INVESTIGATING THE FIRST LEVEL PASS-THROUGH EFFECTS OF THE SACU REGION MONETARY TRANSMISSION MECHANISM

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INVESTIGATING THE FIRST LEVEL PASS-THROUGH EFFECTS OF THE SACU REGION MONETARY TRANSMISSION MECHANISM

BY

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DECLARATION:

In accordance with Rule G5.11.4, I hereby declare that the above-mentioned treatise/ dissertation/ thesis is my work and that it has not previously been submitted for assessment to another University or for another qualification.

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DATE: 2022/03/18

DEDICATION

I dedicate this thesis to my late brother, Hitekani ‘Hitto’ Baloyi.

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ABSTRACT

The purpose of this thesis is to investigate the first-level pass-through effects of monetary policy transmission in SACU using the wavelet analysis methodology. The thesis comprises four empirical themes. 1. Investigating the time-frequency relationship in the Fisher's effect for SACU countries. 2. Investigating the time-frequency relationship in the Purchasing Power Parity (PPP) for SACU countries. 3. Investigating the time-frequency relationship between the exchange rate and the stock returns for SACU countries. 4. Investigating the time-frequency relationship between interest rates, exchange rates, and stock returns for SACU countries. Whilst there exists a considerable amount of empirical works which have studied the four themes in SACU countries that are covered in this study, there is a need for more empirical investigation for several reasons. Firstly, a majority of the studies have focused on South Africa with very little empirical literature existing for Botswana and Lesotho. Secondly, the previous SACU based studies present contradicting findings. Thirdly, Most of these studies did not cover the themes comprehensively, as is the case in this study. Finally, to the best of my knowledge, this methodology has not been employed in any SACU related literature until now. Altogether, the thesis bridges the inconsistencies found in previous SACU-related literature and offers fresh implications for policymakers and market participants. From an empirical perspective, the wavelet coherence analysis proves to be a powerful tool in reconciling previous contradicting empirical evidence on the existence of the Fisher effect in SACU countries. From a policy perspective, more fined tuned implications are derived from the findings of the study as wavelets are able to depict a more accurate description of the different first-level monetary transmission relationships.

Keywords: Fisher effect; PPP; stock returns; exchange rate; nominal interest rates; inflation; CMA; SACU.

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ADF	Augmented Dickey-Fuller Test
ADL	Autoregressive Distributed Lag
AFIMA	Autoregressive Fractionally Integrated Moving Average
ARDL	Autoregressive Distributed Lag
ARFIMA	Autoregressive Fractionally Integrated Moving Average
ARIMA	AutoRegressive Integrated Moving Average
ASEAN	Association of Southeast Asian Nations
ATS	Automated Trading System
BESA	Bond Exchange of South Africa
BLNS	Botswana, Lesotho, Namibia, and Swaziland
BLS	Botswana, Lesotho, and Swaziland
BoB	Bank of Botswana
BoN	Bank of Namibia
BRICS	Brazil, Russia, India, China, and South Africa
BRICT	Brazil, Russia, India, China, and Turkey
BSE	Botswana Stock Exchange
BSE DCI	Botswana Stock Exchange Domestic Company Index
BSM	Botswana Share Market
BWP	Pula
CAL	Capital Account Liberalisation
CB	Central Bank
CBE	Central Bank of Eswatini
CBL	Central Bank of Lesotho
CBS	Central Bank of Swaziland
CBS	Central Bank of Swaziland
CEE	Central and Eastern Europe
CEMAC	Economic and Monetary Community of Central Africa
CMA	Common Monetary Area
CMD	Capital Markets Department
COI	Cone of Influence

CoSSE	Committee of SADC Stock Exchanges
CPI	Consumer Price Index
CPIX	Consumer Price Index Excluding Mortgages
CRR	Cash Reserve Requirements
CWPS	Cross-Wavelet Power Spectrum
CWT	Continuous Wavelet Analysis
DCC	Dynamic Conditional Correlation
DF-GLS	Dickey-Fuller Generalized Least Squares
DWT	Discrete Wavelet Analysis
ECM	Error Correction Model
EGARCH	Exponential Autoregressive Conditional Heteroskedasticity
EMH	Efficient Market Hypothesis
EMU	European Monetary Union
ESE	Eswatini Stock Exchange
EU	European Union
FDI	Foreign Direct Investment
FIP	Fractionally Integrated Processes
FMOLS	Fully Modified Ordinary Least Squares
FSRA	Financial Services Regulatory Authority
G7	Group of Seven
GARCH	Generalised Autoregressive Conditional Heteroskedasticity
GATT	General Agreement on Tariffs and Trade
GCC	Gulf Cooperation Council
GDP	Gross Domestic Product
GMM	Generalized Method of Moment
GPPP	Generalised Purchasing Power Parity
GSE-CI	Ghana Stock Exchange Composite Index
GSE-FSI	Ghana Stock Exchange Financial Services Index
HCPI	Harmonized Consumer Price Index
HCT	High Commission Territories
IFE	International Fisher Effect
IFS	International Financial Statistics
IMF	International Monetary Fund
INT	Interest Rates

IPPR	Institute for Public Policy Research
IRF	Impulse Response Function
JET	Johannesburg Equities Trading
JSE	Johannesburg Stock Exchange
JSE-ASI	Johannesburg Stock Exchange All-Share Index
KSS	Kapetanios–Shin–Snell
LAIA	Latin American Association
LMA	Lesotho Monetary Authority
LNS	Lesotho, Namibia and Swaziland
LOP	Law Of one Price
LR	Liquidity requirements
LR	Long Run
LSL	Loti
LSN	Lesotho Namibia Swaziland
MAS	Monetary Authority of Swaziland
MENA	Middle East and North Africa
MIST	Mexico, Indonesia, South Korea and Turkey
MMA	Multilateral Monetary Area
MSM	Maseru Securities Market
MSVECM	Markov-Switching Vector Error-Correction Model
MWC	Multiple Wavelet Coherence
NAD	Namibian Dollar
NAMFISA	Namibian non-banking financial regulator
NARDL	Nonlinear Autoregressive Distributed Lag
NARDL	Nonlinear Autoregressive Distributive Lag
NEPRU	Namibian Economic Policy Research Unit
NER	Nominal Exchange Rate
NSA	Namibian Statistics Agency
NSX	Namibian Stock Exchange
OCA	Optimum Currency Area
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
OMO	Open Market Operations
PPP	Purchasing Power Parity

PSTR	Panel Smooth Transition Regression
PTA	Preferential Trade Agreement
PWC	Partial Wavelet Coherence
REER	Real Effective Exchange Rate
RER	Real Exchange rate
RMA	Rand Monetary Agreement
RMCI	Real Monetary Conditions Index
RTGS	Real Time Settlement System
S.W.I.F.T	Society for Worldwide Interbank.
SA	South Africa
SACU	South African Customs Unions
SADC	Southern African Development Community
SAFEX	South African Futures Exchange
SARB	South African Reserve Bank
SETAR	Self Exciting Threshold Autoregressive
SETS	Stock Exchange Electronic Trading Service
SNL	Swaziland Namibia and Lesotho
SPSM	Sequential Panel Selection Method
SR	Short Run
SSM	Swaziland Stock Market
SSX	Swaziland Stock Exchange
SUR	Seemingly Unrelated Regressions
SURKSS	Seemingly Unrelated Regressions Kapetanios
SVAR	Structural Vector Autoregressive
SZL	Lilangeni
TAR	Threshold Autoregressive
TMA	Trilateral Monetary Agreement
TVEC	Threshold Vector Error Correction
TVP	Time-Varying Parameters
UIP	Uncovered Interest Parity
UK	United Kingdom
UNDP	United Nations Development Programme
UNTAG	United Nations Transition Assistance Group
US	United States

VAR	Vector Auto Regression
VD	Variance Decomposition
VEC	Vector Error Correction
VECM	Vector Error Correction Model
WA	Weighted Average
WAEMU	Western African Economic and Monetary Community of Central Africa
WC	Wavelet Coherence
WPS	Wavelet Power Spectrum
WT	Wavelet Transform
WTO	World Trade Organisation
XWT	Cross-Wavelet transforms

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

Southern African Customs Union (SACU) nations form the oldest customs union in the world having been established in 1910 and since 1986 these countries, namely: South Africa, Namibia, Lesotho and Eswatini formed a common monetary area (CMA) in which the smaller countries (Eswatini, Lesotho, Namibia) have their exchange rates pegged to the South African Rand. This makes the South African Reserve Bank (SARB) the dominant Central Bank in the region and the *de facto* monetary policy architecture for the rest of the CMA. In comparison to other monetary unions in Africa and Europe, such as the Economic and Monetary Community of Central Africa (CEMAC), the Western African Economic and Monetary Community of Central Africa (WAEMU), and the European Monetary Union (EMU), the CMA is not a fully-fledged monetary union in the sense that, among other things, there is no common central bank conducting monetary policy, they do not have a common pool of reserves, regional surveillances and do not operate using a single currency as demonstrated on Table 1 below.

Table 1: Key features of selected monetary unions

No:	Key features	CMA	Euro Area	WAEMU	CAEMC
1	No of countries	4	17	8	6
2	Common central banks	*	√	√	√
3	Common pool of reserves	*	√	√	√
4	Regional surveillances	*	√	√	√
5	Single currency	*	√	√	√
6	Common external tariff	√	√	√	√
7	Trade free area	√	√	*	*

Notes: "*" denotes not applicable, "√" denotes applicable

Source: Fasano (2003)

Ikhide (2010) argues that since South Africa and other smaller SACU countries have close economic and historic ties, monetary policy changes that are implemented in South Africa as

the dominant country will have an effect on the Lesotho, Namibia and Swaziland (now Eswatini) (LNS) economies. Notably, the objectives of monetary policy (i.e. price stability and stable and sound financial systems that enable sustainable economic growth) are similar across the SACU region. However, it is noteworthy that the manner in which they conduct their monetary policies in achieving the above-mentioned objectives differs across the central banks. Table 2 below shows the monetary policy regime across the SACU region countries. Eswatini, Lesotho, and Namibia use the fixed exchange rate that is fixed with the South African rand. South Africa's monetary policy regime is the inflation targeting of 3-6%. Since Botswana is currently out of the CMA, their monetary policy regime is the crawling band exchange rate which is not fixed with the South African rand.

Table 2: Summary of monetary policy regime in the SACU region

Country	**Regime**
South Africa	Inflation targeting
Swaziland	Fixed exchange rate
Lesotho	Fixed exchange rate
Botswana	Crawling band exchange rate
Namibia	Fixed exchange rate

Source: Authors Tabulation

Mishkin (2005) identifies five channels interest rate channel, the credit channel, the asset price channel, the expectations channel, and the exchange rate channel. The first level pass-through effects of monetary policy within the transmission mechanism can be summarized in four empirical relations namely, i) the relationship between nominal interest rates and inflation ii) The relationship between exchange rates and inflation iii) The relationship between exchange rates and equity markets iv) The relationship between interest rates and exchange rates v) The relationship between interest rates and equity returns.

1.2 PROBLEM STATEMENT

For the past couple of years, there has been a considerable amount of empirical work on monetary policy transmission mechanisms but there has not been much literature on the themes covered by the thesis in SACU. Most of these studies did not cover the themes comprehensively and majority of the studies have focused on South Africa with very little empirical literature existing for Botswana and Lesotho. The previous SACU based studies present contradicting findings. This study will close this gap in literature using wavelet methodology.

Furthermore, since the main monetary policy instrument amongst the SACU countries is the interest or policy rates, the transmission mechanism of monetary policy is similar amongst SACU member states. However, since the decision taken by the SARB is dominant amongst these countries, it would be interesting to know whether the first-level transmission mechanism of monetary policy is similar across the SACU nations. This is important to know since there has been much debate on the viability of the SACU countries as an optimum currency is (OCA) characterised by a singular Central Bank. Focusing on the first-level pass-through effects is also important, as these transmission effects have been the source of previous financial crises and instability. For instance, Bernanke (2002), during his speech at Milton Friedman's 90th Birthday celebration, admitted that the crash of the US financial sector was caused by pass-through effects of the 'close-to-zero interest rate' monetary policy stance implemented by the Federal Reserve in the early 2000s. Therefore, knowing the pass-through effects is important for monetary policy authorities and the decisions they make. Moreover, knowing the first-level pass-through effects of monetary to the financial sector would be of interest to different market participants within financial markets who may be seeking hedging opportunities or seeking more efficient markets to invest in. As far as I am concerned, there is no previous literature that simultaneously examines different first-level monetary policy relationships.

1.3 OBJECTIVES OF THE STUDY

The main objective of this study is to examine the first-level pass-through effect of the monetary policy transmission mechanism in the SACU. The specific objectives of the study are given as follows:

- Investigate the relationship between interest rate and inflation rate in SACU countries.
- Investigate the relationship between exchange rate and inflation rate in SACU countries.
- Investigate the relationship between exchange rate and stock returns in SACU countries.
- Investigate the relationship between interest rate, exchange rate, and stock returns in SACU countries.

1.4 HYPOTHESIS TESTING

H_{01}: There is a similar relationship between interest rate and inflation rate in SACU countries.
H_{A1}: There are different relationships between interest rates and inflation rates in SACU countries.

H_{02}: There is a similar relationship between the exchange rate and inflation rate in SACU countries.
H_{A2}: There are different relationships between exchange rate and inflation rate in SACU countries.

H_{03}: There is a similar relationship between exchange rate and stock returns in SACU countries.
H_{A3}: There are different relationships between exchange rate and stock returns in SACU countries.

H_{04}: There is a similar relationship between interest rate, exchange rate, and stock returns in SACU countries.
H_{A4}: There are different relationships between interest rate, exchange rate, and stock returns in SACU countries.

1.5 METHODOLOGY

To examine the first-level pass-through effect on the SACU region monetary transmission mechanism, I apply continuous wavelet transform analysis. The wavelet theory was introduced first in the mid-1980s by mathematicians (Grossmann and Morlet, 1984; Goupillaud et al., 1984) but quickly became popularized in other fields of science such as Neurosurgery (Omerhodzic and Nuhanovic, 2013 and Gracia, Poza Santamarta, Romeo-Oraa and Hornero, 2018) and geophysics (Torrence and Compo, 1998) and only more recently has the methodology gained traction amongst financial economists (Sadowsky, 1994; Rua and Nunes, 2009; Aguiar-Conraria and Soares, 2011; Ramsay, 2002 and Crowley and Mayes, 2008).

Wavelets are small waves that grow and decay in a limited time period and are made up of two distinct parameters: time (τ) and scale (s). Wavelets are used to decompose a signal or time series across a time-frequency plane and these transforms can either be discrete (returns data vector of the same length as the input signal) or continuous (returns an output vector that is one

dimension higher than the input). Consequentially, wavelets allow one to investigate the co-movement between time series across five dimensions namely i) time-variation ii) cyclical variation iii) changes on strength of the relationship iv) the sign of the relationship v) direction of causality. In this study, I use three different types of wavelet analysis names, Wavelet coherence, vector wavelet coherence, and partial wavelet coherence.

1.6 SIGNIFICANCE OF THE STUDY

For any country to achieve its economic stability, a sound monetary policy is needed. For instance, the Bretton Woods Fixed Exchange Rate System which collapsed in the 1970s was due to the mismanagement of monetary policy (Garber, 1993). In 1980, the Latin American countries experienced a debt crisis due to poor exchange rate management policies (Stein, 2009; Damill, Frenkel, and Rapetti, 2011). In the 1990s, the Asian financial crisis was caused by a crash in the Thai Balt which had spillover over effects to other Asian financial markets. The 2007-2008 global financial crisis arose due to the crash in the US housing market caused by 'close-to-zero' interest rates imposed by the Federal Reserve in the early 2000s the 's and this developed into a fully-fledged international banking crisis which resulted in the slump of the Lehman Brothers bank on the 15th of September in 2008 (Mohan, 2009; Merrouche and Nier, 2010).

The source of the major financial crisis in the past four decades can be traced to the first-level pass-through effects of monetary policy either through exchange rates or equity markets. Investigating the first-level pass-through effects for the SACU countries is important since the BLNS countries have close economic and monetary ties with South Africa, although the monetary union formed by these countries is not fully-fledged in the sense that, among other things, there is no common central bank conducting monetary policy for the region (Seleteng, 2013). However, monetary policy decisions taken by the SARB are transferred to the rest of the CMA countries and it is important for policymakers and financial market participants to know of these pass-through effects. For instance, policymakers can use the findings from this study to determine whether SACU countries are suited to form an OCA and to determine the stability of monetary policy within these countries. Market participants would be interested in the findings from this study to make important financial decisions such as hedging and diversification options.

1.7 ORGANISATION OF THE THESIS

The study is formally divided into nine chapters, which include the current introduction chapter, overview of SACU, literature review, methodology and data, four independent articles, and the conclusion that summarises the entire study. The thesis is arranged as follows:

Chapter 1: Introduction
Chapter 2: Overview of SACU
Chapter 3: Literature Review
Chapter 4: Methodology and data
Chapter 5: Investigating the Fisher effect in the SACU countries
Chapter 6: Investigating Purchasing Power Parity (PPP) in SACU countries
Chapter 7: Investigating the co-movements between exchange rate and stock returns in SACU countries
Chapter 8: Investigating the co-movements: between interest rates, exchange rate, and stock returns in SACU countries
Chapter 9: Conclusion, recommendations, and areas of further studies

CHAPTER 2: SACU OVERVIEW

2.1 SACU HISTORICAL OVERVIEW

SACU countries represent an African regional economic organization and are the world's oldest customs union, founded in 1910. Its members include Botswana, Lesotho, Namibia, South Africa, and Swaziland (now Eswatini). The 5-member states maintain a common external tariff, share customs revenues, and coordinate policies and decision-making on a wide range of trade issues (Wang, Masha, Shirono, and Harris, 2007).

According to Seleteng (2013), the CMA was established in 1986 by Lesotho, Swaziland (now Eswatini), and South Africa. The establishment of the CMA brought within the member countries the main objective which is to monitor the exchange rate policies and monetary policies. However, the broad objectives of the agreement are that there should be sustainable economic development among the CMA countries and more support must be given toward the CMA less developed states to advance their economies. Furthermore, all the benefits that arise in the maintenance and development of CMA must be shared by all the parties involved.

The CMA arrangement resembles an asymmetric monetary union, with the bigger country, South Africa, being responsible for monetary policy formulation and implementation (Alweendo, 2000). In actual fact, the SARB has a considerable influence in terms of monetary policy formulation for the CMA as a whole. Therefore, the SA monetary policy framework is in practice a *de facto* monetary policy framework for the rest of the CMA. This monetary union is not fully-fledged in the sense that, among other things, there is no common central bank conducting monetary policy for the region by taking economic developments and shocks in all countries into account when making a monetary policy stance (Seleteng et. al., 2013).

Figure 1: SACU map

Source: SACU

The SACU area size is 2 674 424 km^2. South Africa has the largest size area in SACU at 1 219 090 km^2 with Namibia closely following at 825 615, Botswana at 582 000 km, Lesotho at 30 355 km, which is completely landlocked by South Africa. Lastly, Eswatini with the smallest area size at 17 364 km (SACU, 2019). See the below table for the country's population estimates. South Africa has the highest population in SACU at 55 619 940.

Table 3: Member state population estimates

	2016	2017	2018	2019
SACU	63 240 704	64 245 463	65 553 059	66 707 227
South Africa	55 619 940	56 521 948	57 725 600	58 775 022
Namibia	2 324 388	2 368 747	2 413 643	2 458 936
Botswana	2 230 905	2 266 857	2 302 878	2 338 851
Lesotho	1 932 814	1 941 941	1 951 688	1 961 985
Eswatini	1 132 657	1 145 970	1 159 250	1 172 433

Source: SACU, 2019

2.2.1 Basic features of customs unions

One of the basic features of the customs unions is that it provides the ability to trade amongst the members (Konish, Kowakzyk, and Sjostrom, 2003). The General Agreement on Tariffs and Trade (GATT) rules have to be adhered to in order for the members to trade. Where single customs are concerned, the above rules are regarded, however, the trade between members of the single customs is tariff-free yet internal border controls still hold. A good example would be SACU as each member state still maintain their own national fiscal regimes, migration, health, and standards Calborg, 1999). SACU as the oldest functioning custom union in the world is deemed as a storyline of the special economic relationship amongst its countries. SACU has a few characteristics that set it apart, namely; the agreement of SACU revenue sharing and SA as the anchor country because of its economic standing (Erasmus, 2009).

Table 4: SACU summary

Types of agreement	Countries	Main Objectives	Products
Custom Union (SACU)	Botswana, Lesotho, Namibia, South Africa and Swaziland (now Eswatini)	Tariff-free	All products

Source: Modified and updated from table 3.1 in Fasano (2003)

Table 5: Main features in SACU

Features	**SACU**
Number of countries	Five
Single currency	No, a de facto common currency
Common currency	No, SARB has considerable influence
Common pool of reserves	No
Free trade are	Yes
Common external tariff	Yes
External current account convertibility	Yes
Degree of capital mobility with region	High
External exchange rate anchor	No

Source: Modified and updated from table 3.1 in Fasano (2003)

2.2.2 Common Monetary Area

The history of the CMA agreement dates back to the era of the de facto currency union. The sole medium of exchange and legal tender in South Africa, Bechuanaland (now Botswana), Lesotho, Namibia, and Swaziland (now Eswatini) was the South African currency (pound) in 1921 after the establishment of the SARB. The capital and money moved freely amongst these nations. The pound sterling was therefore replaced by the South African Rand in 1961 (World Bank, 1996). In the 1960s, Botswana, Lesotho, Namibia, and Swaziland (now Eswatini) gained independence. The Rand Monetary Agreement (RMA) was formalised in 1974 and the currency unions were formed. The primary agreement of this membership was the financial relationship between the involved countries. In 1975, Botswana opted out of the RMA agreement. The CMA came into existence in 1986 when the RMA revised its agreement. Under this CMA agreement, Lesotho and Swaziland (now Eswatini) had the privilege to issue their own currencies and establish their own central banks. However, these currencies would only be legal tenders in their own states and they would be required to circulate side by side with South African currency. The agreement also required currencies from each member country to be pegged to the South African currency (Wang, 2007)

In 1974, Swaziland (now Eswatini) formed a monetary authority which in 1979 then because the Central Bank of Swaziland. Upon the establishment of the bank, Swaziland (now Eswatini) started issuing its currency, Lilangeni, which is pegged at par with the South African currency. Lesotho also formed the monetary authority in 1979 that later became the Central bank of Lesotho in the year 1982 alongside the introduction of its currency, Loti. The Loti, likewise, was pegged with the South African currency. Botswana did not follow the same path as Swaziland (now Eswatini) and Lesotho, after it left the RMA, it established its own currency, the Pula. The Pula was initially linked to the US Dollar at a rate, maintaining parity with the South African currency. Namibia gained independence in 1990 and 1992, it joined the CMA, issuing its own currency, Namibian Dollar (Guillaume and Stasavage, 1999).

Table 6: CMA and SACU: Major events in history

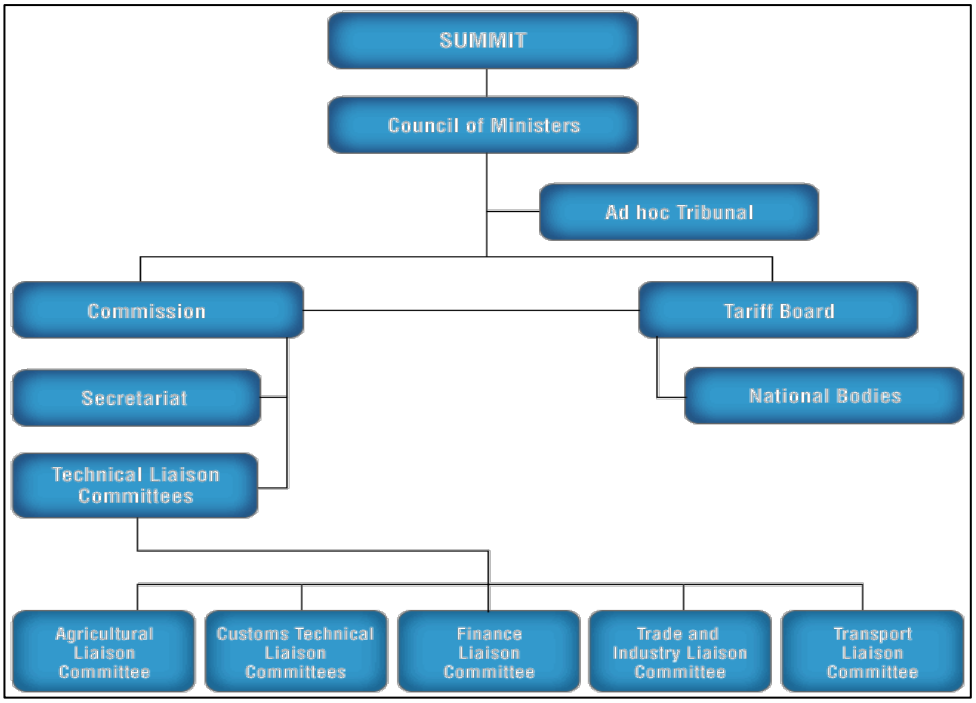
Year	Arrangements	Customs union
Before 1960	Before the SARB establishment in 1921, there was an informal monetary union.	
The 1960s	The member states (excluding Namibia) gained independence	New agreement reached on December 11, 1969; the shares of the smaller members were determined based on a revenue-sharing formula, with the residual allocated to South Africa
1974-75	RMA was signed. Swaziland (now Eswatini) established its own monetary authority and currency. In 1975 Botswana was no longer part of RMA	
1980	Lesotho formed its own central bank	
1986	The CMA Trilateral Agreement which replaced the RMA was signed by South Africa, Lesotho, and Swaziland (now Eswatini)	
1989	The exchange restrictions were removed from the CMA agreement	
1992-1993	Namibia joined the CMA in 1992 after it became independent in 1990. In 1993 Namibia issued its national currency, Namibian dollar	
2002		New revenue-sharing formula had a development component
2003	Rand became a legal tender again in Swaziland (now Eswatini) alongside the lilangeni	

Source: Wang, Masha, Shirono, and Harris (2007)

2.2.3 The structure of SACU institution

SACU Institutions are contained in Article 7 of the 2002 SACU Agreement and it includes the SACU council of members, the SACU commission, the secretariat, a tariff board, a tribal and technical liaison committee. Below is the illustration of the hierarchy of the SACU institution structure.

Figure 2: SACU institution structure



Source: SACU

2.2.4 The 2002 Agreement

Since its inception, SACU has operated under different agreements, which have been negotiated and renegotiated with changing circumstances. The evolution of SACU to its present position has been shaped by four major agreements, namely 1889, 1910, 1969, and 2002 agreements. However, the first formal agreement was in 1910.

Table 7: Summary of SACU agreements.

year	Agreement
1910	Customs Agreement between South African, Basutoland (now Lesotho), Swaziland (now Eswatini), and Bechuanaland (Botswana)
1969	Customs Union Agreement between South Africa, Botswana, Lesotho and Swaziland (now Eswatini) and Namibia joined in 1990.
2002	SACU Agreement South Africa, Botswana, Lesotho, Swaziland (now Eswatini) and Namibia
2014	The Free Trade Agreement (FTA) was established
2016	The Preferential Trade Agreement between the Common Market of the South and the SACU
2017	SACU agreement 2002
2018	SACU concluded the status of Agreements for the member states

Source: SACU

2.2.5 SACU Vision and Mission

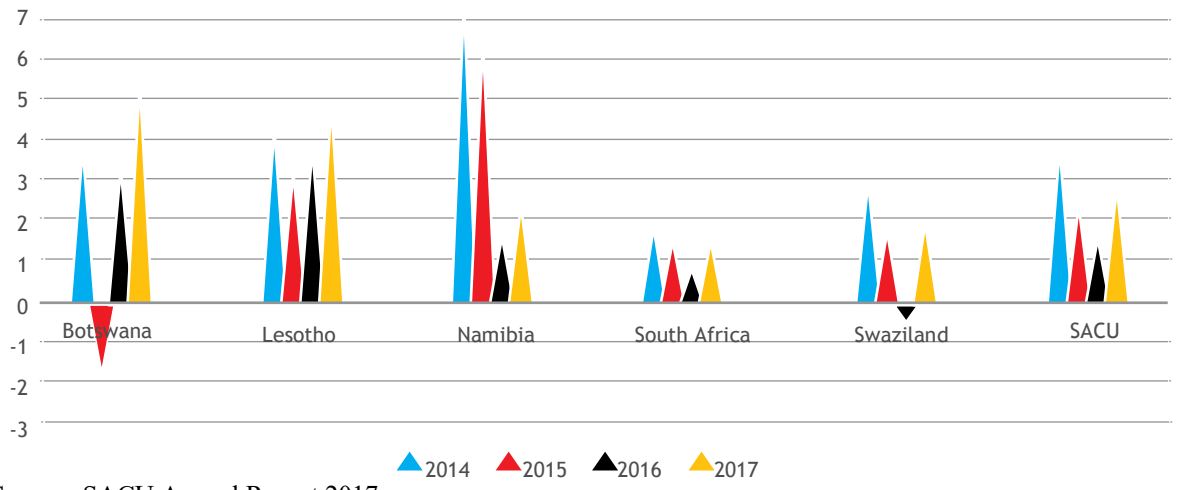
Just like many customs unions, SACU has a number of challenges and in responding to these challenges, SACU outlined visions and missions that address these challenges. SACU's vision is to achieve the development of the member states. The mission is to make sure that there is 1) global competitiveness, 2) industrial and economic diversification, 3) regional integration, and the expansion of intra-regional trade and investment (SACU, 2018).

2.2 SACU ECONOMIC OVERVIEW

2.2.1 Economic growth

Figure 3 illustrates the economic performance of SACU from the period 2014 to 2017. The SACU economies recorded uneven economic performance through the years. Botswana recorded a negative economic performance out of all the member states.

Figure 3: Economic growth



Source: SACU Annual Report 2017

Table 8: GDP growth rates (%)

	2014	2015	2016	2017	2018	2019
Botswana	4,1	-1,7	4,3	2,9	4,5	3,0
Eswatini	0,9	2,2	1,1	2,0	2,4	2,2
Lesotho	1,7	3,1	3,6	-3,2	-1,2	-0,4
Namibia	6,1	4,3	0,0	-1,0	1,1	-1,6
South Africa	1,8	1,2	1,4	1,4	0,8	0,2
SACU (WA)	2,1	1,2	1,4	1,4	1,0	0,2

Source: SACU, 2019

Between the period 2014-2019 in Botswana, a sharp decline in the GDP growth rate by -1,7%, and the highest growth was experienced at 4,5% in 2018 is observed. The growth was associated with the mining sector improvements. Eswatini's GDP growth rate was estimated at 0,9% in 2014, being the lowest growth rate amongst the SACU members in the year 2014. The growth rates showed improvements from 2014 to 2018 and the highest rate was estimated at 2,4% in the year 2018. Lesotho, in 2017 declined drastically from 3,6% in 2016 to -3,2%. The GDP growth showed improvement in 2015 at 3,1%, which was a huge improvement from 1,7% in 2014. In 2014, Namibia's growth rate was the strongest amongst all the SACU members. However, in 2017, it was at the lowest at -1,0% in 2017. South Africa recorded the lowest growth late at 0,2% in 2019 and the highest growth rate observed in 2018 at 1,8%.

2.2.3 Inflation rates

Table 9 reports the annual inflation rates for SACU countries and as can be observed, Eswatini recorded the highest inflation rate in 2016, 2017, and 2018, recording rates of 7,8%, 6,3%, and 4,8% respectively. In 2018, recorded the same highest rate of 4,8%. Lesotho recorded the highest inflation rate in 2019 at 5,2% followed by South Africa at 4,1%, Namibia at 3,7%, Botswana at 2,8%, and Eswatini at 2,6%.

Table 9: Annual inflation rates (%)

	2016	2017	2018	2019
Botswana	2,8	3,3	3,2	2,8
Eswatini	7,8	6,3	4,8	2,6
Lesotho	6,6	5,2	4,8	5,2
Namibia	6,7	6,2	4,3	3,7
South Africa	6,4	5,3	4,7	4,1
SACU HCPI	7,1	5,6	4,7	4,9

Source: SACU Annual Inflation Report, 2019

Table 10 shows the shares of the SACU revenue among the member countries for the financial year 2016/2017 in comparison to 2015/2016. Botswana showed a decline in the revenue share from 18,7 to 18,6. Lesotho also declined from 5,8 to 5,5. Namibia's revenue share increased from 37,7 to 39, 2 and Eswatini showed an increase from 6,2% to 6,3%.

Table 10: Revenue share

Countries	**Botswana**		**Lesotho**		**Namibia**		**SA**		**Swaziland (Eswatini)**	
Financial year	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017
Revenue share	18,7	18,6	5,8	5,5	15,8	17,0	37,7	39,2	6,2	6,3
Adjustments	1,3	-3,1	0,5	-1,0	1,3	-3,0	0,8	0,7	0,6	-1,1
Total	20,0	15,5	6,3	4,5	17,1	14,0	38,6	39,9	6,8	5,2
% change		-22,4	-28,4			-17,8		3,3		-22,9

Source: SACU Annual Report 2017

2.3 SACU MONETARY POLICY OVERVIEW

The section discusses the monetary policy in SACU. During the 1990s, central banks around the world had changed their objectives towards achieving and maintaining price and financial stability (Vredin, 2015), and later in the 2000s, a number of central banks in emerging economies, such as the SARB, changed their policy frameworks towards that of inflation targeting. The below section walks us down the central banks' monetary policies in SACU.

Monetary policy and fiscal policy are the main macroeconomic policies. The fiscal policy involves the government budget, while the monetary policy looks at the money supply and interest rates regulation with the main objective to stabilise the prices and control inflation. Monetary policy changes (i.e. money supply or interest rates) can affect the wider economy. (Ireland, 2008). How these monetary policy changes affect the wider economy is called the transmission mechanism (Mathai, 2009).

2.3.1 Transmission mechanism overview

In order to ensure financial and macroeconomic stability, Central Bank conducts monetary policy by adjusting interest rates or policy rates. The manner in which changes interest rates filters through the financial sector down to the macroeconomy is referred to as the monetary policy transmission mechanism (Smal and Jager, 2001).

2.3.1.1 Monetary policy transmission mechanism in SACU

This section explores in detail the monetary policy and monetary policy transmission mechanism in SACU countries respectively.

<u>Monetary policy in South Africa</u>

The South African Reserve Bank was established in June 1921 under the provisions of the Currency and Banking Act (No. 31 of 1920) following the Gold Conference of October 1919. Following the recommendations of the conference, a Select Committee of Parliament recommended the establishment of a central bank to assume responsibility for the issuing of

banknotes and for taking over the gold held by commercial banks (Gelb, 1989). The Objectives of the bank at the time was to be the sole issuer of banknotes and hold reserves of commercial banks. The SARB opened its doors for business for the first time on 30 June 1921 and issued its first banknotes to the public on 19 April 1922. The SARB is the oldest central bank in Africa (SARB, 2020).

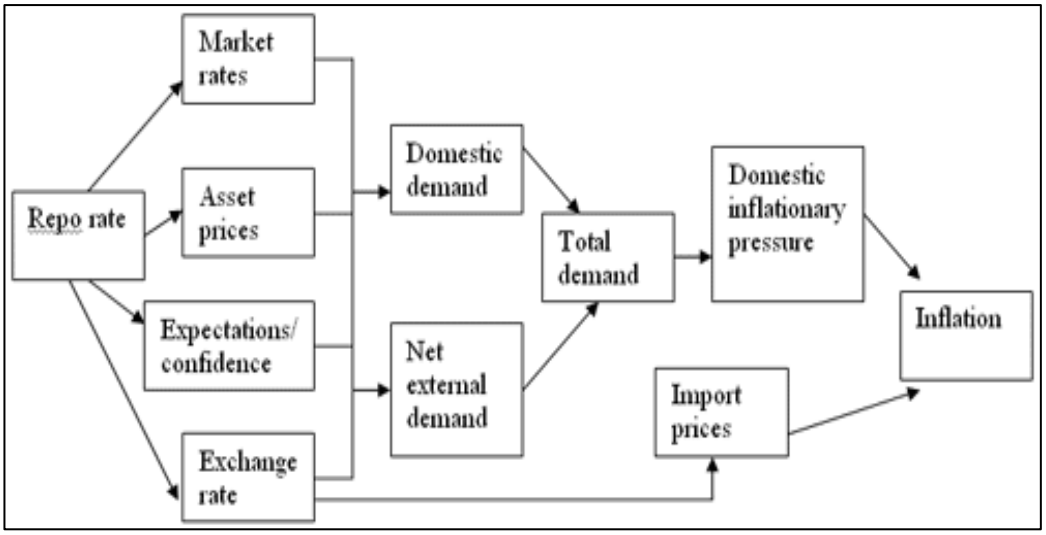
Currently, the primary objective of monetary policy in South Africa is to achieve and maintain price stability in the interest of sustainable and balanced economic development and growth. Other broad objectives of monetary policy, as part of total public economic policy, include promotion of economic growth, rising levels of employment, and achieving domestic and external monetary stability (Stals 1993). These objectives are collectively stipulated in South African Reserve Bank Act 90 of 1989. The above-mentioned objectives can be achieved by influencing the total money demand in the economy through the exercise of control of money supply and over the availability of credit (SARB, 1989). Therefore, monetary policy may become expansionary in times of underemployment of available resources. At full employment, while certain expansion of the monetary base is still required, the degree is lesser, for otherwise inflation and balance of payments problems set in, as demand for goods and services exceeds supply.

In order for the SARB to perform its main functions, the SARB is offered a range of policy instruments, which according to Fourie, Falkena, and Kok (1996) can be divided into four broad categories, namely market-oriented policy instruments, semi-direct policy instruments, direct policy instruments, and instruments with external dimension. In contrast to the direct measures applied in earlier decades, the emphasis nowadays is on market-oriented policy measures. Market-oriented policy measures seek to guide or encourage financial institutions to take certain actions on a voluntary basis. In other words, the authorities create incentives to encourage private enterprise, and hence financial variables, to move in the desired direction (SARB, 2011).

On the other hand, market-oriented policy instruments have two types, the discount policy or refinancing policy and instruments that support the SARB's refinancing policy, namely public-debt management, open-market operations, the operation of tax and loan accounts, variations in reserve-asset requirements, and other measures for influencing the money-market shortage. Semi-direct policy instruments take the form of variations in reserve-asset requirements, while

credit ceilings, selective credit controls: reserve-asset requirements, capital requirements, deposit and lending interest rate controls, moral suasion, hire-purchase credit controls, and import deposit schemes constitute direct policy instruments (Fourie et al., 1996). In February 2000, the adoption of formal inflation targeting range is 3-6% in South Africa was announced. Prior to the formal inflation targeting, the SARB used informal inflation targeting (SARB, 2004).

Figure 4: The monetary policy transmission mechanism (MPTM) for South Africa



Source: SARB

Figure 4 illustrates the MPTM that represents the link between the official rate and the main channels in South Africa. SARB uses the repurchase rate (also known as the repo rate) as the official rate. The repo rate change is therefore transferred to four channels namely: market rates, assets prices, expectations/confidence, and exchange rate. Three of those channels are linked to the domestic demand and net external demand which make up the total demand while the exchange rate is linked to imported prices and inflation ultimately. The total demand is linked with the domestic inflationary pressure which contributes to inflation of the country (SARB, 2018).

Monetary policy in Lesotho

Lesotho also formed the monetary authority in 1979 that later became the Central bank of Lesotho in the year 1982 alongside the introduction of its currency, Loti. The Loti was pegged with the South African currency (Yoshino, 2014). The exchange rate targeting is one of the monetary policy strategies aiming for a given exchange rate against another currency or group

of currencies. It can therefore be stated that the CBL pursues an exchange rate targeting monetary policy framework. The net international reserves (NIR) at a level that is sufficient to guarantee that for every Loti issued there is a basket of foreign currency equivalent reserves is maintained by pegging Loti at par with the Rand. This is the level that underwrites the peg (Hurcan, 2020). There are several tools that the CBL use to achieve its objectives:

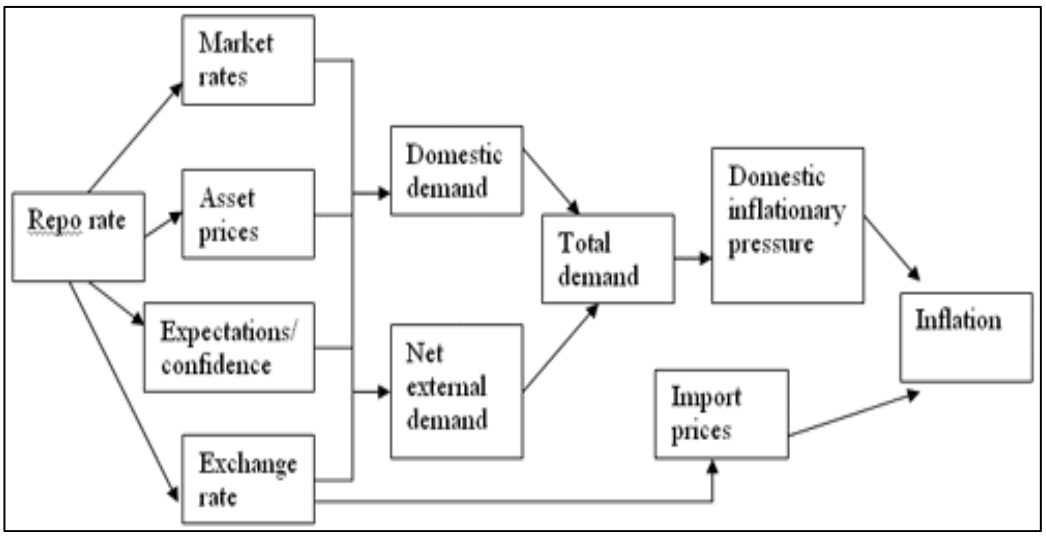
Open Market Operations (OMO)

CBL makes the monetary policy decision through the conduct of OMO. This then influences the short-term interest rates with a view to aligning them with those in the CMA albeit with an allowable deviation margin.

CBL rate

The CBL Rate, as a tool of monetary policy, anchors all other rates in the banking sector. The CBL Rate is also set in alignment with the rates in the CMA, again with some allowable deviation margin. Following the recommendations from the IMF Mission on Money and Capital Markets that visited Lesotho in November 2012, it was recommended that the Central Bank of Lesotho (CBL) needs to introduce a policy rate linked to the South African policy rate in order to provide market signals that would guide pricing in the credit market.

Figure 5: The monetary policy transmission mechanism for Lesotho



Source: SARB

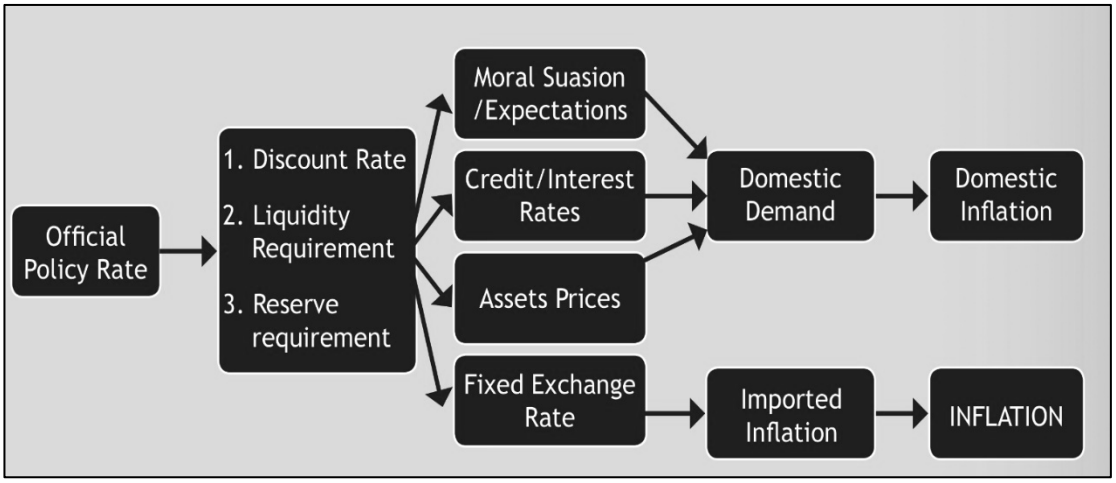
Figure 5 shows the link from official policy rate to demand inflation and inflation as the channels of monetary policy in Lesotho, which is similar to the South African monetary policy

transmission mechanism. Since 2015, the Central Bank of Lesotho use the bank policy rate as the official interest rate which replaces the 91-day Treasury Bill rate. Changes in the official rate are therefore transferred to four channels namely: market rates, assets prices, expectations/confidence, and exchange rate.

