of exchange rate volatility on domestic consumption	ARDL	They showed that exchange rate volatility has differential effects on domestic consumption in both short and long run.

Appendix C

ADF Unit Root Test at Levels and 1st Difference (Exchange Rate)

Null Hypothesis: RER has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.003896	0.5939
Test critical values:	1% level	-4.023506	
	5% level	-3.441552	
	10% level	-3.145341	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RER)
Method: Least Squares
Date: 03/20/19 Time: 11:35
Sample (adjusted): 1981Q2 2016Q4
Included observations: 143 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RER(-1)	-0.055626	0.027759	-2.003896	0.0470
C	0.121775	0.053502	2.276098	0.0244
@TREND("1981Q1")	-0.000115	0.000386	-0.298606	0.7657

R-squared	0.035722	Mean dependent var	0.004804
Adjusted R-squared	0.021946	S.D. dependent var	0.179853
S.E. of regression	0.177869	Akaike info criterion	-0.594788
Sum squared resid	4.429209	Schwarz criterion	-0.532631
Log likelihood	45.52737	Hannan-Quinn criter.	-0.569531
F-statistic	2.593154	Durbin-Watson stat	2.050208
Prob(F-statistic)	0.078373		

Null Hypothesis: D(RER) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.43962	0.0000
Test critical values:	1% level	-4.023975	
	5% level	-3.441777	
	10% level	-3.145474	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RER,2)
Method: Least Squares
Date: 03/20/19 Time: 11:43
Sample (adjusted): 1981Q3 2016Q4
Included observations: 142 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(RER(-1))	-1.055803	0.084874	-12.43962	0.0000
C	0.034923	0.030935	1.128903	0.2609
@TREND("1981Q1")	-0.000412	0.000371	-1.111051	0.2685

R-squared	0.526823	Mean dependent var	-0.001301
Adjusted R-squared	0.520015	S.D. dependent var	0.260917
S.E. of regression	0.180766	Akaike info criterion	-0.562327
Sum squared resid	4.542010	Schwarz criterion	-0.499880
Log likelihood	42.92521	Hannan-Quinn criter.	-0.536951
F-statistic	77.37954	Durbin-Watson stat	1.986585
Prob(F-statistic)	0.000000		

Phillip Perron Unit Root Test at Levels and 1st Difference (Real Exchange Rate)

Null Hypothesis: RER has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.186659	0.4930
Test critical values:	1% level	-4.023506	
	5% level	-3.441552	
	10% level	-3.145341	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.030973
HAC corrected variance (Bartlett kernel)	0.037126

Phillips-Perron Test Equation
Dependent Variable: D(RER)
Method: Least Squares
Date: 03/20/19 Time: 11:49
Sample (adjusted): 1981Q2 2016Q4
Included observations: 143 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RER(-1)	-0.055626	0.027759	-2.003896	0.0470
C	0.121775	0.053502	2.276098	0.0244
@TREND("1981Q1")	-0.000115	0.000386	-0.298606	0.7657

R-squared	0.035722	Mean dependent var	0.004804
Adjusted R-squared	0.021946	S.D. dependent var	0.179853
S.E. of regression	0.177869	Akaike info criterion	-0.594788
Sum squared resid	4.429209	Schwarz criterion	-0.532631
Log likelihood	45.52737	Hannan-Quinn criter.	-0.569531
F-statistic	2.593154	Durbin-Watson stat	2.050208
Prob(F-statistic)	0.078373		

Null Hypothesis: D(RER) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-12.43480	0.0000
Test critical values:	1% level	-4.023975	
	5% level	-3.441777	
	10% level	-3.145474	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.031986
HAC corrected variance (Bartlett kernel)	0.036954

Phillips-Perron Test Equation
Dependent Variable: D(RER,2)
Method: Least Squares
Date: 03/20/19 Time: 11:50
Sample (adjusted): 1981Q3 2016Q4
Included observations: 142 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(RER(-1))	-1.055803	0.084874	-12.43962	0.0000
C	0.034923	0.030935	1.128903	0.2609
@TREND("1981Q1")	-0.000412	0.000371	-1.111051	0.2685

