INFLATION-TARGETING, ECONOMIC GROWTH AND UNEMPLOYMENT RATE CONUNDRUM AMIDST ENERGY PRICE PRESSURES AND MONETARY POLICY IN SOUTH AFRICA

MASTER OF COMMERCE IN ECONOMICS

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by

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DECLARATION

I declare that **INFLATION-TARGETING, ECONOMIC GROWTH AND UNEMPLOYMENT RATE CONUNDRUM AMIDST ENERGY PRICE PRESSURES AND MONETARY POLICY IN SOUTH AFRICA** is my work all the sources that I have used or quoted have been indicated and acknowledged using complete references and this work has not been submitted before for any other degree at any other institution.

16/09/2025

Signature **Date**

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ABSTRACT

This study investigated the conundrum of inflation-targeting, economic growth, and unemployment rate amidst energy price pressures and monetary policy in South Africa from 2000 to 2022. Motivated by the persistent criticisms that inflation-targeting harms economic growth and job creation to maintain an inflation rate within the target range, this research sought to understand the broader implications of such a monetary policy framework in the context of fluctuating energy prices, exchange rates, and interest rates. The primary objectives were to assess whether the South African Reserve Bank's (SARB) inflation-targeting framework, formally introduced in 2000, effectively stabilised the inflation rate without adversely impacting economic growth and increasing unemployment rates. Additionally, the research explored the interaction between energy prices, interest rate, exchange rate, and inflation expectations against inflation-targeting, economic growth, and Unemployment rate in a three-model setting.

The study utilised three econometric models to achieve its objectives. The Autoregressive Distributed Lag approach was employed for cointegration analysis to determine the long-run relationships among the variables. The Granger causality tests were conducted to identify the direction of causality, while the Impulse Response Functions and Variance Decomposition analyses were used to assess the dynamic interactions and the contribution of each variable to the forecast error variance in the system. The three model results indicated that energy prices had a persistent adverse impact on economic growth and unemployment. The findings revealed that while inflation-targeting successfully contained the inflation rate within the target range, it did not sufficiently promote economic growth and reduce unemployment. The interest rate hikes, though effective in curbing the inflation rate in the short run, had detrimental effects on economic growth and job creation in the long run. The Granger causality tests showed bidirectional causality between interest rate and economic growth. Additionally, IRF results indicated that economic growth reacts negatively towards a shock in interest rates. This implies that persistent increases in interest rates can depress economic growth. The study recommended that the SARB consider adopting a dual mandate monetary policy framework.

KEY CONCEPTS: Inflation-targeting, Economic growth, Unemployment rate, Energy prices and Interest rate

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ABBREVIATIONS AND ACRONYMS

SARB - South African Reserve Bank

QPM - Quarterly Projection Model

PP - Public Protector

GDP - Gross Domestic Product

Stats SA – Statistics South Africa

MPC - Monetary Policy Committee

CPI - Consumer Price Index

BRICS – Brazil Russia India China South Africa

NEER - Nominal Effective Exchange Rate

REER - Real Effective Exchange Rate

NERSA - National Energy Regulator of South Africa

IMF – International Monetary Fund

USD - United States Dollar

GBR - British Pound

EUR – Euro

ZAR – Rand

SALGA – South Africa Local Government Association

CEF – Central Energy Fund

DMRE - Department of Mineral Resources and Energy

BFP - Basic Fuel Price

RAF - Road Accident Fund

EAPC - Expectation-Augmented Phillips Curve

AD-AS - Aggregate Demand and Aggregate Supply

RBNZ - Reserve Bank of New Zealand

OCR - Official Cash Rate

PPP - Purchasing Power Parity

ARDL - Autoregressive Distributed Leg

VECM - Vector Error Correction Model

OECD - Organisation for Economic Cooperation and Development
ECM - Error Correction Model

IRF - Impulse Response Function

VDC - Variance Decomposition

PP - Phillips Perron

ADF - Augmented Dickey-Fuller

FPE - Final Prediction Error

AIC – Akaike Information Criterion

SC – Schwarz Information Criterion

HQ - Hannan-Quinn

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CHAPTER 1
ORIENTATION TO THE STUDY

1.1 INTRODUCTION AND BACKGROUND

The monetary policy framework refers to the objectives and conditions of monetary policy decisions (Cobham & Song, 2021). The monetary authorities pursue these objectives. Each economy has its monetary policy objectives depending on the conditions of the economy. Since the 1990s, central banks have embraced monetary policy frameworks that target inflation (Dladla & Malikane, 2022). However, inflation-targeting Central Banks are always criticised for harming economic growth and job creation to keep inflation within the target range (Vermeulen, 2017, 2020). Inflation-targeting was officially adopted in February 2002 as a monetary policy framework, emphasising containing price levels within the target range of 3% - 6% in South Africa. The South African Reserve Bank (SARB) has been expressly utilising inflation-targeting as a monetary policy framework for the past two decades to fulfil its constitutional mandate to safeguard the South African currency's (Rand) value, for balanced and sustainable economic growth. However, the effectiveness of inflation-targeting has become a public debate in stabilising other macroeconomic objectives, such as growth and employment (Nene, Ilesanmi & Sekome, 2022).