Monetary policy in Eswatini

The Central Bank of Swaziland was formally launched in 1974 as the Monetary Authority of Swaziland (MAS) by King Sobhuza II. On 18th July 1979, the Monetary Authority of Swaziland was replaced by the Central Bank of Swaziland, as per Order-in-Council. Later on, followed by the development of Eswatini's monetary authority, Swaziland (Now Eswatini), introduced its own currency, the lilangeni which is pegged at par with the Rand. April 2018, His Majesty King Mswati III announced the name change of the country from the Kingdom of Swaziland to the Kingdom of Eswatini. And lo and behold, the central bank's board members meet on the 31st May 2018 and resolved that the Bank shall now be referred to as Central Bank of Eswatini (CBE) (CBE, 2020). Eswatini's monetary policy objective is maintaining and promoting prices. The CEB uses the discount rate, reserve requirement, liquidity requirement, and OMO as monetary policy instruments to achieve its objectives.

Figure 6: The monetary policy transmission mechanism for Eswatini



Source: Bank of Eswatini

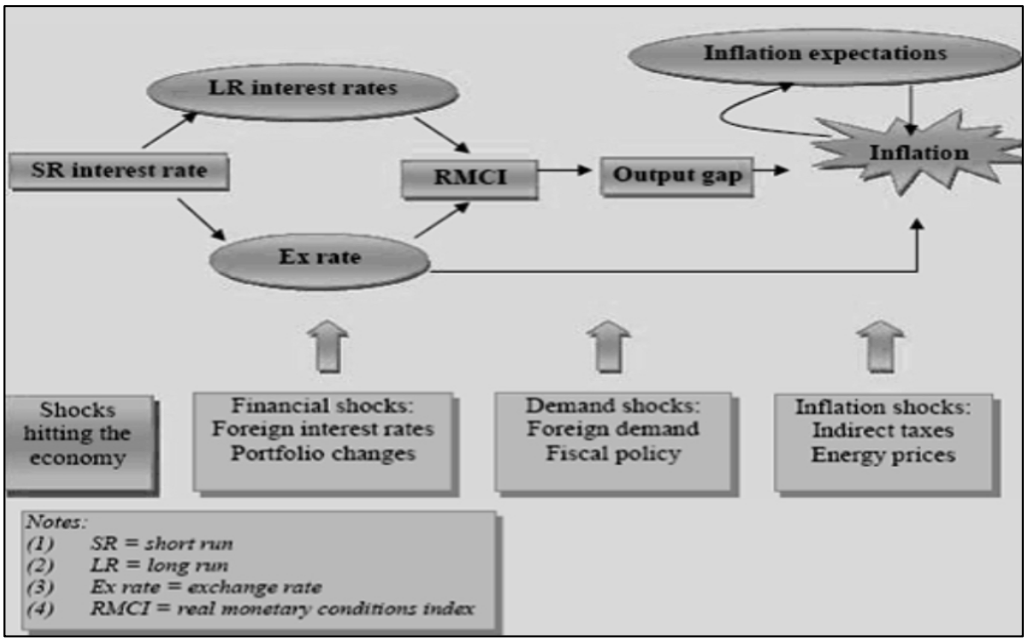
Figure 6 shows the link from the official policy rate to the wider economy in Eswatini. CEB has three main instruments, discount rate, liquidity requirement, and reserve requirement, with the discount rate as the main policy tool. The changes from the policy instruments filter down to the wider economy through four channels namely; moral suasion/expectations,

credit/interest rates, assets prices, and fixed exchange rate. Three of those channels are linked to the domestic demand while the fixed exchange rate is linked to imported inflation. Domestic demand is linked to domestic inflation, while imported inflation is linked to inflation (CEB, 2018).

Monetary policy in Botswana

When the bank of Botswana was established in 1976 after gaining independence in 1966, Botswana withdrew itself from the RMA. Botswana's resolution was due to the fact that the Preparatory Commission believed that they could monitor their own monetary policies that will yield better results for Botswana and on the 23rd of August 1976, the bank launched the national currency, Pula, which was pegged at par with the rand (Grandes, 2003). Maintaining and promoting stability in Botswana is one of the main objectives of the bank The monetary objectives. The Central Bank instruments that are used in achieving these objectives are as follows: Bank Rate, OMO, ERM, and Primary Reserve Requirement (Bank of Botswana, 2020).

Figure 7: The monetary policy transmission mechanism for Botswana



Source: Bank of Botswana

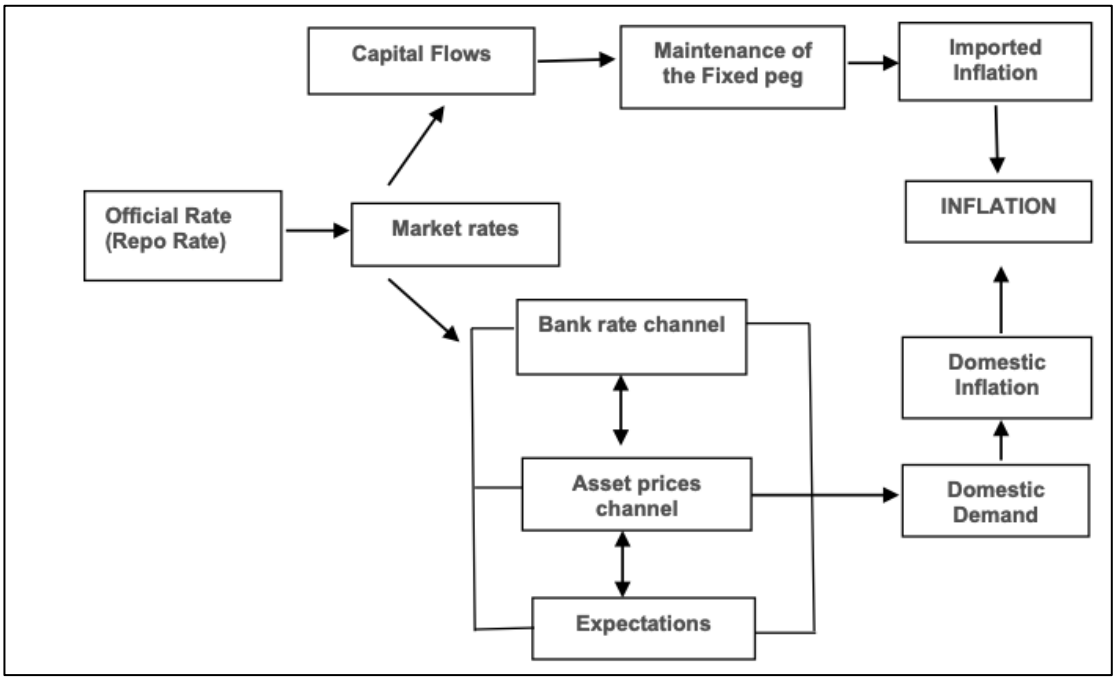
Figure 7 illustrates the MPTM in Botswana. The official interest rate used in Botswana is the bank rate. The bank employs this tool to implement a framework to achieve the medium-term

inflation forecast objective. The changes in the bank rate are therefore transferred through various platforms. Firstly, the short-run decisions affect the long-run interest rate and exchange rate. Secondly, the combination of the changes in long-run interest rates and the exchange rate will lead to changes in the real monetary conditions index. Thirdly, the output gap is determined by the real monetary condition index and lastly, the changes in output gab will be transferred to the inflation together with inflation expectations (Bank of Botswana, 2018)

Monetary policy in Namibia

The Bank of Namibia is a central bank that oversees the monetary policy objectives in Namibia such as maintaining and promoting the price stability of the Namibian economy. Namibia uses the Namibian Dollar as the national currency. The Namibian Dollar is pegged at par with the Rand (Sindano, 2014). The monetary policy framework is boosted by the fixed currency peg to the South African Rand. Under a fixed exchange rate regime, monetary policy is submissive to the fixed peg. Maintenance of the fixed peg, which is the intermediate target, ensures that the goal of price stability is achieved by importing stable inflation from the anchor country (IMF, 2018). The repo rate is used as the official rate. Changes to the repo rate usually consider the SARB's decision. The Bank of Namibia employs the following Monetary policy instruments to achieve its operational targets (Bank of Namibia, 2020).

Figure 8: The monetary policy transmission mechanism for Namibia



Source: Bank of Namibia

Figure 8 above illustrates how monetary policy changes are transmitted in Namibia that show the link between the official rate or repo rate and inflation. The central bank of Namibia uses the repo rate as the official policy rate. Firstly, the official rate decisions affect the market rate, which is then transferred to three channels specifically; the bank rate, the asset prices, and expectations channels. Three channels are directly linked to the domestic demand, the domestic demand then contributes to domestic inflation which has a direct link to inflation. Secondly, changes in market interest rates consequently affect the flows of capital between Namibia and the anchor country (South Africa) (Bank of Namibia, 2018).

Table 11: Summary of monetary policy objectives in SACU

Country	Monetary Policy Objectives
Botswana	Achieve and maintain price stability
Eswatini	Achieve and maintain price stability
Namibia	Achieve and maintain price stability
Lesotho	Achieve and maintain price stability
South Africa	Achieve and maintain price stability

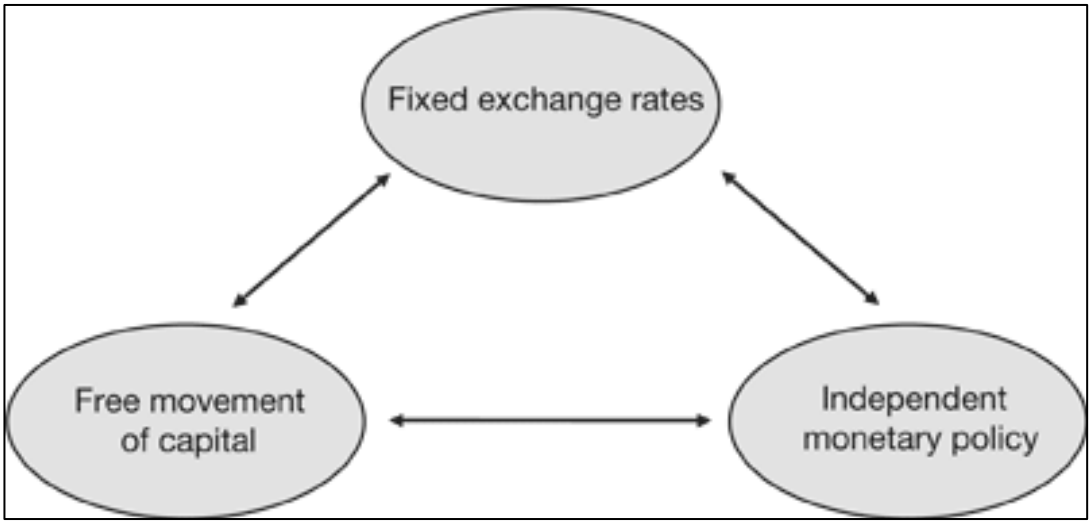
Source: Authors Tabulation

2.3.2 The impossible trinity of monetary policy

Impossible trinity postulates that a country cannot employ the exchange rate policy, free movement of capital, and independent monetary policy at the same time. The country therefore, can only choose two of the three monetary policies. Maintaining the CMA (Al-Raisi et al, 2007). South Africa, Eswatini, Namibia, and Lesotho have established the CMA in 1986. Eswatini, Namibia, and Lesotho have their currency pegged to South African currency and according to the Mundell-Flemming model of open economy's theory of impossible trinity.

However, the impossible trinity concept assumes perfectly functioning financial markets, where even the slightest interest rate differential between countries causes immediate, massive arbitrage as long as the differential holds. In real life, capital movements are not instantaneous, costless, or frictionless. There are transaction costs, convenience considerations, and inertia in moving funds from one country to another. There are also lags; for instance, money deposited in fixed deposit accounts cannot be moved before the deposit reaches its maturity date.

Figure 9: Impossible trinity of monetary policy



Source: Bank of Botswana

2.4 SACU BANKING OVERVIEW

This section provides the overview of the banking sector in SACU. Table 12 provides the structure of the payment systems in SACU. All the payments systems are operational in SACU countries.

Table 12: Payment systems in SACU

Country	Manual	Electronics	RTGS	Agent	International
South Africa	*	*	*	C.B	S.W.I.F.T
Botswana	*	*	*	C.B	S.W.I.F.T
Eswatini	*	*	*	C.B	S.W.I.F.T
Namibia	*	*	*	C.B	S.W.I.F.T
Lesotho	*	*	*	C.B	S.W.I.F.T

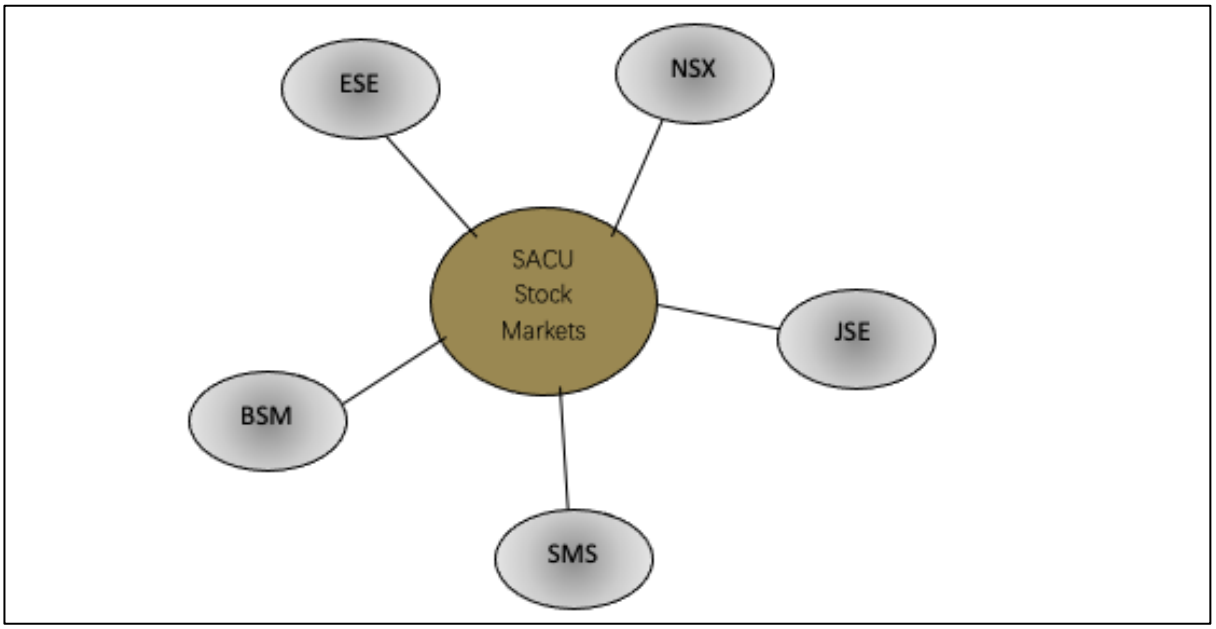
Notes: Manual: Manually operated systems, RTGS: Real time settlement system, C.B: Central Bank and S.W.I.F.T: Society for Worldwide Interbank. "*" denotes applicable.
Source: Authors Tabulation

2.5 SACU STOCK MARKET OVERVIEW

This section will provide the stock market overview in SACU. Each of the member states has its own stock market, with the South African stock market, JSE being the oldest one and the largest in SACU and Africa, and Maseru Securities Market (MSM) being the youngest stock

market in SACU. Refer to Table 13 below for an overview of the history of Stocks markets in SACU.

Figure 10: SACU Stock market



Source: Author Design

The JSE is the oldest and largest stock market in SACU and the Africa continent and is currently ranked the 19th largest stock exchange in the world by market capitalisation (JSE, 2020). JSE Limited (previously the JSE Securities Exchange and the JSE) was formed in 1887 during the first South African gold rush, the JSE is one of the world's 20 largest exchanges by market capitalisation and the largest exchange in Africa. Following the first legislation covering financial markets in 1947, the JSE joined the World Federation of Exchanges in 1963 and upgraded to an electronic trading system in the early 1990s. The JSE acquired the South African Futures Exchange (SAFEX) in 2001 and the Bond Exchange of South Africa (BESA) in 2009 (Hassan, 2013).

The Maseru Securities Market (MSM) is the youngest market in SACU, formed in 2014. The SMS was formulated to enable financial security trading. The MSM is a registered legal entity, and, in common with international practice, a philosophy of self-regulation by the markets is practiced and shall be applied to the MSM (CoSSE, 2017).

Before the Botswana Stock Exchange (BSE) was formed in 1989, it was referred to as the Botswana Share Market (BSM), as the informal market. The BSE was fully transformed and ready for operation by 1994 and several products were listed. In 1986, after the relaxation of the exchange controls in South Africa, several companies had a dual listing in both Botswana and South Africa (Okeahalam, 2005). The BSE is regarded as the best-performing stock in AFRICA (Garonfolo (2012).

The Eswatini Stock Exchange was formally formed in 1990 as the Swaziland Stock Market (SSM). The SSM was a non-bank credit institution in terms of the Financial Institutions (Consolidated) Order, 1975 under Section 18 (1) (b). The SSM became a full-function stock exchange and was renamed the Swaziland Stock Exchange (SSX) (Schiereck, 2018). In 2003, it was incorporated in terms of the Companies Act, 1912 as a public company utilising Central Bank of Eswatini staff as promoters for the purpose of its registration. After the promulgation of the Securities Act of 2010, in January 2013, the SSX was transferred to the Financial Services Regulatory Authority (FSRA) and operated as a 'quasi-company' within the Capital Markets Department (CMD) (Klagge,2018). From January 2017, the SSX moved out of the FSRA to be an independent institution. The SSX operates under the Securities Act of 2010 and the Companies Act 2013. It is licensed and regulated by the FSRA. (CoSSE, 2016) In February 2019, the ESE changed its name from SSX to ESE, which coincided with the launch of its new LOGO and Automated Trading System (ATS).

The first Namibian Stock Exchange (NSX) was founded in 1904 because of the diamond rush, it later on closed. In 1990, the second stock exchange was opened. In 1992 the NSX was officially launched, with one firm and one broker. In 1998, NSX followed JSE's ways of trading. The NSX operating license is issued by NAMFISA. The NSX was officially launched in September of 1992 by Finance Minister then (Matongela and Karodia, 2015)

It is also interesting to note the structure and size differences of stock exchanges in the SACU region, with the Johannesburg Stock Exchange (JSE) having the largest and most diversified stock market in the continent, with over 400 company listings (Phiri, 2015), whilst the other member states have relatively smaller stock exchanges (i.e. Namibia Stock Exchange (NSE) has 50 listed companies, Botswana Stock Exchange (BSE) has 32 list companies, Eswatini Stock Exchange (ESE) has 10 listed companies, Lesotho has no listed companies). The structure of the stock exchanges in the smaller member states is dominated by financial

services, particularly the banking sector and asset management companies, export-linked companies such as diamond/mineral companies in Botswana and Namibia ,and sugar companies in Eswatini.

Table 13: stock markets in SACU

Country	Market	Abbreviation
South Africa	Johannesburg Stock Exchange	JSE
Botswana	Botswana Stock Exchange	BSE
Swaziland	Swaziland Stock Exchange	SSX
Namibia	Namibia Stock Exchange	NSX
Lesotho	Maseru Securities Market	MSM

Source: Authors Tabulation

All SACU members except Botswana are members of the Common Monetary Area, with currencies pegged to the South African rand. Imports from outside SACU are subject to a common external tariff (Hassan, 2013).

2.6 OVERVIEW OF EXCHANGES RATES REGIMES IN SACU COUNTRIES.

The history of South African exchange rate policy dates back to 1944, during the Bretton Woods system. This system called for countries to adopt monetary policies that would manage exchange rates by linking the countries' currencies to gold. South Africa adopted this monetary policy until 1968-1973 when it was cancelled (Vander Merwe, 1996). Since then, South Africa subsequently adopted various exchange rate policies after the dissolution of the Bretton Woods agreement until 1995 (Van der Merwe, 1996) including a crawling peg, fixing the rand to the US dollar, a managed float, and a dual exchange rate regime (Gossel and Biekpe, 2012) comprising of the commercial and financial rand. For the period from March 1995 until 2012, South Africa adopted a floating exchange rate regime and has since maintained the same regime.

The exchange rate policy in Eswatini and Lesotho follows that of South Africa because of its membership in the CMA and has its national currency pegged to the South African rand. By Eswatini and Lesotho being members of CMA, they gave away (to an extent) the control of monetary and exchange rate policy to the South African monetary authorities and becomes interest rates taken from South Africa. However, Eswatini and Lesotho have their own currencies, which grants them a certain degree of independence. Eswatini and Lesotho

introduced their own national currencies (Lilangeni and Loti) after gaining their independence (Grandes, 2003).

When Namibia became independent in 1990, it has to choose between different monetary policy options and exchange rate regimes. That is, to pursue an independent monetary policy or remain in the CMA. Unlike Botswana, Namibia chose to remain in the CMA and that resulted in Botswana exchange rate pegged to that of the anchor country, South Africa. The South African rand remained a legal tender in Namibia (Kalenga, 2001). Furthermore, when Namibia's monetary policy adopted a fixed exchange rate, the exchange rate became the main policy instrument used to control inflation in order to maintain financial stability. By maintaining a fixed peg, a country can achieve its monetary policy objective of price stability by importing stable inflation from the anchor country. (BON, 2008).

After Botswana left the CMA in 1976, it had to then formulate and implement its own exchange rate policy. Currently, the exchange rate regime in use is a crawling peg. Before the implementation and formulation of this exchange rate policy, Botswana the country had no independent monetary or exchange rate policy, and the South African rand circulated in Botswana. So as Botswana left the CMA it then introduced its own currency, pula, and the independent central bank was born in that same year.

Table 14: Exchange rate regime in SACU

Countries	Currency	Regimes
Botswana	Pula	Pegged to basket (South African rand and SDR) crawling
Eswatini	Lilangeni	Pegged to South African rand (CMA)
Namibia	Namibian dollar	Pegged to South African rand (CMA)
Lesotho	Loti	Pegged to South African rand (CMA)
South Africa	Rand	Independently floating; rand is CMA anchor currency

Source: Authors Tabulation

2.7 SUMMARY

The chapter sought to give an overview of SACU countries. Firstly, the chapter provided a history of SACU, where the definition of SACU was provided along with the basic features of the customs unions and the structure of the institution. Secondly, the economic background of

SACU countries was outlined briefly. Thirdly, the chapter looked at monetary policy in the SACU region in detail and their frameworks are provided. Fourthly, the monetary transmission mechanism for the different Central Banks in SACU countries was discussed. Lastly, the financial sector of SACU is discussed, followed by an overview of the stock markets and exchange rate regimes in SACU countries. In the following chapter, the literature review is discussed.

CHAPTER 3: LITERATURE REVIEW

This chapter seeks to review the literature of the first level pass-through effects of the monetary policy transmission and this literature is divided into four main sections: Literature on the Fisher effect (the relationship between interest rates and inflation); Literature on the purchasing power parity (the relationship between exchange rates and inflation); Literature on the relationship between exchange rate and stock returns; Literature on the relationship between interest rate, exchange rate, and stock prices literature.

In order to keep the discussion of the literature tunnel-visioned, the empirical reviews are going to strictly focus on i) studies previously conducted for SACU and ii) international studies which used wavelet analysis as their methodology. It is important to note that no previous SACU-based studies have used wavelets in their empirical analysis despite these revealing more information on the different monetary relationships.

3.1 TRANSMISSION MECHANISM THEORY

Milton Friedman's (1970) monetary theory focuses on the macroeconomic effects of the money supply and central banking procedures or mechanisms. According to this idea, monetary authorities should focus solely on preserving price stability and expanding the money supply regularly, as these two monetary policy instruments are the principal drivers of economic growth.

Adjustable interest rates are used to regulate the money supply in conformity with monetary policy objectives. Customers save rather than spend when interest rates rise, restricting the money supply. Alternatively, depending on the current state of the economy, an expansionary monetary policy characterized by lower interest rates (lower borrowing costs) may be adopted to increase the money supply. As a result, the economy will benefit from higher growth rates, henceforth the understanding of the transmission mechanism of variables is important as it provides policymakers with a clear indication on where to implement expansionary or contractionary monetary policy.

There are two theoretical approaches to the transmission mechanism of how monetary policies affect the real economy namely; Keynesian transmission mechanism and monetarist transmission mechanism. It is important to consider the views about the role of monetary policies in different theoretical on the economy (Adanuraklan and Nargeleçekenler, 2008).

3.1.1 Keynesian Transmission Mechanism

In Keynesian theory, as long as there was no liquidity trap, it is argued that the changes in monetary supply have effects on real interest rates and economic activity (Jackman, 1974). The Keynesian theory suggests an indirect transmission and one of the key focus components is the aggregate spending given by the equation below:

$$Y = C + I + G + (X - M) \quad 1$$

Y = real output, C = consumption, I = investment, G = government spending and X-M = net exports. Figure 11 illustrates the Keynesian monetary transmission mechanism.

Figure 11: Keynesian monetary transmission mechanism

Source: McConnel and Brue (1996)

3.1.2 Monetarist Transmission Mechanism

According to (Wray, 1993), in the monetarist approach, change of monetary policy has more effects than increasing the interest rates in the short term. Traditional quantity theory is based on a simple transmission mechanism, where the increases in monetary supply directly raise the level of demand. This simple mechanism is valid in the conditions, in which the level of demand directly depends on the variation in monetary supply. Compared to Keynesians, Monetarists, use money supply as the focal point. Below I illustrate the monetarist equation:

$$MV = PQ \quad 2$$

M signifies the supply of money, V symbolise the velocity of money, P denotes the price level of the economy and finally, Q indicates the physical volume of all goods and services.

Monetarists led by Milton Friedman posit that money matters and argue that monetary policy is transmitted through either interest rate, exchange rate channel, or both (Friedman and Schwartz, 1963).

Figure 12: Monetarist monetary transmission mechanism

Source: McConnel and Brue (1996)

Interest rate channel

According to Mishkin (1995), there are four general channels of transmission mechanisms by the interest rate, exchange rate, asset prices, and credit channel.

Taylor (1995) conducted a survey on the interest rate changes and strong empirical evidence for substantial interest rate effects on consumption and investment spending. This makes the interest rate monetary transmission mechanism a strong one. Changes in the repurchase rate influence the interest rates on retail financial products (Smal and de Jager, 2001). Domestic banks are likely to adjust their lending rates as soon as the official rate is changed. A change in the interest rates will lead individuals and firms to adjust their investment and spending patterns. As a result, Consumption spending (C), fixed capital formation (I), and real output (y) will then start to respond to this change. Through this channel, demand pressures will lead to changes in the output gap, inflation, and unemployment. The interest rate channels showing the effects of a monetary policy expansion can be represented as follows:

$$\downarrow repo \rightarrow \downarrow interest\ rates \rightarrow (\uparrow I, \uparrow C) \rightarrow \uparrow y \quad (3)$$

Where ↓repo indicates an expansionary monetary policy leading to a fall in the interest rates (↓interest rates), which in turn lowers the cost of capital, causing a rise in investment spending

and consumption (↑I, ↑C), thereby leading to an increase in aggregate demand and rise in output (↑y).

Asset price channels

Initially, the key monetarist objection for analysing monetary policy effects on the economy focused on only one asset price, the interest rate, rather than many asset prices. Modigliani (1971), a Keynesian economist, recognised other channels such as other relative asset prices and real wealth transmit monetary effects onto the economy as being critical to the monetary mechanism. There are, however, two key assets besides bonds that substantial attention in the literature on the transmission mechanism, namely; foreign exchange rate and equities.

Exchange rate channel

Policy changes in interest rates can also affect the exchange rate. The exchange rate is the relative price of the domestic and foreign currencies (Mishkin, 1996). This section will explain the monetary policy transmission operating through exchange rate effects on net exports. This channel also involves the interest rate effects. In South Africa, when the real interest rate falls, demand deposits dominated in rand become less attractive than the demand deposits dominated in foreign currencies and the rand depreciates. The lower the value of the domestic currency (ER) makes domestic goods cheaper than foreign goods, thereby causing a rise in the net exports (NX) and hence in the aggregate output. Another sound consequence of the depreciation of the rand is that it directly increases the cost of imported goods and therefore has a negative effect on the domestic price level, and hence on inflation. The schematic illustration of the exchange rate channel is thus:

$$\downarrow \text{repo} \rightarrow \downarrow \text{interest rates} \rightarrow \downarrow \text{ER} \rightarrow \uparrow \text{NX} \rightarrow \uparrow \text{y} \qquad 4$$

Credit channels

The new view of the monetary transmission mechanism that emphasizes asymmetric information in financial markets was introduced because of the dissatisfaction with how the interest rate explains the impact of monetary policy on expenditure on long-lived assets. There are two basic channels of monetary transmission that arise as the result of information problems

in the credit market, namely; the bank lending channel and the balance sheet channel of firms and households.

3.2 FISHER EFFECT LITERATURE REVIEW

3.2.1 Theoretical review

The Fisher hypothesis, which was first proposed by Irving Fisher (1930), suggests that there is a positive correlation between nominal interest rates and expected inflation. This hypothesis also implies that the real interest rate is constant and independent of monetary measures. In a world of perfect foresight, the Fisher effect can be defined as a one-to-one relationship between nominal interest rates and expected inflation, leaving real interest rates independent of the inflation rate. The basic version of the equation that has been used to test the existence of the Fisher effect is as follows:

$$i_t = \alpha + \beta\pi \quad (5)$$

i_t is the nominal interest rate,
α is the real interest rate and
π is the expected inflation for the period

By definition, β is expected to be equal to 1 in order to conclude for a strong Fisher effect. If β is positive but not equal to one, then there is evidence of the weaker form of the Fisher effect Irving Fisher In his analysis, he used inflation and nominal interest rate data from Great Britain and the United States for the periods 1820-1924 and 1890-1927 respectively. (Fisher, 1930) found no apparent relationship between price changes and interest rates in these countries in the short-run, where a correlation coefficient of -0.459 was obtained from the British data and -0.289 for the United States data without lagging the data. In contrast, when a distributed lag of past inflation was used as a proxy of expected inflation, the correlation coefficients increased substantially.

When expected inflation was used instead of inflation, (Fisher, 1930) obtained correlation coefficients of 0.98 and 0.857 for Great Britain and the United States, when price changes were spread over 28 years and 20 years respectively. From these findings (Fisher, 1930) concluded that he found evidence general and specific, from correlating P' with both bond yields and short-term interest rates, that price changes do, generally and perceptibly affect the interest rate

in the direction indicated by a priori theory. But since forethought is imperfect, the effects are smaller than the theory requires and lagged behind price movements, in some periods, very greatly. When the effects of price changes in interest rates are distributed over several years, I have found remarkably high coefficients of correlation, thus indicating that interest rates follow price changes closely in degree, though rather distantly in time.

Empirical scholars have given other explanations for why Fisher's economically intuitive hypothesis has not held in its fullest version. Due to the influence of inflation on wealth and, as a result, savings, Mundell and Tobin (1963) suggest that nominal interest rates should move less than one-for-one. According to Darby (1975) and Feldstein (1976), the effects of tax would result in a greater than a one-for-one adjustment to predicted inflation. while Shome, Smith, and Pinkerton (1988) argue that a premium should be built into nominal interest rates to account for covariance risk. Carmichael and Stebbing (1983) suggested the inverted Fisher effect, which underlines the possible implications of various econometric techniques and assumptions on the strength of the Fisher effect. Finally, the monetary policy's impact on the Fisher effect. Several scholars have discovered that changes in monetary policy have altered the amplitude of the long-run link between nominal interest rate and projected inflation.

3.2.2 Empirical review

This section will be reviewing Fisher effects empirical studies focusing on the SACU-based and wavelet-based studies.

3.2.2.1 Review of SACU-based studies

This section presents SACU studies by authors such as Wesso (2000), Mitchell-Innes et al. (2007), Phiri and Lusanga (2011), Yaya (2015), Nemushungwa (2016), Bahamani-Oskooee et al. (2016), Bayat et al. (2018), Phiri (2019), Phiri and Mbekeni (2020), Bosupeng (2015), (Khumalo et al. (2017), Peyavali and Sheeefeni (2013), and Phiri (2021). Whilst there exists a considerable amount of empirical works which have studied the Fisher effect for the individual SACU countries (see Table 15 below) I am persuaded that more empirical research needs to be conducted on the topic for SACU countries.

Wesso (2000) investigated the Fisher effect in South Africa using data from 1985 to 1999. The study used a cointegration approach and the results showed FE evidence. Similarly, Mitchell-

Innes, Aziakpono and Faure (2007) analysed the FE in South Africa using data from 2000 to 2005. Using cointegration and error correction models, it was concluded that the short-run Fisher hypothesis did not hold during the relevant period under the inflation targeting monetary policy framework in South Africa.

Phiri and Lusanga (2011) studied the Fisher effect in South Africa. The relationship was examined using the unit-roots within a Threshold Autoregressive (TAR) models and Threshold Vector Error Correction (TVEC) models. The empirical analysis depicts significant long-run Fisher effects whereas such effects are deficient with regards to the short-run.

Peyavali and Sheeefeni (2013) examined the Fisher effect in Namibia. The study used data spanning from period 1992 to 2011. The results of this study revealed that there is no evidence of the Fisher effect in Namibia for the studied period. Khumalo and Assensoh-Kodua (2017) investigated the FE Eswatini using data spanning from 2010-2014. The study employed OLS regressions and concluded that there is evidence of significant FE in Eswatini.

Bosupeng (2015) investigated the Fisher effect for 20 selected countries by interest rates and inflation for the period from 1982 to 2013. The results showed that the Fisher effect holds in all countries under examination. Comparatively, the Johansen cointegration procedure evidenced that the Fisher effect holds in all economies except the US, Bhutan, South Africa, Chile, Switzerland, and Australia

Phiri and Mbekeni (2020) followed a nonlinear ARDL approach to examine the FE in South Africa. The study used data from 2002-2020 and revealed that there is Stronger FE during rising periods in pre-crisis whilst a stronger Fisher effect during the falling period in post-crisis. Phiri (2021) investigated the NeoFisher effect in South Africa using data from the period 2002-2019. The study followed frequency domain causality tests and revealed that there is no evidence of the NeoFisher effect found in South Africa.

Table 15: Summary of SAC-based studies

Author name	Country	Time-period	Methods	Findings
Wesso (2000)	South Africa	1985-1999	VECM	Little evidence of traditional FE
Mitchell-Innes et al. (2007)	South Africa	2000-2005	VECM	Weak cointegrating of long-run FE
Phiri and Lusanga (2011)	South Africa	1980-2011	TAR and TVEC	Significant long-run FE
Peyavali and Sheefeni (2013)	Namibia	1992-2011	VECM	No FE, absence of cointegration effects
Khumalo and Assensoh-Kodua (2017)	Eswatini	2010-2014	OLS	Significant FE
Bosupeng (2015)	Botswana, Lesotho, SA and Namibia	2005-2013	VECM	FE exists for Lesotho and Botswana
Nemushungwa (2016)	South Africa	2001-2014	ARDL	Partial FE
Phiri and Mbekeni (2020)	South Africa	2002-2020	Nonlinear ARDL	Stronger FE during rising periods in pre-crisis whilst stronger Fisher effect during falling period in post-crisis
Phiri (2021)	South Africa	2002-2019	Frequency domain causality tests	NeoFisher effect found

Source: Authors Tabulation

3.2.2.2 Review of wavelet-based studies

The past several decades have seen numerous empirical studies of the Fisher equation. This well-known hypothesis, introduced by Irving Fisher (1930), maintains that the nominal interest rate is the sum of the constant real rate and expected decline in the purchasing power of money. In this paper, the discrete wavelet transform to decompose inflation and different maturity interest rates data for both U.S. and Canada into five-time scales and estimate the Fisher effect at the wavelet domain was employed. The basic findings are that DWT can overcome the

difficulty of spurious regression resulting in long-memory time series and there is a long-run Fisher effect in both United States and Canada but not a short-run Fisher effect.

Bhanja, Dar, Tiwari (2012) investigated the Fisher effect using the tools of the wavelet power spectrum, cross-wavelet power spectrum, and cross-wavelet coherency. The results suggest that for a frequency band between 16 and 32, there is some evidence of the fisher effect. For the rest of the frequencies and time periods, however, there is no evidence of the fisher effect and it seems stock prices have not played any role as an inflation hedge.

Zheng, Yajuan, Zhang (2013) investigated the relationship between the stock market returns and inflation using signal decomposition techniques based on wavelet analysis. The relationship is negative in the intermediate time scale, while the relationship in the short and long time scales is different. Overall, the Fisher model holds at the most time scales, implying that stocks are a good hedge against inflation.

Tiwari, Cunado, Gupta, and Wohar (2019) used UK data from 1970-2017. The methodology of the study was the wavelet analysis. The study found that while the relationship between stock returns and inflation rates varies across frequencies and time periods, there is no evidence of stock returns acting as an inflation hedge.

Moshiri, Pakizeh, and Dabirian (2010) used Tehran data to study the FE and the results show a negative relationship between inflation and the TSE returns in the short run horizon and a positive relationship in the long run horizon. Kim and In (2006) studied the relationship between inflation rate and the stock returns in the US for the period 1947-2001 using wavelet methodology. The study found that industry returns can be a hedge against inflation.

Tiwari, Dar, Bhanja, Arouri, and Teulon (2015) examined the relationship between stock returns and inflation in Pakistan. The study used the methodology of frequency-based causality and continuous wavelet transform for the period 1961-2012. Results indicate that inflation does not erode the value of stocks in Pakistan and stocks could be used as a hedge against inflation at least in the long run be used as a hedge against inflation at least in the long run.

Haniff and Masih (2018) used the data from Malaysia for the period 2007-2015 to study the

hedging effectiveness of Islamic stock returns against inflation for different investment horizons. The evidence showed that The FTSE Bursa Malaysia Emas Shariah Index constituent returns may potentially hedge against inflation.

The above two sections have reviewed the SACU-based studies and wavelet-based studies of the FE. However, there are no evidence of the SACU studies that have studied the FE using the wavelet analysis. this study therefore, seek to close that gap in the literature.

Table 16: Summary of wavelet-based studies

Author	Country	Period	Method	Findings
Bhanja, Dar, Tiwari	India	1960-2009	Wavelet analysis	Between 16 and 32 months, there is some evidence of the fisher effect
Zheng, Yajuan, Zhang (2013)	China	2006-2011	Wavelet analysis	Fisher model holds at the most time scales
Tiwari, Cunado, Gupta, and Wohar (2019	UK	1970-2017	Wavelet analysis	No evidence of SR acting as an inflation hedge
Moshiri, Pakizeh, and Dabirian (2010).	Tehran	-	Wavelet analysis	Results show a negative relationship between inflation and the TSE returns in short-run horizon and a positive relationship in long-run horizon.
Kim and In (2006)	USA	1947-2001	Wavelet analysis	Results show that industry returns can be a hedge against inflation.
Tiwari, Dar, Bhanja, Arouri and Teulon (2015)	Pakistan	1961-2012	Wavelet analysis	Inflation does not erode the value of stocks in Pakistan and stocks could be used as hedge against inflation in the long-run
Haniff and Masih (2018	Malaysia	2007-2015	Wavelet analysis	The FTSE Bursa Malaysia Emas Shariah Index constituent returns may potentially hedge against inflation

Source: Authors Tabulation

3.3 PURCHASING POWER PARITY LITERATURE REVIEW

There is a lot of controversy about the PPP. Studies have found evidence consistent with the PPP and other studies found that the PPP doesn't hold for both developed and developing economies. The majority of these studies have employed the unit root tests and cointegration techniques studies to test for the PPP. In this section, the discussion of the previous studies of PPP as well as the generalised purchasing power parity studies is presented. The literature review is organized into three main areas. The first is the review of the purchasing power parity theories. The second section reviews the empirical evidence from SACU-based studies. Thirdly, the chapter concludes with a review of wavelet-based studies. Finally, the chapter reviews studies that have investigated the Generalized PPP (GPPP).

3.3.1 Purchasing Power Parity Theory

The theory of PPP was introduced by Gustav Cassel (1918), however, the concept originated in the 16th century with the school of Salamanca. One of the most controversial theories of PPP is based on the inflation-exchange rate relationship. Exchange rates adjust so that a market basket of goods costs the same, regardless of the country of purchase. According to Madura (2018), the PPP theory is supported by the notion that a country with higher inflation will see a decline in demand for its currency due to decreased export (due to higher local pricing) and increased import (resulting from lower foreign prices). As a result, the exchange rate will alter in accordance with the resulting shift in currency demand. The absolute form and the relative form are the two major versions of the PPP theory (Officer, 1978).

Absolute form

The PPP in its absolute term is called the law of one price. The law of one price assumes that the price of similar products of two different countries should be equal if measured in a common currency (Krugman and Obstfeld, 2009). If the law of one price did is rejected, then the good should shift from one country in such a way that the prices will have to converge. There are three assumptions for the Law of one price to hold. Namely: The transaction costs must be zero, there should be no barriers to trading such as tariffs, taxes, and transport costs and the commodities in question must be identical. This theory in its realistic form does not

happen due to market imperfection brought by my different levels of technology, cost of production, taxation, cost of transport (Findreng, 2014)

Relative form

The relative form is an alternative PPP form that accounts for the imperfections that may exist in the market that states that the rate of change in the price level of commodities in one country relative to the rate of change in the price level in another determines the rate of change of the exchange rate. This form acknowledges the fact that the price of similar products in different countries will not necessarily be the same, even if measured in common currency. However, it states that the rate of change in the prices of similar products in different countries will be somewhat similar when measured in a common currency. The assumption is that the transportation costs and other trade barriers remain constant. with the passage of time, both countries will experience some inflation and the exchange rate or trade between the two countries will automatically adjust itself in such a manner so that the difference in the rate of inflation will be offset. In such a situation the prices of the products in the 2 countries will appear similar to its citizens (Nahavandi, 1990)

The theory of purchasing power parity is usually expressed by a long-run relationship between the nominal exchange rate and the relative price levels. The theory states that the exchange rate between two countries equals the ratio of the country's price levels. PPP thus asserts that all country's price levels are equal when measured in terms of the same currency (Krugman and Obsetfeld, 2003).

3.3.2 Empirical review

This section will be reviewing PPPs empirical studies focusing on the SACU-based, GPPP-based, and wavelet-based studies.

3.3.2.1 Review of SACU-based studies

In the context of SACU, the empirical literature is very limited. Studies such as Chang, Chu, and Su (2009), Kargbo (2004), Makhetha (2007), Iyke and Odhiambo (2015) provided evidence of the PPP in Lesotho. Atta, Jefferis, and Monnathoko (1996), Kargo (2003), Tshipinare (2005), Paul and Motlaleng (2008), Mohd and Soon (2011), Tsai, Weng and lin

(2012), and Sejoe, Sinha, and Kahaka (2020) found contradiction results of the PPP in Botswana. While Hoarau (2010) found evidence of PPP in Eswatini and finally, Ocran (2014) could not support any evidence of PPP in Namibia.

Atta, Jefferis, and Monnathoko (1996) investigated price formation dynamics in the short and long run. The findings indicate that South African prices and the rand/pula exchange rate have a very large long-run influence on Botswana pricing. In the near run, both domestic and foreign inflationary forces drive price growth. This implies that monetary, exchange rate, and fiscal policy can all be employed to control inflation in the short run.

Kargo (2003) investigated the long-run purchasing power parity in Africa. Using data spanning data from 1958 to 1997 using Johansen cointegration technique. The empirical evidence showed strong support for long-run PPP in Africa, thereby providing wider acceptance for the applicability of PPP in the exchange rate and other macroeconomic adjustment policies. Tshipinare (2005) investigated Purchasing Power Parity for Botswana and South Africa using a cointegration test. The study found that the Purchasing Power Parity hypothesis fails to hold in the long run for Botswana and South Africa.

Makhetha (2007) examined the validity of purchasing power parity hypothesis fixed exchange rate regime. The study employed the ADF unit root tests. The real exchange rate is found to be a random walk, a revelation that does not lend support to the validity of the PPP doctrine. Paul and Motlaleng (2008) confirmed the PPP theory in Botswana in both absolute and relative terms for the Pula-Dollar exchange rate from the third quarter of 1992 to the fourth quarter of 2002. Chang, Chu, and Su (2009) examined whether the purchasing power parity theory holds for a sample of African countries from 1980 to 2003. A rigorous, highly dynamic non-linear unit root test was used in the investigation. PPP holds for these six nations, namely the Central African Republic, Côte d'Ivoire, Kenya, Madagascar, Uganda, and Lesotho, according to the findings.

Hoarau (2010) used data from 1970 to 2007 to investigate the long-run purchasing power parity hypothesis for a panel of 17 African economies. The novel panel data stationary test was used in the study, and the results provided significant evidence for purchasing power parity when the Balassa-Samuelson variant was evaluated. This study lends credence to the notion that purchasing power parity is most likely to be found in high inflation in less developed countries

and non-CFA countries. Mohd and Soon (2011) analysed the long-run evolution of eleven African countries' black and official currency rates and discovered that the majority of African countries support the long-run informationally efficient theory. Tsai, Weng, and lin (2012) studied the PPP in Botswana, South Africa, Swaziland using data from the period 1970-2011. The study employed the ADRL approach. The study found that the PPP theory is only evident in South Africa.