R-squared	0.526823	Mean dependent var	-0.001301
Adjusted R-squared	0.520015	S.D. dependent var	0.260917
S.E. of regression	0.180766	Akaike info criterion	-0.562327
Sum squared resid	4.542010	Schwarz criterion	-0.499880
Log likelihood	42.92521	Hannan-Quinn criter.	-0.536951
F-statistic	77.37954	Durbin-Watson stat	1.986585
Prob(F-statistic)	0.000000		

ADF Unit Root Test at Levels and 1st Difference (Domestic Consumption)

Null Hypothesis: DC has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.122823	0.1367
Test critical values:	1% level	-4.023506	
	5% level	-3.441552	
	10% level	-3.145341	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DC)
Method: Least Squares
Date: 03/20/19 Time: 11:40
Sample (adjusted): 1981Q2 2016Q4
Included observations: 143 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DC(-1)	-0.109820	0.035167	-3.122823	0.0006
C	0.928567	0.264351	3.512630	0.0006
@TREND("1981Q1")	0.001707	0.000471	3.622538	0.0004

R-squared	0.086300	Mean dependent var	0.008559
Adjusted R-squared	0.073247	S.D. dependent var	0.080054
S.E. of regression	0.077066	Akaike info criterion	-2.267549
Sum squared resid	0.831487	Schwarz criterion	-2.205391
Log likelihood	165.1297	Hannan-Quinn criter.	-2.242291
F-statistic	6.611570	Durbin-Watson stat	1.918781
Prob(F-statistic)	0.001804		

Null Hypothesis: D(DC) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.74960	0.0000
Test critical values:	1% level	-4.023975	
	5% level	-3.441777	
	10% level	-3.145474	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DC,2)
Method: Least Squares
Date: 03/20/19 Time: 11:41
Sample (adjusted): 1981Q3 2016Q4
Included observations: 142 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DC(-1))	-1.001308	0.085221	-11.74960	0.0000
C	-0.001249	0.013761	-0.090741	0.9278
@TREND("1981Q1")	0.000138	0.000166	0.829423	0.4083

R-squared	0.498355	Mean dependent var	-0.000424
Adjusted R-squared	0.491137	S.D. dependent var	0.113118
S.E. of regression	0.080692	Akaike info criterion	-2.175454
Sum squared resid	0.905057	Schwarz criterion	-2.113007
Log likelihood	157.4572	Hannan-Quinn criter.	-2.150078
F-statistic	69.04412	Durbin-Watson stat	1.991075
Prob(F-statistic)	0.000000		

Phillip Perron Unit Root Test at Levels and 1st Difference (Domestic Consumption)

Null Hypothesis: DC has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.063812	0.2368
Test critical values:	1% level	-4.023506	
	5% level	-3.441552	
	10% level	-3.145341	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.005815
HAC corrected variance (Bartlett kernel)	0.006141

Phillips-Perron Test Equation
Dependent Variable: D(DC)
Method: Least Squares
Date: 03/20/19 Time: 11:55
Sample (adjusted): 1981Q2 2016Q4
Included observations: 143 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DC(-1)	-0.109820	0.035167	-3.122823	0.0006
C	0.928567	0.264351	3.512630	0.0006
@TREND("1981Q1")	0.001707	0.000471	3.622538	0.0004

R-squared	0.086300	Mean dependent var	0.008559
Adjusted R-squared	0.073247	S.D. dependent var	0.080054
S.E. of regression	0.077066	Akaike info criterion	-2.267549
Sum squared resid	0.831487	Schwarz criterion	-2.205391
Log likelihood	165.1297	Hannan-Quinn criter.	-2.242291
F-statistic	6.611570	Durbin-Watson stat	1.918781
Prob(F-statistic)	0.001804		

Null Hypothesis: D(DC) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-11.75034	0.0000
Test critical values:	1% level	-4.023975	
	5% level	-3.441777	
	10% level	-3.145474	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.006374
HAC corrected variance (Bartlett kernel)	0.005871

Phillips-Perron Test Equation
Dependent Variable: D(DC,2)
Method: Least Squares
Date: 03/20/19 Time: 11:56
Sample (adjusted): 1981Q3 2016Q4
Included observations: 142 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DC(-1))	-1.001308	0.085221	-11.74960	0.0000
C	-0.001249	0.013761	-0.090741	0.9278
@TREND("1981Q1")	0.000138	0.000166	0.829423	0.4083