In South Africa, economists and policymakers generally agree that inflation-targeting has a negative effect on economic growth (Mandeya & Ho, 2021; Kumo, 2015; Comert & Epstein, 2011; Ncube & Ndou, 2011). The conundrum hovers over whether inflation-targeting influences the economy positively or negatively. Other Central Banks of advanced economies are explicitly implementing a dual mandate in their monetary policy conduct. For instance, the Central Bank of the United States of America, and the Federal Reserve Bank adopted a dual mandate policy framework that expressly aims for price stability and maximum sustainable employment (Bohl, Kanelis, & Siklos, 2023). The Reserve Bank of Australia and the Reserve Bank of New Zealand have a clear dual mandate monetary policy framework of ensuring price stability and promoting full or maximum sustainable employment (Cobham, Macmillan, Mason, & Song, 2022). Norway, Sweden, and Iceland are a few more nations whose economies have embraced a hybrid monetary policy framework. The confusion with the current monetary policy mandate is that the mandate of sustainable economic growth is implicit rather than explicit. Hence, the SARB has a single mandate.

Inflation uncertainty harms economic growth (Adaramola & Dada, 2020). The argument against inflation-targeting is that it neglects the stabilisation of economic growth (Kotsokoane & Rena, 2021). In addition, the SARB's primary policy instrument is the repurchase rate (repo rate), which controls price levels. The inflation rate can be driven by excess demand or supply costs. As such, monetary authorities must increase interest rates when inflation increases (Olgun, 2022). Such a policy stance is contractionary and more efficient when inflationary pressures emerge from the demand side (Rehman, 2014). However, under the inflation-targeting monetary policy framework, the central bank actively seeks to maintain the inflation rate within the target range of 3%–6%, as applied in the South African context. Therefore, a framework that focuses solely on achieving low inflation in the long run may have consequences for economic growth and job creation. Inflation uncertainty and interest rate adjustments can influence overall economic performance, potentially limiting growth and employment opportunities. This study does not oppose the inflation-targeting framework but rather seeks to assess the feasibility of incorporating additional macroeconomic objectives within the framework. Given that inflation uncertainty can be driven by external factors or supply-side shocks beyond the control of SARB, it is essential to find a balance between inflation control, economic growth, and unemployment reduction to ensure sustainable macroeconomic stability.

According to SARB (2023), monetary policy views inflationary pressures in South Africa are mainly driven by changes in energy prices (fuel and electricity), weak currency and load-shedding, which has an estimated 0.5% inflationary impact on the economy. However, the SARB decides on interest rates based on its forward-looking Quarterly Projection Model (QPM) (SARB, 2023). A tight monetary policy could be counterproductive if the inflation rate is driven by high energy prices, because of adverse spillover effects on the overall economic performance (Rehman, 2014). Sehlapelo and Inglesi-Lotz (2022), argued that policymakers believe an increase in electricity prices will significantly affect the economy negatively in South Africa.

The South African economy has long exhibited slow growth and a high unemployment rate (Pasara & Garidzirai, 2020; Kotsoane & Rena, 2021). Therefore, maintaining an inflation-targeting framework when faced with stagnant economic growth, may exacerbate the economy's health, with persistent increases in the cost of living attributed to tight monetary policy. Kotsoane and Rena (2021) maintain that this is due to the inflexibility of inflation targeting giving the monetary authorities the ability to isolate inflation control as the sole mandate in the policy framework. Furthermore, Mavikela, Mhaka and Phiri, 2016), indicated that any central bank concerned with price stability has found that the degree to which the inflation rate affects output growth or economic performance is a subject of considerable relevance.

Vermeulen (2020), argued that the criticism of the SARB's implementation of monetary policy through an inflation-targeting framework stems from the perception that the SARB's insistence on maintaining price stability restrains economic growth and job creation and, more generally, does not support the government's overall economic strategy and goals. The highest independent institution that supports and strengthens constitutional democracy in South Africa, the Public Protector (PP) also proposed controversial remedial actions in an investigation relating to the SARB to amend its mandate to include the socio-economic conditions of ordinary citizens in its mandate (PP, 2017). The key objective of this research is to gain insight into the conundrum of inflation-targeting, economic growth, and unemployment rate amidst energy price pressures, interest rate, and exchange rate for the period 2000 to 2022. This is meant to interrogate the possibility of an explicit dual adoption of a monetary policy framework in South Africa.