Sheefeni and Ocran (2014) explored the pass-through of currency rates to domestic pricing in Namibia. The impulse response functions and variance decompositions produced from a structural vector autoregressive model were used in the investigation, which spanned the years 1993 to 2011. The impulse response function results reveal that changes in exchange rates have a large and long-lasting effect on inflation in Namibia, as well as an incomplete pass-through, demonstrating that PPP does not apply to the price level in Namibia. Iyke and Odhiambo (2015) examined the validity of the PPP hypothesis for two Southern African countries, namely: Lesotho and Zambia using two unit root tests without structural breaks. The data covers the period spanned 1960-2010 and 1955-2010, for Lesotho and Zambia, respectively. The study found that the PPP hypothesis was supported in the case of Lesotho, but rejected in the case of Zambia.

Sejoe, Sinha, and Kahaka (2020) investigated Purchasing Power Parity theory in Botswana from 1976 to 2016, taking into account both currency rates, notably the Pula/Rand and the Pula/US dollar. Five cointegration approaches were used to test the theory's validity between these two exchange rates. When utilizing the Engle-Granger cointegration approach, the results revealed that there was no long-run association between the variables in both situations of the Pula/Rand and Pula/US dollar exchange rates. The error correction model, however, indicated a short-run cointegration, and ARDL results revealed that the variables were cointegrated with each other for both Botswana and South Africa, as well as Botswana and the United States of America. This demonstrated a long-run relationship between the variables and verified the long-run PPP theory between Botswana and South Africa, as well as Botswana and the United States of America.

Table 17: Summary of SACU-based studies

Author name	Country	Time-period	Methods	Findings
Atta, Jefferis, and Monnathoko (1996)	South African and Botswana	1976-2016	Cointegration test	variables are cointegrated with each other for both Botswana and South Africa
Kargo (2003)	Africa countries	1958-1997	Cointegration test	Long run PPP
Tshipinare (2005)	Botswana and South Africa	1985-2005	Cointegration test	No long run PPP
Makhetha (2007)	Lesotho	1977-2000	ADF unit root tests	No PPP
Paul and Motlaleng (2008)	Botswana	1992-2002	Cointegration test	PPP
Chang, Chu, and Su (2009)	Africa countries	1980-2003	Unit root test	PPP holds true for these 6 nations
Hoarau (2010)	Africa countries	1970-2007	Panel data stationary test	Mixed results
Mohd and Soon (2011)	Africa countries	1980-1998	Cointegration test	Mixed results
Tsai, Weng, and lin (2012)	Botswana, South Africa and Swaziland	1970-2011	ADRL	PPP holds for South Africa
Sheefeni and Ocran (2014)	Namibia	1993-2011	SVAR	No PPP
Iyke and Odhiambo (2015)	Lesotho and Zambia	1955-2010	Unit root tests	PPP holds only for Zambia
Sejoe, Sinha and Kahaka (2020)	Botswana	1976-2016	ARDL	Long run PPP

Source: Authors Tabulation

3.3.2.2 Review of wavelet-based studies

Few recent studies have studied the relationship between the nominal exchange rate and the prices using the wavelets, however, this study becomes the first of its kind to study the PPP in SACU using the wavelets. In this section of the paper, I review recent literature which applied wavelet tools to investigate the relationship between nominal exchange rates and prices. The studies such as Lan (2011), Berger (2012), Bhanja, Dar and Samantaraya (2013), Almasri,

Mansson, Sjolander and Shukur (2016), and Vo and Vo (2020) have all found evidence of the PPP across different countries and time frames using the wavelets.

Lan (2011) used wavelet analysis and investigated the behaviour of nominal and real exchange rates over different time horizons. Both techniques' empirical results support PPP for the British pound, Japanese yen, and Swiss franc. The anticipated long-run duration for these three currencies ranges from 1.5 to 5 years. The results for the Canadian dollar and the euro indicate a probable long-term reliance.

Berger (2012) used wavelets and Fractionally Integrated Processes (FIP) to derive an OLS estimate of the long-run memory parameter. The findings reveal that real exchange rates are mean-reverting and vulnerable to large fluctuations, implying that unit root tests are ineffective for analysing exchange rates. Bhanja, Dar, and Samantaraya (2013) investigated the relative version of Purchasing Power Parity in India against the currency of its leading trade partners, the US and Britain. The study used quantile regression and semi-parametric wavelet-based regression. The results show that at higher quantiles of the exchange rate, there is some evidence for the parity to hold for the rupee-pound exchange rate. Similarly, at higher time scales, the parity relation is evident for rupee-dollar and rupee-pound exchange rates.

Almasri, Mansson, Sjolander, and Shukur (2016) used two different non-parametric wavelet-based panel unit-root tests in the presence of unknown structural breaks and cross-sectional dependencies in the data to test for the PPP. The results find strong, clear-cut support for PPP in this developing region. Vo and Vo (2020) used the wavelet approach to study the PPP in order to throw some light on the international finance literature that PPP holds in the long run but not in the short run. The results suggest that the decomposed measures provide insight for future actual change rate movements. Furthermore, the nominal exchange-rate dynamics are dominated by low-frequency activity. As a result of the findings of this study, researchers and practitioners will be able to build a more efficient exchange-rate modelling framework.

Table 18: Summary of wavelet-based studies

Author name	Country	Time-period	Methods	Findings
Lan (2011)	British pound, Japanese yen, and Swiss franc	1973-2008	Wavelet analysis	Evidence for PPP for the British pound, Japanese yen, and Swiss franc. The estimated length of the long run for these three currencies varies from 1.5 to 5 years
Berger (2012)	Sweden, Norway, Japan, Britain, US, Europe	1990-2011	Wavelet analysis and FIP	Exchange rates are mean reverting and subject to long swings
Bhanja, Dar, and Samantaraya (2013)	India	-	Semi-parametric wavelet analysis	PPP hold for the rupee-pound exchange rate
Almasri, Mansson, Sjolander and Shukur (2016)	Central America	-	Non-parametric wavelet analysis	Found support for the PPP hypothesis when applying the new wavelet-based method but not when using the traditional parametric IPS and Wald tests
Vo and Vo (2020)	Eurozone, US, Japan, UK, Switzerland, Canada and China	1999-2019	Wavelet analysis	Nominal exchange-rate dynamics are dominated by activities corresponding to low frequencies

Source: Authors Tabulation

3.3.2.3 Generalised Purchasing Power (GPPP)

In reviewing the GPPP literature, it is observed that a majority of the previous literature has been focused on the ASIAN economy Bayoumi and Eichengreen (1994), Enders and Hurn (1997), Liang (1999), Mouratidis (2001), Grandes (2003), Wilson and Choy (2007), Choudhry (2005), Ahn, Kim, Chang (2006), Mishra and Sharma (2010), Rangkakulnuwt, Ahn, Wang and He (2010), Taguchi (2010), Nusair (2012), Kawasaki (2012) and Thanakijsombat (2016).

Authors such as Mkenda (2001), Grandes (2003), Redda and Muzindusti (2017), Zerihun and Breitenbach (2018) and Gitimu (2018) studies GPPP for the African economy. Bernstein (2000) and Antonucci and Girardi (2006) focused on the Euro area. Mouratidis (2001) studied GPPP for EMU, Enders and Hum (1997) looked at the G7 countries, Sarno (1997) investigated the UK, Italy, France, Germany, and Japan, Caporale and Girardi (2011) investigated Baltic, Latifa, and Aicha and Soumia (2016) looked at GCC economy and Hakim, AboElsound and Dahalan (2012) studied the GPPP in B-8 economy.

Bayoumi and Eichengreen (1994) used the Generalised Purchasing Power Parity (GPPP) hypothesis framework to check if Southeast Asia (Hong Kong, Indonesia, Malaysia, Singapore, and Thailand) and Northeast Asia (Japan, Korea, and Taiwan) could form an OCA. The study used data spanning from 1969 to 1989. The results showed that Southeast Asia and Northeast Asia could form an OCA. Enders and Hurn (1997) also put GPPP to the test with the G7 countries. They discovered one cointegration vector at the 5% significance level, implying that the real exchange rates of those nations appear to be linked by a single long-run equilibrium relationship and that a shock to anyone rate is likely to affect the long-run values of the others. Liang (1999) discovered that G-PPP holds for China, Hong Kong, Japan, and the United States and that these countries form an optimal currency region. Bernstein (2000) examined G-PPP for the eurozone and discovered that the null hypothesis of noncointegration cannot be rejected.

Mouratidis (2001) examined the issue of OCA in five European Monetary System nations, namely France, Greece, Italy, Portugal, and Spain, using Generalised Purchasing Power Parity based on the Johansen cointegration technique. It assesses the degree of asymmetry in various sub-periods using four equilibria. According to the empirical findings, these countries were only a part of the OCA from 1991 to 1998. Mkenda (2001) used the Generalized Purchasing Power Parity approach to determine whether the East African Community, which includes Kenya, Tanzania, and Uganda, is an optimal currency area. The Generalised Purchasing Power Parity technique encourages the creation of a regional currency union. Using the GPPP approach, the study established cointegration between East African real exchange rates from 1981 to 1998, and even from 1990 to 1998. This study shows that the three countries are susceptible to similar shocks.

Using annual data from 1967 to 1997, Yuen and Ling (2001) discovered that Singapore, Malaysia, Japan, Korea, and Taiwan-Hong Kong are potential candidates for monetary

integration. They argue that achieving regional monetary integration should be accomplished in stages and that regional monetary integration could begin with smaller currency areas. Grandes (2003) carried out a two-step econometric exercise based on the theory of generalised purchasing power parity to check if the Common Monetary Area in Southern Africa, henceforth CMA, has ever been an optimal currency area. According to the analysis, the CMA (as well as Botswana as a de facto member) form an OCA due to the existence of long-run patterns in their bilateral real exchange rates. Lee (2003) also discovered that Australia, New Zealand, and Japan form an optimal currency region, but this is not the case for Australia, New Zealand, and the United States.

Choudhry (2005) found evidence of GPPP for Indonesia, Malaysia, the Philippines, South Korea, and Thailand relative to the US, Japan, and Thailand for the entire period and the post-Asian crisis period, but not for the pre-Asian crisis period, using monthly data from 1990 to 2004 and the Johansen procedure. Using the Johansen procedure and monthly data from 1970 to 2003, Ahn et al. (2006) discovered evidence of GPPP for the Association of Southeast Asian Nations (ASEAN)4 (Indonesia, Malaysia, Singapore, and Thailand) and four Northeast Asian countries (Hong Kong SAR, Japan, Korea, and Taiwan) and concluded that those eight countries could form an OCA. Similarly, Huang and Guo (2006) discovered that Hong Kong, Indonesia, Korea, Malaysia, Singapore, and Thailand could create an OCA using annual data from 1970 to 2002. Some have recently examined the numerous OCA criteria as a composite index.

Wilson and Choy (2007) discovered limited evidence for GPPP for ASEAN5 prior to the Asian crisis and conflicting results for the postcrisis era using the Johansen technique and monthly data from 1975 to 2004. Taguchi (2010) investigated the economic viability of constructing an Asian regional currency bloc by using a generalized purchasing power parity approach to assess the existence of similar trends in real exchange rates among a set of nations. The study estimated bilateral and multilateral co-integration on real exchange rates utilizing samples from 17 Asian nations including South Asia after the 1997-98 crisis. The findings are as follows: First, Japan, China, and Korea are revealed to be poor candidates for optimum currency zones. Second, ASEAN and South Asia as a whole met the G-PPP requirement. Third, several noteworthy co-integrating interactions were discovered between ASEAN and South Asian nations.

Rangkakulnuwt, Ahn, Wang, and He (2010) used quarterly data from 1980 to 2003 and the cointegration technique to investigate the extended G-PPP for Korea, Malaysia, the Philippines, Singapore, and Thailand relative to Japan. They discover evidence of two cointegrating vectors, notwithstanding a hiatus in 1990 caused by the fall of the asset price bubble and Japan's economic stagflation. The first is understood as GPPP and the countries meeting necessary criteria for the formation of an OCA, while the second is interpreted as expanded G-PPP.

Caporale and Girardi (2011) studied the macroeconomic interdependencies between the Euro area and three transition economies (Estonia, Lithuania, and Latvia), with the aim of establishing whether the latter is ready to adopt the Euro, using the VEC model. The theoretical framework is based on the Generalised Purchasing Power Parity hypothesis, which is empirically tested within a VEC model. The study used monthly and quarterly data over the period 1993 to 2005. The results found that GPPP holds for the real exchange rate vis-à-vis the Euro of each Baltic country.

Nusair (2012) used the Johansen cointegration and the generalized purchasing power parity theory to analyse the potential for an optimum currency area for the ASEAN5 plus the major three during a period with severe structural cracks. The findings support long-run G-PPP and show that the larger group might establish an OCA in a single step. The influence of the Asian crisis appears to be limited to when the United States is the base country, and the findings indicate a shift in the GPPP connection between the pre-and post-crisis periods. Furthermore, stability tests indicate that G-PPP has been steady over the time period studied.

Kawasaki (2012) explored whether or whether ASEAN5, China, Korea, and Japan have evolved into OCAs in recent years. While transforming the previous generalized purchasing power parity model into a modern non-linear econometric model and addressing the incorporation of the Asian monetary unit (AMU) into this domain. The study yielded favourable empirical results, indicating the formation of an East Asian common currency. Thanakijsombat (2016) explored the feasibility of OCA creation and the optimal anchor currency selection in ASEAN. Using the GPPP framework, modern cointegration tests were used on bilateral exchange rates involving ASEAN-5 currencies versus four currencies of ASEAN's key trading partners between 2003 and 2014. The findings show that ASEAN

countries are not yet ready to create an OCA, with only a few significant bivariates and inconclusive multivariate cointegrating connections discovered.

Latifa, Aicha, and Soumia (2016) employed the Generalized Purchasing Power Parity using exchange rate data to explore the feasibility of an ideal currency area in Gulf Cooperation Council (GCC) countries, including Saudi Arabia, Bahrain, Kuwait, Oman, Qatar, and the United Arab Emirates, from 1981 to 2013. The empirical findings reveal a long-term link between real exchange rates, confirming the GCC's planned monetary integration.

Redda and Muzindusti (2017) used the generalised purchasing power parity framework on price (inflation rate) and exchange rate, which is consistent with the OCA theory. Johansen cointegration test, vector error correction model, and Pedron's panel cointegration test were all used in the procedure. According to the study's findings, GPPP is prevalent throughout SADC. Zerihun and Breitenbach (2018) investigated the viewpoint of the GPPP hypothesis and optimum currency area theory in SADC using Johansen’s multivariate co-integration technique. This result has important policy implications for the proposed monetary union in SADC.

Gitimu (2018) used exchange rates between the East African Community (EAC) member states with the US dollar for the time period from 2000 to 2015 using Kenya. The study discovered some convergence in the MCC, implying that the EAC economies could converge even further. Based on GPPP theory, the examination revealed a long-term relationship in both sets of bilateral exchange rates, qualifying the EAC to be a currency region.

Table 19: Summary of GPPP studies

Author name	Country	Time-period	Methods	Findings
Bayoumi and Eichengreen (1994)	Southeast Asia	1969-1989	Cointegration test	Evidence of GPPP
Enders and Hurn (1997)	G7 countries	1973-1989	Cointegration test	Evidence of GPPP
Liang (1999)	China, Hong Kong, Japan, and the United States	1979-1998	Cointegration test	Limited evidence for GPPP
Bernstein (2000)	Eurozone	1972-1996	Cointegration test	Limited evidence for GPPP
Mouratidis (2001)	5 European Monetary System nations	1991-1998	Cointegration test	Evidence of GPPP
Mkenda (2001)	East African	1981-1998	Cointegration test	Evidence of GPPP
Yuen and Ling (2001)	Singapore, Malaysia, Japan, Korea, and Taiwan-Hong Kong	1967-1997	Cointegration test	Evidence of GPPP
Grandes (2003)	Southern Africa	1990-2000	Cointegration test	Evidence of GPPP
Lee (2003)	Australia, New Zealand,	1975-2000	Cointegration test	Evidence of GPPP except for the USA
Choudhry (2005)	Indonesia, Malaysia, the Philippines, South Korea, and Thailand relative to the US, Japan, and Thailand	1990-2004	Cointegration test	Evidence of GPPP
Ahn et al. (2006)	ASEAN4, 4 Northeast Asian countries	1970-2003	Cointegration test	Evidence of GPPP
Huang and Guo (2006)	Hong Kong, Indonesia, Korea, Malaysia, Singapore, and Thailand	1970-2002	Cointegration test	Evidence of GPPP

Wilson and Choy (2007)	ASEAN5	1975-2004	Cointegration test	Limited evidence for GPPP
Taguchi (2010)	17 Asian nations	1997-1998	Cointegration test	Japan, China, and Korea are revealed to be poor candidates for OCA. ASEAN and South Asia as a whole met the G-PPP
Rangkakulnuwt, Ahn, Wang and He (2010)	Korea, Malaysia, the Philippines, Singapore, and Thailand relative to Japan	1980-2003	Cointegration test	Evidence of GPPP
Caporale and Girardi (2011)	Euro area and Estonia, Lithuania, and Latvia	1993-2005	VEC model	Evidence of GPPP
Nusair (2012)	ASEAN5	1973-2009	Cointegration test	Evidence of GPPP
Kawasaki (2012)	ASEAN5	-	Cointegration test	Evidence of GPPP
Thanakijsombat (2016)	ASEAN5	2003-2014	Cointegration test	Not ready for OCA
Latifa, Aicha, and Soumia (2016)	GCC	1981-2013	Cointegration test	Evidence of GPPP
Redda and Muzindusti (2017)	SADC	1995-2015	Cointegration test	Evidence of GPPP
Zerihun and Breitenbach (2018)	SADC	1995-2012	Cointegration test	Evidence of GPPP
Gitimu (2018)	EAC	2000-2015	Cointegration test	Evidence of GPPP

Source: Authors Tabulation

3.4 STOCK PRICE AND EXCHANGE RATE LITERATURE REVIEW

3.4.1 Theoretical review

According to the monetary transmission mechanism, economic variables help understand the changes in stock returns Friedman and Paden (1983). Fang and Miller (2002) stated that when

investors invest in both domestic and foreign markets, they have to consider how movements in the currencies will affect their expected stock returns. Below, the discussing the exchange rates and stock prices theories is presented.

3.4.1.1 Exchange rates and stock prices theories

There are two classical theoretical approaches that explain the relationship between exchange rate and stock prices, namely; the traditional approach (Dornbusch and Fisher, 1980) and the portfolio approach (Branson, 1983). These approaches describe the channels through which changes in the exchange rates are transmitted to stock prices and vice-versa. The two approaches are addressed in further depth further below:

The traditional approach (Flow-oriented)

According to Huy (2016) traditional approach is viewed as flow-oriented which suggests that exchange rate granger-cause stock prices. When a currency depreciates, the competitiveness of the local firms will improve, leading to higher exports (Dornbusch and Fischer, 1980). Solnick (1987) states that a real currency appreciation is a bad news for the domestic corporation because it will reduce its competitive ability to export, while a real depreciation enhances its ability to export in the short run. Note that the flow-oriented approach suggests a positive relationship between stock price and exchange rate. However, Pilbean (1998) states that the model does not consider international capital movements, but these capital movements dominate the foreign currency market.

The portfolio approach (Stock-oriented)

The portfolio approach is viewed as a stock-oriented exchange rate model, indicating that the effect is from stock prices to exchange rates. This model was developed after Flow-oriented models by Branson (1983). The portfolio adjustment approach supports the opposite view that there is a negative relationship between stock price and exchange rate whereby movements in exchange rates are driven by changes in stock prices, that is the causality runs from stock prices to exchange rate. Therefore, an inverse relationship is suggested to exist between exchange rates and stock prices. Contrary to portfolio balance models, monetary models (Gavin, 1989) conclude that there is no linkage between exchange rates and stock prices.

3.4.1.3 The Efficient Market Hypothesis

Fama (1970) established EMH suggesting that capital markets are incredibly efficient as they reflect all available information regarding a stock market or any individual stock. This hypothesis was in terms of the fair game model which postulated that investors can be confident that a current market price fully reflects all available information about security and the reflected return based upon this price is consistent with risk (Naseer and Tariq, 2014). There existed many market participants that analysed securities, a large number of competing investors who attempted to adjust the price of a stock, and new information arrived randomly (Huang, 2019) Fama (2016, 1970) further classifies the market efficiency into three forms; weak, semi-strong and strong forms. These forms are determined based on how rapidly information is factored into stock prices and thus it is influenced by dynamic forces such as transactional costs, informational costs, and the level to which investors agree on the implication of current information.

The EMH is classified into three levels: weak, semi-strong, and powerful. Forms of efficiency: Because all prior information is priced into stock in such a market, current returns cannot be predicted from past ones, according to the weak form EMH. If prices in a market quickly absorb historical information, then the market is efficient. In such a market, it is impossible to forecast future profits based on past ones. Thus, macroeconomic fundamentals cannot be used to forecast stock market returns (Ferson et al. 2005).

According to the weak form, EMH information from a series of asset returns cannot be used to beat the market and gain abnormal returns. This requires the time series on the returns on the asset to evolve as a random walk and thus being unpredictable.

According to the semi-form EMH, public information is immediately priced into the stock, and so neither fundamental nor technical research can offer returns above market averages. Furthermore, the semi-strong form efficient market indicates that macroeconomic factors, such as exchange rates, could not be used to predict stock prices.

While the strong form of EMH suggests that all available information (public and private) is absorbed into the stock price and that no investor can have a competitive advantage over the market as a whole.

3.4.2 Empirical review

Based on the theoretical models that suggest causal relations between stock prices and exchange rates, several notable kinds of research have been carried out to empirically investigate the interactions between these two variables - stock prices and exchange rates. However, consensus on the course of effect and causality between these two financial markets variables remains unresolved. The inconsistent or contradictory results in this field vary from one study to another.

3.4.2.1 Review of previous SACU-based studies

In reviewing the previous literature examining the relationship between exchange rates and stock returns for SACU countries I find that a majority of the previous literature has been focused on the South African economy Adjasi and Biekpe (2005), Ocran (2010), Hsing (2011), Alam, Uddim, and Taufique (2011), Ndako (2013), Mlambo et al. (2013), Sui and Sun (2015), Fowowe (2015), Ncanywa and Ralarala (2019) and Phiri (2020). Only one study by Lesotho et al. (2016) was performed for Botswana Stock Exchange and another one study by Eita (2012) in Namibia whilst, to the best of my knowledge, there is no empirical evidence on the subject matter for the remaining SACU country, Eswatini and Lesotho.

According to Adjasi and Biekpe (2005) who investigated the relationship between stock prices and exchange rate movement in Ghana, South Africa, Egypt, Kenya, Mauritius, and Nigeria using a VAR model and found that there is no long-run stable relationship between stock market prices and exchange rates for Egypt, Ghana, Kenya, Mauritius, Nigeria, and South Africa. Ocran (2010) studies the relationship between stock prices and exchange rates of South Africa and the US. This study employed Granger causality, impulse response functions, and forecasting error variance decompositions methods. The study found that there is a bi-directional causality from the stock price index to the exchange rate. Furthermore, It was also found that the Standard & Poor's stock price index accounts for a significant portion of the variations in the Johannesburg Stock Exchange's All Share index.

Hsing (2011) studied the effects of selected macroeconomic variables on the stock market index in South Africa using the exponential GARCH model. The study found a negative association between the share price index and the nominal effective exchange rate. Alam, Uddim, and Taufique (2011) studied the relationship between the daily price indices of all

securities listed on the JSE and the exchange rate for the period from 2000 to 2004 in South Africa. This study ought to provide supporting evidence of the existence of market efficiency and the exchange rate sensitivity on the stock prices. Using the unit root test, the ADF test, and the Granger causality test, the study found evidence that the JSE is informationally efficient. There is a long-run co-movement between the stock prices and the exchange rates.

Eita (2012) investigated the macroeconomic determinants of stock market prices in Namibia. The study was conducted using a VECM econometric methodology and the results show that Namibian stock market prices are chiefly determined by economic activity, interest rates, inflation, money supply, and exchange rates. Ndako (2013) investigated the relationship between stock prices and exchange rates in Mauritius, Ghana, Kenya, Nigeria, and South Africa using dynamic conditional correlation models. He identified stock price-real exchange rate causality rates in Ghana and Mauritius, as well as real exchange rate-stock price causality rates in Nigeria, but there is no causation between stock price and real exchange rate in Kenya and South Africa. Ghana, on the other hand, is the only country with a positive link between stock prices and the real exchange rate.

A study done by Mlambo et al. (2013) found a very weak relationship between currency volatility and the stock market. The study ought to assess the effects of currency volatility on the JSE using the GARCH model. The study employed monthly South African data for the period from 2000 to 2010. Sui and Sun (2015) investigated the relationships among local stock returns, foreign exchange rates, interest differentials, and stock returns in BRICS countries; Brazil, Russia, India, China, and South Africa for the regime of managed floating exchange rate, but China manipulates the foreign exchange rate, interest rate and restricts foreign capital flows most strictly. The results show that there are significant spillover effects from foreign exchange rates to stock returns in the short-run, but not vice versa. Stock returns shock significantly influence stock markets in Brazil, China, and South Africa. Furthermore, there are stronger spillover effects between exchange rates and stock returns during the 2007–2009 financial crisis.

Furthermore, the study was concluded by Fowowe (2015) in South Africa and Nigeria while investigating the relationship between stock prices and exchange rates for the two largest economies in Africa, South Africa, and Nigeria showed that causality runs from exchange rates to domestic stock prices in Nigeria while in South Africa, no causality exist from domestic

stock prices and exchange rates, in addition, there is causality from the London stock market to both countries' stock markets, showing that international stock markets are driving both the Nigerian and South African stock markets. A study done by Otisitswe (2015) investigated the effect of bilateral exchange rate movements on stock market returns in Botswana. The data used in the study is monthly data from 2001 to 2014. To examine whether this effect exists or not, the Johansen cointegration test, VECM, Granger causality test, Impulse Response Function (IRF), and Variance Decomposition (VD) are employed. The empirical results indicate that there exists a long-run equilibrium relationship between the stock market returns and exchange rates in Botswana.

Another study by Ncanywa and Ralarala (2019) was conducted in South Africa to investigate the relationship between stock market prices and the exchange rate using monthly data for the period 2006 to 2016. The study employed the Johansen cointegration, ARCH, and the GARCH models due to the high volatility of the stock market prices. The study shows that when the foreign exchange rate appreciates, the stock market will be negatively affected and that there is a long-run relationship between stock market prices and the exchange rate.

A study done by Phiri (2020) investigated how the 2007 sub-prime crisis and the adoption of the Millennium trading platform affected the exchange rate and equity return in the JSE. The study employed the nonlinear autoregressive distributive lag cointegration using the monthly data from 2000-2017. The results show that the crisis exchange rates appreciations generally cause stock returns whereas depreciations are unlikely to cause stock returns to decrease. However, during the crisis period this relationship entirely disappears whilst resurfacing subsequent to the adoption of a new trading platform although the dynamics of the time series differs between sectors.

Table 20: Summary of SACU-based studies

Author name	Country	Time-period	Methods	Findings
Adjasi and Biekpe (2005)	Ghana, South Africa, Egypt, Kenya, Mauritius and Nigeria	1992-2005	VAR	No relationship
Ocran (2010)	South Africa and the US	1986-2006	Granger causality, impulse response functions, and forecasting error variance decompositions	Bi-directional causality from the stock price index to the exchange rate
Hsing (2011)	South Africa	1980-2010	GARCH model	Negative Relationship
Alam, Uddim, and Taufique (2011)	South Africa	2000-2004	Unit root, ADF and the Granger causality test	Found evidence of the relationship
Eita (2012)	Namibia	1998-2009	VECM	Found evidence of the relationship
Ndako (2013)	Mauritius, Ghana, Kenya, Nigeria, and South Africa	1990-2010	EGARCH	No causation for South Africa
Mlambo et al. (2013)	South Africa	2000-2010	GARCH	Weak relationship
Sui and Sun (2015)	BRICS countries	2007-2009	VECM and VAR	Found evidence of the relationship
Fowowe (2015)	South Africa, and Nigeria	2003-2013	Cointegration test	In South Africa, no causality exists between the variables
Otisitswe (2015)	Botswana	2001-2014	Johansen cointegration and VECM	Long run relationship
Ncanywa and Ralarala (2019)	South Africa	2000-2017	VECM and VAR	Appreciations cause stock returns whereas cause stock returns to decrease

Source: Authors Tabulation

3.4.2.2 Review of wavelet-based studies

It is interesting to note that this study is not the first in the literature to make use of wavelets to investigate the relationship between exchange rates and stock returns. In this section of the paper, I review recent literature (He et al. (2012), Dar et al. (2014), Afshan et al. (2018), Dahir et al. (2018), Owusu et al. (2018), Tursoy and Mar'I (2020) and Das (2021)) which applied wavelet tools to investigate the relationship between exchange rates and stock returns. Notably, most of these recent studies have been conducted for emerging economies.

In Turkey, He et al. (2012) studied the causal relationship between the Turkish stock market returns and foreign exchange rates. The study employed the wavelet coherence approach for the period from 2000 to 2019. The wavelet coherence showed that the Turkish stock market returns are found to be strongly correlated with the exchange rates. Furthermore, Turkish stock market returns and foreign exchange rate returns are in anti-phase at short-term and medium-term scales, implying that in the short and medium-term over the selected time period, there is a negative correlation between foreign exchange returns and the Turkish stock market returns. According to the results of the wavelet power spectrum, Both exchange rates exhibit high power during the 2000 banking and the 2001 economic crises and during the exchange rate crisis in 2018 but only at the scale of 0–16 periods. The results clearly reveal that there is significant volatility in the patterns of the exchange rates. These results show how these crises affected the behaviour of the exchange rates in Turkey, not only in the short term but also in the medium term.

Dar et al. (2014) investigated the relationship between stock and foreign exchange markets using wavelet-based correlation and quantile regression approach for the Asian markets. The study exhibited a negative relationship in accordance with the portfolio balance approach and this relationship is heterogeneous across different time scales. Furthermore, it is noted that when periods of longer than one year are considered, the existence of an intense negative relationship between stock markets and exchange rates cannot be ruled out. The OLS approach showed that there is a significantly negative relationship across all countries.

Afshan et al. (2018) use the wavelets approach methodology namely; Continuous wavelet power spectrum, cross wavelet transform and wavelet coherence to investigate the relationship between stock prices and exchange rate in Pakistan. The results of continuous wavelet power

spectra (CWT) identify the patterns of strong variance in many small, medium and long time periods for exchange rates and stock price returns, however, the stock returns lack visibility in long periods. The cross wavelet transforms were used to measure the covariance between the variables and witnessed the presence of the Traditional Approach in the medium time period during 1997-2000 and later in 2007-2008. The wavelet coherence exhibit dominance of SP during 2005-2006 and 2011-2012 in the period of 8-16 and 16-32 weeks cycle. For almost the entire studied period on a long scale, the study evidences the strong coherence between both the series. The coherence between both the series. The study also found the existence of bidirectional causality in the long timescale, where the arrows are exhibiting out phase relationship with mutually leading and lagging the market.

Dahir et al. (2018). Investigated the relationships between stock returns and exchange rates in Brazil, Russia, India, China, and South Africa (BRICS) using data from the period 2006 to 2016. The study employed the wavelet analysis methodology. Using the Wavelet coherences, the study found high co-movements of exchange rates and stock markets in the BRICS countries in the medium and long term, except in China, implying greater correlations, which suggests the existence of strong interdependence between exchange rates and stock returns.

Owusu et al. (2018) investigated the two indices on the Ghana Stock Exchange, the larger Ghana Stock Exchange Composite Index (GSE-CI) and the smaller Ghana Stock Exchange Financial Services Index (GSE-FSI) with the US dollar and Euro using means of the Continuous Morlet Wavelet Transform fostering covariance/correlation, lead-lag causal relationship as well as coherency through the wavelets analysis. The study used the daily data from 2011 to 2016. The study revealed a narrowly identifiable lead-lag relationship between GSE-CI and USD/GHS and GSE-FSI and USD/GHS. The results of the wavelet coherencies reveal a very high co-movements exist between the variables.

Tursoy and Mar'I (2020) investigated the relationship between money supply and inflation in Turkey. The study used the wavelet analysis, mainly focused on continuous wavelet analysis, cross wavelet transforms, and wavelet coherence and phase-difference, for the period from 1987 to 2019. The study found a bidirectional relationship between money supply and inflation using the phase difference. The results are said to be consistent with both the traditional quantity theory of money in the long run and the modern quantity theory of money in the short-run and long run. Das (2021) investigated the time-frequency relationships between stock

market returns, crude oil prices, and exchange rates in India using the cross wavelet spectrum plots to measure the association between the variables. The study found the co-movements between the variables at different time scales.

Table 21: Summary of wavelet-based studies

Author name	Country	Time-period	Methods	Findings
He et al. (2012)	Turkey	2000-2019	Wavelet coherence approach	Found that the rises affected the behaviour of the exchange rates in Turkey, not only in the short term but also in the medium term
Dar et al. (2014)	Asian markets	1996-2013	Wavelet-based correlation	Negative relationship in accordance with the portfolio balance approach
Afshan et al. (2018)	Pakistan	1997-2012	Continuous wavelet power spectrum, cross wavelet transform and wavelet coherence	Found the existence of bidirectional causality in the long timescale
Dahir et al. (2018).	BRICS countries	2006-2016	Wavelet coherences	Found high co-movements of exchange rates and stock markets in the BRICS countries at the medium and long term
Owusu et al. (2018)	Ghana	2011-2016	Continuous Morlet Wavelet Transform	The results of the wavelet coherencies reveal a very high co-movements exist between the variables
Tursoy and Mar'I (2020)	Turkey	1987-2019	Continuous wavelet	Found a bidirectional

			analysis, cross wavelet transforms and wavelet coherence and phase-difference	relationship between money supply and inflation using the phase difference
Das (2021)	India	1999-2021	Wavelet analysis	The co-movements between the variables at different time-scales

Source: Authors Tabulation

3.5 INTEREST RATES, EXCHANGE RATES, AND STOCK RETURNS LITERATURE REVIEW

This section discussed theoretical and empirical literature on interest rates, exchange rates, and stock returns. The empirical literature review is going to have 3 strands of literature; Interest rates and stock prices studies; Interest rates and exchange rates studies; and wavelet-based studies.

3.5.1 Interest rates and exchange rates literature review

3.5.1.1 Theoretical review

The interest rates channel shows how exchange rates respond to monetary policy shocks. The causality runs from changes in interest rates to changes in exchange rates and this implies a negative relationship between exchange rates and interest rates (Mishkin, 2001). Theoretically, the relationship between the exchange rate and the interest rate can be examined in the short and long run. In the short run, the exchange rate and the interest rate are typically considered to be negatively related and that is when product prices are sticky, and in the long, the exchange rate and the interest rate are positively related when they are not sicky.

Interest rate is an important macroeconomic variable and the theoretical approach illustrates the channel through which changes in interest rates are transmitted through the economy to ultimately affect the exchange rate. The Interest Rate Parity theory states a positive relationship between Interest rates and Exchange rate in a country (Wu and Chen, 1998). Hacker, Kim, and Mansson (2010) noted that exchange rate determination models in the flexible-price monetary

tradition tend to indicate there should be a positive relationship between the interest rate and the exchange rate

Higher interest differentials, according to the Mundell-Flemming model, would attract capital inflows and result in exchange rate appreciation. Monetarists, on the other hand, believe that higher interest rates lower demand for money, resulting in currency depreciation due to excessive inflation (Sargent and Wallace, 1981).

The theory that links interest rates and exchange rates is the Uncovered Interest Parity theory (UIP). According to the UIP theory, discrepancies in interest rates across countries can be explained by predicted exchange rate movements. In other words, the interest rate differential between the domestic country and the rest of the globe is equal to the predicted change in the domestic exchange rate. The uncovered interest parity framework is as follows:

$$i_t - i_t^* = E(e_{t+1}) - e_t + RP_t \qquad 6$$

where i_t is the domestic interest rate at time t, i_t^* is the foreign interest rate at time t, e_t is the domestic exchange rate at time t, $E(e_{t+1})$ is the expected exchange rate at time $t + 1$, and RP_t is the country risk premium which incorporates both the exchange risk premium and the default risk premium on domestic bonds. According to this framework, an increase in the domestic interest rates will reduce e_t, i.e. appreciate the current exchange rate if i_t^* and $E(e_{t+1})$ are kept constant. This is explanation is proposed by the traditional view.

3.5.1.2 Empirical review

This section will be reviewing interest rates and exchange rates empirical studies focusing on the SACU-based and wavelet-based studies.

3.5.1.2.1 Review of SACU-based studies

Few studies in SACU have been conducted by authors such as Raputsoane and Todani (2008) in South Africa, Wilson and Sheefeni (2014) in Namibia, Makombo (2015) in Botswana. Raputsoane and Todani (2008) used data from 1986 to 2005 to study the relationship between rand per US dollar exchange rates, money, income, and interest rate differentials between the

two countries. The study employed the Johansen (1995) cointegration framework. The results show the existence of a long-run relationship between the variables.

Wilson and Sheefeni (2014) examined the relationship between the exchange rate and the interest rate for Namibia using quarterly data for the period 1993 to 2012. This study used unit root tests, cointegration tests, impulse response, and variance decomposition as the methodology. The results for cointegration show that there is no cointegration among the variables. The empirical results of this study have been unable to detect a clear systematic relationship between interest rates and exchange rates.

Makombo (2015) studied the determinants of interest rate spreads in the commercial banks in Botswana using data from 1996 to 2006. The study finds that intermediation costs, Herfindahl index, inflation, and exchange rate depreciation are the main drivers of interest rate spreads while liquidity, equity, and overhead costs proved to be statistically insignificant.

Table 22: Summary of SACU-based studies

Author name	Country	Time-period	Methods	Findings
Raputsoane and Todani (2008)	South Africa	1986-2005	Cointegration test	Long-run relationship among the variables
Wilson and Sheefeni (2014)	Namibia	199-2012	Unit root tests, cointegration tests	No cointegration among the variables
Makombo (2015)	Botswana	1996-2006	Cointegration test	Cointegration among the variables

Source: Authors Tabulation

3.5.2 Interest rates and stock returns literature review

3.5.2.1 Theoretical review

The interest rate channel shows that changes in interest rates lead to changes in stock prices, therefore the causality runs from interest rates to stock prices. This channel predicts a negative correlation between stock prices and interest rates. An expansionary monetary policy lowers interest rates, therefore, lead an increase in the demand for stocks, pushing up the price of stocks. Contractionary monetary policy increases the interest rates that leading to an increase

in the demand for debt securities and a fall in the demand for stocks and stock prices. The relationship between the two markets arises from this trade-off (Alam and Uddin, 2009).

3.5.2.2 Empirical review

This section will be reviewing interest rates and stock prices empirical studies focusing on the SACU-based and wavelet-based studies.

3.5.2.2.1 Review of SACU-based studies

This section presents the literature of the studies done in SACU. Coetzee (2002) examined the relationship between monetary variables such as inflation, short-term interest rates, the rand-dollar exchange rate, and stock prices. Using data from 1991 to 2001. The study found that the variables are negatively related in both the short run and the long run. Adjasi and Biekpe (2006) found that there is a long-run relationship between interest rates and stock market returns in Kenya and South Africa. This relationship was positive for Kenya but negative for South Africa. The literature does not provide a clear direction on the relationship between interest rate and stock market returns which means that the causal relationship between interest rate and stock market returns remains an open question or an empirical issue.

Galebotswe and Tlhalefang (2012) studied the impact of monetary policy shocks on stock returns using the standard VAR technique. The study used quarterly data for Botswana for the period 1993 to 2010. The results indicated that positive interest rate innovations are associated with increases, rather than decreases, in the aggregate stock returns. In the same year, a study was done in Botswana by Nemaorani (2012). The relationship between real and nominal stock returns and the short-term interest rate was explored. The study focused on monthly data for the period 2001 to 2011. The study established a positive and statistically significant relationship between interest rate changes and stock returns in Botswana. Eita (2012) used the vector error correction model to study the macroeconomic determinants of stock market prices in Namibia over the period from 1998 to 2009. The evidence presented in this paper suggests that increases in income level and money supply raise stock prices while inflation rate and interest rate had a negative impact on stock prices.

Sikalao-Lekobane (2014) investigated the long-term equilibrium relationship between the Botswana stock market price and selected domestic and global macroeconomic variables. The

study used the quarterly data for the period 1998 to 2012. The methodology employed is the VECM framework. The study found that the short-term interest rates and market prices are positively related and long-term real interest rates are negatively related to the stock market price. Eita (2014) investigated the between interest rate and stock market return in Namibia for the period 1996 to 2012 using cointegrated vector autoregression methods. The results show that there is a negative relationship between stock market returns and interest rates in Namibia. The results suggest that contractionary monetary policy through higher interest rates decreases stock market returns in Namibia.

John, Ibenta, Adigwe (2020) studies the effect of interest rate on stock market performance in Nigeria, South Africa, and Ghana. Using time-series data from 1986 to 2018. The data was analysed using the ARDL. The study showed that the interest rate has a negative effect on the stock performance in Nigeria, South Africa, and Ghana. Marozva (2020) examined the extent to which stock returns are linked to interest rate and exchange rate in South Africa from 1995 to 2019, using OLS and GARCH. The study revealed a positive and significant relationship between stock returns volatility and interest rates. However, exchange rates only exhibited a significant positive relationship under the OLS methodology for the JSE All-Share Index return volatility.

Table 23: Summary of SACU-based studies

Author name	Country	Time-period	Methods	Findings
Coetzee (2002)	South Africa	1991-2001	VEC	Negative relationship
Adjasi and Biekpe (2006)	Kenya and South Africa	-	GMM	Positive for Kenya. Negative for South Africa
Galebotswe and Tlhalefang (2012)	Botswana	1993-2010	VAR	Positive relationship
Nemaorani (2012)	Botswana	2001-2011	Cointegration test	Positive relationship
Eita (2014)	Namibia	1996-2012	VAR	Negative relationship
John, Ibenta, Adigwe (2020)	Nigeria, South Africa, and Ghana	1986-2018	ARDL	Negative relationship
Marozva (2020)	South Africa	1995-2019	OLS and GARCH	Positive and significant relationship

Source: Authors Tabulation

3.5.2.3 Review of wavelet-based studies

Several studies applied the wavelet analysis to study how exchange rates and interest rates relate to each other using the ordinary econometric methodology. However, few studies used wavelet analysis. Wavelet analysis has the advantage that it can decompose a time series into different time scales so that the relationship between variables can be analysed in the short run, intermediate run, and up to the long run. Authors such as Tari and Adasiz (2009), Hamrita (2011), Tiwari (2012), Hacker et al. (2014), Andries et al. (2014), Andries, Capraru, Ihnatov and Tiwari (2014), Tiwari, Bhanja, Dar, and Islam (2014), Ozun and Cifter (2014), Moya-Martinez, Ferrer-Lapena and Escribano-Sotos (2015), Ferrer, Bolos, and Benitez (2016), Andries, Capraru, Ihnatov and Tiwari (2017), Jayashankar and Rath (2017), Si, Li, Chang, Bai (2018), Tursoy and Mar'I (2020) and Si, Li and Ge (2020).

Tari and Abasiz (2009) studied the relationship between short-term nominal interest rates and nominal exchange rates for the period of 1987 to 2008. The study was analysed by using a frequency-domain approach within the framework of spectral analysis. According to the findings, the causal relationship from the exchange rate to the interest rate was valid only for

the short run, whereas this relationship was effective for a total 45 of months before, during and after the crisis. Using the wavelet transform, Hamrita (2011) investigates the relationship between the interest rate, exchange rate, and stock price in the United States. The relationship between interest rate and the exchange rate is not considerably different from zero, however, the relationship between interest rate returns and stock index returns is.

Tiwari (2012) used a continuous wavelet approach to study the time-frequency relationship between interest rate and share prices in India using monthly data covering the period of 1990 to 2009 and found that for the Indian economy the causal and reverse causal relations between SP and IR vary across scale and period. Hacker et al. (2014) studied the relationship between the spot exchange rate and the nominal interest rate differential for seven different countries using the wavelet analysis. The study found that the variables are negatively correlated.

Andries, Capraru, Ihnatov, and Tiwari (2014) followed the wavelet analysis methodologies to study the relationship between interest rate, stock price, and exchange rate in India. Using data from the period 1997-2010. Their results show that stock prices, exchange rates, and interest rates are linked. The cross wavelet results show that stock price movements are lagging both to the exchange rate and interest rate fluctuations.

Tiwari, Bhanja, Dar, and Islam (2014) investigated the relationship between exchange rates and share prices in India by employing the wavelets approach. The study used data from 1980 to 1993. The study showed proved that the wavelet approach uncover the hidden relationships within the time-frequency domain. Ozun and Cifter (2014) examined the effects of exchange rates on interest rates in Turkey. The study employed the wavelet methodology. The results that the wavelet approach captured the non-linear dynamics between the selected time series. Ferrer, Bolos, and Benitez (2016) used 10-year government bond yields and stock returns from the major European countries for the continuous wavelet transform and found that the degree of connection between interest rates and stock prices differs considerably among countries and also varies over time and depending on the time horizon considered. The significant linkage is mainly concentrated at investment horizons from one to two years.