R-squared	0.498355	Mean dependent var	-0.000424
Adjusted R-squared	0.491137	S.D. dependent var	0.113118
S.E. of regression	0.080692	Akaike info criterion	-2.175454
Sum squared resid	0.905057	Schwarz criterion	-2.113007
Log likelihood	157.4572	Hannan-Quinn criter.	-2.150078
F-statistic	69.04412	Durbin-Watson stat	1.991075
Prob(F-statistic)	0.000000		

ADF Unit Root Test at Levels and 1st Difference (Foreign Consumption)

Null Hypothesis: FC has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.361217	0.3982
Test critical values:	1% level	-4.024935	
	5% level	-3.442238	
	10% level	-3.145744	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(FC)
Method: Least Squares
Date: 03/20/19 Time: 11:44
Sample (adjusted): 1982Q1 2016Q4
Included observations: 140 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FC(-1)	-0.019930	0.008440	-2.361217	0.0197
D(FC(-1))	0.127394	0.079005	1.612475	0.1092
D(FC(-2))	0.227719	0.077231	2.948549	0.0038
D(FC(-3))	0.297688	0.079127	3.762136	0.0003
C	0.171700	0.070801	2.425109	0.0166
@TREND("1981Q1")	0.000131	6.49E-05	2.012239	0.0462

R-squared	0.350551	Mean dependent var	0.007567
Adjusted R-squared	0.326318	S.D. dependent var	0.005356
S.E. of regression	0.004396	Akaike info criterion	-7.974240
Sum squared resid	0.002590	Schwarz criterion	-7.848170
Log likelihood	564.1968	Hannan-Quinn criter.	-7.923009
F-statistic	14.46575	Durbin-Watson stat	1.915079
Prob(F-statistic)	0.000000		

Null Hypothesis: D(FC) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.075879	0.0086
Test critical values:	1% level	-4.024935	
	5% level	-3.442238	
	10% level	-3.145744	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(FC,2)
Method: Least Squares
Date: 03/20/19 Time: 11:45
Sample (adjusted): 1982Q1 2016Q4
Included observations: 140 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FC(-1))	-0.387634	0.095105	-4.075879	0.0001
D(FC(-1),2)	-0.482351	0.097219	-4.961475	0.0000
D(FC(-2),2)	-0.267431	0.079395	-3.368362	0.0010
C	0.004549	0.001247	3.646939	0.0004
@TREND("1981Q1")	-2.09E-05	1.00E-05	-2.087559	0.0387

R-squared	0.465662	Mean dependent var	9.44E-05
Adjusted R-squared	0.449830	S.D. dependent var	0.006027
S.E. of regression	0.004470	Akaike info criterion	-7.947761
Sum squared resid	0.002698	Schwarz criterion	-7.842703
Log likelihood	561.3433	Hannan-Quinn criter.	-7.905069
F-statistic	29.41227	Durbin-Watson stat	1.890135
Prob(F-statistic)	0.000000		

Phillip Perron Unit Root Test at Levels and 1st Difference (Foreign Consumption)

Null Hypothesis: FC has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.934533	0.9483
Test critical values:	1% level	-4.023506	
	5% level	-3.441552	
	10% level	-3.145341	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	2.78E-05
HAC corrected variance (Bartlett kernel)	8.43E-05

Phillips-Perron Test Equation
Dependent Variable: D(FC)
Method: Least Squares
Date: 03/20/19 Time: 11:46
Sample (adjusted): 1981Q2 2016Q4
Included observations: 143 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FC(-1)	-0.002073	0.009860	-0.210232	0.8338
C	0.027243	0.082859	0.328794	0.7428
@TREND("1981Q1")	-1.81E-05	7.55E-05	-0.239419	0.8111

R-squared	0.065627	Mean dependent var	0.007393
Adjusted R-squared	0.052279	S.D. dependent var	0.005475
S.E. of regression	0.005330	Akaike info criterion	-7.610220
Sum squared resid	0.003977	Schwarz criterion	-7.548063
Log likelihood	547.1308	Hannan-Quinn criter.	-7.584962
F-statistic	4.916567	Durbin-Watson stat	1.305404
Prob(F-statistic)	0.008638		