1.2 STATEMENT OF THE PROBLEM

The perception of having a solo monetary policy mandate is that the monetary policy officials believe that the best contribution to the economy is to provide a low inflationary environment that is suitable for achieving long term sustainable growth rates (Idisi, Dirisu, Adewale, Bandele, & Olufemitan, 2023; Castillo, Montoro, & Tuesta, 2020; Puni, Osei, & Barnor, 2014). It becomes very complex for monetary officials to change interest rates to contain inflation rates emanating from rising energy prices and weak exchange rates (Eo, & Lie, 2020; Rehman, 2014). Those are attributed to external economic factors, including the geopolitical positions of each nation and its trading partners on global matters. Low growth and excessive unemployment rates have been problems in South Africa. As a result, Pasara and Garidzirai, (2020), noted that even though economic expansion and job creation have dominated national government development policies in recent years, the economy of South Africa continues to struggle to grow at a rate higher than 5%. For instance, the Gross Domestic Product (GDP) increased by 1,6% in 2022's third quarter following a 0.7% decrease in the second quarter, while in the fourth quarter of 2024, the economy shrank by 1.3% (Stats SA, 2023). The persistently high unemployment and low growth rates are associated with a stagnated economy. According to Stats SA (2020), the unemployment rate (official) in the third quarter of 2022 was 32.7%, while the expanded rate was 43.1%. As a result, South Africa is falling short of the goal of a 6% unemployment rate in the NDP (2013).

The SARB Monetary Policy Committee (MPC) increased the repo rate by 150 basis points overall from late 2022 to early 2023 (from October 2022 to March 2023) after three consecutive 75 basis point increases, in the face of a high unemployment rate and low economic growth (SARB, 2023). The notion that inflation-targeting central banks are achieving price stability at the expense of high unemployment rates and low economic growth is problematic because it is detrimental to the socioeconomic well-being of ordinary citizens (Rehman, 2014). The economic conditions are getting difficult to resolve coupled with the prolonged electricity blackouts. Rising interest rates make it more expensive for households to live, which weakens aggregate demand. It is problematic that the MPC is hiking rates when the economy is still recovering from two global economic adverse shocks (the COVID-19 pandemic and the Russian-Ukraine invasion) from the supply side (SARB, 2022). The complexity of inflation-targeting in addressing cost-driven inflations needs adequate attention from policymakers and researchers. South Africa's conduct of monetary policy needs to be gradually changed to consider shifting economic realities. According to SARB (2023), hiking interest rates to control inflationary pressures is data dependency because its QPM is forward-looking, and future inflationary trends need immediate action. However, interest rate increases have a direct influence on the economy because they reduce consumption and investment spending (Vermeulen, 2022). Therefore, if growth is not expanding, it becomes difficult for the economy to create sustainable employment for its citizens.

According to Bedná, Erdlová, Kadeábková, and Eábek (2022), one of the key determinants of the political, economic, and social growth of every nation's economy is energy. According to Rehman (2014), energy price pressures lead to more production costs and reduce aggregate supply. Households and businesses find it difficult to cope with persistent interest rate increases when their income levels are not improving due to weak economic performance and high living costs. However, energy prices declined significantly due to a fall in demand, for instance, from $32.25 per barrel in March 2020 to $18.11 per barrel in April 2020, the price of Brent crude oil dropped (Wu & Ma, 2021). Moreover, during post COVID-19 pandemic recovery in 2022, the political conflict between Russia and Ukraine triggered an energy crisis and this led to an increase in energy prices across the world (Zhang, Shan, Zheng, Wang, Guan, Yan, Ruzzenenti, & Hubacek, 2023). In turn, the cost of living will increase coupled with high interest rates.

The SARB received heavy criticism from labour groups and political parties for increasing interest rates when the economy is growing at a low rate and high unemployment rate. Some proposed to expand the SARB mandate to meet the economic needs (News24, 2023). However, inflation-targeting framework criticism should be heedful and not be confused with short term political gains. The need for a blended monetary policy framework must be tested and supported empirically before the constitution can be amended. As a result, a thorough examination is conducted to determine the efficacy of a dual mandate monetary policy framework in South Africa in the face of pressures from energy prices, a weak domestic currency, and interest rate shocks.

1.3 RESEARCH AIM AND OBJECTIVES

1.3.1 Aim of the study

The study aims to investigate the conundrum of inflation-targeting, economic growth, and unemployment rate amidst energy price pressures, interest rate, inflation expectations, and exchange rate from 2000 to 2022.