Andries, Capraru, Ihnatov, and Tiwari (2017) studied Romania's relationship between interest rates and exchange rates using the wavelet methodologies. The study found that the relationship between interest rates and exchange rates differs across small emerging countries and advanced

economies. Jayashankar and Rath (2017) studied the linkage between exchange rate, stock return, and interest rate using MODWT in India. The data employed were monthly data from 2000 to 2014. Their findings suggest that a relationship between these variables is not significant at lower scales. On a higher scales, there is a clear linkage between them, and three markets are associated with each other. Si, Li, Chang, Bai (2018) studied the relationship and causality between exchange rates and interest rate differentials in the BRICS countries. This study employed wavelet analysis from the period from 1996 to 2015. Empirical results indicate that co-movement and causality between interest rate differentials and exchange rates vary across frequencies and evolve over time, and they are more pronounced during the period of the recent global financial crisis in these countries.

Tursoy and Mar'I (2020) investigated Turkey's interest rate and exchange rate using wavelet analysis during the period from 2005 to 2019. They investigate the interrelationship between the interest rate and exchange rate at different time horizons (overnight, 6 months, and up to 1 year) in Turkey using wavelet analysis, mainly continuous wavelet, cross wavelet, and wavelet coherence, during the period from 2005 to 2019. The results indicate that the relationship in the long-run and short-run between exchange rate and interest rate is generally positive and this confirms the purchasing power parity theory and Keynesian approach theoretical predictions on the relationship between exchange rate and interest rate, the negative relationship in the short term is consistent with sticky price models.

Si, Li, and Ge (2020) investigated the exchange rates and the interest rate differentials in China. They employed the wavelet analysis to explore the time-frequency co-movement and causality using the data from 1999 to 2018. The co-movement is intensified at a low frequency after the exchange rate reform in 2005. Exchange rates are found to positively co-move with interest rate differentials, and the former leads the latter. More importantly, they provide robust evidence of meaningful asymmetry and substantial time and frequency variations in the co-movement and causality between the two variables.

Table 24: Summary of wavelet-based studies

Author name	Country	Time-period	Methods	Findings
Tari and Abasiz (2009)	Turkey	1987-2008	Wavelet analysis	The causal relationship was valid only for the short run
Hamrita (2011)	US	1990-2008	Wavelet analysis	The relationship is not considerably different from zero
Tiwari (2012)	India	1990-2009	Wavelet analysis	Causal and reverse causal relations between SP and IR vary across scale and period
Hacker et al. (2014)	Sweden, US, Euroarea, Japan, UK and Norway	1999-2009	Wavelet analysis	Variables are negatively correlated
Andries et al. (2014)	India	1997-2010	Wavelet analysis	Interest rate and exchange rate pair leads alternatively
Tiwari, Bhanja, Dar, and Islam (2014)	India	1980-1993	Wavelet analysis	Found support to the traditional as well as the new portfolio hypothesis, over different time periods and different time scales
Ozun and Cifter (2014)	Turkey	2003-2006	Wavelet analysis	The results that the wavelet approach captured the non-linear dynamics
Ferrer, Bolos, and Benitez (2016)	10 European countries	1993-2012	Continuous wavelet transform	The linkage is mainly concentrated at investment horizons from 1 to 2 years
Andries, Capraru,	Romania	1999-2014	Wavelet analysis	The relationship differs across

Ihnatov, and Tiwari (2017)				small emerging countries and advanced economies
Jayashankar and Rath (2017)	India	2000-2014	wavelet analysis	The relationship is not significant at lower scales.
Si, Li, Chang, Bai (2018)	BRICS	1996-2015	wavelet analysis	More pronounced during the period of the recent global financial crisis in these countries
Tursoy and Mar'I (2020)	Turkey	2005-2019	Wavelet analysis	The relationship in the long-run and short-run between is positive and confirms the PPP
Si, Li, and Ge (2020)	China	1999-2018	Wavelet analysis	The co-movement is intensified at a low frequency after the exchange rate reform in 2005

Source: Authors Tabulation

3.6 CRITIQUE OF THE PRESENTED LITERATURE

Whilst there exists a considerable amount of empirical works which have studied the four themes in SACU countries that are covered in this study, there is a need for more empirical investigation for several reasons. Firstly, a majority of the studies have focused on South Africa with very little empirical literature existing for Botswana and Lesotho. Secondly, the previous SACU based studies present contradicting findings. Thirdly, Most of these studies did not cover the themes comprehensively, as is the case in this study. Fourthly, with the exception of the works of Phiri and Lusanga (2011), Bahamani-Oskooee et al. (2016), Phiri and Mbekeni (2020), and Phiri (2021) for the case of South Africa, the remaining studies have used linear econometric models to investigate Fisher effect. This is important to point out since the data

coverage in most previous studies covers a range of structural breaks caused by financial crisis and advances in monetary policy conduct such as increased liberalization of interest rates. Finally, To the best of my knowledge, this methodology has not been employed in any SACU related literature until now.

3.7 CONCLUSION

In this chapter, a literature review was given for the four empirical relationships which describe the first level monetary policy pass-through effects namely i) the relationship between nominal interest rates and inflation (Fisher's hypothesis) ii) the relationship between exchange rates and inflation (PPP hypothesis) iii) the relationship between exchange rates and stock returns iv) the relationship between interest rates, exchange rates, and stock returns. For each of the topics, the theory was first outlined followed by an empirical discussion on i) SACU-based studies ii) international studies which used wavelet analysis.

From the review, I note that SACU-based studies which tend to use traditional econometric analysis tend to produce conflicting empirical shreds of evidence whilst those which have used wavelet analysis in international studies tend to produce more consistent results. There is an exception for literature on the Fisher effect and GPPP hypothesis of which I observed no previous studies which have used wavelet techniques in their empirical analysis. The thesis applies several wavelets analytical to investigate the different first-level monetary policy pass-through relationships for the SACU countries. These methods are discussed in the following chapter.

CHAPTER 4: METHODOLOGY

4.1 INTRODUCTION

The previous chapter discussed the existing empirical and theoretical literature on the Fisher effect, the PPP, exchange rate and stock returns, interest rate, exchange rate, and stock return relationship. The main objective of this chapter is to outline the methodology of the study, which is the wavelet analysis. For the empirical analysis, the thesis employs Wavelet Coherence (WC), Partial Wavelet Coherence (PWC), and Multiple Wavelet Coherence (MWC) to investigate the first level pass-through effects of the SACU region monetary transmission mechanism. The wavelet methodology is used mostly in Geophysics and recently getting footprints in weather, environment, economics, and finance-related studies also (Ng and Chan, 2012; Afshan et al., 2018; Wu et al., 2019). To the best of my knowledge, this methodology has not been employed in any SACU related literature until now.

Wavelet analysis allows one to take into account both the time and frequency domains within a unified framework, that is, one can assess simultaneously how variables are related at different frequencies and how such a relationship has evolved. Despite the potential value of wavelet analysis, it is still a relatively unexplored tool in the field of economics. The wavelet approach has several advantages over traditional econometric tools when analysing time series:

- The assumption of stationarity can be relaxed.
- A time series with non-normal distribution can be used.
- Events localized in time can be captured efficiently.
- The analysis is done from a time-frequency perspective.
- It is very effective for capturing non-linear relationships.
- It can determine the strength and direction of the association and distinguish between short, medium, and long-term relationships at the same time.
- Different types of wavelet functions can be used depending upon the nature of data which allows more efficient and accurate tracking of the co-movements.
- It can capture bi-directional (lead-lag) relationships at the same time between different time-frequency combinations (Grinsted et al., 2004; Ng and Chan, 2012; Vacha and Barunik, 2012).

4.2 WAVELETS

Wavelet analysis is known to be a time-scale analysis that decomposes data in different components of the frequency and surveys each component in terms of resolution proportional to its scale. This was introduced in the 1980s by Goupillaud et al. (1984) and the main purpose was to overcome the limitations of the Fourier transform in its ability to link frequency components of a signal along a time scale (Percival and Walden 2000; Gencay et al., 2002). Over the years, the wavelet analysis has gained a lot of popularity amongst the economics and finance authors due to the flexibility that it has (Antonakakis et al., 2017, Ferrer et al., 2016, Yang et al., 2017). Wavelet analysis is also used in disciplines such as geophysics, engineering, climatology, or medicine because of its flexibility (i.e Gencay et al., 2002, Ramsey and Lampart, 1998a, Ramsey and Lampart, 1998b).

Wavelet analysis consists of two types of wavelet transform depending on the use of orthogonal and nonorthogonal wavelets as merit functions: the discrete wavelet analysis and the continuous wavelet analysis. Discrete Wavelet Analysis (DWT) was dominating economic applications for the longest time (Gencay et al., 2002; Ramsay, 2002; Gallegati and Gallegati, 2007). Continuous Wavelet Analysis (CWT) became a popular methodology in economics in the last couple of years.

4.2.1 Discrete Wavelet Analysis and Continuous Wavelet Analysis

Discrete wavelet analysis compresses how the data is displayed and it also helps with the noise reduction, however, the continuous wavelet analysis is good when the wavelet is used with the intention for extraction. The discrete wavelet has been the leading wavelet analysis because of the ability to simplify data and that it is, produces only the minimal number of coefficients necessary to reconstruct the original signal. An important element of the discrete wavelet analysis is that its observations have to be dyadic. Discrete wavelet encompasses both the father and mother wavelets.

The continuous wavelet analysis is a recommended wavelet analysis for extraction purposes. Furthermore, a continuous wavelet is best for investigating the relationship between two-time series variables. This is due to the fact that time-series data is not normally distributed, therefore the continuous wavelet analysis would be the best fit for such investigations. For this study, the focus is only the continuous wavelet transform measuring the local correlation of two time

series in the time-frequency domain because it has a better feature extraction purpose as compared to DWT which has noise reduction as well as data compression. The important part of the continuous wavelet analysis is the ability to study interactions or co-movement between two time series in the time-frequency domain using the cross-wavelet tools (Aguiar-Conraria et al., 2008; Rua and Nunes, 2009).

Notably, the Haar transform and Haar wavelets constitute the most simple type of wavelet analysis and can serve as the prototype for all other wavelet operations. The scaling function, also known as the father wavelet, and the wavelet function, often known as the mother wavelet, are two essential components in any wavelet analysis (Haar,1909)

4.2.2 Complex and noncomplex wavelets

A complex wavelet is a function with only positive frequencies in its spectrum. Because a complex wavelet only responds to nonnegative frequencies in a given signal, it generates a transform with a lower modulus than a real wavelet. This characteristic is extremely useful for recognizing and tracking instantaneous frequencies in a transmission.

The following are some well-known complicated wavelet families:

- complex Cauchy wavelet,
- complex Mexican Hat wavelet,
- complex Morlet wavelet.

For the purpose of this study, the most commonly used wavelet, the complex
Morlet is employed.

4.3 MORLET WAVELETS

Wavelets are defined as small waves that grow and decay in a limited time period. There are two types of wavelets that can be identified based on different normalization rules; namely, father wavelets ϕ and mother wavelets ψ. The father wavelet integrates to 1 ($\int \phi(t)dt = 1$) and the mother wavelet integrates to 0 ($\int \phi$(t)dt=0). The father wavelet denotes the smooth and low-frequency parts of a signal (the raw data), and the mother wavelet denotes the detail and the high-frequency components. A wavelet is made of two distinct parameters: time (ι) and scale (m). Originating from mother wavelet ψ, a family of daughter wavelets ($\psi_{\iota m}$) can be

produced over scaling and translating ψ (Torrence and Compo, 1998; Percival and Walden, 2000; Gencav et a., 2002; Ramsey, 2002);

$$\psi_{lm}(t) = \frac{1}{\sqrt{s}}\psi\left(\frac{t-u}{s}\right) \quad 7$$

Where s is a scale or dilate parameter that controls the length of the wavelet, while u is a location parameter that determines its position in the time domain. To be a mother wavelet, ψ(t), must fulfill several conditions (Gencay et al. (2002), Percival and Walden (2000), Bruce and Gao (1996): it must have zero mean, its square integrates to unity, which means that ψ(t) is limited to an interval of time; and it should also satisfy the so-called admissibility condition, where $\psi(\omega)$ is the Fourier transform of ψ(t), that is, the latter condition allows the reconstruction of a time series x(t) from its continuous wavelet transform, $W_x(\tau,s)$. Thus, it is possible to recover x(t) from its wavelet transform through the following formula. There exist many families of complex wavelets (see section 4.2.2.), however, for the empirical purpose of this study, empirical estimation, wavelet (ψ) approach of Morlet wavelet family to estimate the co-movement between variables is adopted according to scale and time function. The morlet wavelet follows the Gaussian-windowed Fourier transform of sine and cosine oscillation of the central frequency and is specified according to the follow's notations (Morlet, 1983). Morlet wavelet is recommended when using the wavelet analysis for feature extraction purposes.

When using wavelets for feature extraction purposes the Morlet wavelet (with ω0=6) is a good choice, since it provides a good balance between time and frequency localization. I, therefore, restrict my further treatment to this wavelet, although the methods I present are generally applicable (Foufoula-Georgiou, 1995). However, the similarity between the portrayed patterns in this period is quite low and it is therefore hard to tell if it is merely a coincidence.

The wavelet transform can be used to analyse time series that contain nonstationary power at many different frequencies (Daubechies 1990). Assume that one has a time series, x_n, with equal time spacing δt *and* $n = 0 \ldots N - 1$. Also assume that one has a wavelet function, $\psi_0(\eta)$, that depends on a non-dimensional time parameter η. To be admissible as a wavelet, this function must have zero mean and be localized in both time and frequency space (Farge 1992). The Morlet wavelet is modulated by Gaussian:

$$\psi_0(\eta) = \pi^{-\frac{1}{4}} e^{i\omega o \eta} e^{-\frac{\eta^2}{2}}, \quad 8$$

Where ω_0 Is the non-dimensional frequency. The term wavelet function is used generically to refer to either orthogonal or non-orthogonal wavelets. The term wavelet basis refers only to an orthogonal set of functions. The use of an orthogonal basis implies the use of the discrete wavelet transform, while a nonorthogonal wavelet function can be used with either the discrete or the continuous wavelet transform (Farge 1992).

4.4 WAVELETS TOOLS

4.4.1 Wavelet power spectrum

The Wavelet Power Spectrum (WPS) for a discrete series measures the variance of a time series across a time-scale dimension i.e.

$$WPS_x(\tau, s) = |W_x(\tau, s)|^2 \quad 9$$

To the extent the framework to the bi-variate case in which I seek to examine the co-movement between a pair of time series x(t) and y(t) in the time-frequency domain, I firstly define their WPS as $|W_x(\tau, s)|^2$ and $|W_y(\tau, s)|^2$, respectively, and then compute their Cross-Wavelet Power Spectrum (CWPS), which is analogous to the covariance between x(t) and y(t) in the time-frequency domain.

$$(CWPS)_{xy} = W_{xy} = |W_{xy}| \quad 10$$

4.4.2 Cross-Wavelet transforms (XWT)

The cross-wavelet transform is often described as the basic wavelet analysis tool that can manage time-frequency dependencies between two time series. Given two-time series x_n and y_n first introduced by Hudgins et al. (1993) is defined as $W^{XY} = W^X W^{Y*}$, where Wy* denotes the complex conjugation. The XWP is:

$$(XWP)(XWP)_{xy} = |W_{xy}| \quad 11$$

The XWP of two time series depicts the local covariance between them at each time and frequency and shows the area in the time-frequency space where the two signals exhibit high common power. Therefore, the XWP gives us a quantified indication of the similarity of power between two-time series. Further define the cross wavelet power as $|W^{XY}|$. The complex argument (W^{xy}) can be interpreted as the local relative phase between x_n and $y_n$in time-frequency space. The theoretical distribution of the cross wavelet power of two time series with background power spectra P_K^X and P_K^Y is given in Torrence and Compo (1998) as:

$$D\left(\frac{|W_n^X(s)W_n^Y(s)|}{\sigma X \sigma Y} < P\right) = \frac{Z_V(P)}{v}\sqrt{P_k^X P_K^Y} \qquad 12$$

where $Z_v(P)$ is the confidence level associated with the probability p for a pdf defined by the square root of the product of two x^2 distributions.

4.4.3 Wavelet coherency

Wavelet coherence is a useful measure of assessing the relationship between two time series of the cross wavelet in time-frequency space. According to Torrence and Compo (1998) and Aguiar-Conraria, Azevedo, and Soares, (2008) the wavelet coherency is referred to as the ratio of the cross-spectrum to the product of each series spectrum and can be thought of as the local correlation between two time series in time-frequency space. Wavelet coherence used the 5% statistical significance level by Monte Carlo. Following Torrence and Webster (1999), wavelet coherency can be defined by:

$$W_{xy}(u,s) = W_x(u,s)W_y^*(u,s) \qquad 13$$

where u is a position index and s denotes the scale, symbol * denotes a complex conjugate. Furthermore, I define cross wavelet power as $|W_{Xy}(u,s)|$ (Hudgins et al., 1993; Torrence and Compo, 1998). The cross wavelet power uncovers areas in time–scale space where the time series show high common power, i.e. it represents the local covariance between the time series at each scale. In the analysis of financial time series, I am also interested in areas, or regions, where the two time series in time–scale-space comove but does not necessarily have high power. A useful wavelet tool that can uncover these co-movements is wavelet coherence.

Cross wavelet power reveals areas with high common power. Another useful measure is how coherent the cross wavelet transform is in time-frequency space. Following Torrence and Webster (1998), the wavelet coherence of two-time series is defined as:

$$R^2(u,s) = \frac{|S\left(s^{-1}W^{xy}(u,s)\right)|^2}{S\left(s^{-1}|W^x(u,s)\right)|^2)S\left(s^{-1}|W^y(u,s)\right)|^2} \quad 14$$

Where S indicates a smoothing operator factor over time as well as scale and $0 \leq R^2(u,s) \leq 1$ which balances resolution and significance. A value close to 0 specifies a weak relationship, while a value close to 1 indicates a strong relationship (Rua and Nunes, 2009). The quantity $R^2(u,s)$ represents the wavelet squared coherence. Its value is between 0 and 1. There is a co-movement between the series in the time-frequency domain depicted by wavelet analysis. The higher its value, the higher the co-movement between the two time series. I note that, unlike the classical correlation of two time series, wavelet squared coherence is restricted to positive values. For the purpose of this study, this estimation helps us in investigating the degree of interdependence between time-series variables.

However, at this stage, the coherency cannot distinguish between positive or negative co-movement, or between positive and negative correlation. Therefore, wavelet phase difference is used to solve this problem Terrence and Compo (1998) to capture the two possible co-movements: positive and negative. Moreover, by using the graphical presentation of the wavelet squared coherence I can also investigate the causal relationships between the two time series.

4.4.4 Phase difference

The wavelet transform coherence phase difference indicates the relationship between the two time series. Since positive and negative correlations cannot distinguished, therefore the phase difference tool is required to present positive or negative correlations and lead-lag relationships between two time series as a function of frequency. The phase difference gives details about delays of oscillation (cycles) of the two examined time series. Following Torrence and Webster (1999), the wavelet coherence phase difference is defined as:

$$\phi_{xy}(u,s) = tan^{-1}\left(\frac{Im\{S(s^{-1}W^{xy}(u,s))\}}{Re\{S(s^{-1}W^{xy}(u,s))\}}\right) \quad 15$$

where, Im and Re are the imaginary and real operators of the smoothed cross wavelet transform**,** respectively. Phases are indicated by black arrows on the wavelet coherence plots. A zero phase difference indicates that the examined time series move together at a particular scale. The arrows are pointing to the right (left) when the time series are in-phase (out-phase). In-phase is when the time-series is positively corrected and out-phase is when the time-series are negatively correlated. Arrows pointing up and down imply a causality relationship between them. An arrow pointing up means that the first variable is leading, an arrow pointing down indicates that the second variable is leading the first.

The circular mean of the phase over regions with higher than 5% significance to quantify the correlation is used. See below equation $(ai, i = 1 \dots n)$ is defined as (Zar, 1999):

$$a_m = \arg(X,Y)\ with\ X = \sum_{i=1}^{n}\cos(ai)\ and\ Y = \sum_{i=1}^{n}\sin(ai)\,, \quad 16$$

It is difficult to calculate the confidence interval of the mean angle reliably since the phase angles are not independent. The number of angles used in the calculation can be set arbitrarily high simply by increasing the scale resolution. However, it is interesting to know the scatter of angles around he mean. For this, the circular standard deviation is defined as:

$$s = \sqrt{-2\ In\left(\frac{R}{n}\right)}, \quad 17$$

where R= √ (X2+Y 2). The circular standard deviation is analogous to the linear standard deviation in that it varies from zero to infinity. It gives similar results to the linear standard deviation when the angles are distributed closely around the mean angle. In some cases, there might be reasons for calculating the mean phase angle for each scale, and then the phase angle can be quantified as several years.

4.4.5 Partial Wavelet Coherence (PWC)

The PWC is estimated by calculating WTC between two variables, eliminating the effect of the third variable. This method permits the examination of the wavelet coherence of different variables while controlling for their mutual related factors described by the influence of various independent factors (Ng and Chan, 2012). In this methodology, the co-movements are studied between two variables while controlling for the common effects of a third variable. Similar to wavelet coherence, Monte Carlo methods are used to estimate PWC. The technique lets one find the wavelet coherence among two different variables x_2 and x_1 subsequently eliminating the impact of another variable y. Therefore, coherence among x_1 and x_2, x_1 and y and x_2 and y is transcribed as:

$$\mathrm{R}(Open, x_2) = \frac{S|w(x_1,x_2)|}{\sqrt{S[W(x_1)]\,S[W(x_2)]}} \quad 18$$

$$R^2(x_1, x_2) = R\,(x_1, x_2).R(x_1, x_2)\,*; \quad 19$$

$$\mathrm{R}(x_1,\ y) = \frac{S|w(x_1,\ y)|}{\sqrt{S[W(x_1)]\,S[W(y)]}} \quad 20$$

$$R^2(x_1,\ y) = R\,(x_1,\ y).R(x_1, y\ )\,*; \quad 21$$

$$\mathrm{R}(x_2,\ y) = \frac{S|w(x_2,\ y)|}{\sqrt{S[W(x_2)]\,S[W(y)]}} \quad 22$$

$$R^2(x_2,\ y) = R\,(x_2,\ y).R(x_2, y\ )\,*; \quad 23$$

Whereas "*R*" represents the coherence between two variables while "*x*1", "*x*2" and "*y*" represent the variables of interest. The significance level in PWC is calculated using the Monte Carlo method.

4.4.6 Multiple Wavelet Coherence (MWC)

MWC, Similar to wavelet coherence, investigates the coherence of multiple independents on a dependent; that is, of y and x on z in this case. Therefore, the application of MWC can be expressed as follows:

$${R_m}^2(x, y, z) = \frac{R(x,y)^2+R(x,z)^2-2Re[R(x,y)R(x,z)^*R(y,z)^*]}{1-R(x,y)^2} \quad 24$$

Equation 16 calculates the proportional wavelet power of the two Equation 16 calculates the proportional wavelet power independent x and y to explain the dependent time series z in time-frequency space. The Monte Carlo approach is used to examine the significance levels. Specifically, an exceptionally high coherence may be produced when x and y are dependent because MWC is sensitive to dependent time series z (Ng and Chan, 2012). Using this point, the MWC is employed as the robust test. Moreover, the Cone of Influence (COI) is denoted by a lighter shade dividing the higher-strength area from the remaining area of the wavelet power band through significant strength impacts (Raza et al., 2017; Torrence and Compo, 1998). The external values from COI establish the significance level for all scales of wavelet coherence. Furthermore, the multiple wavelet estimations have remarkable strength during the typical time-series frameworks, predominantly when the time-series data in the investigation are non-stationary (Roueff and Von Sachs, 2011).

4.4.7 Vector Wavelet Coherence (VWC)

The squared n-dimensional vector wavelet coherency between series y and other series $x_1, x_2, \ldots x_n$ will be denoted by $VR^2_{y(q)}$

$$VR^2_{y(q)=}\ VR^2_{1(23\ldots n)} = 1 - \frac{M^d}{S_{11}M^d_{11}} \quad 25$$

where M denote the n×n matrix of the all the smoothed cross-wavelet spectra Sijwhich is the smoothed version of Wij

$$S_{ij} = S(W_{ij}) \quad 26$$

Where S is a certain smoothing operator

The wavelet analysis is performed using the latest version of R software.

4.5 CONCLUSION

Chapter 4 provides the research methodology to be used in this study. As such, the chapter provides an overview of the wavelet analysis used to study the co-movements of the variables. However, more focus is oriented on the wavelet coherence, partial wavelet coherence, and multiple wavelet coherence. Through wavelet analysis, I can visualise the degree of association among the model parameters, how such linkages grow with the passage of time, and the lead-lag position of variables in the short, medium, and long run. In the following chapters, wavelet

analysis is used to investigate the first-level monetary transmission relationships for SACU countries.

CHAPTER 5: INVESTIGATING THE FISHER EFFECT IN THE SACU COUNTRIES

5.1 INTRODUCTION

This chapter examines the Fisher effect of the SACU countries (South Africa, Botswana, Lesotho, Eswatini, Namibia) which constitutes one of the oldest customs unions in the world. The SACU countries operate under a Multilateral Monetary Area (MMA) in which the South African Rand serves as a common currency for the Customs Union. Therefore, the MMA is administered by the SARB, and South African monetary policy is considered the *de facto* policy of the SACU region and the other SACU member states sacrifice a certain degree of their own independence (Aziakpono, 2008; Nchake et al., 2018). Since 2002, the SARB has adopted a 3-6% inflation target regime in which uses its short-term policy rates to curb inflation expectations, whereas the focus of monetary policy in the remaining SACU member states is to ensure interest rate alignment with the SARB. An important policy question in this regard is whether the Fisher effect can hold amongst the central banks in individual SACU countries and particularly amongst the smaller member states which do not directly target inflation.

Whilst there exists a considerable amount of empirical works which have studied the Fisher effect for the individual SACU countries (see Table 15) there is a need for more empirical investigation for several reasons. Firstly, a majority of the studies have focused on South Africa with very little empirical literature existing for Botswana and Lesotho. Secondly, the previous SACU based studies present contradicting findings. Lastly, with the exception of the works of Phiri and Lusanga (2011), Bahamani-Oskooee et al. (2016), Phiri and Mbekeni (2020), and Phiri (2021) for the case of South Africa, the remaining studies have used linear econometric models to investigate Fisher effect. This is important to point out since the data coverage in most previous studies covers a range of structural breaks caused by financial crisis and advances in monetary policy conduct such as increased liberalization of interest rates.

To overcome the aforementioned challenges with previous literature, this chapter makes use of continuous wavelet transforms to provide a time-frequency analysis of the Fisher effect in SACU countries. The remainder of the chapter is structured as follows. Section 5.2 provides a description of the data. Section 5.3 presents the empirical analysis. Section 5.4 concludes the chapter.

5.2 DATA DESCRIPTION

5.2.1 Data description

The empirical analysis uses monthly adjusted time-series data obtained for different periods per SACU country. For South Africa, I restrict the scope of study to the inflation targeting beginning in 2001 whilst for the remaining SACU countries I rely on data availability. The time series used in this study were sourced from the websites of South African Reserve Bank (SARB), Bank of Botswana (BoB), Central Bank of Eswatini (CBE), and Bank of Namibia (BoN). I use the central bank's policy rates as a proxy for nominal interest rates whilst percentage change in CPI is employed as a measure of inflation. Following Mitchell-Innes et al. (2007), I proxy the inflation expectations by using 5-month moving averages (two leads and two lags) of actual inflation.

5.2.2 Descriptive statistics and correlation matrix

Table 25: Descriptive Statistics

Interest rates	**Botswana**	**Eswatini**	**Namibia**	**Lesotho**	**SA**
Mean	9,631944	6,998611	7,108333	7,325661	11,18008
Median	9,500000	6,750000	6,750000	6,639000	11,50000
Maximum	15,50000	11,50000	10,50000	13,24000	21,85000
Minimum	4,750000	5,000000	5,500000	4,938000	4,690000
Std. Dev.	3,737496	1,821561	1,437744	1,957122	4,545910
Skewness	0,277085	1,019129	1,266694	1,339552	0,344132
Kurtosis	1,625278	3,167616	3,673033	4,007214	2,025615
Inflation rates	**Botswana**	**Eswatini**	**Namibia**	**Lesotho**	**SA**
Mean	6,431833	6,386778	5,649222	7,320370	8,931875
Median	6,320000	5,660000	5,495000	5,430000	7,550000
Maximum	15,06000	14,71000	12,25000	15,14000	20,70000
Minimum	2,100000	1,600000	0,940000	2,000000	0,200000
Std. Dev.	3,310226	2,571187	2,169107	6,753475	4,596214
Skewness	0,751563	0,961460	0,582186	3,344046	0,393708
Kurtosis	2,824343	4,020549	3,364060	3,443430	2,049911

Source: Authors Tabulation.

South Africa recorded the highest average interest rates for the sample at, 11,18008%, for the whole period with its lowest minimum being 4.69000%. Within the period range of the study, South Africa also experienced the highest maximum of 21,85000% in one period. Botswana

followed closely behind South Africa with an average interest rate of 9,631944%, and its maximum positive interest rate was 15,50000% over the period of study.

Eswatini and Namibia have the least mean interest rate in SACU countries, with Eswatini being the lowest mean of 6,998611% whilst Namibia also recorded the lowest maximum (10,50000%). Another important statistic to discuss is the standard deviation, which shows the volatility of the variables. South African and Botswana are the only two countries that have the highest interest rate volatility in SACU.

With regards to inflation rates from table 25, the inflation rates for South Africa showed the highest peaks over the period of the study in SACU. Lesotho followed closely with 7,320370% mean, with Botswana and Eswatini being closely related at 6,431833% and 6,386778% mean respectively. Namibia has the lowest interest rate mean in SACU. In terms of maximus, Botswana, Eswatini, Namibia, Lesotho and South Africa recorded 15,06000%, 14,71000%, 12,25000%, 15,14000% and 20,70000% respectively for the inflation rate. In general, Eswatini displayed the least mean variability with regard to interest rates over the sample period in SACU and Namibia displayed the least variability with regard to the inflation rate in SACU. Lesotho and South Africa recorded the highest inflation rate volatility in SACU.

Table 26: Correlation Matrix

Country	**Correlation**
Botswana (Interest rates and inflation rates)	0,862239
Eswatini (Interest rates and inflation rates)	0,560191
Namibia (Interest rates and inflation rates)	0,444523
Lesotho (Interest rates and inflation rates)	0,617994
South Africa (Interest rates and inflation rates)	0,524740

Source: Authors Tabulation.

Covariance analysis measures the strength of the linear dependence between variables. The correlation matrices are presented in table 26. The interest rate is positively related to inflation rate for all the countries in SACU at correlation coefficient of 0,862239, 0,560191, 0,444523, 0,617994, 0,524740 respectively which confirms *a priori* expectations. Namibia has the lowest correlation coefficient of 0,444523 and Botswana has reported the highest correlation coefficient of 0,862239. Therefore, for the period covered in this study, the interest rates and inflation rate in SACU countries move in the same direction at different magnitudes and that is the one-for-one movement of Fisher effect at correlation coefficient holds.

5.3 EMPIRICAL ANALYSIS

5.3.1 Wavelet Power Spectrum and time series plots of individual series

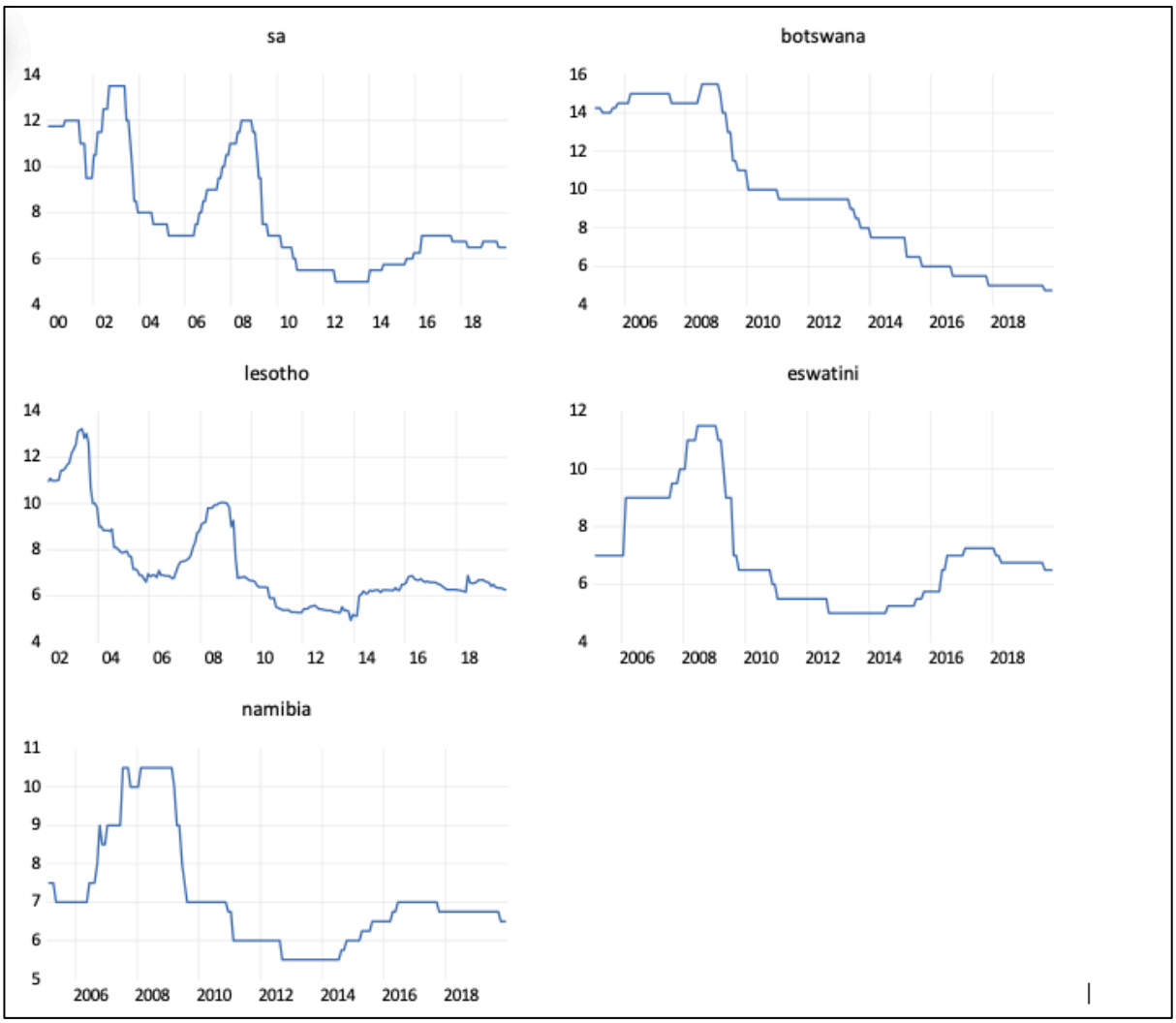
In this section, I present the wavelet power spectrum analysis on the individual interest rate and inflation series for all SACU countries. The WPS captures the distribution of the energy contained within the time series across a time-frequency space and informs us how much frequency band has contributed to the energy of the series at different time periods. Henceforth, the periodicities in the time series and their duration can be easily discerned using the WPS. This information is presented across two-dimensional heat maps that measure time along the horizontal axis and the corresponding frequency along the vertical axis. Note that the frequency components have been converted into 'time cycles' with longer (shorter) time cycles corresponding to lower (higher) frequency components. The different colour contours within the heat maps measure the strength of variability within the series at different scales and the warmer (cooler) colours indicate stronger (weaker) variation. The white contour lines surrounding the colour contours represent the 95% confidence level whilst the faint inverted U-shaped curve denotes the cone of influence and represents regions where the WPS suffers from edge effects and hence caution is taken in interpreting regions just inside the cone of influence.

5.3.1.1 Nominal interest rates and WPS plots in SACU countries

Figure 13 presents the time series plots for the nominal interest rates in the SACU countries whilst Figures 14-18 present their corresponding WPS plots. From the onset, it is interesting to note that the interest rate series have similar trends in the time domain (Figure 13) as well as in the time-frequency domain (Figures 14-18). Nevertheless, the WPS gives more localized information on the dominant periodicities contained in the series, and in the SACU case, the dominant cycles are established between the 24 and 128 frequency bands, although the strength and duration of these cycles differ amongst the countries. For instance, South Africa, Botswana and Lesotho both show strong variability between 2000 and 2010, which represent the period covering the Asian Financial crisis and the global financial crisis, whilst the remaining SACU countries have moderate variation. Moreover, the range of variability or frequency bandwidth is much smaller for Botswana whilst those for the remaining SACU countries have a wider range of cyclical variability. However, one common feature in all interest rate series, is that the

variability weakens subsequent to the global financial crisis period and higher frequency components gradually lose their relevance to lower frequency components.

Figure 13: Nominal interest rates in SACU countries



Source: Authors computation

Figure 14: Wavelet power spectrum for interest rates in South Africa

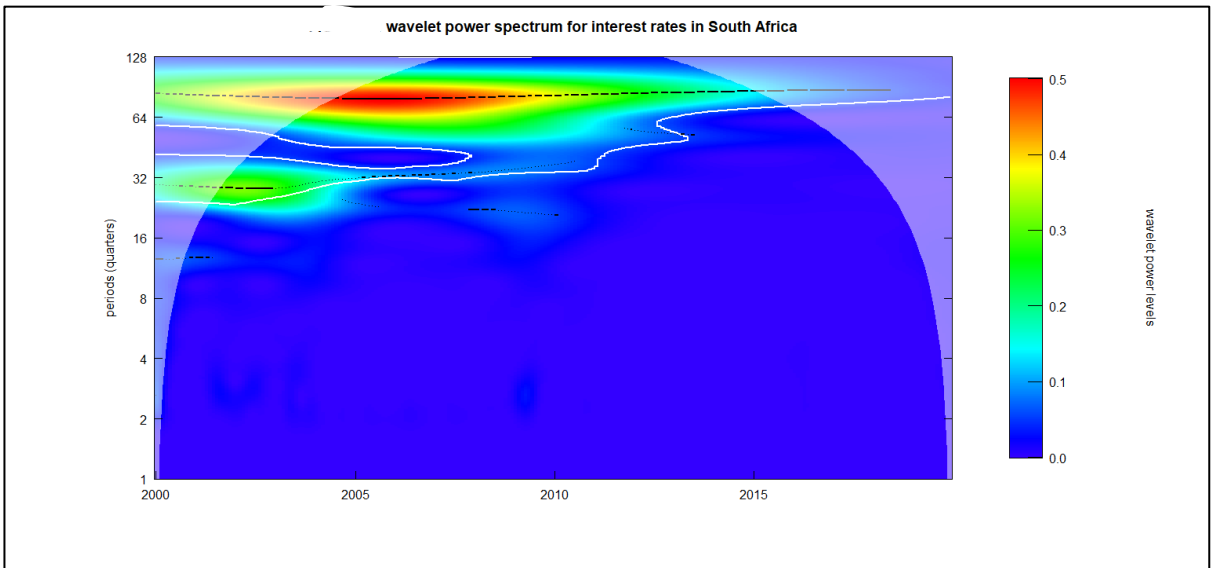


Figure 14 reports the wavelet power spectrum for the nominal interest rate in South Africa. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level. The cone of influence, which indicates the area affected by edge effects, is the outside region of the black line. The colours code for power indicates the level of intensity ranges from blue to red.

Figure 15: Wavelet power spectrum for interest rates in Botswana

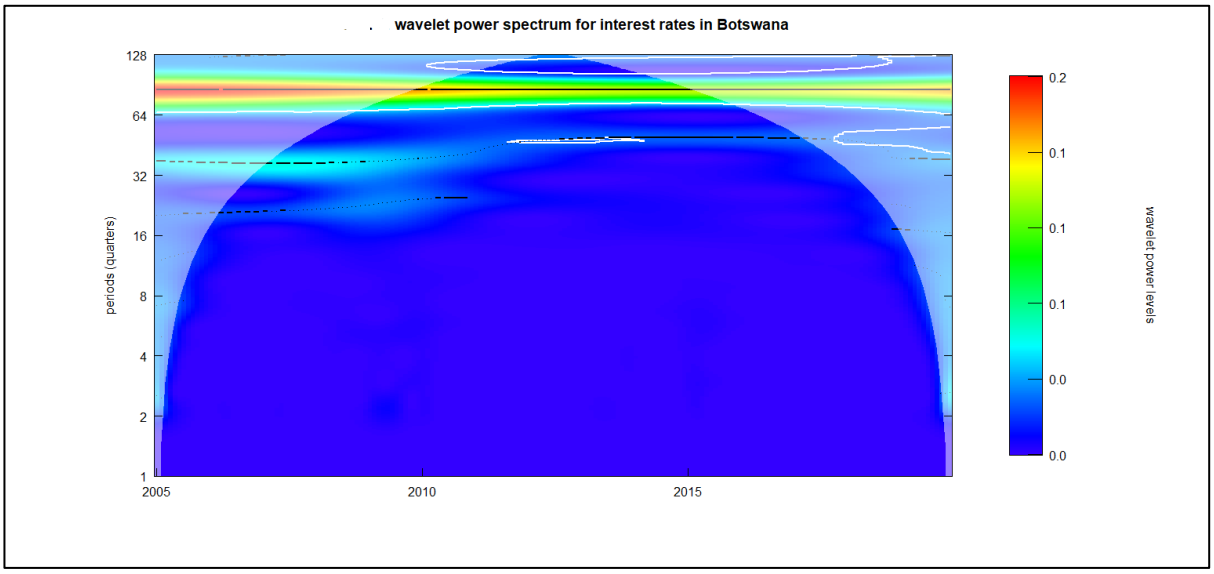


Figure 15 reports the wavelet power spectrum for the nominal interest rate in Botswana. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level. The cone of

influence, which indicates the area affected by edge effects, is the outside region of the black line. The colours code for power indicates the level of intensity ranges from blue to red.

Figure 16: Wavelet power spectrum for interest rates in Lesotho

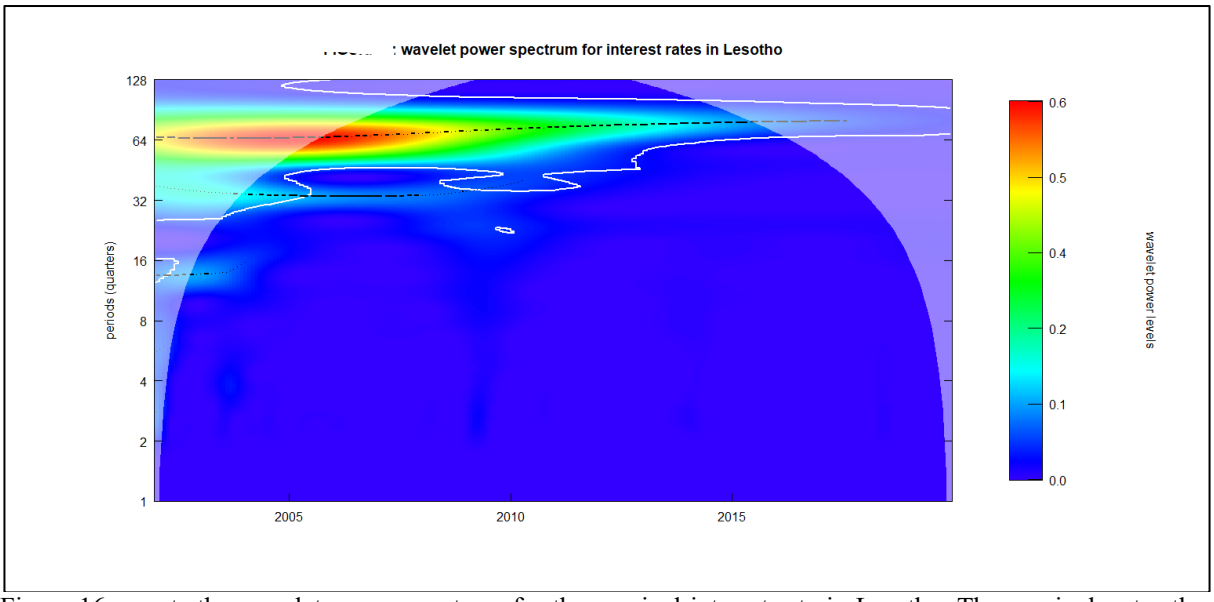


Figure 16 reports the wavelet power spectrum for the nominal interest rate in Lesotho. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level. The cone of influence, which indicates the area affected by edge effects, is the outside region of the black line. The colours code for power indicates the level of intensity ranges from blue to red.