Null Hypothesis: D(FC) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 6 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-9.038838	0.0000
Test critical values:	1% level	-4.023975	
	5% level	-3.441777	
	10% level	-3.145474	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	2.42E-05
HAC corrected variance (Bartlett kernel)	3.44E-05

Phillips-Perron Test Equation
Dependent Variable: D(FC,2)
Method: Least Squares
Date: 03/20/19 Time: 11:47
Sample (adjusted): 1981Q3 2016Q4
Included observations: 142 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FC(-1))	-0.665855	0.078859	-8.443633	0.0000
C	0.006804	0.001151	5.908820	0.0000
@TREND("1981Q1")	-2.53E-05	1.05E-05	-2.399437	0.0177

R-squared	0.339214	Mean dependent var	4.43E-05
Adjusted R-squared	0.329706	S.D. dependent var	0.006074
S.E. of regression	0.004973	Akaike info criterion	-7.748792
Sum squared resid	0.003437	Schwarz criterion	-7.686345
Log likelihood	553.1642	Hannan-Quinn criter.	-7.723416
F-statistic	35.67770	Durbin-Watson stat	2.220750
Prob(F-statistic)	0.000000		

Appendix D

Lag Order Selection

VAR Lag Order Selection Criteria
Endogenous variables: RER DC FC
Exogenous variables: C
Date: 03/20/19 Time: 10:17
Sample: 1981Q1 2016Q4
Included observations: 136

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-80.97497	NA	0.000690	1.234926	1.299176	1.261035
1	727.8997	1570.169*	5.37e-09*	-10.52794*	-10.27094*	-10.42350*
2	735.6031	14.61384	5.48e-09	-10.50887	-10.05912	-10.32610
3	743.3652	14.38269	5.58e-09	-10.49067	-9.848168	-10.22957
4	752.3981	16.33893	5.59e-09	-10.49115	-9.655902	-10.15173
5	758.9039	11.48082	5.80e-09	-10.45447	-9.426474	-10.03672
6	767.0843	14.07514	5.89e-09	-10.44242	-9.221672	-9.946337
7	772.4248	8.953034	6.23e-09	-10.38860	-8.975105	-9.814191
8	776.0503	5.918107	6.77e-09	-10.30956	-8.703319	-9.656826

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

Appendix E

Johansen Cointegration Test

Date: 03/20/19 Time: 10:13
Sample (adjusted): 1981Q3 2016Q4
Included observations: 142 after adjustments
Trend assumption: Linear deterministic trend
Series: RER FC DC
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.134158	32.45053	29.79707	0.0242
At most 1	0.072423	11.99507	15.49471	0.1572
At most 2	0.009249	1.319520	3.841466	0.2507

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.134158	20.45546	21.13162	0.0619
At most 1	0.072423	10.67555	14.26460	0.1712
At most 2	0.009249	1.319520	3.841466	0.2507

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

RER	FC	DC
1.111612	-8.338207	5.230652
1.057065	3.865296	-1.426914
-1.503058	3.614431	-0.218650

Unrestricted Adjustment Coefficients (alpha):

D(RER)	-0.028033	-0.023309	0.013208
D(FC)	-0.001058	-0.000806	-0.000263
D(DC)	-0.021322	0.014682	-0.000138

1 Cointegrating Equation(s): Log likelihood 762.8351

Normalized cointegrating coefficients (standard error in parentheses)

RER	FC	DC
1.000000	-7.501005	4.705466
	(1.66935)	(0.97208)

Adjustment coefficients (standard error in parentheses)

D(RER)	-0.031162
	(0.01684)
D(FC)	-0.001176
	(0.00046)
D(DC)	-0.023702
	(0.00730)

2 Cointegrating Equation(s): Log likelihood 768.1729

Normalized cointegrating coefficients (standard error in parentheses)

RER	FC	DC
1.000000	0.000000	0.634603
		(0.39420)
0.000000	1.000000	-0.542709
		(0.06023)

Adjustment coefficients (standard error in parentheses)

D(RER)	-0.055801	0.143648
	(0.02303)	(0.13800)
D(FC)	-0.002028	0.005705
	(0.00063)	(0.00377)
D(DC)	-0.008183	0.234541
	(0.00989)	(0.05927)