Figure 17: Wavelet power spectrum for interest rates in Eswatini

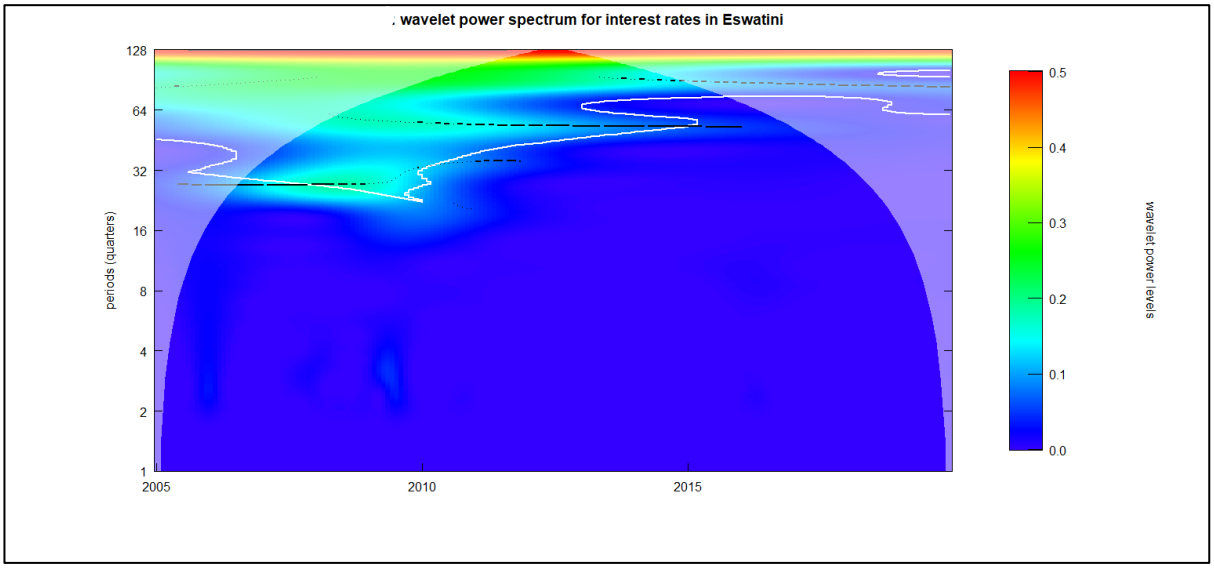


Figure 17 reports the wavelet power spectrum for the nominal interest rate in Lesotho. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level. The cone of

influence, which indicates the area affected by edge effects, is the outside region of the black line. The colours code for power indicates the level of intensity ranges from blue to red.

Figure 18: Wavelet power spectrum for interest rates in Namibia

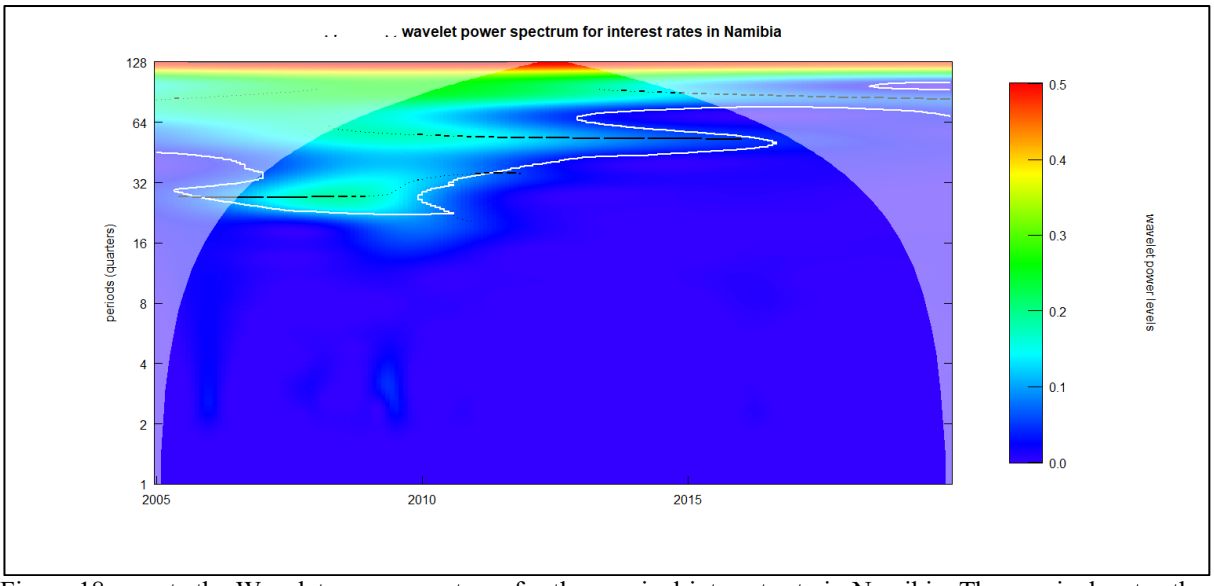


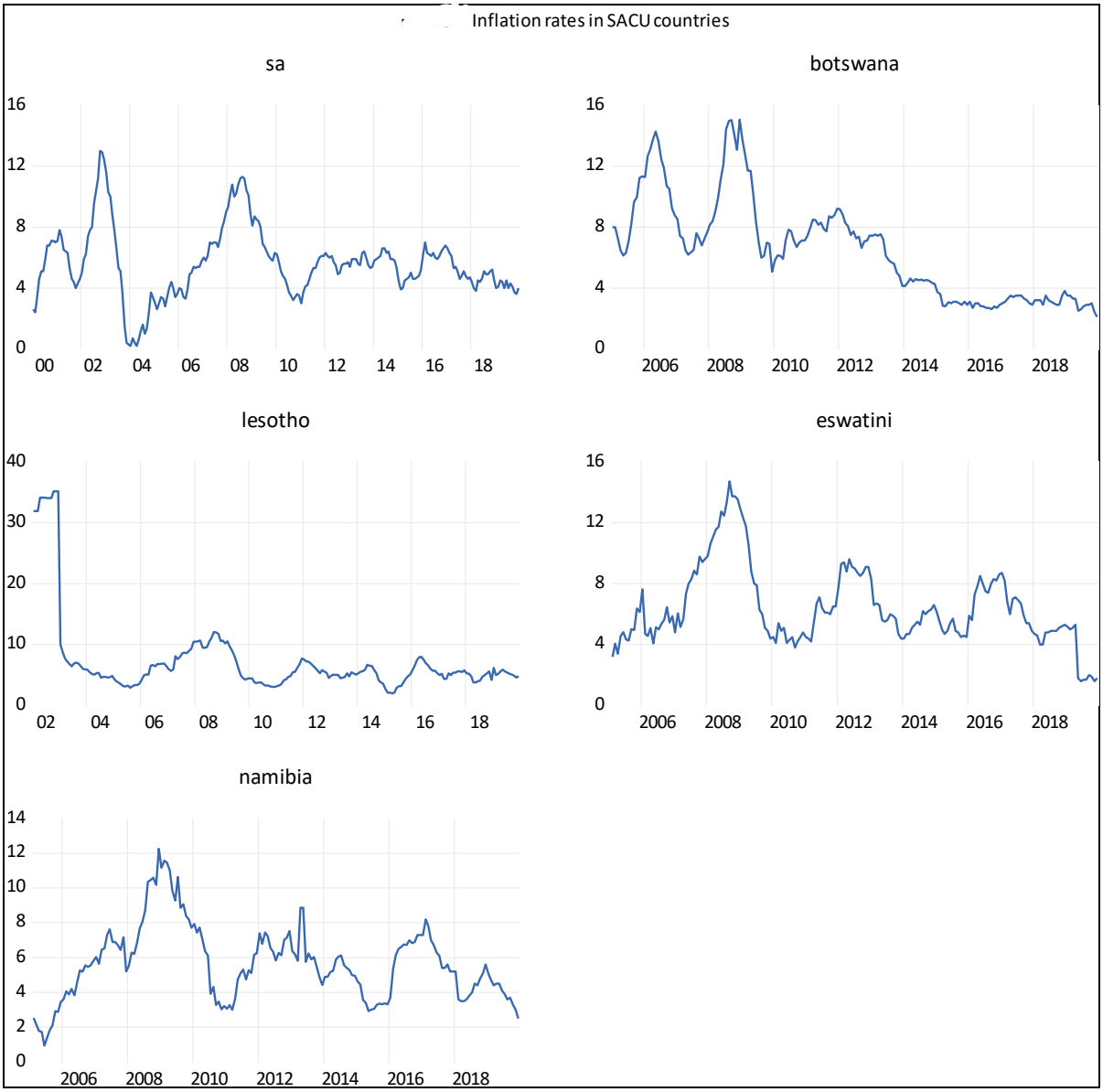
Figure 18 reports the Wavelet power spectrum for the nominal interest rate in Namibia. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level. The cone of influence, which indicates the area affected by edge effects, is the outside region of the black line. The colours code for power indicates the level of intensity ranges from blue to red.

5.3.1.1 Inflation rates and WPS plots in SACU countries

Figure 19 presents the time series plots for the inflation rates in the SACU countries whilst Figures 20-24 present their corresponding WPS plots. Notably, the time series plots for inflation rates in SACU countries follow a similar trajectory along with a time domain, however, the size, strength, and duration of the periodicities detected within the time series, as shown in the WPS, differs amongst the SACU nations. For instance, South Africa shows two dominant periodicities at cyclical frequencies of i) 16-40 months between 2000 and 2009 and ii) 40-100 months between 2000 and 2015. Similarly, inflation in Lesotho is characterized by two dominant cyclical bands at i) 6 – 10 month frequencies between 2001-2003 ii) 16-70 month cycles between 2001-2010. For the remaining SACU countries. The remaining countries, Eswatini and Namibia, are mutually characterized by single dominant periodicities of 32-64 month cycles throughout the entire time period. Moreover, judging by the colour contours in the WPS, all SACU countries mutually show strong variability around the global financial

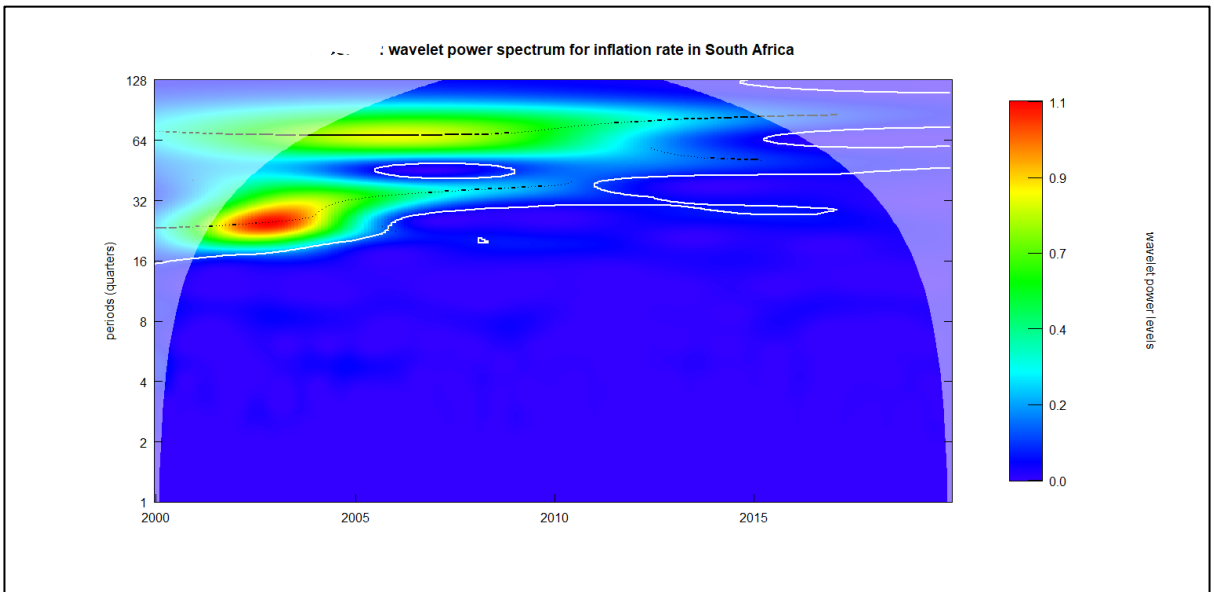
crisis period although this weakens in the post-crisis for South Africa, Botswana, and Lesotho, and extends into the post-crisis period for Eswatini and Namibia.

Figure 19: Inflation rates in SACU countries



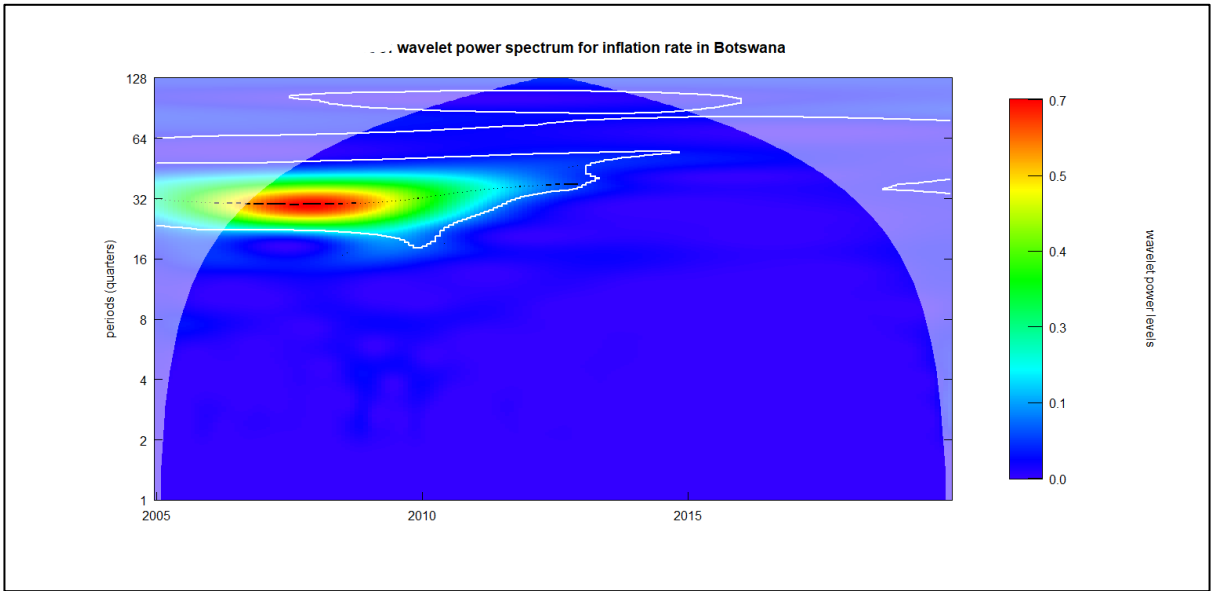
Source: Authors Computation

Figure 20: Wavelet power spectrum for inflation rates in South Africa



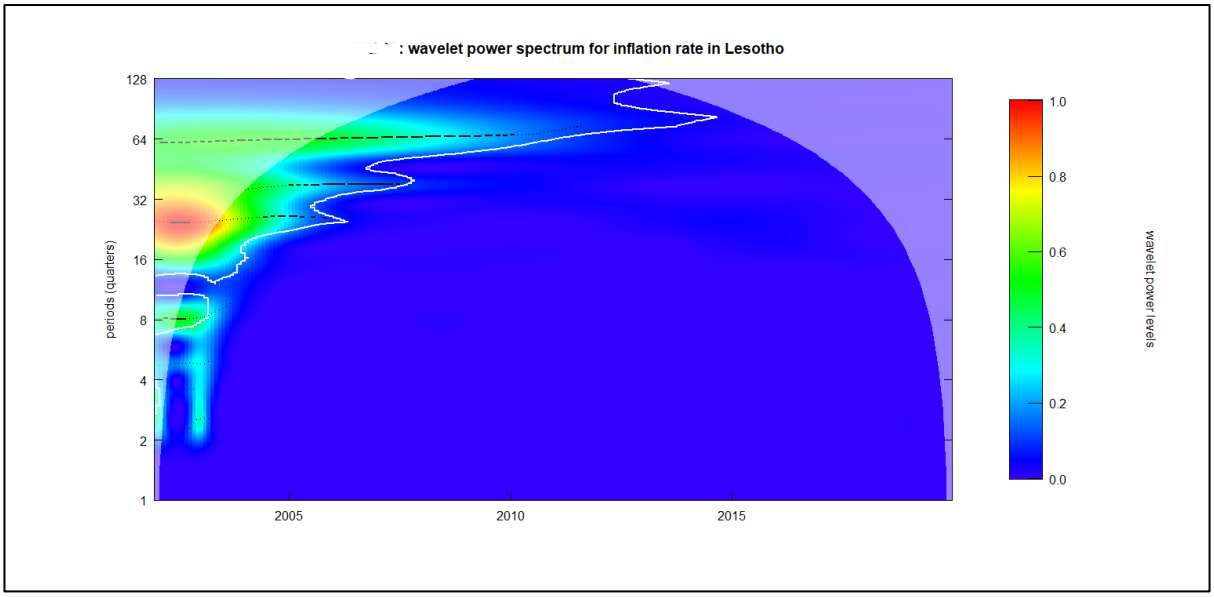
Notes: Figure 20 reports the wavelet power spectrum for the inflation rate in South Africa. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level. The cone of influence, which indicates the area affected by edge effects, is the outside region of the black line. The colours code for power indicates the level of intensity ranges from blue to red.

Figure 21: Wavelet power spectrum for inflation rates in Botswana



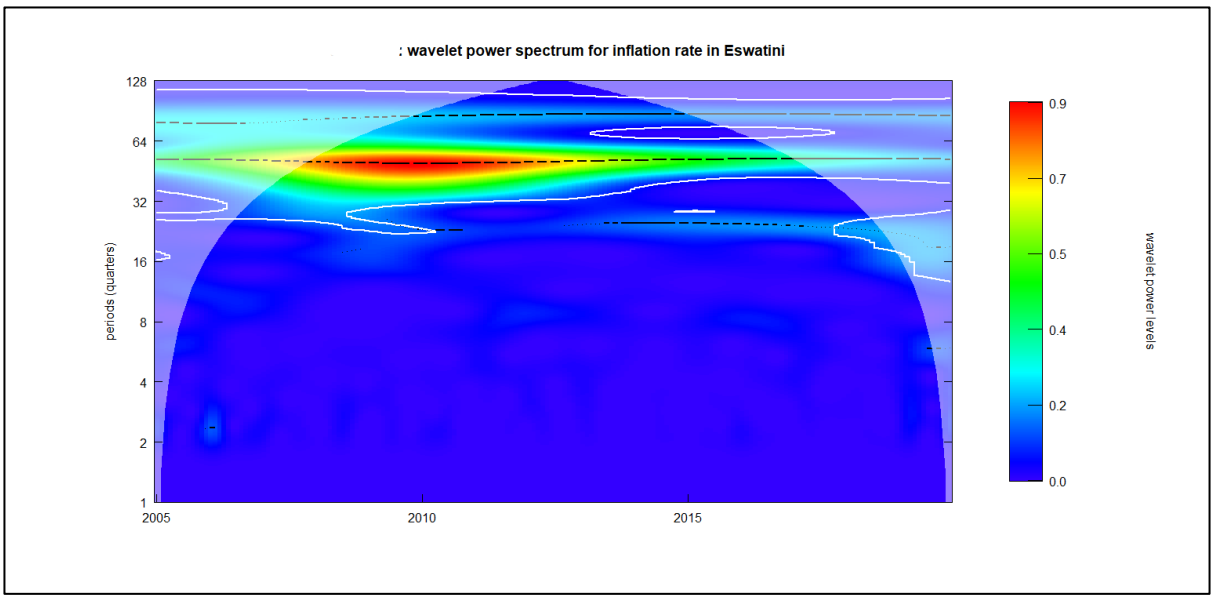
Notes: Figure 21 reports the wavelet power spectrum for the inflation rate in Botswana. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level. The cone of influence, which indicates the area affected by edge effects, is the outside region of the black line. The colours code for power indicates the level of intensity ranges from blue to red.

Figure 22: Wavelet power spectrum for inflation rates in Lesotho



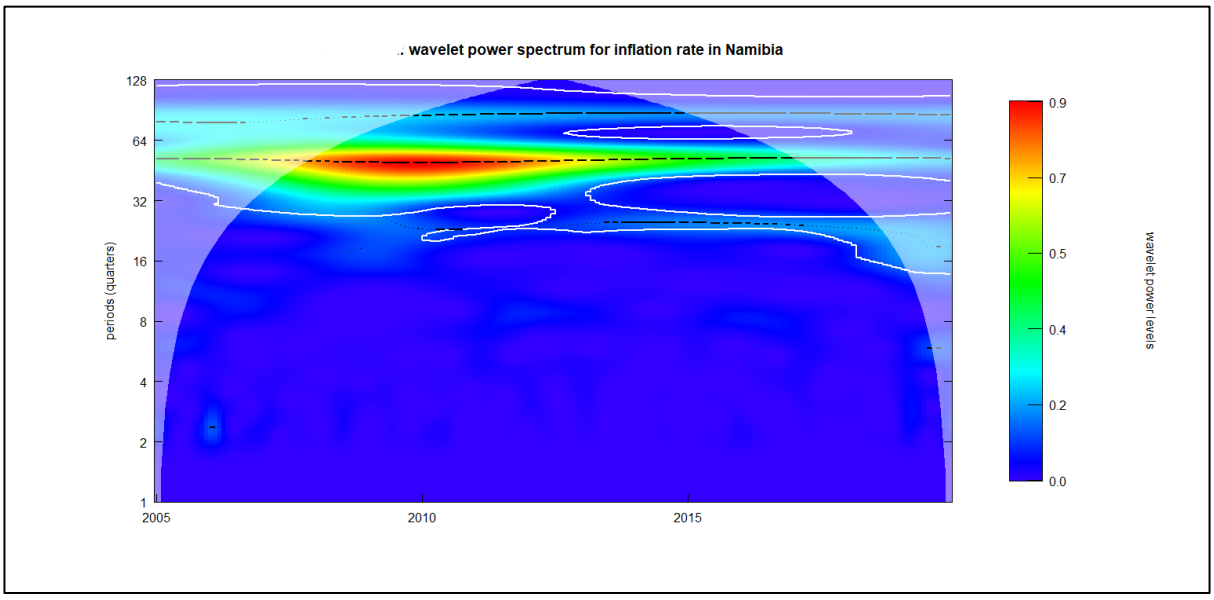
Notes: Figure 22 reports the wavelet power spectrum for the inflation rate in Lesotho. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level. The cone of influence, which indicates the area affected by edge effects, is the outside region of the black line. The colours code for power indicates the level of intensity ranges from blue to red.

Figure 23: Wavelet power spectrum for inflation rates in Eswatini



Notes: Figure 23 reports the wavelet power spectrum for the inflation rate in Eswatini. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level. The cone of influence, which indicates the area affected by edge effects, is the outside region of the black line. The colours code for power indicates the level of intensity ranges from blue to red.

Figure 24: Wavelet power spectrum for inflation rates in Namibia



Notes: Figure 24 reports the wavelet power spectrum for the inflation rate in Namibia. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level. The cone of influence, which indicates the area affected by edge effects, is the outside region of the black line. The colours code for power indicates the level of intensity ranges from blue to red.

5.3.2 Wavelet coherence analysis

In this section, I present the findings from the wavelet coherence analysis which analyses the co-movement between nominal interest rates and inflation (expectations) for SACU countries across a time-frequency domain. For comparative sake, I present the individual cross-sectional time series plots of nominal interest rates and inflation for the 5 SACU countries in Figure 25.

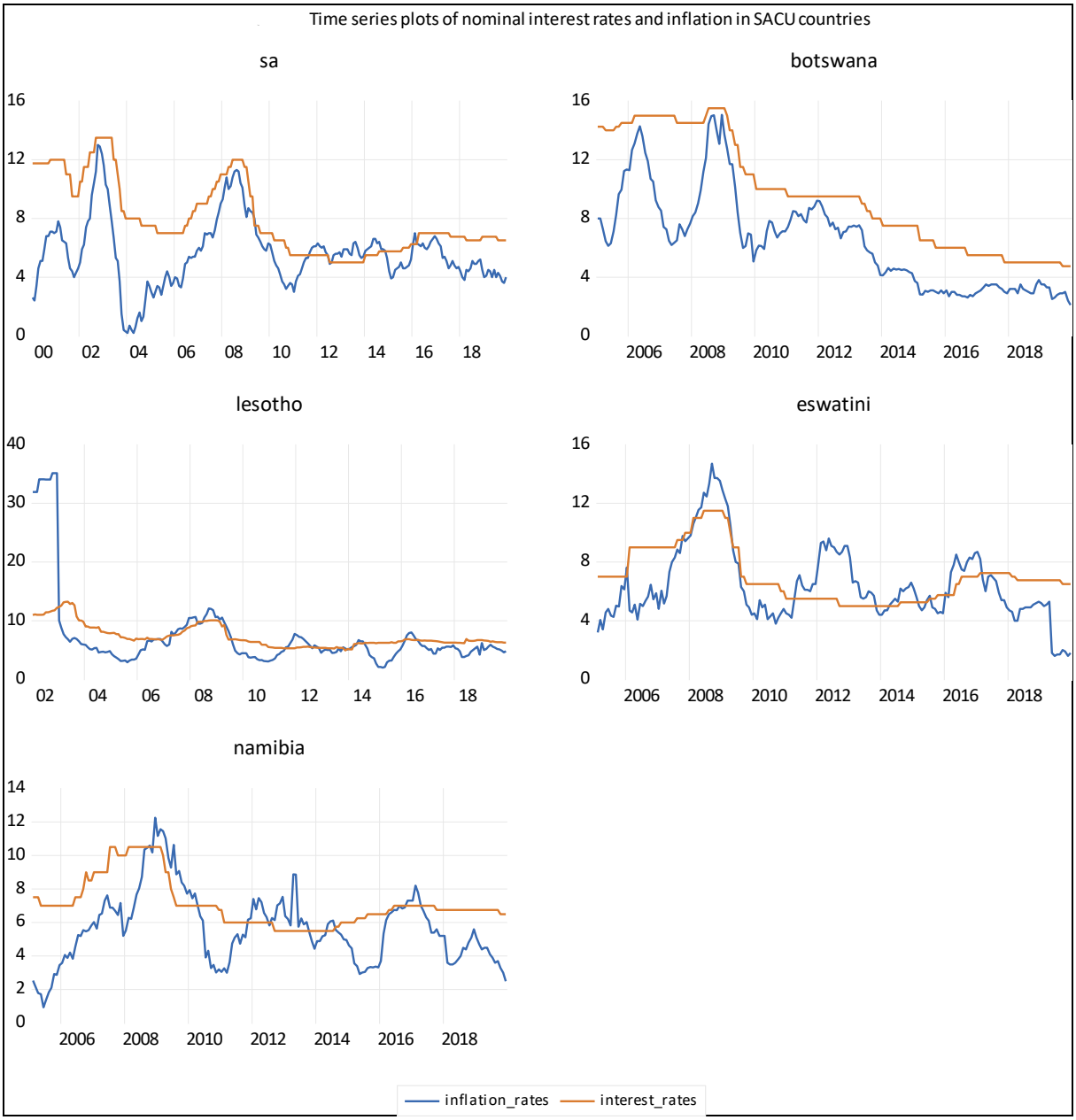
The main wavelet coherence plots are reported in Figures 26-30 describe the co-movement between interest rates and inflation in the time-frequency domain. The intensity of synchronization between the series is measured by the colour contours in the heatmaps, with the red contours implying a 'one-for-one' co-movement between the series (full fisher effect) at certain periodicities across different time periods whilst less warm colour contours indicate a partial Fisher effect. The faint white lines surrounding the colour contours indicate the 5% significance level whereas the inverted U-shaped curve is the cone of influence which represents the edge effects.

The phase difference dynamics within the wavelet coherence plots are indicated by arrow orientation and provide information on whether the series is in-phase (positively related) or anti-phase (negatively correlated) as well as on the lead-lag synchronization between the series. The arrow notations, ↑, ↗, →, ↘, indicate that an in-phase relationship between the series which is consistent with the traditional Fisher effect, whilst the arrow notations, ↓, ↙, ←, ↖ indicate that an anti-phase relationship between the series which is consistent with the Mundell-Fisher effect. Moreover, the arrow notations, ↑, ↗, →, ↙,←, indicate that nominal interest rates are leading inflation rates, which is in line with traditional theory. On the other hand, the arrow notations, ↘,↓,↖, indicate that inflation expectations are leading nominal interest rates which is consistent with causal dynamics underlying the Neo-Fisherian effect (Cochrane, 2014; Amano et al., 2016; Williamson, 2018; Uribe, 2018).

It is interesting to note that the synchronization between nominal interest rates and inflation across a time-frequency plane exhibits a similar dynamic for all SACU countries. For starters, in all wavelet coherence plots, the frequency bandwidth varies from 16-128 month cycles. Moreover, in wavelet plots higher frequency components begin to be eliminated, firstly the 16-32 month cycles disappear in the post-global financial crisis and secondly, in the post-2015 period, frequency cycles of 32-64 months lose their relevance, leaving only frequency bands of 64-128 months. However, some discrepancies between the SACU countries are observed.

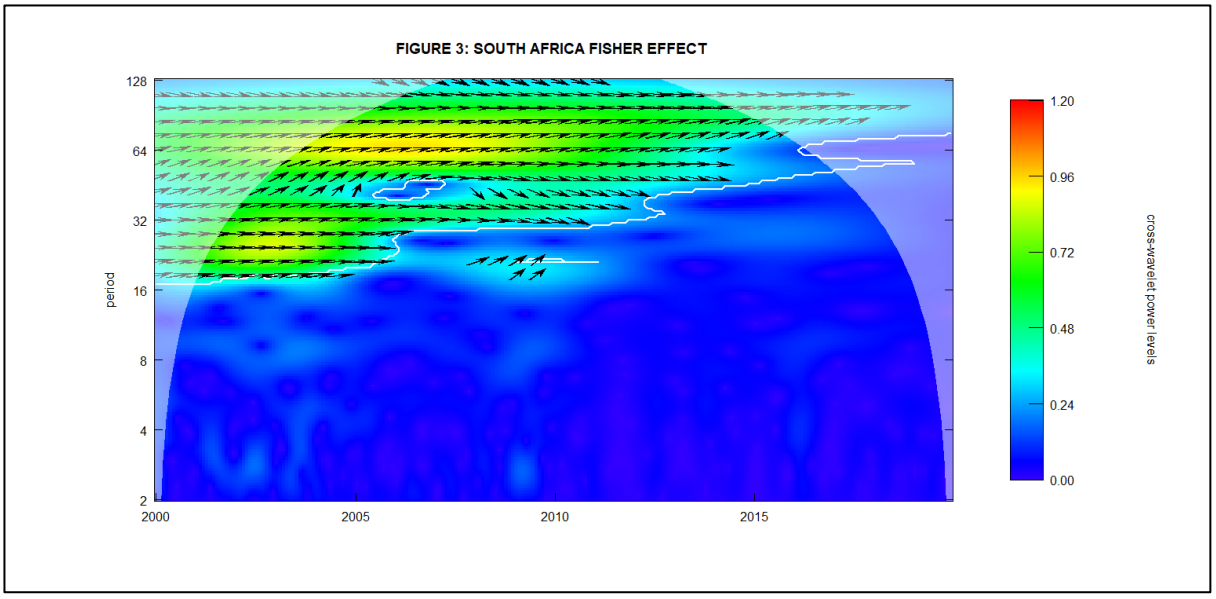
For instance, judging by the colour contours, a full Fisher effect is established for Botswana around the global financial crisis. Similarly, stronger Fisher effects are also found around this period for the other SACU countries but in a less than one-for-one co-movement i.e. partial Fisher effects. Further judging by the arrow orientation, I observed that synchronization between the series is generally in-phase with nominal interest rates leading to inflation expectations as insinuated by the traditional Fisher effect except for Lesotho during the 2001-2005 period where the frequency bands of 16-32 months are anti-phase which is evidence in favour of the Tobin-Mundell effect. From a lead-lag perspective nominal interest rates are leading inflation expectations (see arrows → and ↗) with the exception of the period 2007-2012 where the frequency bands around 32 - 40 months contain cycles whereby inflation rates lead nominal interest rates (see arrows ↘).

Figure 25: Time series plots of nominal interest rates and inflation in SACU countries



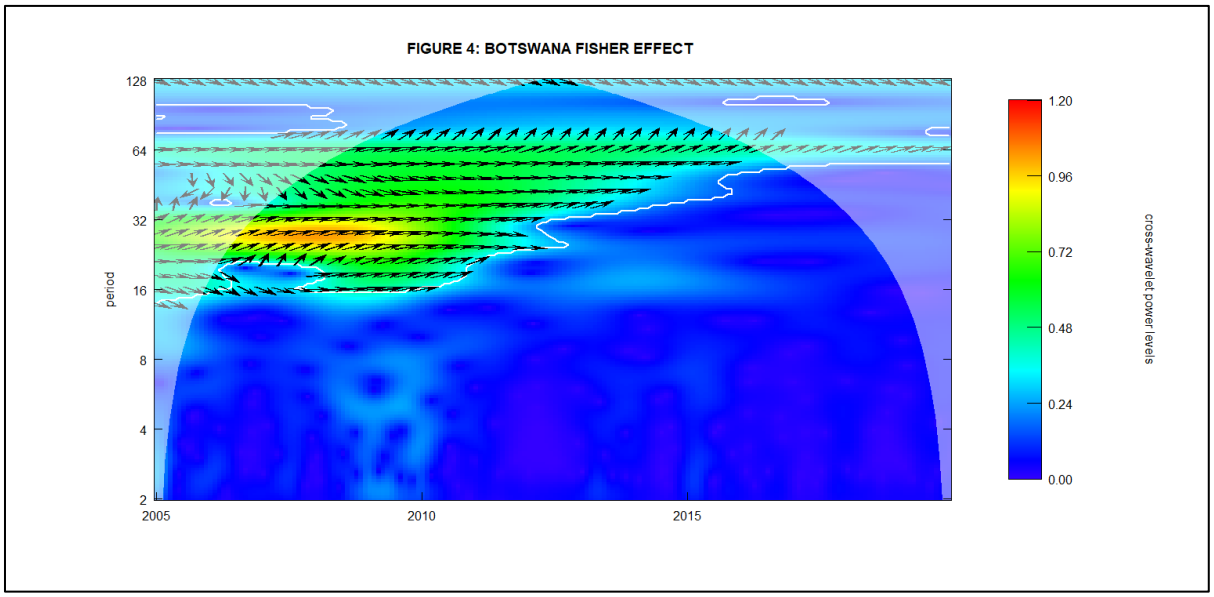
Source: Authors Computation

Figure 26: South Africa Fisher effect



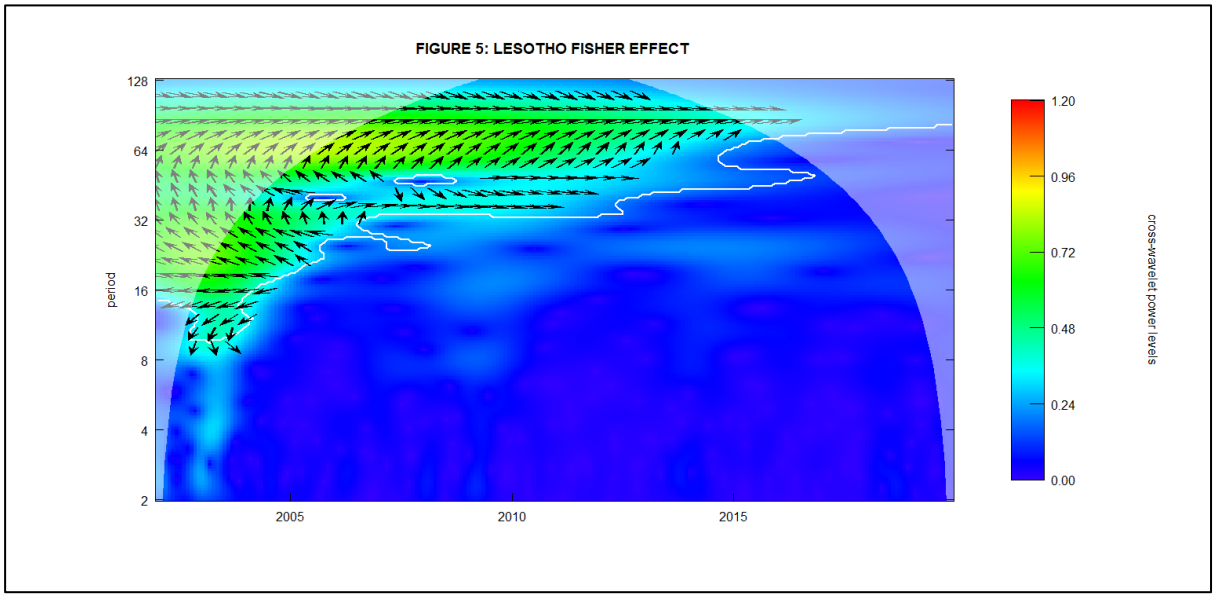
Notes: Figure 26 reports the Fisher effect wavelet coherence in South Africa. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level estimated by Monte Carlo simulations. The colour scale on the right side of the figure represents the level of correlation of the Fisher effect in South Africa. The red colour indicates high correlations among the time series variables.

Figure 27: Botswana Fisher effect



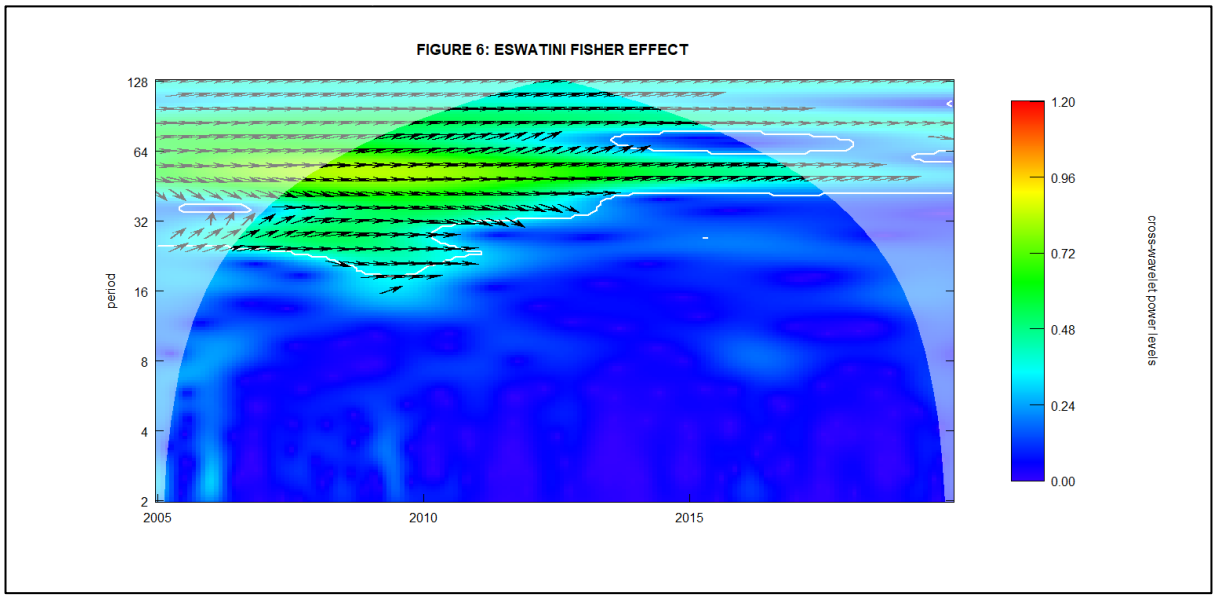
Notes: Figure 27 reports the Fisher effect wavelet coherence in Botswana. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level estimated by Monte Carlo simulations. The colour scale on the right side of the figure represents the level of correlation of the Fisher effect in Botswana. The red colour indicates high correlations among the time series variables.

Figure 28: Lesotho Fisher effect



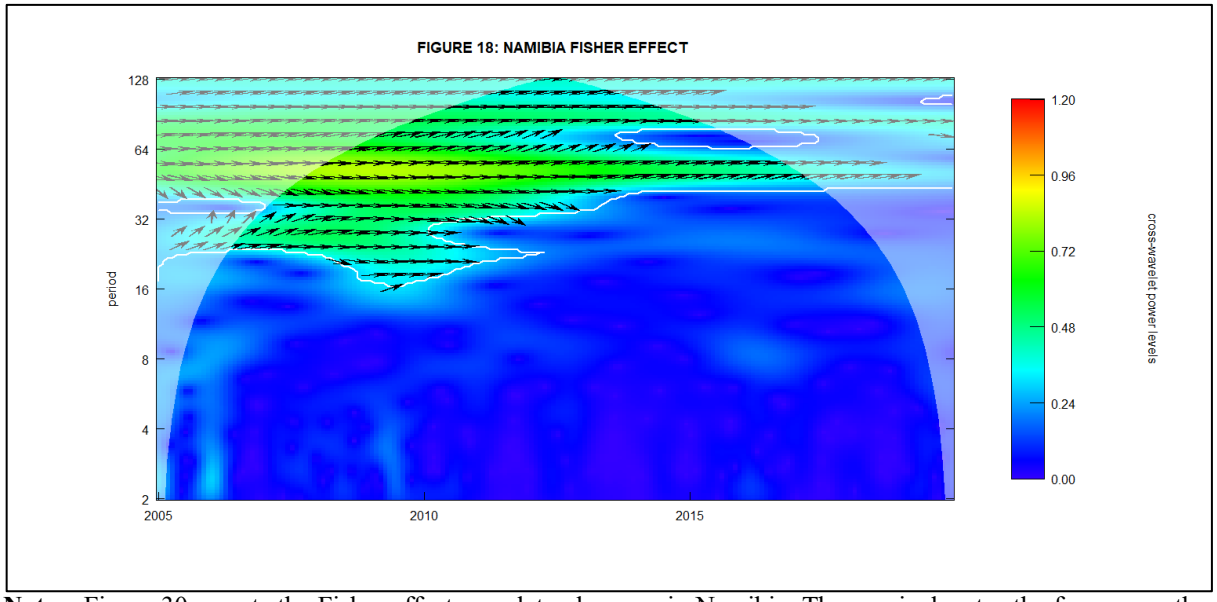
Notes: Figure 28 reports the Fisher effect wavelet coherence in Lesotho. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level estimated by Monte Carlo simulations. The colour scale on the right side of the figure represents the level of correlation of the Fisher effect in Lesotho. The red colour indicates high correlations among the time series variables.

Figure 29: Eswatini Fisher effect



Notes: Figure 29 reports the Fisher effect wavelet coherence in Eswatini. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level estimated by Monte Carlo simulations. The colour scale on the right side of the figure represents the level of correlation of the Fisher effect in Eswatini. The red colour indicates high correlations among the time series variables.

Figure 30: Namibia Fisher effect



Notes: Figure 30 reports the Fisher effect wavelet coherence in Namibia. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level estimated by Monte Carlo simulations. The colour scale on the right side of the figure represents the level of correlation of the Fisher effect in Namibia. The red colour indicates high correlations among the time series variables.

5.4 CONCLUSION

This chapter examined the Fisher effect for SACU countries as a Common Monetary Area (CMA) using a set of continuous wavelet tools which allow us to investigate the co-movement between nominal interest rates and inflation expectations over a time-frequency domain. This differs from conventional methods used in the current literature which depend on time-domain estimation techniques which ignore important frequency oscillations in the data. The wavelet tools, such as wavelet power spectrum, cross wavelet power spectrum and phase dynamics, present a formidable unified analytical framework that simultaneously addresses empirical inconsistencies and puzzles existing in the Fisher relationship.

Altogether, the wavelet tools allow one to examine the co-movement between nominal interest rates and inflation expectations in SACU countries from 5 dimensions. Firstly, from a time perspective, I find that there has been continuous co-movement between the series in the post-2000 period for all countries. Secondly, from a frequency perspective, I find that higher frequency co-movements are dominant during the pre-global financial crisis whilst lower frequency synchronizations are dominant during the post-crisis period. Thirdly, from a magnitude perspective, I find that the Fisher effect is most dominant during the global financial

crisis whilst weakening in the post-crisis period. Fourthly, from a phase perspective, I find that the series are in-phase (positively co-related) with the exception of Lesotho which has some anti-phase synchronizations during the inflation surge in 2001-02. Lastly, from a lead-lag perspective, I find that whilst nominal interest rates lead inflation expectations at low frequencies, as is consistent with traditional theory, at higher frequency components around the global financial crisis, I find evidence of reverse causality which is conformity to NeoFisherian dynamics.

CHAPTER 6: INVESTIGATING THE PURCHASING POWER PARITY (PPP) FOR SACU COUNTRIES

6.1 INTRODUCTION

This chapter undertakes a bilateral approach to investigating the PPP amongst the SACU countries and South Africa is treated as the anchor country in this analysis, which correlates well with the fact that rand is the dominant currency within the SACU's Common Monetary Area (CMA) and is the main trade and investment partner for the smaller SACU nations. In differing from many recent studies for African countries, which rely on unit root tests on real exchange rate series (Chang, Lu, Tang, Liu, and Lee (2010), Olayungbo (2011), Tsai, Weng and lin (2012), Bahmani-Oskooee, Chang and Lee (2014), Iyke and Odhiambo (2015), Kyei-Mensah (2019)), the study adopts the regression approach which examines the co-movement between nominal exchange rates and price differentials which is more in line with traditional theory.

The chapter uses continuous wavelet transform to examine the PPP across a time-frequency domain which allows us to decompose the co-movement between nominal interest rates and price differentials in a scale-by-scale manner. In turn, I am able to investigate the PPP hypothesis from five dimensions namely i) time-varying ii) frequency varying iii) strength/magnitude varying iv) phase dynamics (negative or positive co-movements) v) lead-lag dynamics (causality). One prominent advantage of using the wavelet approach is that the wavelet output for any given time period is not distorted by shortening or lengthening the data under observation. This is unlike conventional time series models, whose estimates tend to change for different time period lengths even if different forms of nonlinearity are accounted for within the methodology. This renders the output from continuous wavelet transforms more definite than that produced by time series models.

The remaining parts of the chapter are outlined as follows. Section 6.2 presents the data. Section 6.3 analyses the empirical results and discussions. Section 6.4 summarises the study.

6.2 DATA

The data sample includes Botswana, Eswatini, Namibia, Lesotho, with South Africa as the base country. The Nominal Exchange Rate (NER) was calculated based on the ZAR expressed in

pula (ZAR/BWP), lilangeni (ZAR/SZL), Namibian dollar (ZAR/NAD), and Loti (ZAR/LSL) respectively. The data for these variables were obtained from the related central banks, the IMF (accessed via Open Data per country), and the IFS (IFS).

6.2.1 Descriptive statistics

This section will provide the descriptive statistics, correlation matrix, and time series plots of the time series variables employed in the study. Table 27 depicts the descriptive statistics of the price difference and NER of four SACU countries. The NER for Eswatini showed the highest peak over the sample period. Namibia followed closely behind with the average mean of 0,996388% with Botswana showing the least mean average at 0,757914%. The standard deviation of the exchange rate in SACU ranges from 0,131686% (Botswana), 0,139335% (Eswatini), 0,013003% (Namibia) to 0,1228852% (Lesotho).These are important statistics to note are the standard deviations, which show the volatility of the variables. Lesotho is the only country that has the lowest NER volatility in SACU. The skewness is positive for Namibia and negative for the rest of the SACU countries. The kurtosis statistic specifies that the distribution of the exchange rates for Botswana and Lesotho are platykurtic and Eswatini and Namibia are Keptokurtic in their distribution.

For the price difference, Botswana recorded the poorest price difference at -0,909466% while Eswatini recorded the highest mean average during the sample period. The standard deviation ranges from 0,116519% (Botswana), 0,017396% (Eswatini), 0,008889% (Namibia) to 0,017797% (Lesotho), with Botswana indicating the highest price difference volatility in SACU for the sample period. The skewness is negative for all the countries. The price difference is all platykurtic for all the countries except for Namibia which is keptokurtic in its distribution.

Table 27: Descriptive statistics

NER	Botswana	Eswatini	Namibia	Lesotho
Mean	0,757914	1,021595	0,996388	0,949810
Median	0,755736	1,040831	0,996181	0,969535
Maximum	1, 017504	1,069715	1,064871	1,008774
Minimum	0,437742	0,000000	0,948164	0,000000
Std. Dev.	0,136186	0,139335	0,013003	0,128852
Skewness	-0,256427	-1,808215	0,480374	-6,863135
Kurtosis	2,679810	3,424701	3,301481	2,313992
Price difference	**Botswana**	**Eswatini**	**Namibia**	**Lesotho**
Mean	0,909466	1,041542	0,996951	0,969760
Median	0,947850	1,040391	0,998413	0,9710§8
Maximum	1,051567	1,065301	1,009329	1,008169
Minimum	0,696071	1,000000	0,961411	0,924713
Std. Dev.	0,116519	0,017396	0,008889	0,017797
Skewness	-0,581117	-0,704481	-1,449245	-0,134434
Kurtosis	1,837031	2,867178	3,425399	2,527631

Source: Authors Tabulation

6.2.2 Correlation analysis

The correlation matrices are presented in Table 28 below. According to Table 28, NER is highly correlated with the price difference in Botswana and Namibia. This is in line with *a priori* expectations. Eswatini's NER and price difference have the lowest correlation coefficient. Lesotho shows a negative correlation between the variables. NER is correlated positively with the price in all the countries at 0,784175, 0,460341, 0,756862 and 0,543890 respectively. Eswatini has the lowest correlation coefficient of 0,460341% and Botswana has reported the highest correlation coefficient of 0,784175.

Table 28: Correlation Matrix

Country	Correlation
Botswana	0,784175
Eswatini	0,460341
Namibia	0,756862
Lesotho	0,543890

Source: Authors Tabulation

The analysis is based on monthly observations. Employing a longer span of data would have been advisable. However, due to data availability constraints, monthly data is collected for the purpose of this study. The data used in this empirical analysis comprises the time series variables of the NER and price indices for SACU. The collected price series are based on the total CPI for Lesotho, Namibia, Botswana, Eswatini and South Africa as the base country.

6.3 EMPIRICAL ANALYSIS

6.3.1 PPP

In this section, the wavelet analysis to investigate the co-movement between exchange rates and prices in SACU economies is employed, South Africa as a base country. I show these plots to examine bivariate co-movements in the frequency and time domains that show the measure of local correlation amongst the variables and phase differences to depict any lag or lead relationships between variables.

An arrow in the wavelet coherence shows the lead/lag linkage between variables. With regards to the phase difference, when arrows are pointing to the right suggests that the two series are in phase (positive correlation), and pointing to the left mean that the two series are out of phase (negative correlation). While the arrows pointing to the right and up means the first series is lagging and arrows pointing to the right and down means the first series is leading, arrows pointing to the left and up shows the first series is leading and when the move goes to the left and down, then the first series is said to be lagging (Roesch and Schmidbauer, 2014). The order of the series is the same as the order in which the names appear on top of the plots.

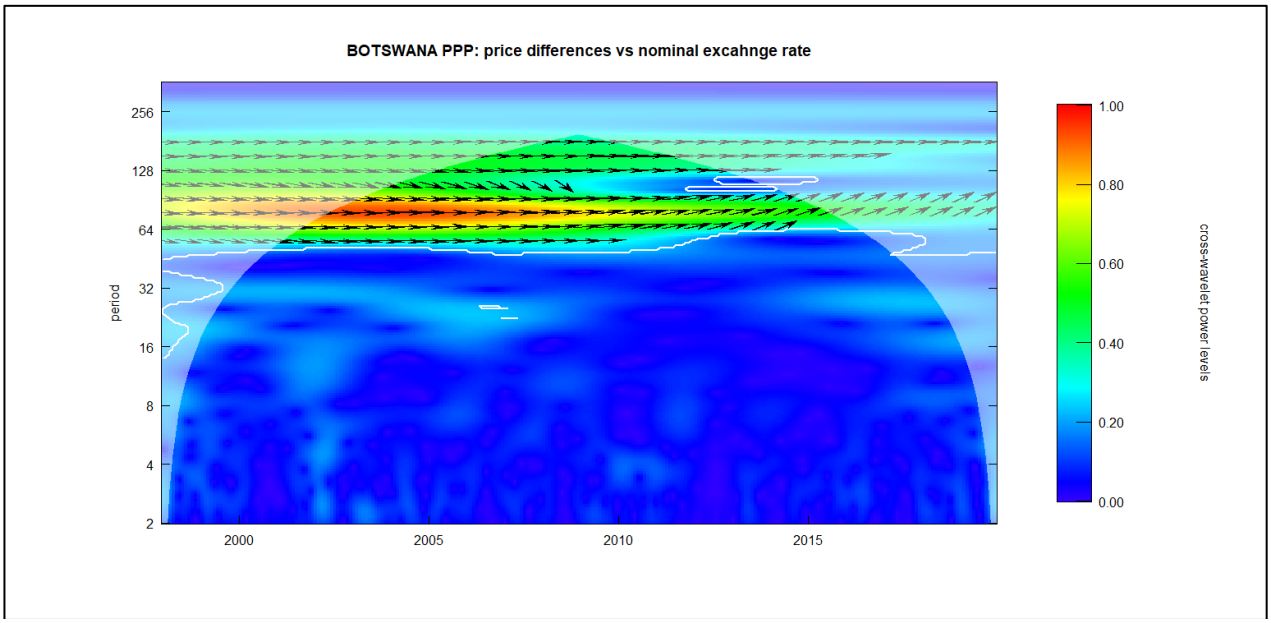
6.3.1.1 Botswana

The figure below depicts evidence of PPP in the long run from 60-240 months frequency bands. The arrows are pointing rightward right until 2012. Indicated an in-phase correlation or a positive relationship. From 2012 until the end of the period of the study, the arrows are pointing rightward-up, implying a positive relationship where the price is leading the exchange rate. According to the wavelet results, there is strong evidence of the PPP in 2004-2005 in Botswana and this is related to the decision by the authorities to devalue the Pula in 2004 as well as adopting the crawling peg mechanism in 2005 so as to maintain a stable and competitive real effective exchange rate.

Botswana and South Africa have high trade linkages and are geographically close, and this could support the long-run PPP evidence observed, as Atta et al. (1999) stated that the PPP theory is likely to perform better under such conditions. There are mixed findings of PPP in Botswana. Studies like Tsai, Weng, and lin (2012), Tshipinare (2005) and Paul and Motlaleng (2008) found no support of the PPP in Botswana. On the contrary, Atta et al (1996) Sethunya

Sejoe, Narain Sinha and Zibanani Kahaka(2020), Baharumshah, Mohd and Soon (2011), Atta, Jefferis, and Monnathoko (1996), Rapelana (2014), Sinha et al. (2018) and Paul & Motlaleng (2008) found the evidence of the long run PPP in Botswana.

Figure 31: Wavelet coherence between price and nominal exchange rate in Botswana

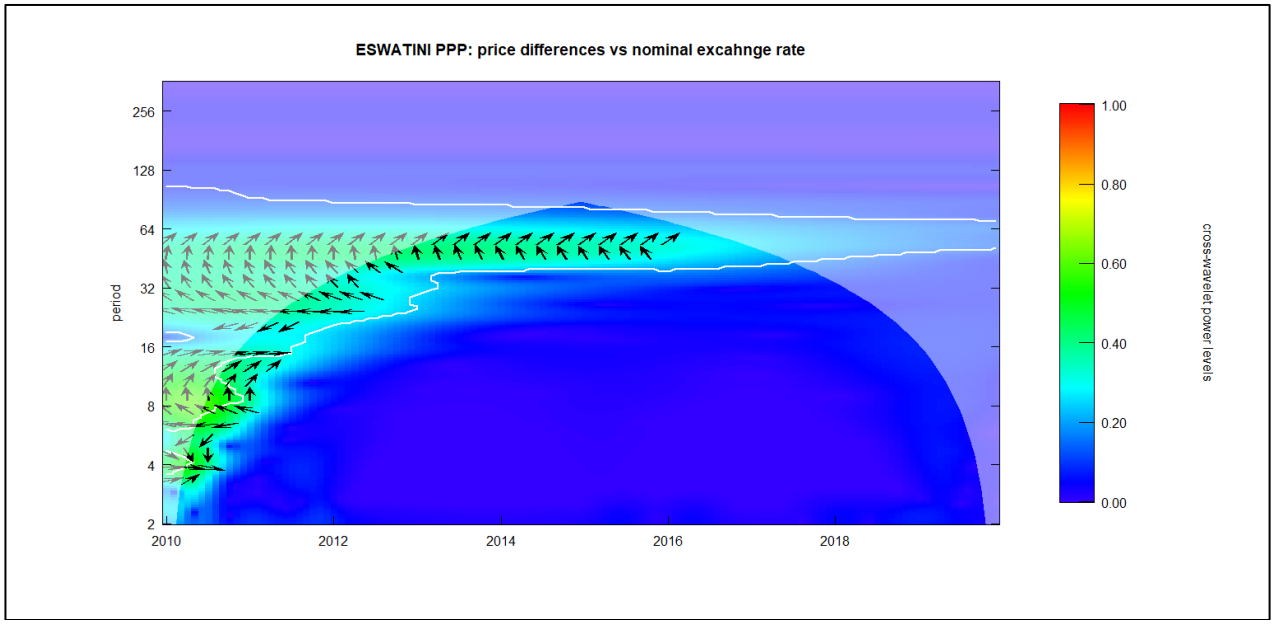


Notes: Figure 31 reports the wavelet coherence between Co-movement between CPI and nominal exchange rates in Botswana. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level estimated by Monte Carlo simulations (500 trials). The colour scale on the right side of the figure represents the level of correlation between Co-movement between CPI and nominal exchange rates in Botswana. The red colour indicates high correlations among the time series variables.

6.3.1.2 Eswatini

The co-movements between prices and exchange rates in Eswatini show a gradual increase from the short-run to the medium-run. Around 8-16 months frequency band over the period 2010-2011 after the global financial crisis of 2007/8, I observed arrows facing rightward-up. This indicates short-run PPP in Namibia, where the prices are leading the exchange rates. The variables are positively correlated. In the medium run, indicated by 32-64 months frequency band over the 2010-2916, I observed majority of the arrows that are facing leftward-up. Indicating an out-of-phase relationship with the first series leading. On the contrary, Kargo (2006) found overwhelming support for long-run PPP in Africa and Makhethaa (2007) also found evidence of PPP in SACU. The above-mentioned studies do not provide the frequency and the period where the PPP was identified, therefore, this study provides a different methodology that provides the time and frequency of when the co-movements occurred.

Figure 32: Wavelet coherence between price and nominal exchange rate in Eswatini

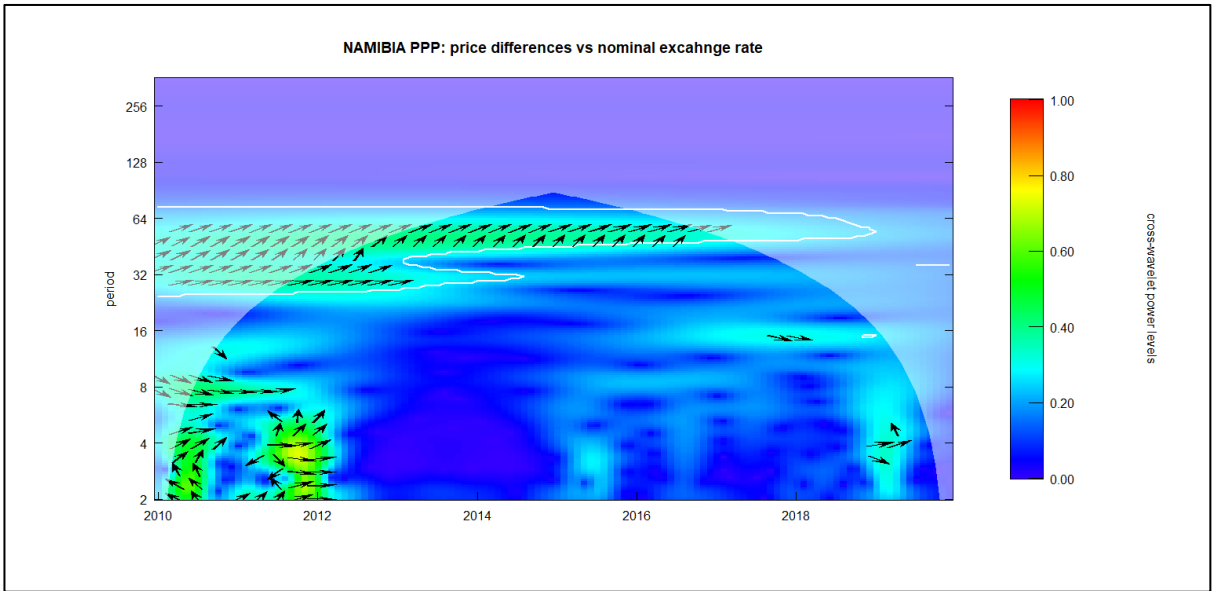


Notes: Figure 32 reports the wavelet coherence between Co-movement between CPI and nominal exchange rates in Eswatini. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level estimated by Monte Carlo simulations (500 trials). The colour scale on the right side of the figure represents the level of correlation between Co-movement between CPI and nominal exchange rates in Eswatini. The red colour indicates high correlations among the time series variables.

6.3.1.3 Namibia

The wavelet diagram provides evidence of the short-run and medium co-movements in Namibia for the years 2010 and 2012. The cross-wavelet coherence plotted in Figure 33 shows three time-scale areas of co-movement on lower frequencies around 2-8 months band. This indicates the short-run relationship between the prices and exchange rates in Namibia. The majority of the arrows are pointing rightward-up, indicating a positive relationship between the prices and exchange rates, where the prices are leading the exchange rates. There is a unidirectional causality running from prices to exchange rates. A similar relationship or behaviour appears again at a higher frequency around 30-64 months band over the period 2010-2017. The results in both the short-run and medium-run indicate an in-phase correlation. According to SACU (2020), Namibia is part of the common monetary area, whereby South Africa sets the monetary and exchange rate policies. Namibia issued the Namibian dollar in 1993 soon after it has gained independence in 1990. Namibian dollar remained fixed to the South African Rand on a one-to-one parity. Hence the PPP between the two countries is anticipated.

Figure 33: Wavelet coherence between price and nominal exchange rate in Namibia

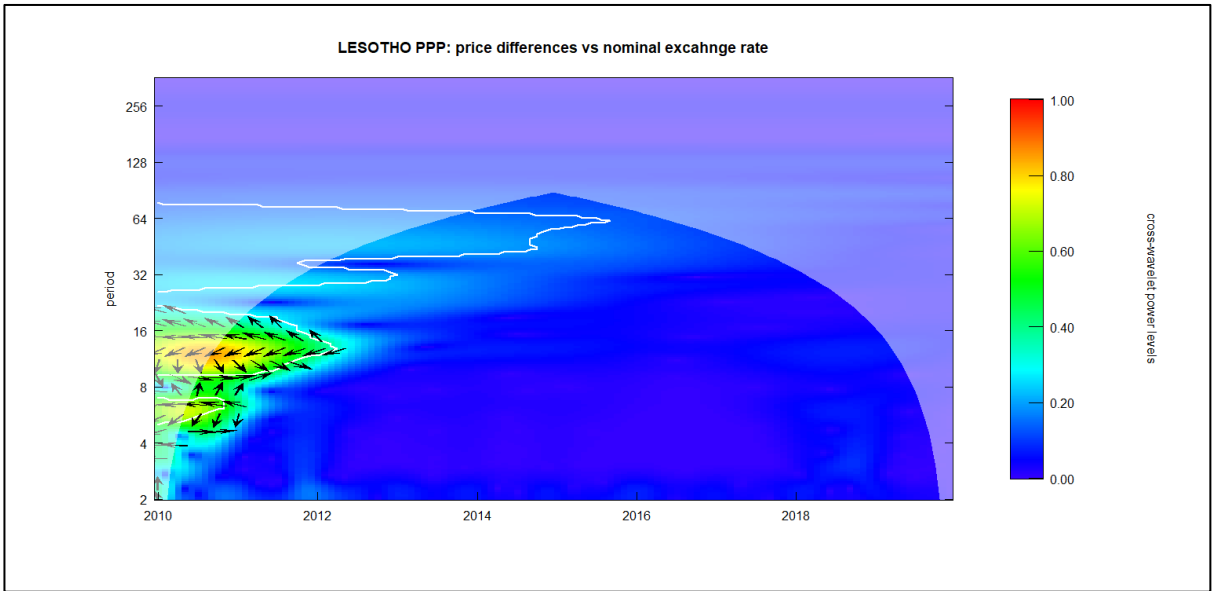


Notes: Figure 33 reports the wavelet coherence between Co-movement between CPI and nominal exchange rates in Namibia. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level estimated by Monte Carlo simulations (500 trials). The colour scale on the right side of the figure represents the level of correlation between Co-movement between CPI and nominal exchange rates in Namibia. The red colour indicates high correlations among the time series variables.

6.3.1.4 Lesotho

Lesotho's results are different compared to the rest of the SACU country's results. Lesotho is the only country in SACU that shows very little evidence of the PPP. From Figure 34, I observed PPP evidence in short-run and medium run over the 4-18 months frequency bands over the period 2010 and 2012. Though there might not be a clear-cut direction of the arrows since they are pointing in different directions. In other words, the direction of the arrows varies across the same frequency bands over the time period under consideration. Even though it is difficult to draw clear-cut conclusions, by observing the yellow circle, I observed that over the 8-16 months frequency band the arrows are pointing leftward-down. Indicating an out-of-phase relationship. The above results are not consistent with the results found in a study done by Kargo (2003b) who found evidence of the long run PPP in Lesotho. According to the CMA arrangement that exists between South Africa and Lesotho implies that monetary shocks in South Africa will be transmitted to Lesotho's economy.

Figure 34: Wavelet coherence between price and nominal exchange rate in Lesotho



Notes: Figure 34 reports the wavelet coherence between Co-movement between CPI and nominal exchange rates in Lesotho. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level estimated by Monte Carlo simulations (500 trials). The colour scale on the right side of the figure represents the level of correlation between Co-movement between CPI and nominal exchange rates in Lesotho. The red colour indicates high correlations among the time series variables.

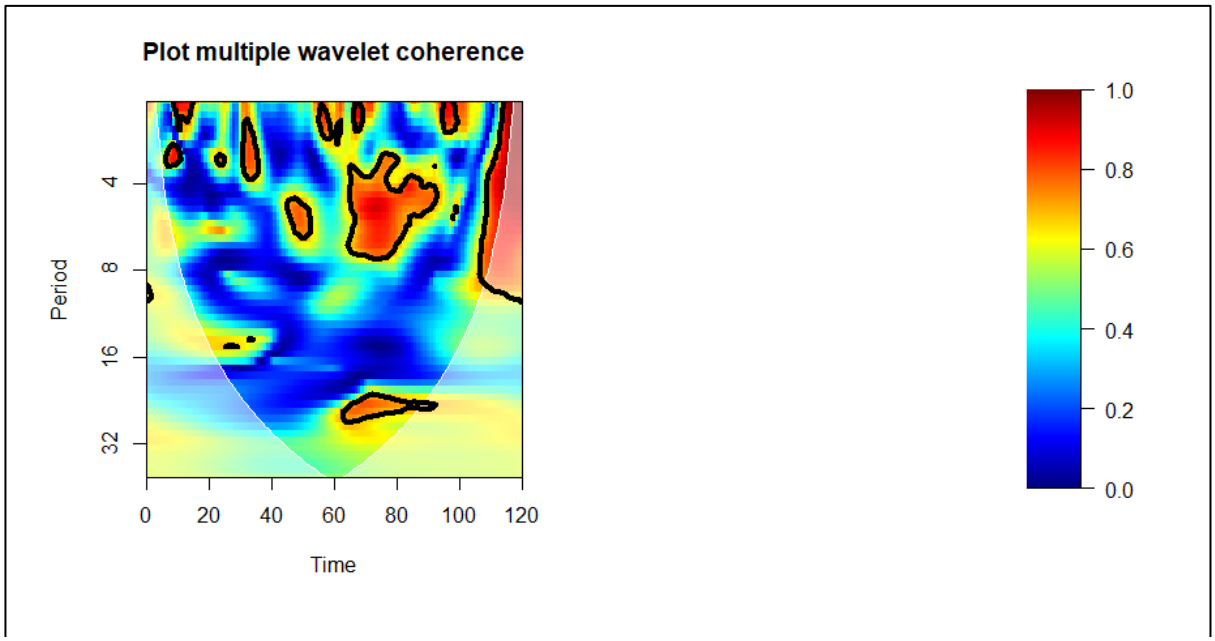
6.3.2 GPPP

In section 6.3.1, I analysed the PPP individually per country in SACU, using South Africa as the base country and wavelet coherence analysis. In this section, I are analysing GPPP, using the Real Exchange rate (RER) in all SACU countries to examine the co-movements of the multivariate time series using the vector wavelet coherence (VWC). The VWC plot for the GPPP analysis is provided in Figure 35.

When considering the co-movements of RER in SACU countries, it can be observed that the multi-correlation of the real exchange rate in SACU countries is not continuous but occurs across different time periods and frequency levels. The strong co-movements are identified for both low and medium frequencies. In the short-run, two significant periods of strong co-movements are observed during the period 2009-2011 at 4-8 frequency cycle and 2015-2019 at the 0-8 frequency cycle where the correlation is ranging between 0.8 and 1.0 (a period close to financial crisis and Euro crisis). It is worth mentioning that from the period 2016-2019 at the 0-8 frequency, the co-movement is not significant as it is outside the white line contour designates the 5% significance level. In the medium-run, I observed the existence of one co-

movement between 2009-2011. The multiple wavelet coherence indicates strong co-movements when analysing the relationship of the RER in SACU, that is I found evidence of the GPPP in SACU countries in the short and medium run. Contrary to studies such as Mkenda (2001), Grandes (2003), Redda and Muzindusti (2017), Zerihun and Breitenbach (2018), and Gitimu (2018) who focused on the evidence for the long run.

Figure 35: Multiple wavelet coherence of RER in SACU



Notes: Figure 35 reports the multiple wavelet coherence of the co-movement between RER in SACU countries. The y-axis denotes the frequency, the x-axis shows the time period. The white line contour designates the 5% significance level. The colour scale on the right side of the figure represents the level of correlation between RER in SACU. The red colour indicates high correlations among the time series variables.

Note: Time: 0 – 2000; 20 – 2003; 40 – 2006; 60 – 2009; 80 – 2012; 100 – 2015; 120 - 2019

6.4 CONCLUSION

This chapter investigate the PPP and GPPP hypothesis for SACU countries using the wavelet coherence and vector wavelet coherence analysis, respectively. Firstly, the PPP is examined between the exchange rates and inflation differential data between South Africa and the smaller SACU countries. Secondly, the GPPP is examined for the real exchange rates of the SACU countries.

The results from the PPP analysis indicate strong long-run PPP effects between Botswana and South Africa implying that there is no comparative advantage in trade amongst the countries. Conversely, Eswatini, Namibia, and Lesotho show evidence of the short run PPP hence

implying that the exchange rate between the two countries does not appreciate/depreciate to equalise the ratio of the two countries' price levels over the long-run and hence speculative opportunities exist in trade. Note that the weakest PPP relations are observed between south Africa and Lesotho.

The results from the GPPP analysis show that the collectively co-movement between the real exchange rates in SACU countries occurs in spurts that differ across frequency and time scales. More significant co-movement across the short-run and long-run is observed during periods of crisis such as the global financial crisis of 2007-2009. These findings have implications on the viability of OCA amongst the SACU countries.

CHAPTER 7: INVESTIGATING THE CO-MOVEMENTS BETWEEN EXCHANGE RATE AND STOCK RETURNS IN SACU COUNTRIES

7.1 INTRODUCTION

This chapter investigates the link between currency and equity markets for 5 SACU countries. What makes the focus on these countries important and interesting is that these nations form a CMA in which the currencies of Lesotho, Eswatini, and Namibia are pegged to the South Africa Rand as a regional anchor currency whilst the currency for Botswana is determined by a basket of currencies which places heavy weight on the South African Rand. In turn, the South African Rand is floated on international currency markets, therefore, allowing for pass-through effects of global shocks into exchange rates of the other SACU members.

It is also interesting to note the structure and size differences of stock exchanges in the SACU region, with the JSE having the largest and most diversified stock market in the continent, with over 400 company listings (Phiri, 2015), whilst the other member states have relatively smaller stock exchanges. The structure of the stock exchanges in the smaller member states is dominated by financial services, particularly the banking sector and asset management companies, export-linked companies such as diamond/mineral companies in Botswana and Namibia, and sugar companies in Eswatini. The financial sector and export markets in these economies are prone to exchange rate fluctuations in the South African Rand as the region's dominant currency, and in turn, the Rand is susceptible to both global and domestic shocks.

This study makes use of continuous wavelet transforms to investigate the dynamic co-movement between exchange rates and stock market returns in SACU economies. Most previous studies have relied on time-domain techniques hence they have been unable to identify frequency-varying correlations within the time series. The use of wavelets enables us to fill this empirical gap in the literature. Note that frequency correlations are equivalent to measuring short-run, medium-run, and long-run correlations across a moving time window. Distinguishing between these frequency components is important for capturing the heterogeneous activity of different market participants who base their decisions across different frequency horizons.

The remaining parts of this paper are as follows. Section 7.2 presents the data description and summary statistics of the time series. Section 7.3 analyses the empirical results and discussions. Section 7.4 summarises the study.

7.2 DATA AND DESCRIPTIVE STATISTICS OF TIME SERIES

7.2.1 Data description

For empirical purposes, this study made use of monthly data for stock market indices and exchange rates for four SACU countries i.e. South Africa, Botswana, Eswatini, and Namibia. Note that Lesotho is excluded in the study as the Stock price dataset is not available due to the market launched in 2016 (Cossesite,2020). The stock indexes studied are the Botswana Stock Exchange Domestic Company Index (BSE DCI), the Eswatini Stock Exchange (ESE All-share Index), the Namibian Stock Exchange (NSX Overall Index), and the Johannesburg Stock Exchange (JSE All-Share Index). The exchange rates were calculated based on the USD 1 expressed in pula (USD/BWP), lilangeni (USD/SZL), Namibian dollar (USD/NAD), and rand (USD/ZAR) respectively. The data for these variables were obtained from the related central banks, the IMF (accessed via Open Data per country), and IFS.

7.2.2 Descriptive statistics correlation matrix and unit root tests

In this section, the descriptive statistics, correlation matrix, and integration properties of the time series variables used in the study are provided. From Table 29, which summarizes the descriptive statistics of the time series, I observed some stylized facts on the variables. For instance, the average dollar exchange rate is lowest in Botswana (strongest currency), followed by South Africa (2nd strongest currency), Namibia (2nd strongest currency), and lastly Eswatini (weakest currency). Also judging by the average stock returns, the Namibian stock market is the most profitable market in the SACU region followed by South Africa, and then finally Eswatini and Botswana, with the latter two exchanges showing negative averages over the sample period. The standard deviation reveals very little difference in the volatility of stock returns and exchange rates amongst the SACU countries, whilst the Jarque-Bera statistics show that all series are non-normal, which is characteristical of financial time series.

Table 29: Descriptive statistics

Exchange rates	Botswana	Eswatini	Namibia	SA
Mean	7,791031	10.74946	9,775944	8.600522
Median	7,515880	10,61000	8,588400	7,648505
Maximum	11,36100	16,17000	16,17000	16,38913
Minimum	4,188400	1,960000	5,534700	3,640671
Std. Dev.	2,030058	2,921104	3,012285	3,122404
J-B p-value	0,001131	0.0555900	0.000096	0.000000
Stock returns	**Botswana**	**Eswatini**	**Namibia**	**SA**
Mean	-0,001895	-0,000729	0,006226	0,000777
Median	-0,002813	-0,000743	0,008713	0,000774
Maximum	0,049020	0,101105	0,286988	0,000888
Minimum	-0,037581	-0,102523	-0,310295	0,000644
Std. Dev.	0.016861	0,047765	0,062916	0,036356
J-B p-value	0,000000	0,000000	0.001701	0,000000

Source: Authors Tabulation

The correlation coefficients between exchange rates and stock returns are presented in Table 30 which presents preliminary evidence of a positive co-movement between the variables although this provides no information on the direction of causality.

Table 30: Correlation Matrix

Country	Correlation
Botswana	0,776001
Eswatini	0,784353
Namibia	0,718722
South Africa	0,834705

Source: Authors Tabulation

Table 31 presents the unit root tests results of the ADF and DF-GLS tests performed with an intercept and inclusive of a trend. In general, I find the exchange rates to difference stationary whilst the returns series are levels stationary. In either case, the variables, whether I(1) or I(0), are compatible with continuous wavelet transforms.

Table 31: Unit root test results

Panel A: ADF					
Variables	**Level I(0)**		**1st different I(1)**		**Decision**
	Intercept	Trend and intercept	Intercept	Trend and intercept	
Botswana					
USD/ZAR	-1,1464	-2,7376	-14,7094***	-14,6766***	I(1)
BSE DCI	-8,3604***	-8,7755***	-13,8731***	-11,5025***	I(0)
Eswatini					
USD/SZL	-1,5799	-3,9750	-11,4553***	-11,4377***	I(1)
ESE_ASI	-12,2583***	-12,2126**	-8,8096***	-8,7727***	I(0)
Namibia					
USD/NAD	-1,0493	-2,5447	-14,6134***	-14,5722***	I(1)
NSX overall index	-14,4952***	-14,5030***	-11,7913***	-11,7565***	I(0)
SA					
USD/ZAR	-1,0967	-2,2234	-13,1829***	-13,1606***	I(1)
JSE_ASI	-17,9019***	-17,8915***	-11,2057***	-11,1861***	I(0)

Panel B: DF-GLS					
Variables	**Level I(0)**		**1st different I(1)**		**Decision**
	Intercept	Trend and intercept	Intercept	Trend and intercept	
Botswana					
USD/ZAR	0,7444	-2,7659*	-3,3325***	-12,7260***	I(0)
BSE DCI	-8,3314***	-8,7046***	-1,2437	-17,0476***	I(0)
Eswatini					
USD/SZL	-1,3891	-2,9565*	-14,0825***	-15,8530***	I(0)
ESE_ASI	-11,7638***	-12,1447***	-15,3734***	-11,2889***	I(0)
Namibia					
USD/NAD	-0,2214	-2,5260	-12,9907***	-13,6046***	I(1)
NSX overall index	-14,5361***	-14,5441***	-1,8428*	-15,3423***	I(0)
SA					
USD/ZAR	-0,4092	-2,2295	-12,9298***	-12,9742***	I(1)
JSE_ASI	-17,9327***	-17,8888***	-21,0014***	-21,7788***	I(0)

Notes: Significance levels are given as follows: "***", "**", "*" represent the 1%, 5% and 10% significance levels respectively.

7.3 EMPIRICAL ANALYSIS

7.3.1 Wavelet Power Spectrum and time series plots of individual series

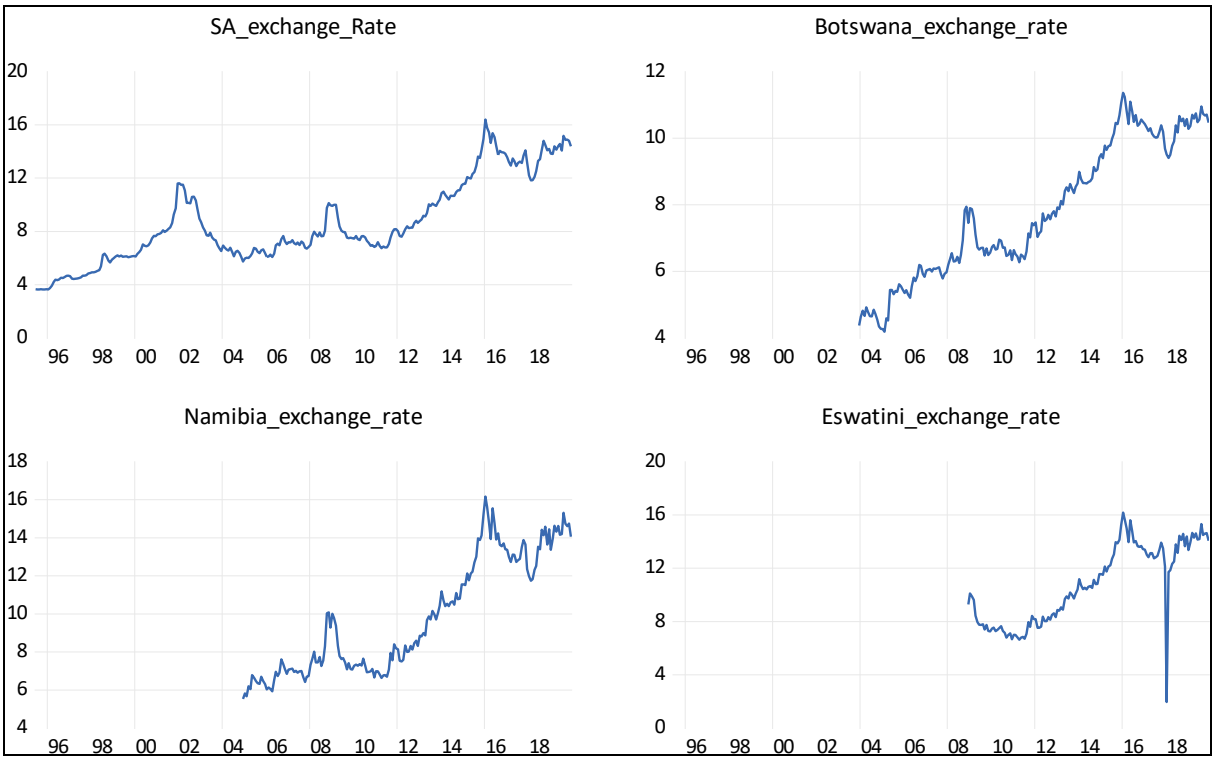
I begin the empirical analysis by presenting the WPS plots of the individual time series and for comparative purposes, I also provide their time series plots. Whilst the time series plots present information on how the signal evolves across a time domain, the WPS provides further

information on the energy distribution of the signal in a time-frequency plane and allows us to determine how frequency band (which I measure in time cycles i.e. time=1/frequency) has contributed to the energy of a series at different time intervals. The strength of the variation is measured by the colour contours in the WPS, with warm contours indicating stronger variation and cooler colours indicating weaker variation. The faint white line surrounding the WPS denotes the 5% significance levels and the cone of influence reflects the boundary for 'edge effects'.

7.3.1.1 Wavelet Power Spectrum and time series plots of individual series for exchange rates

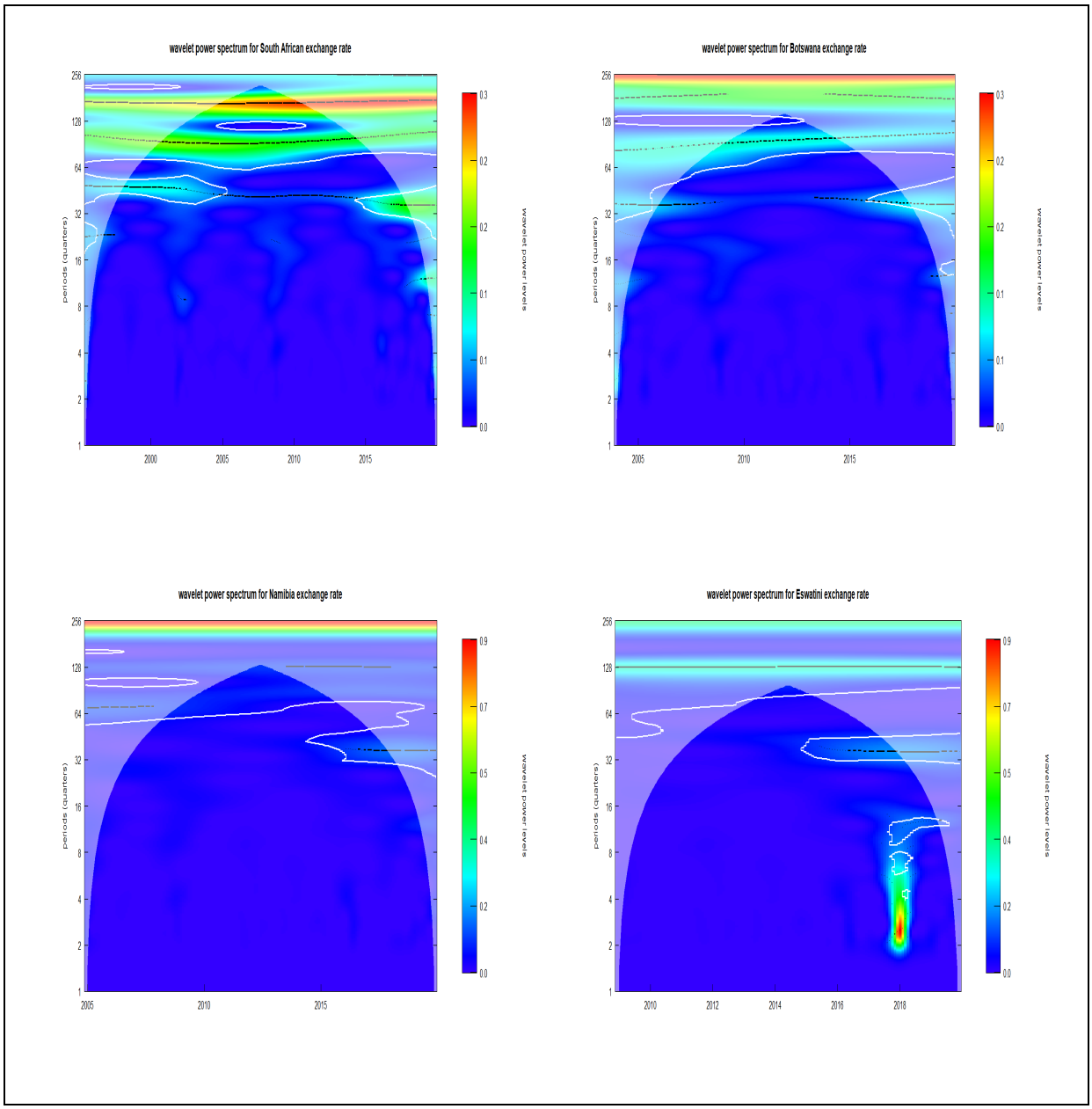
Figures 36 and 37 present the time series plots and WPS of the exchange rate series, respectively, for the SACU countries. From the time series plots, I observed three periods at which the exchange rates in SACU countries experienced sharp spikes. Firstly, during the 1999-2002 period which corresponds to the Asian financial crisis and September 11 US terrorist attacks. Secondly during the global financial crisis period of 2007-2009. Lastly, during the 2016-2017 period which corresponds to the exchange rate crashed which occurred due to the 'Nenegate crisis', in which former president Jacob Zuma abruptly fired then newly-hired finance minister Nhlanhla Nene in December 2016 (Maserumule and Alagidede, 2017; May et al, 2018;). Moreover, the corresponding WPS in Figure 37 is able to capture some of the frequency features in data which are would be difficult to observe in the time series plots. For instance, the WPS for South African and Botswana, and Namibian exchange rates which identifies that low-frequency oscillations of between '64 and 200 days' are most dominant in the series although the strength of variation is strongest for South Africa, moderate for Botswana, and weak for Namibia. Higher frequency components of 32 days are periodically observed for these countries during the GFC period of 2008 and the more recent 'Nenegate crisis' of 2016. For the case of Eswatini, low-frequency variation is observed in the post-GFC period of 2011 onwards, and higher frequency components are most notable around the 2016 Nenegate crisis with strong variation existing within cycles of '2-8 days'.

Figure 36: Time series plots of exchange rates in SACU countries



Source: Authors Computation

Figure 37: Wavelet Power Spectrum of exchange rates in SACU countries



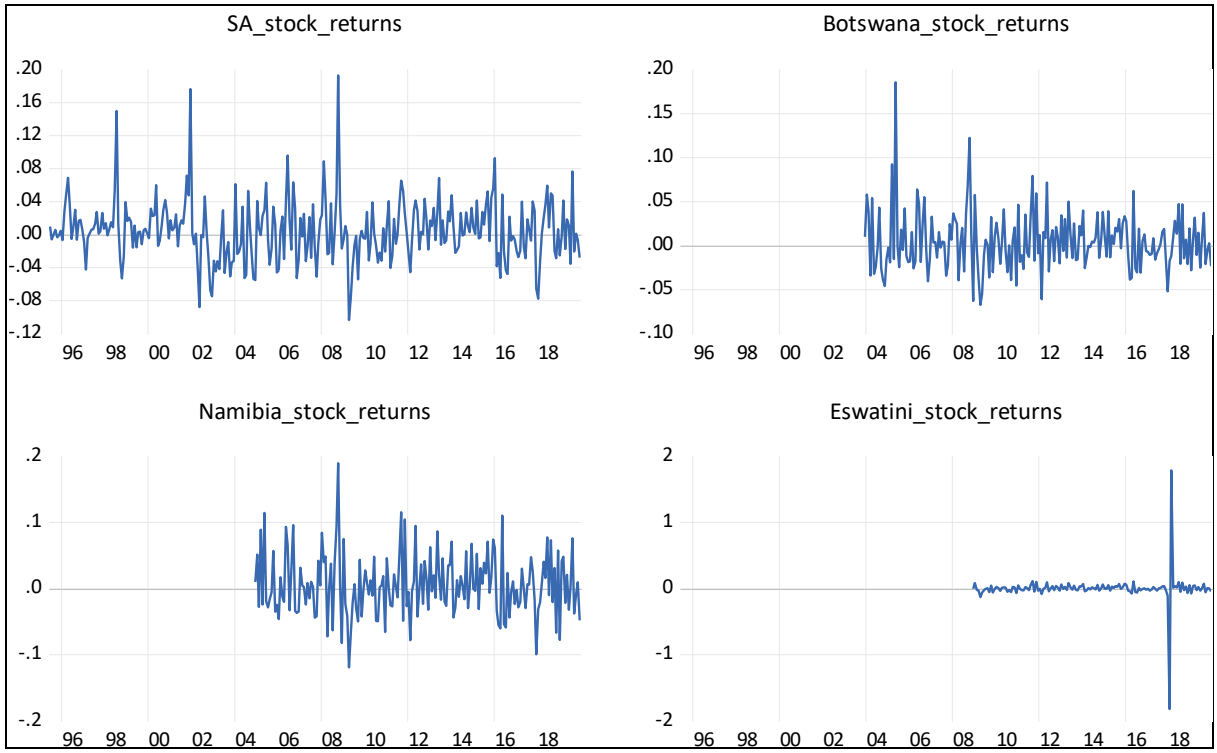
Notes: Figure 37 reports the wavelet power spectrum for the exchange rate in SACU. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level. The cone of influence, which indicates the area affected by edge effects, is the outside region of the black line. The colours code for power indicates the level of intensity ranges from blue to red.