Appendix F

Nonlinearity Test Results

1. Test for Linearity and Transition Variable Determination Result

*** Fri, 10 May 2019 15:37:41 ***

TESTING LINEARITY AGAINST STR

variables in AR part: CONST Rer(t-1) Dc(t) Fc(t) Dc(t-1) Fc(t-1)

param. not under test:

sample range: [1981 Q2, 2016 Q4], T = 143

p-values of F-tests (NaN - matrix inversion problem):

transition variable	F	F4	F3	F2	suggested model
Rer(t-1)	1.5492e-04	6.1331e-04	7.1208e-02	5.4030e-02	LSTR1
Dc(t)*	1.4081e-56	3.7914e-61	7.0978e-01	7.2681e-01	LSTR1
Fc(t)	NaN	NaN	8.8143e-01	8.3578e-01	Linear

2. STR Grid Search Results

*** Fri, 10 May 2019 15:44:29 ***

STR GRID SEARCH

variables in AR part: CONST Rer(t-1) Dc(t) Fc(t) Dc(t-1) Fc(t-1)

restriction theta=0:

transition variable: Dc(t)

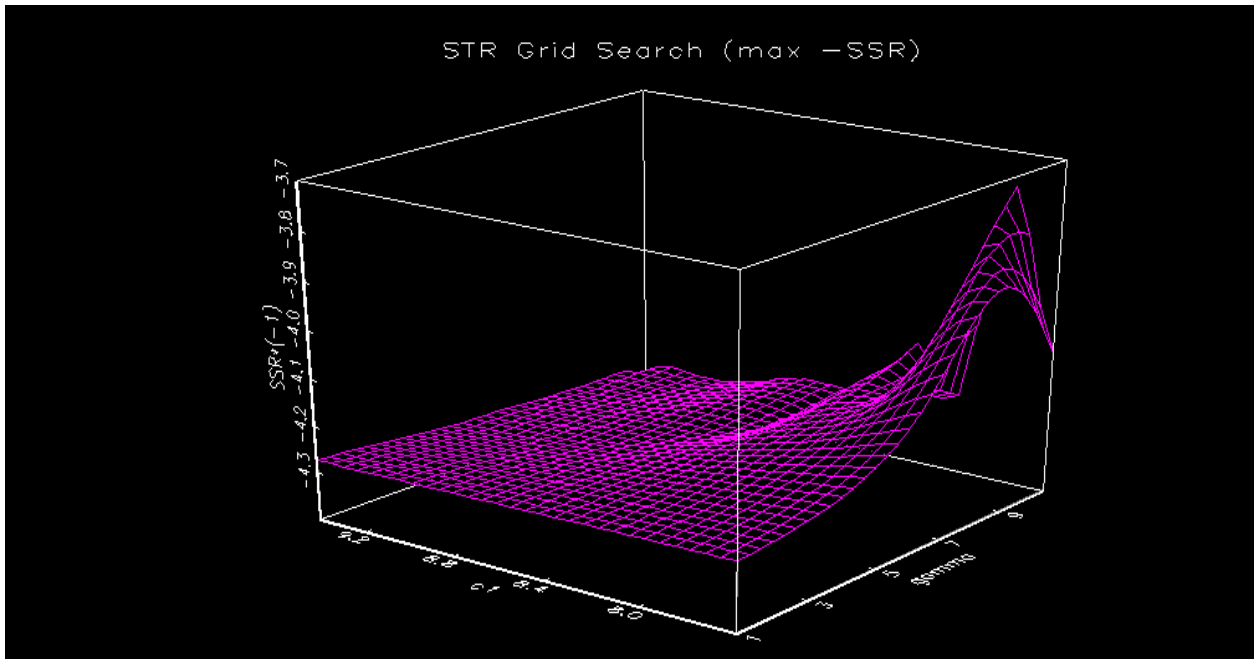
sample range: [1981 Q2, 2016 Q4], T = 143