7.3.1.2 Wavelet Power Spectrum and time series plots of individual series for stock returns

Figures 38 and 39 present the time series plots and WPS of the stock returns series, respectively, for SACU countries. From the onset, the time series plots indicate that the stock returns series are 'very noisy' and exert sharp spikes particularly during the 1998-2000 Asian financial crisis and the 2001 US terrorist attacks, and the GFC for South Africa, Botswana, and Namibia. For

Eswatini, the time series plots show a sharp spike in stock returns during the 2016-2017 period which corresponds to the period in when the US suspended the country from African Growth and Opportunity Act (AGOA) agreements in 2015 and then was re-instated in 2017.

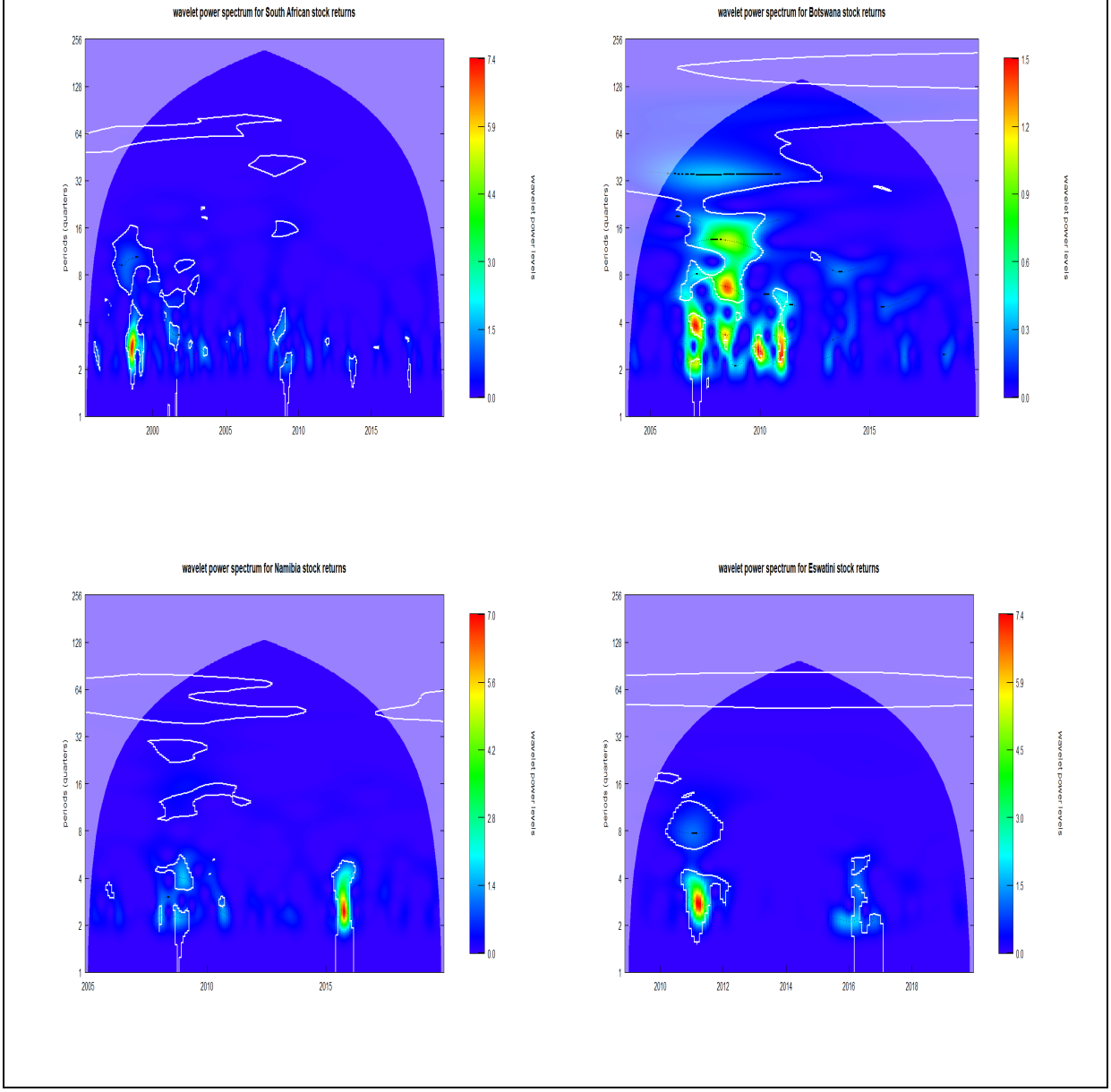
Figure 38: Time series plots of stock returns in SACU countries



Source: Authors Comupation

The WPS plots of the stock return series for the SACU countries, as presented in Figure 39, show that higher frequency fluctuations are most dominant in the series for all SACU countries. The WPS depicts the strongest variability during the AFC of 1998 for South Africa, during the 2008-2012 mining revenues crisis for Botswana; during the GFC for Namibia, and during the 2016-2017 period of 'AGOA suspension and reinstatement for Eswatini.

Figure 39: Wavelet Power Spectrum of stock returns in SACU countries



Notes: Figure 39 reports the wavelet power spectrum for the stock returns in SACU. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level. The cone of influence, which indicates the area affected by edge effects, is the outside region of the black line. The colours code for power indicates the level of intensity ranges from blue to red.

7.3.2 Wavelet coherence analysis

In this section, I present the wavelet coherence plots which I use to examine the time-frequency co-movement between exchange rate and stock returns in SACU countries. Within the wavelet coherence plots I am able to examine the co-movement between exchange rates and stock returns from 4 dimensions, firstly, from a time-varying perspective along the horizontal;

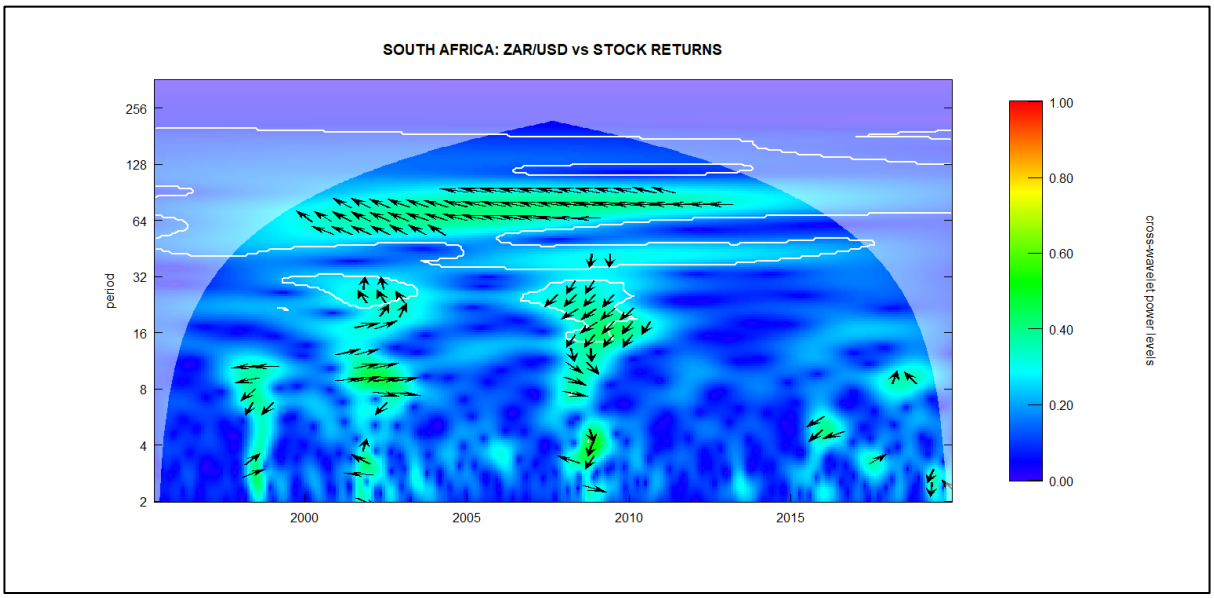
secondly, from a frequency perspective along the vertical axis; thirdly from a strength perspective which is measured by the colour code of the contours, with warmer (cooler) colours indicating stronger (weaker) synchronizations; and lastly from a phase perspective which provides information on the sign (negative or positive) or causal direction between the variables. The arrow orientation in the wavelet coherence plots provide information on the phase dynamics with i) arrows between (and including) ↑ and → (0-90 degrees) indicating in-phase synchronization with causality running from stock returns to exchange rates ii) arrows between → and ↓ (90-180 degrees) indicating in-phase (positive) synchronization with causality running from stock returns to exchange rates iii) arrows between (and including) ← and ↓ (180-270 degrees) indicating anti-phase (negative) synchronization with causality running from exchange rates to stock returns iv) arrows between ← and ↑ (270-360 degrees) indicating anti-phase (negative) synchronization with causality running from stock returns to exchange rates. Note that since I use indirect quotation of the exchange rate, a negative (positive) co-movement implies that an appreciation comoves with an increase (decrease) in stock returns and vice versa. Therefore, anti-phase or negative co-movement with causality running from exchange rate to stock returns would be evidence of the traditional approach of Dornbusch and Fisher (1980) whilst in-phase or positive co-movement with causality running from stock returns to exchange rates would be evidence of the stock-flow approach of Branson et al. (1977), Branson and Henderson (1983) and Frankel (1983).

7.3.2.1 South Africa

From Figure 40, which shows the wavelet coherence analysis for South Africa, I observed dominant co-movement between the series at low-frequency components of '64 and 128-month' cycles and note that at these low frequencies the synchronizations of the series are anti-phase (negative relationship) with exchange rates leading stock returns. This implies that, over the long-run, exchange rate appreciations lead to stock price depreciation which is in line with the traditional approach of Dornbusch and Fischer (1980) and some of the previous South-African related literature (Mlambo et al., 2013; Sui and Sun, 2015; Tang and Yao, 2018, Ncanywa and Ralarala, 2019; Owusu and Twenboah, 2020; Phiri, 2020) but differs from other studies which find no causality effects between the variables for different sample periods (Ocran, 2010; Alam et al., 2011; Fowowe, 2015). I also observed periodic higher frequency components which are in-phase (positive relationship) around the 2001 US terrorist attacks and anti-phase (negative relationship) during the 2007-2009 GFC period, and these latter findings

correspond with that previously found in Adjasi et al., (2011) and Sui and Sun (2015) who found significant short-run spill over effects from currency to South African stock market particularly around the GFC.

Figure 40: Wavelet coherence between exchange rates and stock returns in South Africa.



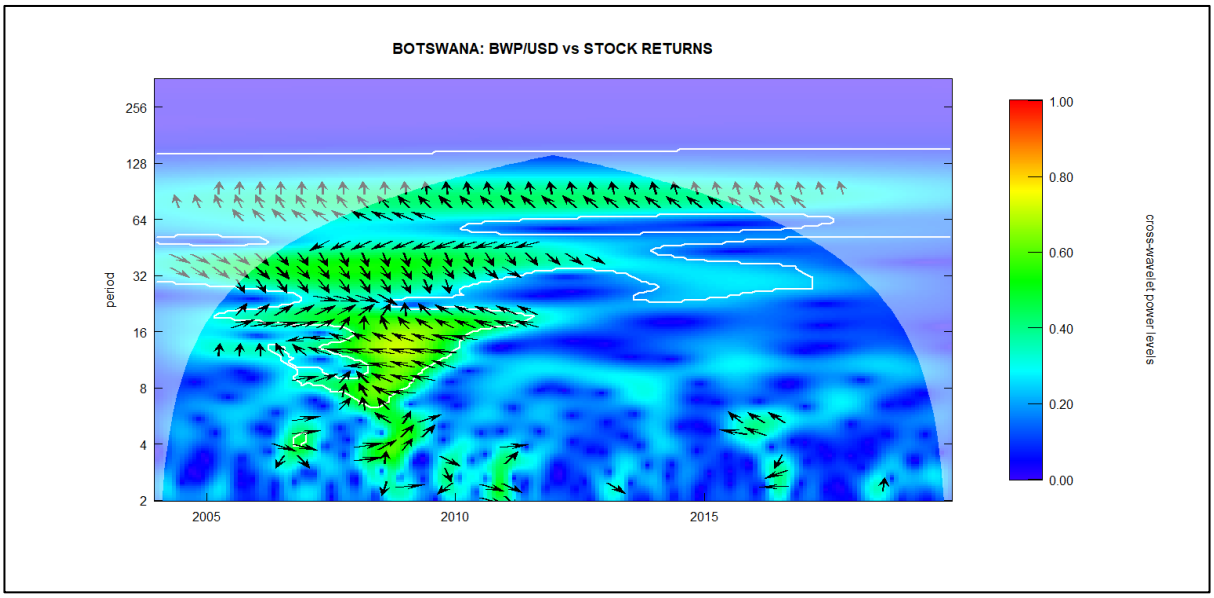
Notes: Figure 40 reports the wavelet coherence between exchange rates and stock returns in South Africa. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level estimated by Monte Carlo simulations. The colour scale on the right side of the figure represents the level of correlation between exchange rates and stock returns in South Africa. The red colour indicates high correlations among the time series variables.

7.3.2.2 Botswana

From Figure 41, which shows the wavelet coherence analysis for Botswana, I observed 3 distinguishable frequency components with different phase dynamics across the time window. Firstly, there are low-frequency components between '64-128 month' cycles across the entire time domain which are anti-phase (negative) and have stock returns causing exchange rates. Secondly, I observed frequency oscillations of '32-40 month' cycles which are in-phase (positive) and have stock returns causing exchange rates i.e. 'stock-flow effect'. Thirdly, there are higher frequency components at '4-16 month' cycles which are anti-phase (negative) and have exchange rates causing stock returns i.e. traditional effect. Overall, the findings from the higher frequency components complement those previously presented in Lesotho et al. (2016) whom similar observed a significant positive and long-run relationship for Botswana with

causality running from exchange rates and stock markets. However, I observed that these higher frequency components are temporal and disappear after 2012 when the economy restored fiscal balance (Bothlale, 2017).

Figure 41: Wavelet coherence between exchange rates and Stock returns in Botswana.

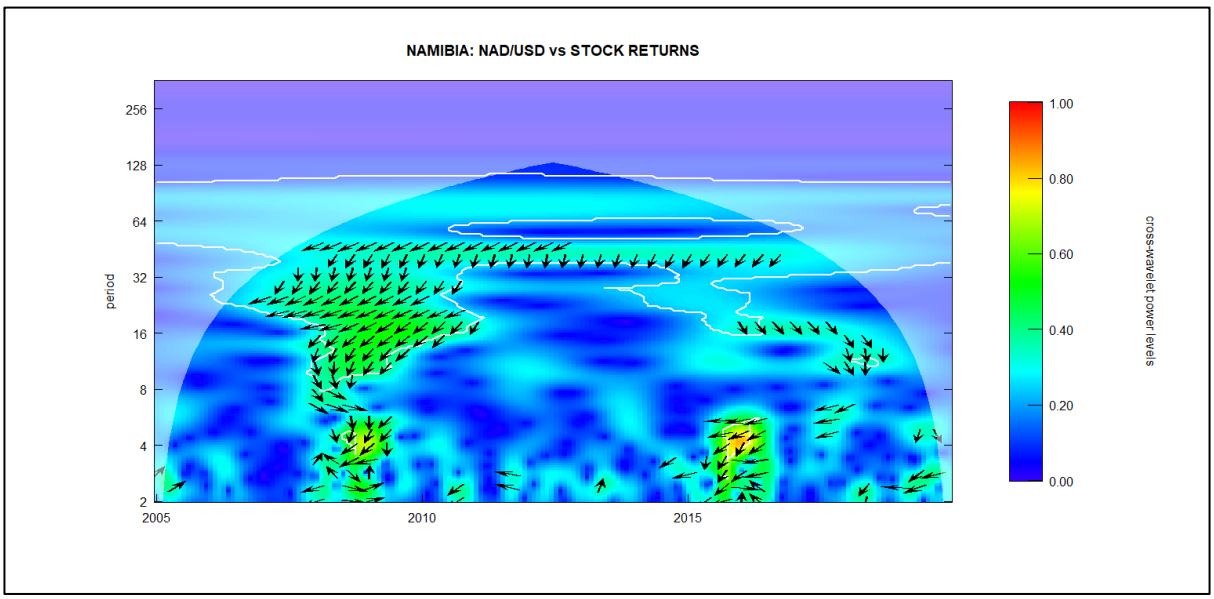


Notes: Figure 41 reports the wavelet coherence between exchange rates and stock returns in Botswana. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level estimated by Monte Carlo simulations (500 trials). The colour scale on the right side of the figure represents the level of correlation between exchange rates and stock returns in Botswana. The red colour indicates high correlations among the time series variables.

7.3.2.3 Namibia

From Figure 42, which shows coherence between the series for Namibia, I find dominant anti-phase (negative) cyclical oscillations around the GFC with frequency components ranging from '2-64 month' cycles with exchange rates causing stock returns. These findings are comparable to those found in the previous studies of Eita (2012) and Raji et al. (2017) who find a long-run negative relationship between exchange rates and stock markets in Namibia and this, in turn, complies with the traditional approach of Dornbusch and Fischer (1980). However, I further find that subsequent to the GFC, the higher frequency components lose significance to lower frequency components. I also note other short-lived, anti-phase higher frequency components of 2-8 month' cycles around the 'Nenegate' crisis of 2016, where exchange rates cause stock returns.

Figure 42: Wavelet coherence between exchange rates and stock returns in Namibia.

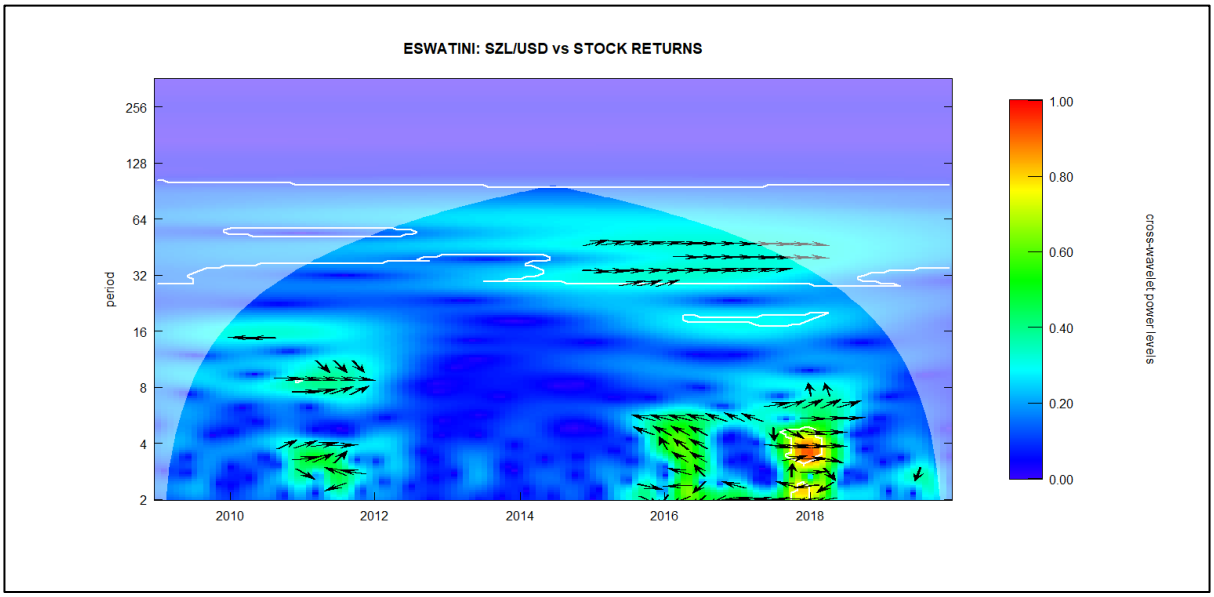


Notes: Figure 42 reports the wavelet coherence between exchange rates and stock returns in Namibia. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level estimated by Monte Carlo simulations (500 trials). The colour scale on the right side of the figure represents the level of correlation between exchange rates and stock returns in Namibia. The red colour indicates high correlations among the time series variables.

7.3.2.4 Eswatini

Figure 43 presents the wavelet coherence plots for Eswatini, where I observed very weak in-phase coherence at lower frequencies 32-64 month' cycles with exchange rates causing stock returns. Within the plots, I observed two notable high frequency oscillations, first during the 2016 Nenegate crisis where the co-movements are anti-phase and, second during the 2018 AGOA reinstatement period where the synchronizations are in-phase. I treat this as evidence of the 'portfolio flow effect' existing during the crisis period and a 'stock effect' in which improvements in the stock market lead to weaker exchange rates during periods of renewed trade agreements. These findings are novel to the literature since, to the best of my knowledge, no previous literature exists for Eswatini.

Figure 43: Wavelet coherence between exchange rates and stock returns in Eswatini.



Notes: Figure 43 reports the wavelet coherence between exchange rates and stock returns in Eswatini. The y-axis denotes the frequency, the x-axis shows the time. The blue thick contour designates the 5% significance level estimated by Monte Carlo simulations (500 trials). The colour scale on the right side of the figure represents the level of correlation between exchange rates and stock returns in Eswatini. The red colour indicates high correlations among the time series variables.

7.4 CONCLUSION

This chapter investigates the time-frequency relationship between exchange rates and stock returns for 4 SACU countries (South Africa, Botswana, Namibia, and Eswatini) using a set of continuous wavelet tools such as the wavelet power spectrum, wavelet coherence plots, and the phase difference dynamics. I firstly use the WPS to examine the uni-variate properties of exchange rates and equity returns variables across a time-frequency domain which allows us the extract the varying frequency components of the individual series along with a time window. I then use the wavelet coherence analysis and phase dynamics to examine the dynamic synchronizations between the series across allowing us to determine the strength (strong or weak), sign (negative or positive), and direction of causality (exchange rate leading stock returns or vice versa) of their relationship across a time-frequency plane.

From the WPS plots, it is observed that for the cases of South Africa, Botswana and Namibia, the exchange rates are dominated by low-frequency components, and higher frequency components are periodically observed during the financial crisis and the 'Nenegate crisis' whilst for Eswatini there are no low-frequency components and exchange rates are strongly influenced by higher frequency oscillations during crisis periods. Conversely, the WPS plots for stock returns show that the series is dominated by high-frequency bands which are more prominent during the financial crisis for South Africa, Botswana, and Namibia, whilst those observed for Eswatini correspond to periods when the country was suspended from AGOA trade agreements.

From the wavelet coherence plots, it is observed dominant low-frequency synchronizations for all SACU countries across the entire time window, (except for Eswatini where low-frequency oscillations are very weak), and at these low-frequencies, an appreciation (depreciation) in exchange rate leads to a rise (fall) in stock returns, with exchange rate leading stock returns which, in turn, is consistent with the traditional, flow-oriented hypothesis. I also observed high-frequencies that emerge at various periods for the individual countries and these higher frequencies, the phase dynamics differ and the 'stock-flow' dynamics are more prominent. For South Africa, the high-frequency components exist during the 2001 US terrorist attacks and the GFC; for Botswana, they emerge during the GFC, for Namibia they appear during the GFC and the 'Nenegate crisis' whilst for Eswatini they emerge during the 'Nenegate crisis' and the AGOA reinstatement period.

CHAPTER 8: INVESTIGATING THE CO-MOVEMENTS: BETWEEN INTEREST RATES, EXCHANGE RATE, AND STOCK RETURNS IN SACU COUNTRIES

8.1 INTRODUCTION

This chapter seeks to investigate the relationship that exists between the interest rate, exchange rate, and stock prices in the SACU economies. Note that two relationships are investigated in this chapter. Firstly, there is the relationship between interest rates and exchanges rates which describes the first-level pass-through from the policy rate to exchange rates. This is important for SACU countries since interest rate decisions taken by Central Banks in the smaller SACU countries are determined by those taken by the SARB. Moreover, the smaller SACU countries have their currencies pegged to the South African Rand whilst the Rand is floated in international markets. Note that monetary policy coordination is enhanced if pass-through effects from interest rate to exchange rates are similar in SACU countries. Secondly, there is the relationship between interest rates and exchanges rates which describes the first-level pass-through effects from the policy rate to exchange rates. Whilst interest rates in the SACU countries have close co-movements, their levels of stock market development are different. Investigating the pass-through effects from policy rate to stock returns is important for policymakers and investors since traditional theory suggests that the pass-through effects from policy instrument to stock market should be quickly absorbed in stock prices and hence interest rates should not be able to predict market returns to ensure market efficiency.

This chapter uses a different methodological approach to investigate the co-movement between i) interest rates and exchange rates, and ii) interest rates and stock returns in SACU economies and uses wavelet coherence and partial wavelet coherence analysis. Despite the numerous studies that have been carried out in emerging and developing countries, the relationship has not yet been explored using in SACU using wavelet analysis. Moreover, previous literature has not considered using partial wavelets in their analysis in which the partial correlation between interest rates, exchange rates, and stock returns is explored. This is noteworthy because the pass-through mechanism from interest rates to exchange rates and equity markets is simultaneous, hence controlling for partial effects is important.

The rest of this chapter is structured as follows. Section 8.2 presents the data description and summary statistics of the time series. 8.3 presents the empirical results. Section 8.4 summarises the chapter.

8.2 DATA

For empirical purposes, this study made use of monthly data for stock market indices, exchange rate, and interest rates for four SACU countries i.e. South Africa, Botswana, Eswatini, Lesotho, and Namibia. Note that for the interest rates and stock prices co-movements, Lesotho is excluded in the study as the Stock price dataset is not available due to the market launched in 2016 (Cossesite,2020). The stock indexes studied are the BSE DCI, the ESE All-share Index, the NSX Overall Index, and the JSE All-Share Index. The exchange rates were calculated based on the USD 1 expressed in pula (USD/BWP), lilangeni (USD/SZL), Namibian dollar (USD/NAD), and rand (USD/ZAR) respectively. The data for these variables were obtained from the related central banks, the IMF (accessed via Open Data per country), and the IFS.

8.2.1 Descriptive Statistics

Table 32 reports the descriptive statistics of the time series variables for interest rates, exchange rates, and stock returns in SACU. Starting with the interest rates, Lesotho recorded the highest average interest rates at 13,00000%, with the highest minimum at 9,130000%. Botswana recorded the second-highest average interest rates for the sample at, 9,537303%, for the whole period with its minimum being 5,00000%. Eswatini recorded the lowest mean average at 6,075949%. Another important statistic to discuss is the standard deviation, which shows the fluctuations of the variables. South Africa and Botswana's interest rates are the only two time-series variables that fluctuate more than the other interest rates in SACU at 4,066364% and 3,370359 % respectfully.

With the exchange rates, Eswatini recorded the highest average interest rates at 10,91459%, with Namibia following closely at 9,734231%. Lesotho recorded the lowest mean average at 7,596563 %. Another important statistic to discuss is the standard deviation, which shows the fluctuations of the variables. Lesotho shows the highest interest rates volatility in SACU at 3,550275%. Botswana's exchange rates are negatively skewed out of all the SACU countries. With the stock returns, Eswatini recorded a negative mean and median. South Africa is the only country that recorded a positive minimum. South Africa recorded the highest standard

deviation at -0,000644%. Another important statistic to discuss is skewness. Namibia is the only country whose stock returns are negatively skewed in SACU.

Table 32: Descriptive Statistics

Interest rates	**Botswana**	**Eswatini**	**Namibia**	**Lesotho**	**SA**
Mean	9,537303	6,246241	7,110497	13,44711	9,507153
Median	9,500000	6,500000	6,750000	13,00000	7,500000
Maximum	15,00000	11,50000	10,50000	22,00000	21,85000
Minimum	0,001865	5,000000	5,500000	9,130000	5,000000
Std. Dev.	3,780359	1,215036	1,434041	3,120105	4,066364
Skewness	0,201727	1,818322	1,264997	0,422096	0,917888
Kurtosis	1,740391	7,862849	3,682756	2,173918	2,885830
Exchange rates	**Botswana**	**Eswatini**	**Namibia**	**Lesotho**	**SA**
Mean	8,055555	10,91459	9,734231	7,596563	8,596883
Median	7,726700	10,70410	8,471500	7,115000	7,640000
Maximum	11,47330	16,07585	16,17000	16,07585	16,07585
Minimum	4,188400	6,592350	5,534700	2,522004	3,619500
Std. Dev.	1,986003	2,851605	3,004897	3,550275	3,130153
Skewness	0,109106	0,043568	0,468062	0,531153	0,643469
Kurtosis	1,668266	1,580968	1,739741	2,416729	2,414132
Stock returns	**Botswana**	**Eswatini**	**Namibia**	**SA**	
Mean	0,005257	-0,000729	0,006226	0,000777	
Median	0,002327	-0,000743	0,008713	0,000774	
Maximum	0,138433	0,101105	0,286988	0,000888	
Minimum	-0,106975	-0,102523	-0,310295	0,000644	
Std. Dev.	0.033368	0,047765	0,062916	5,560005	
Skewness	0,304198	0,000826	-0,618483	0,086210	
Kurtosis	3,381318	3,121911	3,795702	2,134094	

Source: Authors Tabulation

8.2.1 Correlation analysis

The correlation matrices are presented in Table 33. From Table 33, for all the SACU countries, except for Eswatini, interest rates and exchange rates are negatively correlated. The interest rates and stock returns in SACU are all negatively correlated. Exchange rates are correlated negatively with stock returns with Botswana, Namibia, and South Africa except for Eswatini.

Table 33: Correlation analysis

Countries	Interest rates/ Exchange rates	Interest rates/ Stock returns	Exchange rates/ Stock returns
South Africa	-0,560660	-0,103280	-0,081644
Namibia	-0,279574	-0,115258	-0,026949
Eswatini	0,021338	-0,041559	0,025778
Botswana	-0,795392	-0,308323	-0,308625
Lesotho	-0,625242		

Source: Author's Tabulation

8.3 EMPIRICAL ANALYSIS

This section presents the empirical results of the relationship between interest rate and stock returns in SACU economies except for Lesotho. The Stock price dataset for Lesotho is not included in this study due to the market was launched in 2016 (Cossesite,2020). In this section, I employ the wavelet analysis to evaluate the co-movement of exchange rates and stock returns in SACU. I show these plots to examine bivariate co-movements in the frequency and time domains that show the measure of local correlation amongst the variables and phase differences to depict any lag or lead (also known as causality) relationships between variables.

To understand the below results, an arrow in the wavelet coherence shows the lead/lag and in-out phase relationship between the variables. With regards to the phase difference, when arrows are right-pointing, they indicate that there is an in-phase relationship between exchange rates and stock returns. In this case, the variables move in the same direction. when arrows are left-pointing, they indicate that there is an out-phase relationship between exchange rates and stock returns and the move in a reverse direction.

While arrows pointing rightward-down and leftward-up means the first variable is leading and the arrows pointing to the rightward-up and leftward-down means the first variable is lagging. (Roesch & Schmidbauer, 2014). The order of the series is the same as the order in which the names appear on top of the plots. The strength of the interdependence between the paired series is indicated by the colour of the surface and depicted by the colour pallet. The red colour (warm) denotes sections with significant interactions, while the blue colour (cold) indicates a lower correlation between the series.

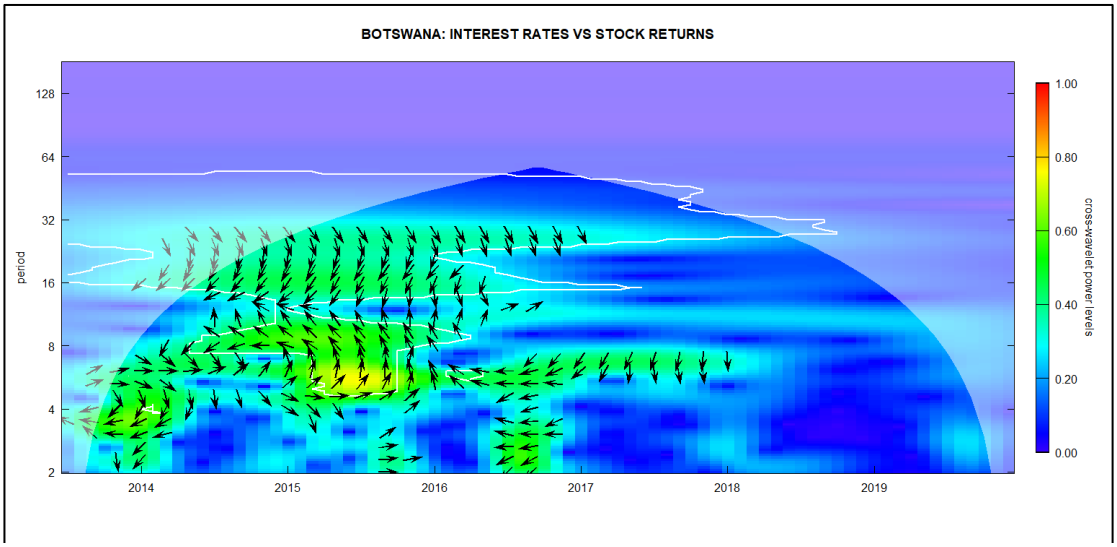
8.3.1 Interest rates to Stock returns

This section presents the empirical results of the relationship between interest rate and stock returns in SACU economies except for Lesotho. The Stock price dataset for Lesotho is not included in this study due to the market was launched in 2016 and data is still unavailable (Cossesite,2020). The analysis follows that of wavelet analysis.

8.3.1.1 Botswana

Figure 44 displays the wavelet coherence between interest rates and stock returns for Botswana. The relationship between the two variables is strong, especially in the medium run. Towards the end of 2014, I notice some significant co-movement between the series at frequency cycles of 2-8 months. The arrows in the contour are pointing leftward-down, indicating an out-of-phase correlation. The stock price is leading the interest rates during this period. It is worth mentioning that from 2014 to the end of 2016, I observed little to no activity of the co-movement between the interest rates and the stock returns in the short run. Furthermore, from the period 2015-2016, a significant co-movement is observed in the medium frequency between 4-32 months frequency cycle. The causality during this period is bidirectional as the majority of the arrows from the 4-16 months frequency cycle are pointing leftward-up. This indicates that the two variables are out-of-phase, with the interest rates as a leading variable. However, from the 16-32 months frequency cycle, the arrows are pointing downwards. From 2018 onward there is no activity, that is, the changes that were made with regards to the interest rate showed no effect on the stock returns in Botswana. These results are not in line with the previous studies done by Galebotswe and Tlhalefang (2012) and Nemaorani (2012) in Botswana. However, Sikalao-Lekobane (2014) found similar results to this study.

Figure 44: Botswana's Interest rates and stock returns



Notes: Figure 44 reports the wavelet coherence between interest rates and stock returns in Botswana. The y-axis denotes the frequency, the x-axis shows the time. The colour scale on the right side of the figure represents the level of correlation between interest rates and exchange rates in Lesotho. The red colour indicates high correlations among the time series variables.

8.3.1.2 Eswatini

Figure 45 displays the wavelet coherence between interest rates and stock returns for Botswana. Note a strong co-movement between the variables particularly around the 2008 global financial crisis, over the short frequency bands of 2-4 months. Note that the arrows within the contours point to the right, indicating a positive relationship. However, this co-movement was short-lived as lasted between 2-4 month frequency band and then reappears at medium frequency. From the 8-32 month frequency band, I perceive that the relationship between interest rates and stock returns is heterogonous across time scales, arrows pointing at different directions over the period 2007-2012. From the 32-64 month frequency band, the arrows are pointing upward, indicating the interest rate as a leading variable.

Figure 45: Eswatini's Interest rates and stock returns

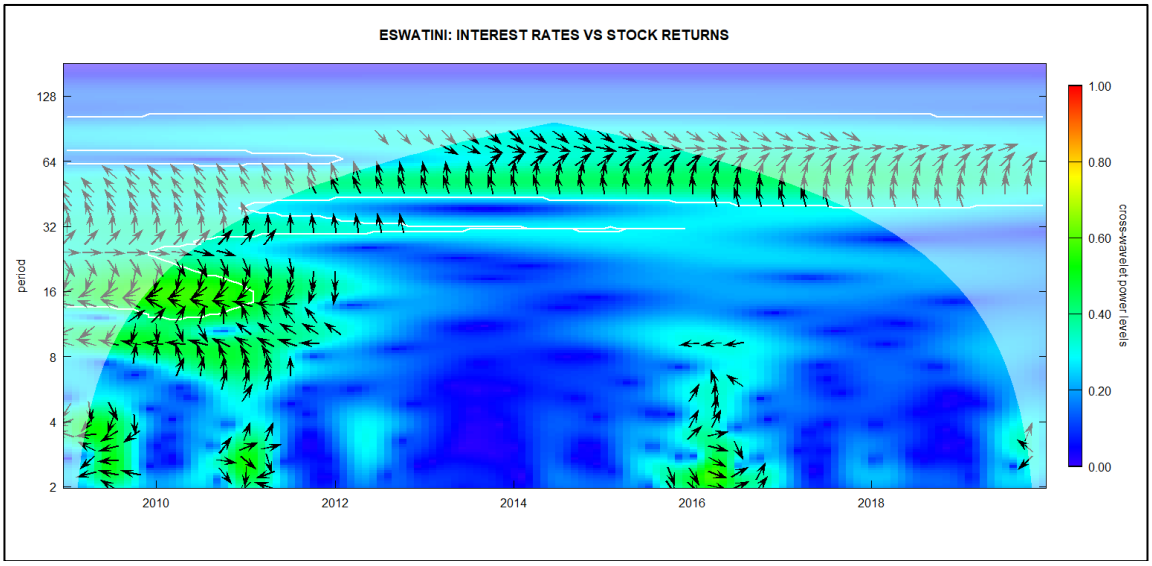


Figure 45 reports the wavelet coherence between interest rates and stock returns in Eswatini. The y-axis denotes the frequency, the x-axis shows the time. The colour scale on the right side of the figure represents the level of correlation between interest rates and exchange rates in Lesotho. The red colour indicates high correlations among the time series variables.

8.3.1.3 Namibia

The wavelet coherence results in figure 46 shows two main episodes of strong co-movements between interest rates and stock returns in Namibia. The first episode is observed between 32-96 months frequency band over 2005-2011. The arrows are pointing leftward-up, indicating that these variables are not in phase (moving in the opposite direction) with the interest rate as a leading variable. The second episode occurs during the period 2008-2011, and the arrows are pointing leftward-down, indicating that the variables are out-of-phase (negative relationship) interest rate as a leading variable. From 2016, I only see that there is no further relationship between interest rate and stock returns detected in Namibia, that is, the interest rate has no effect on the stock returns during this period. Eita (2012) and Eita (2014) found similar results, where they confirmed that interest rates had a negative impact on stock prices in Namibia.

Figure 46: Namibia's Interest rates and stock returns

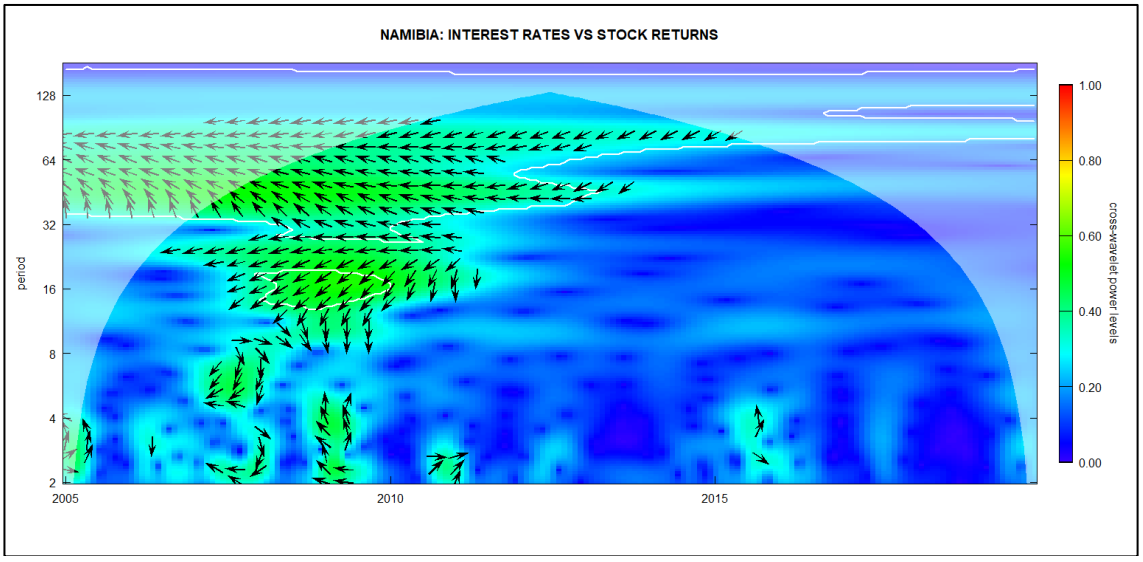
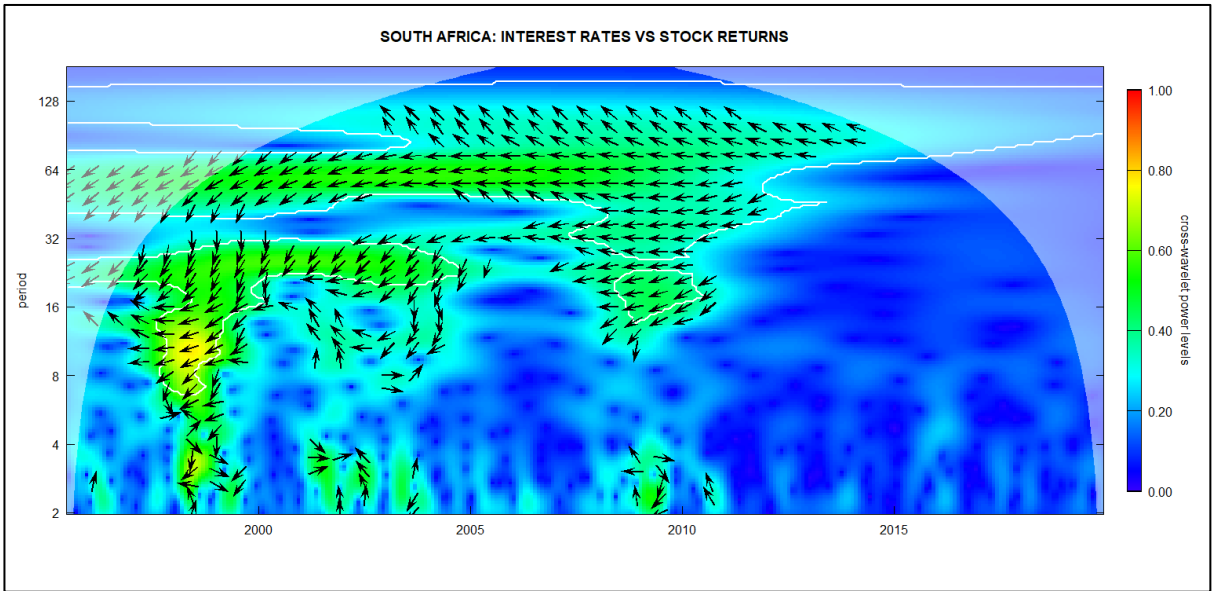


Figure 46 reports the wavelet coherence between interest rates and stock returns in Namibia. The y-axis denotes the frequency, the x-axis shows the time. The colour scale on the right side of the figure represents the level of correlation between interest rates and exchange rates in Lesotho. The red colour indicates high correlations among the time series variables.

8.3.1.4 South Africa

Figure 47 displays the wavelet coherence between interest rates and stock returns for South Africa. Firstly, note that for periods before 2000, that is in the pre-inflation targeting era, there exists short frequency bands of 8-16 frequency month band, which are significant strengths. The arrows are pointing to the left, indicating that the variables are out-of-phase (negative relationship). Secondly, note that there is consistent long-run co-movement which appears at the medium to the high-frequency band (32-128 cycle) over the entire sample period. The phase differences depict that the relationship between interest rates and stock returns is heterogonous across time scales. For the period 1990-2015 at 32-64 frequency band, the arrows are pointing leftward-down indicating that the two variables are out-of-phase with an interest rate as a lagging variable. And for the period 2004-2015 at 64-128 frequency band cycle, the arrows are pointing leftward-up indicating out-of-phase with an interest rate as a leading variable. Therefore, for the same period, the causality is two ways. The results of this study are similar to studies done by John, Ezeabasili, Adigwe (2020), and Adjasi and Biekpe (2006) who found a negative relationship between interest rates and stock returns in South Africa. However, these studies are restricted to classical time series methodologies that do not provide information about frequency differences. However, Marozva (2020) found contradicting results.

Figure 47: South Africa's Interest rates and stock returns.



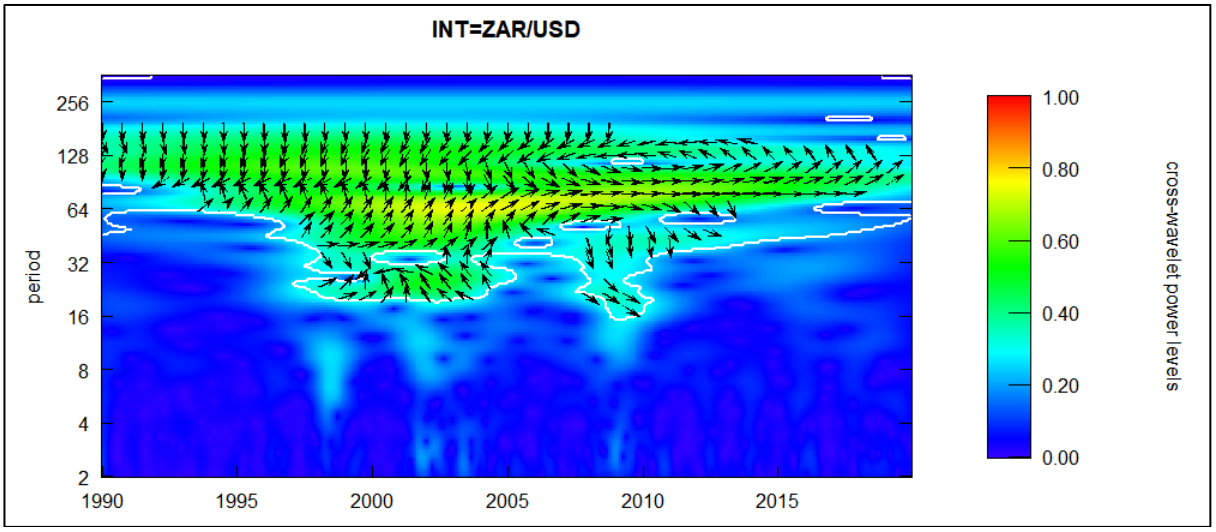
Notes: Figure 47 reports the wavelet coherence between interest rates and stock returns in South Africa. The y-axis denotes the frequency, the x-axis shows the time. The colour scale on the right side of the figure represents the level of correlation between interest rates and exchange rates in Lesotho. The red colour indicates high correlations among the time series variables.

8.3.2 Interest rates and exchange rates

8.3.2.1 South Africa

The findings from the wavelet coherence plot shows there is a medium-run and long-run co-movement between interest rates and exchange rates in South Africa. The majority of the arrows are pointing rightward-up, indicating an in-phase correlation. The causality runs from interest rates to exchange rate, and that is the interest rate is the leading variable. The causal effect was much stronger during the period of introducing the target inflation and the global financial crisis, indicated by the yellow area. The results reveal that interest rates are important for predicting the exchange rates; the exchange rate reacts to interest rates, especially in the long run in South Africa. The findings of this study are similar to the results found in a study done by Coetzee (2002) and Raputsoane and Todani (2008) for previous South Africa literature.

Figure 48: South Africa's Interest rates and exchange rates

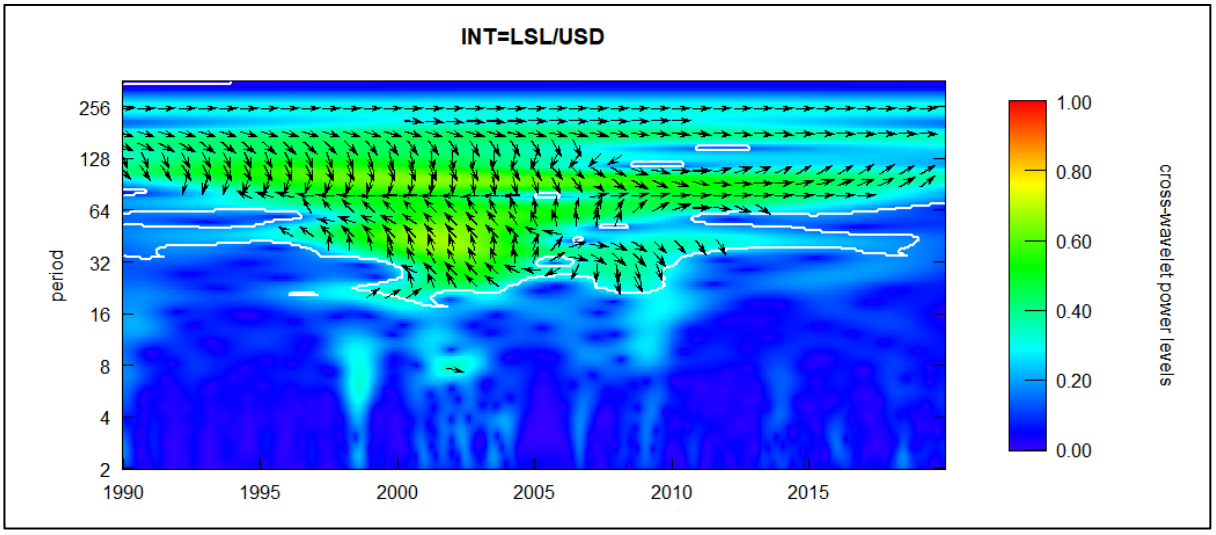


Notes: Figure 48 reports the wavelet coherence between interest rates and exchange rates in South Africa. The y-axis denotes the frequency, the x-axis shows the time. The colour scale on the right side of the figure represents the level of correlation between interest rates and exchange rates in South Africa. The red colour indicates high correlations among the time series variables.

8.3.2.2 Lesotho

The wavelet coherence plot for Lesotho shows strong co-movements from the period 1990 to 2005. Between 32-64 frequency month band, the arrows are pointing leftward-up. This indicates an out-of-phase relationship (negative relationship). The unidirectional causality runs from interest rate to exchange rate and 64-230 frequency month band, the arrows are pointing rightward-down. This indicates an in-phase relationship (positive relationship) with unidirectional causality running from exchange rate to interest rates. Altogether, negative correlations occur at lower frequency cycles whilst negative co-movements are found at short-frequency cycles.

Figure 49: Lesotho's Interest rates and exchange rates

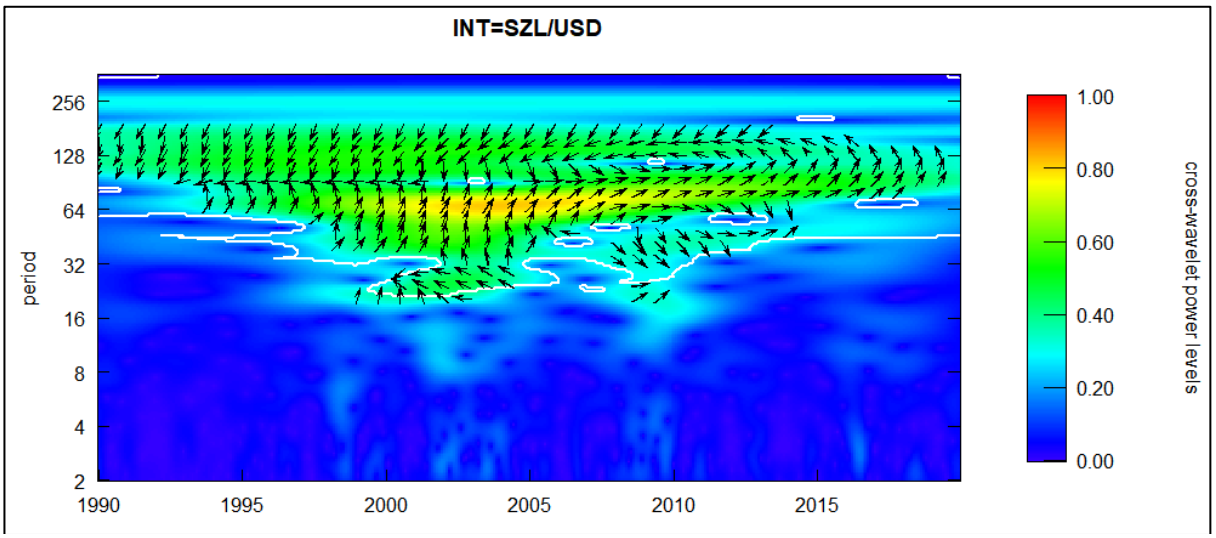


Notes: Figure 49 reports the wavelet coherence between interest rates and exchange rates in Lesotho. The y-axis denotes the frequency, the x-axis shows the time. The colour scale on the right side of the figure represents the level of correlation between interest rates and exchange rates in Lesotho. The red colour indicates high correlations among the time series variables.

8.3.2.3 Eswatini

Eswatini's wavelet coherence plot results are very similar to the results in South Africa. The plot shows that there is a medium-run and long-run co-movement between interest rates and exchange rates. Between 32-64 frequency month band over the period 1990 to 2005, the arrows are pointing up, indicating that the interest rates are leading the exchange rates. On the contrary, between 64-196 frequency month band over the period 1990 to 2005, the arrows are pointing down. indicating that the exchange rates are leading the interest rates. From 2005, the majority of the arrows are pointing rightward-up, indicating an in-phase correlation. The causality runs from interest rates to exchange rate, and that is the interest rate is the leading variable. The causal effect was much stronger during the period of the global financial crisis, indicated by the yellow area. The results reveal that interest rates are important for predicting the exchange rates; the exchange rate reacts to interest rates. Eswatini followed the flexible-price model.

Figure 50: Eswatini's Interest rates and exchange rates

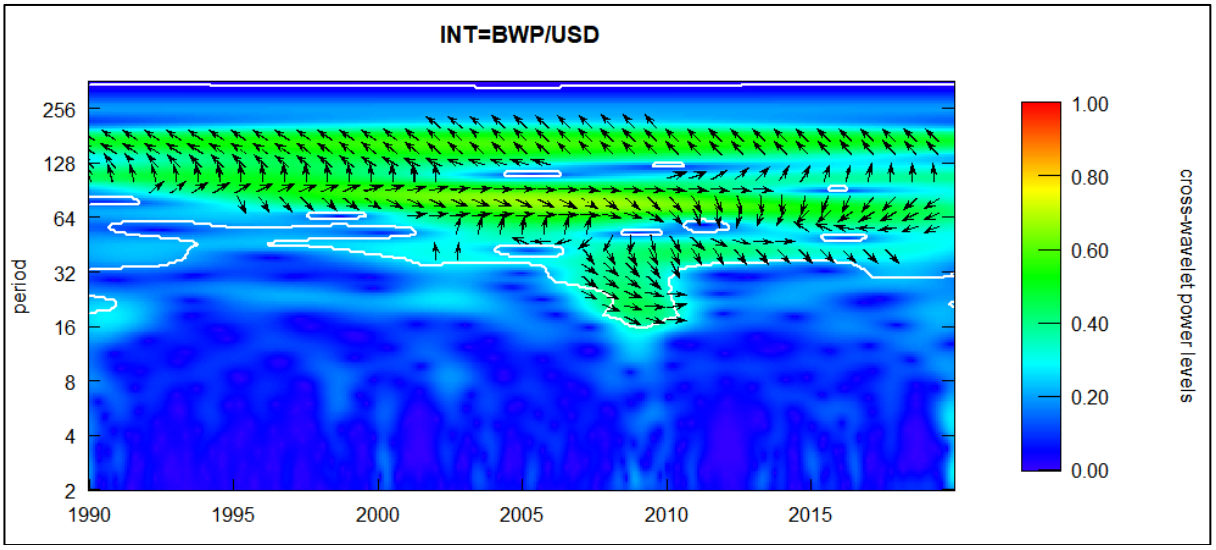


Notes: Figure 50 reports the wavelet coherence between interest rates and exchange rates in Eswatini. The y-axis denotes the frequency, the x-axis shows the time. The colour scale on the right side of the figure represents the level of correlation between interest rates and exchange rates in Eswatini. The red colour indicates high correlations among the time series variables.

8.3.2.4 Botswana

The wavelet coherence plot results for Botswana show no significant co-movements between interest rates and exchange rate in the short-run, and only between medium-run and long-run frequencies. During the period of the global financial crisis, I observed the co-movement between interest rates and exchange rates between 16-64 frequency month band. The arrows are rightward-down, indicating an in-phase. The causality is unidirectional, runs from exchange rates to interest rates. The results reveal that the exchange rate was leading during this period. These results are consistent with the results of the period of 2005 where Botswana implemented an exchange rate policy that entailed the adoption of the current framework, which is based on a crawling band mechanism where the rate of the crawl is based on the differential between the Bank of Botswana's inflation objective, and forecast inflation in trading partner countries. Between 128-256 frequency month band over the period 1990 to 2019, the arrows are pointing leftward-up, indicating a negative co-movement. The causality runs from interest rate to exchange rate.

Figure 51: Botswana's Interest rates and exchange rates

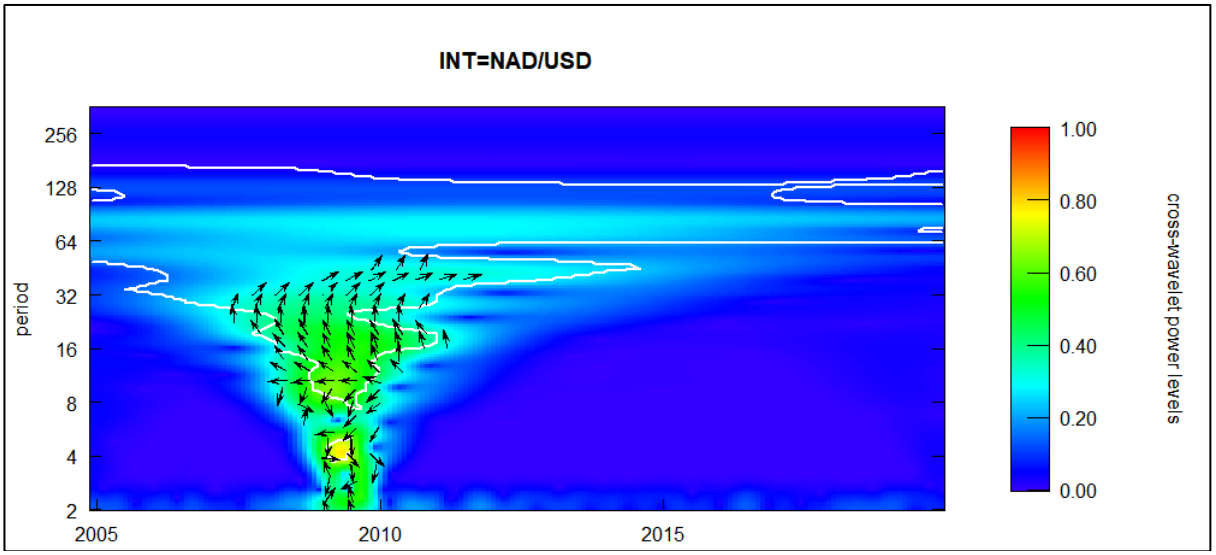


Notes: Figure 51 reports the wavelet coherence between interest rates and exchange rates in Botswana. The y-axis denotes the frequency, the x-axis shows the time. The colour scale on the right side of the figure represents the level of correlation between interest rates and exchange rates in Botswana. The red colour indicates high correlations among the time series variables.

8.3.2.5 Namibia

From Figure 52, wavelet coherence plot results only show that there is a co-movement between interest rates and exchange rates in the short-run and medium-run over the period 2007-2010 for Namibia. In the short-run, indicated by 2-16 frequency month band the arrows are pointing different directions and there is no conclusive direction, even though I observed the highest correction indicated by the yellow area. From 16-64 over the period 2007-2010, the arrows are pointing leftward-up. The arrows indicate out-of-phase correlation, where the interest rates are leading. Altogether, the wavelet dynamics depict little co-movement between the series outside the financial crisis period which can be compared to the study done by Wilson and Sheefeni (2014) who found no cointegration between interest rates and exchange rates in Namibia.

Figure 52: Namibia's Interest rates and exchange rates



Notes: Figure 52 reports the wavelet coherence between interest rates and exchange rates in Namibia. The y-axis denotes the frequency, the x-axis shows the time. The colour scale on the right side of the figure represents the level of correlation between interest rates and exchange rates in Namibia. The red colour indicates high correlations among the time series variables.

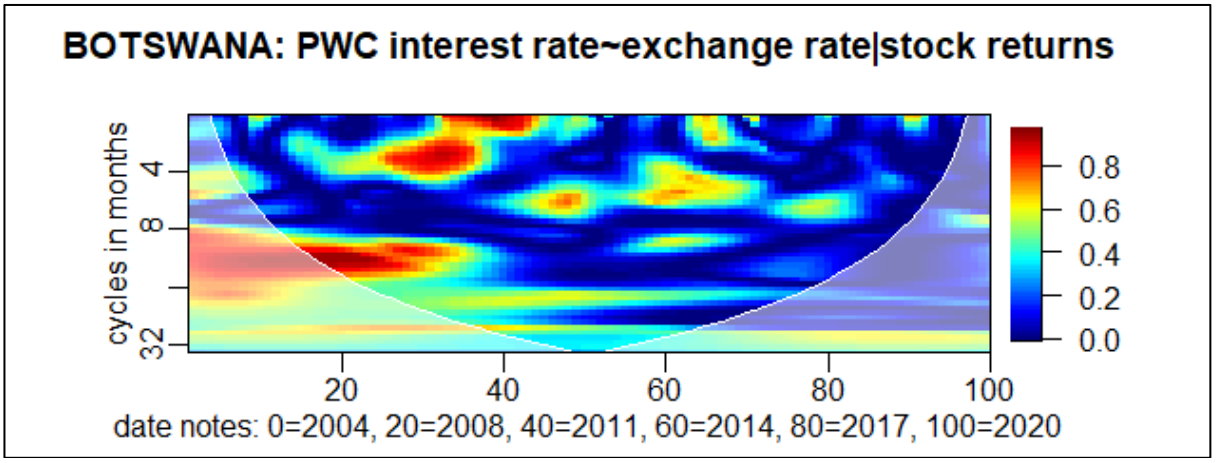
8.3.3 Partial wavelet coherence

The following section reports the partial wavelet coherence. The results will be discussed in two sections. The first section investigates the partial co-movement between interest rates and exchange rate controlling stock returns and the second section investigates the partial co-movement between interest rates and stock returns controlling exchange rate.

8.3.3.1 Interest rate and exchange rate controlling stock returns

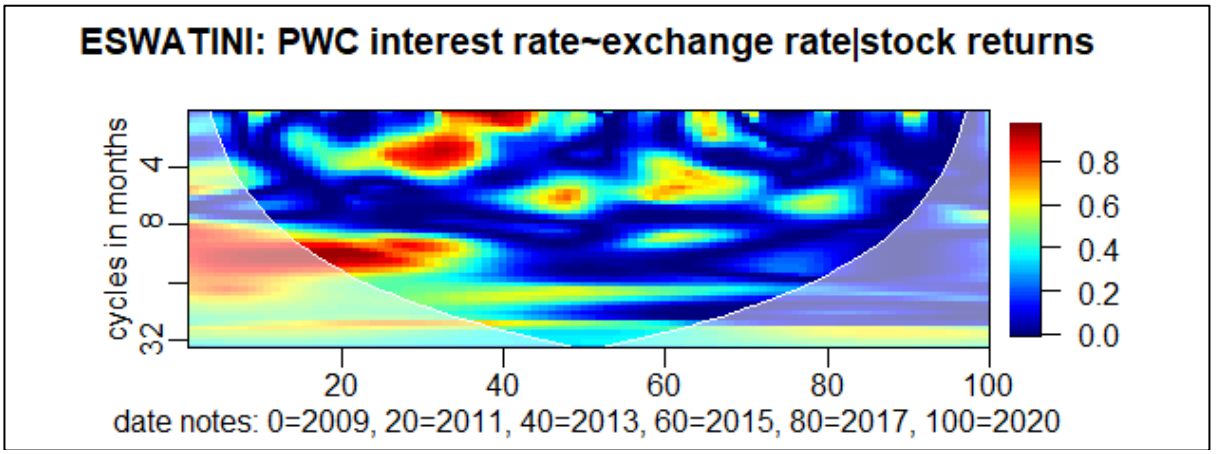
The partial wavelet figures of the relationship between interest rates and exchange rate controlling stock returns for the SACU countries are demonstrated below in figures 53-56. Concerning these figures, all the figures behave in a similar fashion. There is a very strong correlation between the variables, indicated by the two large red colour contours identified for the 0-4 months cycle and between 8-16 month cycle during the period 2004-2008 within the cone of influence.

Figure 53: Botswana interest rate and exchange rate controlling stock returns



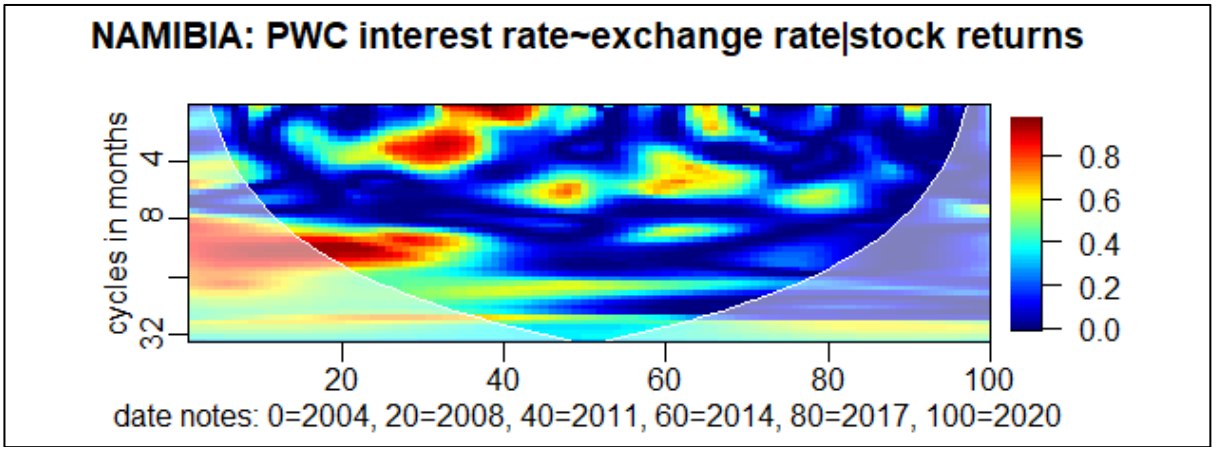
Notes: Figure 53 Partial wavelet coherence between interest rate and exchange rate controlling for stock returns in Botswana. The white contour designates the 5% significance level estimated. The region with large (small) coherency is described in red (blue) colours.

Figure 54: Eswatini interest rate and exchange rate controlling stock returns



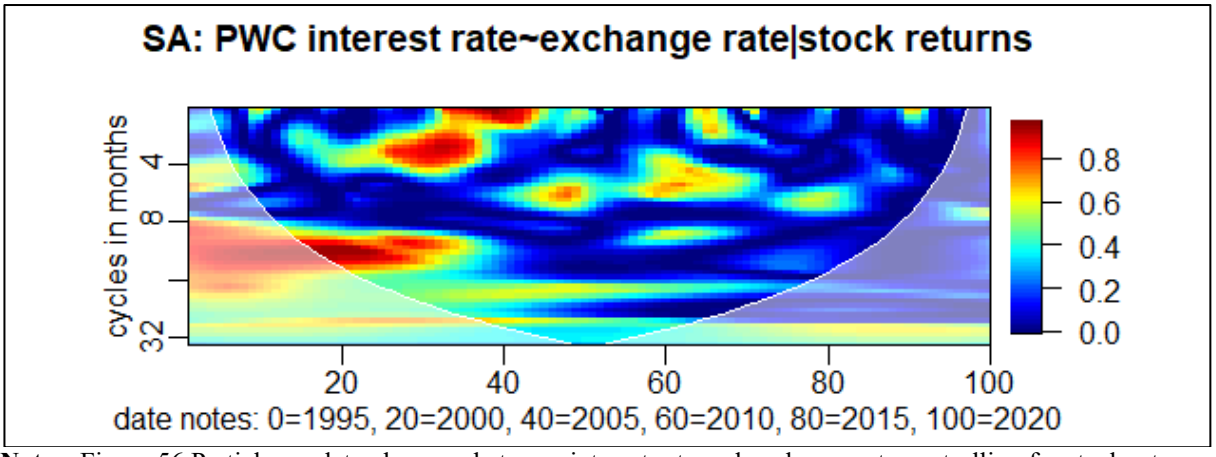
Notes: Figure 54 Partial wavelet coherence between interest rate and exchange rate controlling for stock returns in Eswatini. The white contour designates the 5% significance level estimated. The region with large (small) coherency is described in red (blue) colours.

Figure 55: Namibia interest rate and exchange rate controlling stock returns



Notes: Figure 55 Partial wavelet coherence between interest rate and exchange rate controlling for stock returns in Namibia. The white contour designates the 5% significance level estimated. The region with large (small) coherency is described in red (blue) colours.

Figure 56: South Africa interest rate and exchange rate controlling stock returns



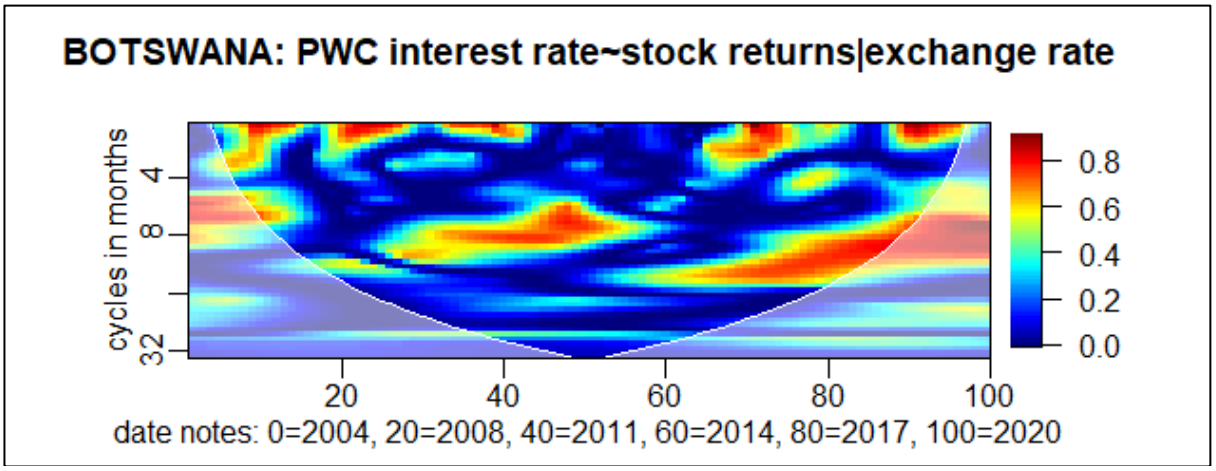
Notes: Figure 56 Partial wavelet coherence between interest rate and exchange rate controlling for stock returns in SA. The white contour designates the 5% significance level estimated. The region with large (small) coherency is described in red (blue) colours.

8.3.3.2 Interest rate and stock returns controlling the exchange rate

The partial wavelet figures of the relationship between interest rates and stock returns controlling exchange rates for the SACU countries are presented in Figures 57-60. Note that from all figures I observed similar partial co-movement across the time-frequency plane. The observed strong co-movement is indicated by the red colour contours, which occur at two episodes. The first strong co-movement is observed between a 4-16 month cycle over the period 2008 to 2014. The second strong co-movement occurs between an 8-16 month cycle over the period 2015 to 2017 within white contour designates the 5% significance level. The red colour

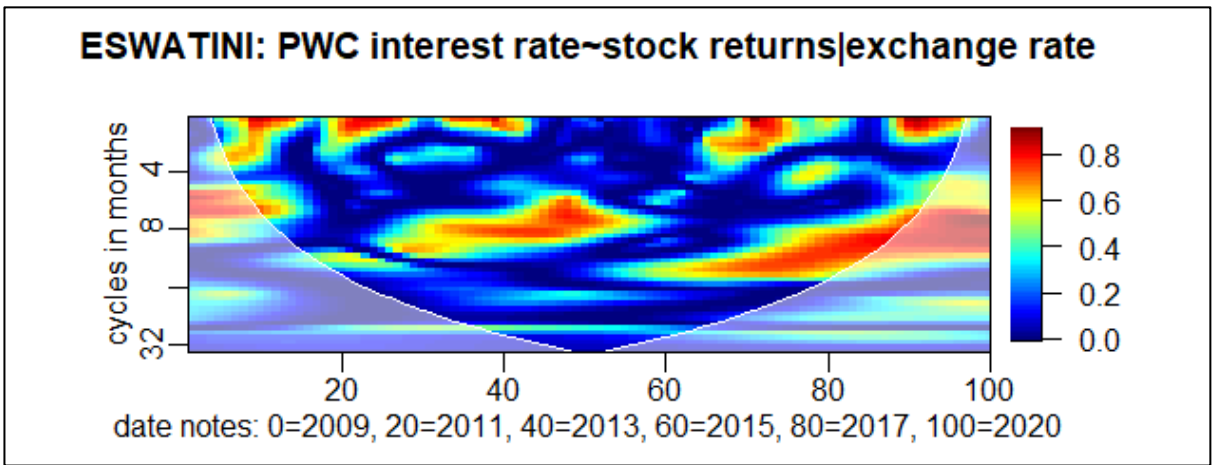
inside the contour is almost equal to 0.80 implying the existence of strong partial cyclical correlations at different time periods.

Figure 57: Botswana Interest rate and stock returns controlling the exchange rate



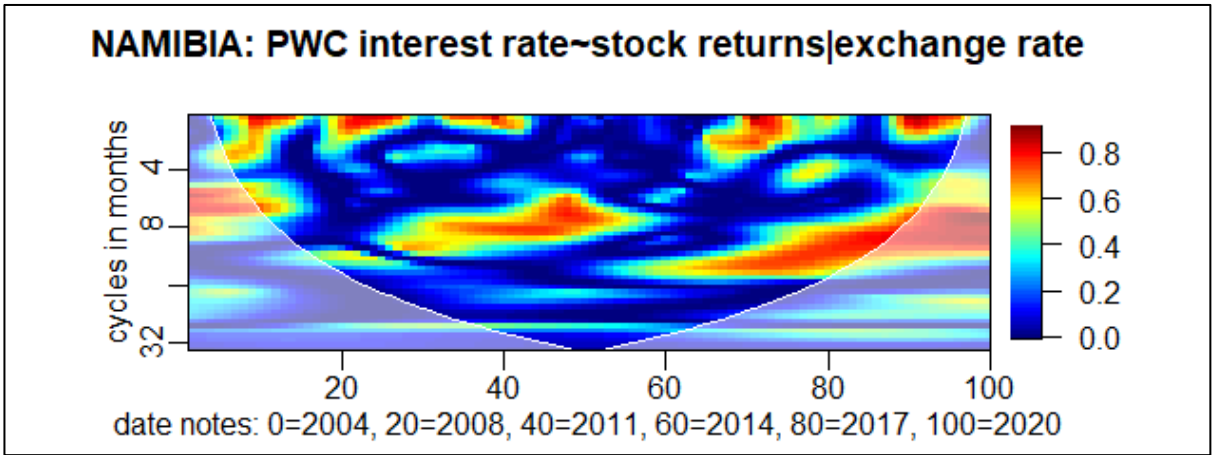
Notes: Figure 57 Partial wavelet coherence between interest rate and stock returns controlling for exchange rates in Botswana. The white contour designates the 5% significance level estimated. The region with large (small) coherency is described in red (blue) colours.

Figure 58: Eswatini Interest rate and stock returns controlling the exchange rate



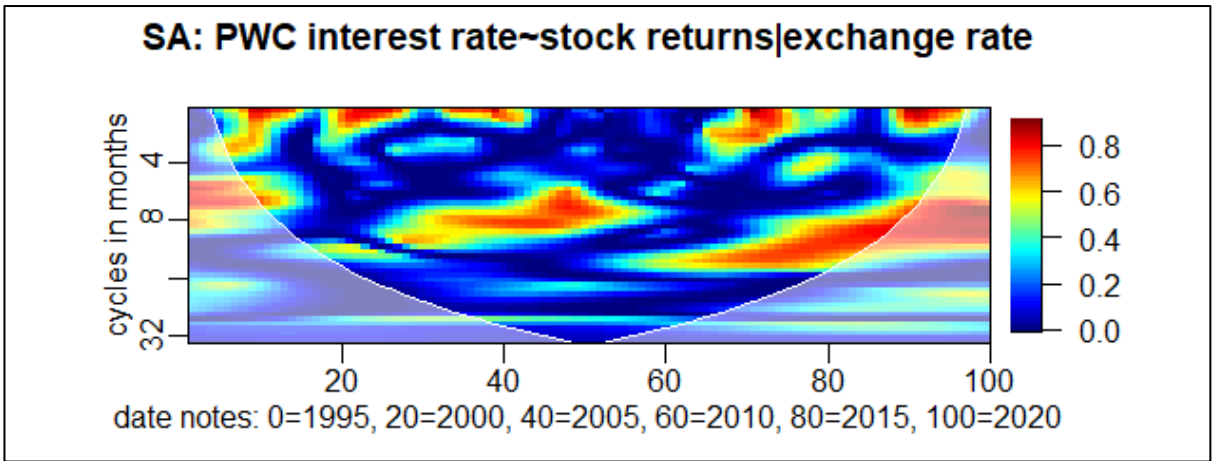
Notes: Figure 58 Partial wavelet coherence between interest rate and stock returns controlling for exchange rates in Eswatini. The white contour designates the 5% significance level estimated. The region with large (small) coherency is described in red (blue) colours.

Figure 59: Namibia Interest rate and stock returns controlling the exchange rate



Notes: Figure 59 Partial wavelet coherence between interest rate and stock returns controlling for exchange rates in Namibia. The white contour designates the 5% significance level estimated. The region with large (small) coherency is described in red (blue) colours.

Figure 60: South Africa Interest rate and stock returns controlling the exchange rate



Notes: Figure 60 Partial wavelet coherence between interest rate and stock returns controlling for exchange rates in SA. The white contour designates the 5% significance level estimated. The region with large (small) coherency is described in red (blue) colours.

8.4 CONCLUSION

This chapter investigated the relationship between interest rates, exchange rates, and stock returns in SACU countries using wavelet coherence and partial wavelet coherence methods. Firstly, the relationship between interest rates and exchange rates is investigated using wavelet coherence. Secondly, the relationship between interest rates and stock returns is investigated using wavelet coherence. Thirdly the partial co-movement between interest rates and exchange rates whilst controlling for stock returns is investigated using partial wavelet coherence. Lastly,

the partial co-movement between interest rates and stock return whilst controlling for exchange rates is investigated using partial wavelet coherence.

From the empirical analysis, four important findings are highlighted. Firstly, I observed strong long-run relationship between interest rates and exchange rates in all SACU countries implying strong pass-through effects amongst the series. Secondly, I observed a strong long-run relationship between interest rates and stock returns only in South Africa, Botswana, and Namibia although the dynamics differ between these countries. Thirdly, the pass-through effects from interest rates to both exchange rates and stock returns is more prominent during the global financial crisis. Fourthly, pass-through effects are weaker when investigating partial co-movements between the variables and are most prominent during the global financial crisis.

CHAPTER 9: SUMMARY AND CONCLUSION OF THE THESIS

9.1 INTRODUCTION

This thesis investigates the first-level pass-through effects of monetary policy transmission in SACU. The thesis investigates four empirical relationships. 1. It investigates the time-frequency relationship in the Fisher's effect for SACU countries. 2. It investigates the time-frequency relationship in the Fisher's effect for SACU countries. 3. It investigates the time-frequency relationship between the exchange rate and the stock returns for SACU countries. 4. It investigates the time-frequency relationship between interest rates, exchange rates, and stock returns for SACU countries.

The study makes use of the wavelet analysis methodology. Wavelets are essentially mathematical tools that decompose a time-series into a time-frequency space and consequentially yield localized time-frequency information on the series. This is unlike conventional econometric tools which can either analyse time series localized in or in frequency but not in both time and frequency. Furthermore, the wavelet transforms present an interesting property of being compatible with both stationary and nonstationary series which enables the researcher to examine the time and frequency varying correlations between a pair of time series with different integration properties.

In applying wavelet analysis to the four empirical first-level monetary policy pass-through relationships the thesis is organized according to four empirical themes.

9.2 SUMMARY

Under the first empirical theme, the time-frequency relationship in the Fisher's effect is investigated for SACU countries using continuous wavelet transforms. The wavelet results indicate similar co-movement between interest rates and inflation for SACU countries in the post-2000 period, with stronger Fisher effects existing around the global financial crisis, and evidence of reverse causality at higher frequencies during the crisis period. However, subsequent to the crisis period lower frequency oscillation becomes increasingly dominant as higher frequency components lose significance. Altogether, the study shows that

Under the second empirical theme, the time-frequency relationship in the Purchasing Power Parity in SACU countries is investigated. The empirical analysis is two-staged. Firstly, wavelet coherence analysis and phase dynamics tools are employed to examine the synchronization between the variables in a time-frequency space. Secondly, multiple wavelet coherence of the co-movement between RER in SACU countries is used to examine the co-movements of the multivariate time series. Eswatini, Namibia, and Lesotho show evidence of the short-run PPP. Botswana is the only country that finds results consistent with long-run PPP. The relationship between Nominal exchange rates and prices is diverse across different time scales. In light of my finding for GPPP, SACU countries share similar real disturbance in both the short and long run and the variables move together.

Under the third empirical theme, the time-frequency relationship between exchange rates and stock market returns in SACU countries is investigated in a two-staged empirical process. Firstly, the wavelet power spectrum is used to examine the time-frequency properties of the individual series. Secondly, wavelet coherence analysis and phase dynamics are used to examine the synchronization between the variables in a time-frequency space. The findings show that low-frequency relationships are most dominant in SACU countries in which appreciations (depreciation) in currency lead to higher (lower) stock returns in line with traditional theory. I also find some periodic high-frequency relationships which only exist during periods of financial, economic, and political crisis, and during these crisis periods, the phase dynamics between the variables become inconsistent.

The last theme investigated the time-frequency relationship between interest rates, exchange rates, and stock returns for SACU using two types of wavelet analysis. Firstly, I use wavelet coherence to investigate the relationship between interest rates to stock returns and interest rates to exchange rates. The wavelet results indicate similar co-movement between interest rates and stock returns for SACU countries during the global financial crisis. Furthermore, the wavelet results indicate very similar co-movement between interest rates and exchange rates for SACU countries throughout the sample period. These results are observed during the lower frequency. Secondly, I used partial wavelet coherence. The findings show that high-frequency relationships are most dominant in SACU countries when the interest rate and exchange rate are controlling stock returns and Interest rate and stock returns are controlling the exchange rate.

9.3 IMPLICATIONS AND RECOMMENDATIONS OF THE STUDY

Altogether, this thesis makes new contributions to the literature and further has important implications for policymakers, market participants, and the academic community. From an empirical perspective, the wavelet coherence analysis proves to be a powerful tool in reconciling previous contradicting empirical evidence on the existence of the Fisher effect in SACU countries. From a policy perspective, more fined tuned implications are derived from the findings of the study as wavelets are able to depict a more accurate description of the different first-level monetary transmission relationships.

From the first empirical analysis, the results reveal that the Fisher effects in all SACU nations follow similar dynamics over a time-frequency domain. For all SACU countries, high-frequency co-movements are most present during the pre-global financial crisis period and only low-frequency co-movements exist during the post-crisis period. These findings imply a common behaviour change in SACU monetary authorities who are increasingly acting as variance-minimizers and whose volatility transfer has been caused by a mutual change in policy preferences. From a policy perspective, the findings of higher frequency components losing their relevance in favour of lower frequency oscillations over time is indicative of Central Banks SACU countries increasingly behaving as variance-minimizing policymakers as articulated in control theory literature. Considering that Botswana has adopted a crawling-peg monetary regime whilst the other smaller SACU nations (Eswatini, Lesotho, and Namibia) form a Common Monetary Area with South Africa, whose monetary policy hinges on an inflation-targeting framework, the study shows that these monetary arrangements have not distorted the synchronization of interest rate and inflation co-movements in the region.

From the second empirical analysis, the results reveal a strong long-run PPP relationship between South Africa and Botswana whilst those between South Africa and the smaller SACU countries is very weak. The GPPP results further show that there is weak co-movement between the Real exchange rates in SACU countries and is particularly strong during periods of crisis. In turn, these findings have relevance towards the debate on the readiness of the SACU countries in forming an optimal currency area and provide evidence against the argument that

these nations have at least the 'monetary readiness' as exemplified through the synchronization key monetary policy variables.

From the third empirical analysis, the results verify the notion that long-run developments in the South African Rand are important for stock market activity, not only in South Africa but also in Botswana and Namibia and therefore the long-run stability of the exchange rate is key for improved stock market activity in the region. The analysis also shows that the exchange rate-stock returns relationship is susceptible to short-run shocks such as the global financial crisis and the more recent oil out of 2015 and hence policy intervention is necessary for market stabilization in such instances. Nevertheless, the lack of short-run co-movements other than during periods of crisis and financial turmoil leads us to conclude that short-run changes in the exchange rate cannot be used for predicting short-run equity returns and this discourages speculative behaviour amongst market participants, therefore, thus implying that SACU equity markets are informationally efficient.

From the last empirical analysis, the results have three important implications. Firstly, there is a strong pass-through from interest rates to exchange rates in all SACU countries, which is evidence in favour of strong monetary synchronization. High-frequency oscillations are only observed during periods of crisis implying stronger pass-through effects during periods of financial turmoil. Secondly, the pass-through effects from exchange rates to stock returns are strongest in South Africa, Botswana, and Namibia and weaker in Eswatini. This implies that exchange rates can be used to beat stock markets in the more developed exchanges in the SACU region. Thirdly, in controlling for partial effects in the relationship between interest rates, exchange rates, and stock returns, the relationships are not as strong and are most prominent over the short-run and during periods of crisis. This would imply weaker pass-through effects of monetary policy to exchange rates and stock returns which is good for market efficiency but not policy synchronization in SACU countries.

9.4 AVENUES FOR FUTURE RESEARCH

From each of the four empirical studies, several shortcomings are identified and suggested as avenues for future research. These are discussed below.

From the first empirical study, the following shortcomings are identified for future research. Firstly, the current analysis does not Fisher effect at different classes of interest rates. Secondly, the current analysis does not use direct measures of inflation expectations in the analysis due to data constraints. Thirdly, the current analysis does not address the readiness of the SACU countries from the perspective of other macroeconomic conditions for optimum currency areas such as business cycle synchronizations. It would be interesting to investigate synchronizations in economic variables amongst SACU countries using similar continuous wavelet tools such as those used in this current study in the context of the Fisher effect.

From the second empirical study, the following shortcomings are identified for future research. Firstly, the study focuses on bilateral exchange rates and future studies can investigate the case of multilateral exchange rates. Secondly, the analysis focuses on the relative version of the PPP, and future studies can investigate the thee absolute version of the relationship. Thirdly, future studies can apply vector wavelet coherence analysis to investigate the GPPP for other currency areas or studies for optimum currency areas (OCA).

From the third empirical study, the following shortcomings are identified for future research. Firstly, under the current analysis, stock market activity has been aggregated for each SACU country, whilst in practice, different firms may respond to exchange rates fluctuations in different manners. Conducting the empirical study at a disaggregated level would provide industry-specific or firm-specific information on the time-frequency relationship with exchange rates and I suggest this as an avenue for future research. Secondly, the study can be extended to other markets in African countries with emerging stock exchanges where empirical evidence is lacking.

From the last empirical study, the following shortcomings are identified for future research. Firstly, since pass-through effects are identified between interest rates and exchange rates in SACU countries, a more formal assessment of the covered and uncovered interest parity can be investigated in the future. Secondly, the interest rates pass-through to stock returns can be investigated at a disaggregated level. Thirdly, the interest rate pass-through to bank rates and credit sector can be investigated in future studies as an extension of the current study on firstly level monetary transmission pass-through effects to the financial sector.

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APPENDIX

Turnitin Summary Results

INVESTIGATING THE FIRST LEVEL PASS-THROUGH EFFECTS OF THE SACU REGION MONETARY TRANSMISSION MECHANISM

ORIGINALITY REPORT

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