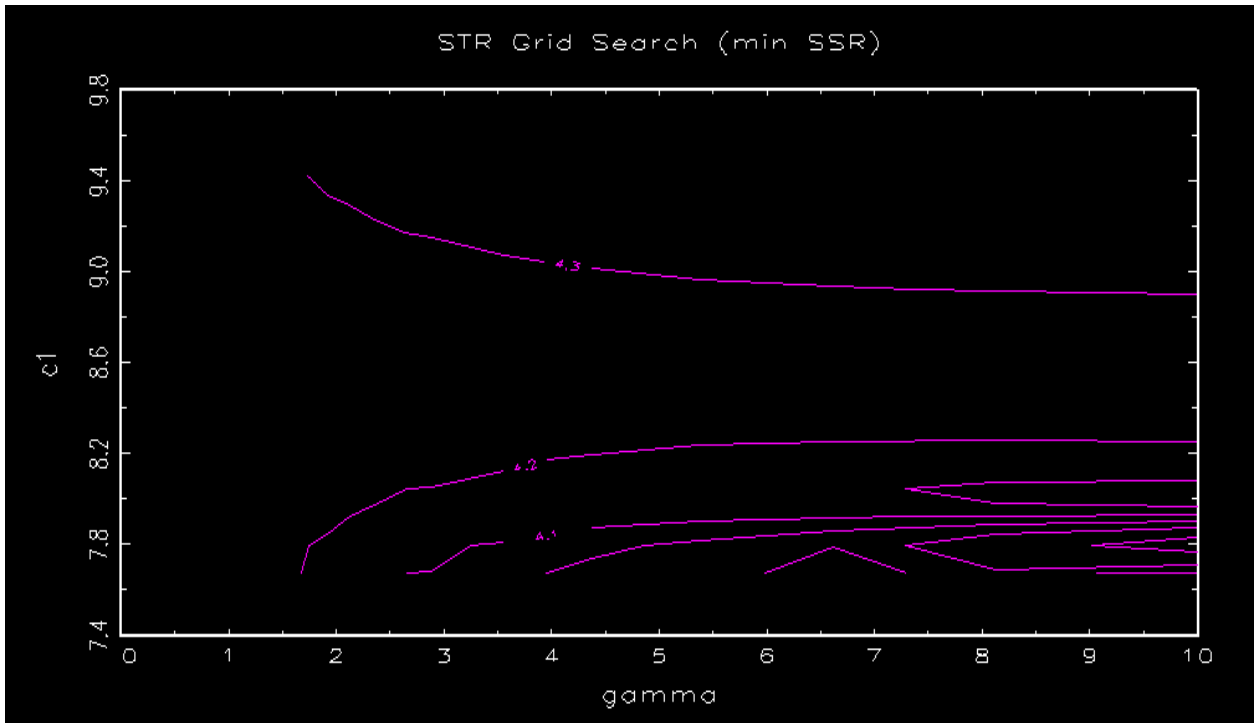
transition function: LSTR1

grid c { 7.61, 9.42, 30}

grid gamma { 0.50, 10.00, 30}

SSR	gamma	c1
3.7706	10.0000	7.7951


STR Grid Search (max −SSR)
SSR(−1)
−4.3 −4.2 −4.1 −4.0 −3.9 −3.8 −3.7
c1
gamma


STR Grid Search (min SSR)
c1
7.4 7.8 8.2 8.6 9.0 9.4 9.8
0 1 2 3 4 5 6 7 8 9 10
gamma
4.3
4.2
4.1

3. STR Results for Linear and Nonlinear Parts

*** Fri, 10 May 2019 15:49:01 ***

STR ESTIMATION

variables in AR part: CONST Rer(t-1) Dc(t) Fc(t) Dc(t-1) Fc(t-1)

restriction theta=0: Fc(t) Dc(t-1) Fc(t-1)

restriction phi=0:

restriction phi=-theta:

transition variable: Dc(t)

sample range: [1981 Q2, 2016 Q4], T = 143

transition function: LSTR1

number of iterations: 23

variable	start	estimate	SD	t-stat	p-value
----- linear part -------					
CONST	-20.39042	-32.10421	6.4121	-5.0068	0.0000
Rer(t-1)	0.76354	0.67433	0.0835	8.0762	0.0000
Dc(t)	3.43321	0.99043	0.2421	4.0910	0.0001
Fc(t)	0.01524	0.37441	2.8145	0.1330	0.8944
Dc(t-1)	-0.89708	-0.86686	0.1757	-4.9337	0.0000
Fc(t-1)	0.07702	-0.34408	2.8361	-0.1213	0.9036
---- nonlinear part ----					
CONST	19.91532	32.01522	6.4149	4.9908	0.0000
Rer(t-1)	0.17837	0.26967	0.0891	3.0276	0.0030
Dc(t)	-2.58096	-0.64778	0.2304	-2.8115	0.0056
Gamma	10.00000	0.780977	0.0311	25.1118	0.0001
C1	7.79507	2827.46156	2088.4887	1.3539	0.1779

AIC: -3.5246e+00

SC: -3.2967e+00

HQ: -3.4320e+00

R2: 8.9436e-01

adjusted R2: 0.8951

variance of transition variable: 0.3121

SD of transition variable: 0.5586

variance of residuals: 0.0274

SD of residuals: 0.1654

4. Test of No Error Autocorrelation

*** Fri, 10 May 2019 15:59:44 ***

Test of No Error Autocorrelation (NaN - matrix inversion problem):

lag	F-value	df1	df2	p-value
1	0.0821	1	130	0.7749
2	0.6145	2	128	0.5425
3	0.4106	3	126	0.7456
4	0.3243	4	124	0.8612
5	0.2567	5	122	0.9357
6	0.2172	6	120	0.9707
7	0.2174	7	118	0.9808
8	0.1938	8	116	0.9913

5. Test of No Remaining Nonlinearity

*** Fri, 10 May 2019 15:59:44 ***

Test of No Remaining Nonlinearity (NaN - matrix inversion problem):

transition variable	F	F4	F3	F2
Dc(t)	9.8807e-01	7.3291e-01	9.7602e-01	8.7997e-01

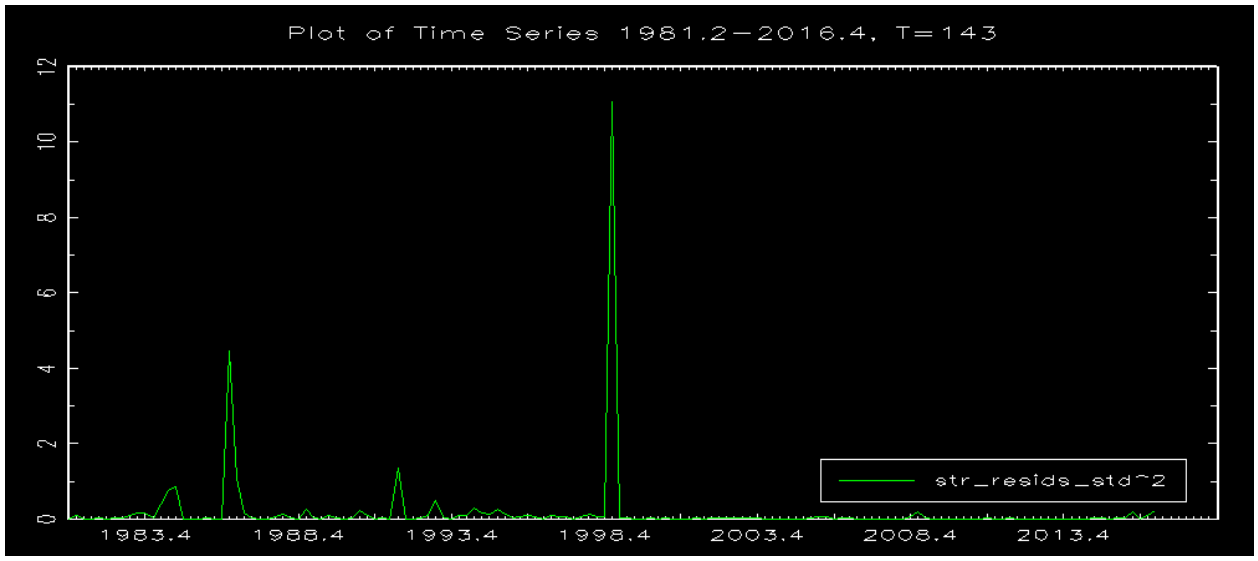
6. Parameter Constancy Test

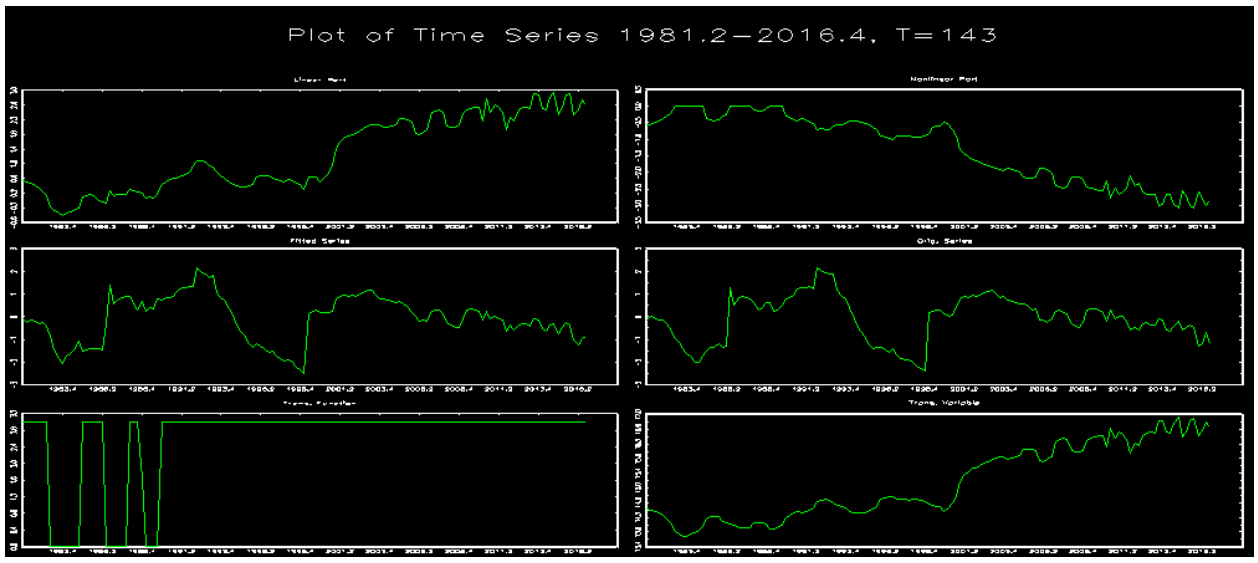
*** Fri, 10 May 2019 15:59:44 ***

Parameter Constancy Test (NaN - matrix inversion problem):

variables not under test:

transition function	F-value	df1	df2	p-value
H1	5.6403	9.0000	121.0000	0.0000
H2	3.7192	18.0000	112.0000	0.0000
H3	3.0519	27.0000	103.0000	0.0000


Plot of Time Series 1981.2—2016.4, T=143
0
2
4
6
8
10
12
1983.4
1988.4
1993.4
1998.4
2003.4
2008.4
2013.4
str_resids_std^2


Plot of Time Series 1981.2—2016.4, T=143
Linear Part
Nonlinear Part
Fitted Series
Orig. Series
Trans. Variable

Appendix G
Granger Causality Tests

```
Linear Granger Test Dc to Rer
-----------------------------------------------
        Test of causality
-----------------------------------------------
The lag parameter: p = 1
The Granger Causality Index: GCI = 2.16437e-005
The value of the F-test: 0.00614688
The p value of the F-test: 0.937563
The critical value with 5% of risk:: 3.936

Linear Granger Test Rer to Dc
-----------------------------------------------
        Test of causality
-----------------------------------------------
The lag parameter: p = 1
The Granger Causality Index: GCI = 0.000102569
The value of the F-test: 0.0291311
The p value of the F-test: 0.864598
The critical value with 5% of risk:: 3.936

NonLinear Granger Test Rer to Dc
-----------------------------------------------------------
         Results of the non-linear Granger causality test
-----------------------------------------------------------
The lag parameter: p = 1
The Granger Causality Index: GCI = 0.149933
The value of the F-test: 5.51994
The p value of the F-test: 1.77393e-006
The critical value at 5% of risk: 2.032
```

```
NonLinear Granger Test Dc to Rer
-----------------------------------------------------------
         Results of the non-linear Granger causality test
-----------------------------------------------------------
The lag parameter: p = 1
The Granger Causality Index: GCI = 0.149933
The value of the F-test: 5.51994
The p value of the F-test: 1.77393e-006
The critical value at 5% of risk: 2.032
```