1.3.2 Objectives of the study

To achieve the aim, the following research objectives are formulated:

- To determine the impact of energy price pressures, exchange rate, interest rate, inflation expectations, economic growth, and unemployment rate on inflation targeting.
- To ascertain the association of energy price pressures, exchange rate, interest rate, inflation expectations, inflation-targeting, and unemployment rate on economic growth.
- To verify the relationship among energy price pressures, exchange rate, interest rate, inflation expectations, inflation-targeting, and economic growth on the unemployment rate.

- To investigate causality among inflation rate, economic growth, unemployment rate, energy price pressures, interest rates, inflation expectations, and exchange rates.
- To forecast the path of inflation, economic growth, and unemployment rate midst of economic shocks of energy price pressures, exchange rate, inflation expectations, and interest rate.

1.4 RESEARCH QUESTIONS

The study intends to address the following research questions study:

- What is the impact of energy price pressures, exchange rate, interest rate, inflation expectations, economic growth, and unemployment rate on inflation-targeting?
- Do energy price pressures, exchange rates, interest rates, inflation expectations, inflation-targeting, and unemployment rates have an association with economic growth?
- What is the nature of the relationship between energy price pressures, exchange rate, interest rate, inflation expectations, inflation-targeting, and economic growth on the unemployment rate?
- What is the nature of causality among inflation, economic growth, unemployment rate, energy price pressures, exchange rate, inflation expectations, and interest rate?
- How will inflation, economic growth and unemployment rate perform amidst energy price pressures, exchange rate, inflation expectations, and interest rate shocks in the foreseeable future?

1.5 DEFINITION OF CONCEPTS

- **Economic Growth**

Economic growth refers to a process by which a country's total value of output and wealth increase over time (Hess, 2013). This refers to the value of outputs produced in the economy over a period. GDP, which is measured quarterly, is used to gauge economic growth. Hence, in this study, GDP is the proxy for economic growth level.

- **Inflation-targeting**

A monetary policy approach known as inflation-targeting is based on the public revelation of a specified numerical inflation rate target (Svensson, 2018). It ensures the execution of monetary policy that aims to control the inflation rate. Mohr (2015), on the other hand, defines inflation rate as an increase in general prices of goods and services over time in the economy. The inflation rate can be used to indicate the cost of living in a country. In this study, the headline Consumer Price Index (CPI) is used to estimate the monthly inflation rate, which serves as a stand-in for inflation-targeting.

- **Unemployment rate**

The unemployment rate refers to the proportion of people in a country who are of working age but are not actively employed (Bell & Blanchflower, 2009). In South Africa, the strict definition of unemployment is used as the official unemployment rate. The unemployment rate is the proxy of unemployment.

- **Foreign exchange rate**

The price of a currency from one nation relative to another is known as the foreign exchange rate, according to Angel and Stockman (1980). Changes in the relative pricing of products resulting from changes in supply or demand also cause exchange rates to vary and cause deviations from purchasing power parity. The study utilised the value of the foreign exchange rate pair between the Rand and the US Dollar as a proxy for foreign exchange.

- **Interest rate**

According to Mohr (2015), interest rate refers to the cost of borrowing funds. The interest rate refers to the price paid for borrowing money. On the other hand, the SARB lends money to commercial lenders in South Africa at the repurchase (repo) rate. This serves as the credit cost benchmark. The repurchase rate therefore acts in this study as a stand-in for the interest rate.

- **Energy price pressures**

Energy price pressures denote the economic condition in which the expenses related to energy resources such as electricity, natural gas, and petroleum are experiencing a substantial increase, thereby exerting pressure on both consumers and enterprises due to heightened costs incurred from energy acquisition, which may subsequently contribute to inflationary trends and affect overall economic performance (Kastner & Stern, 2015). It should be mentioned, nonetheless, that in this study, energy prices such as a Consumer Price Index for electricity and other fuels serve as a stand-in for energy price pressures. According to the U.S. Bureau of Labour Statistics (2020), energy prices consist of household residential energy prices for household energy appliances (which includes cooking, heating, lighting, and other items) including prices for fuels (household fuels and motor fuels).

1.6 ETHICAL CONSIDERATIONS

The study upholds all fundamental ethical standards and abides by the University of Limpopo's plagiarism policies. The dissertation acknowledges the usage of all sources. The secondary data used in this study was handled ethically and respectfully.

1.7 SIGNIFICANCE OF THE STUDY

This study contributes to the body of literature on the potential adoption of a dual mandate monetary policy framework in South Africa, highlighting its relevance and significance in the country's economic policy landscape. Kotsokoane and Rena (2021), shed some light on the implications of the effects of inflation-targeting on the expansion of the South African economy. They used the VECM multivariate model with inflation, economic growth, interest rate, and unemployment rate from 2000 to 2018. Similarly, Takentsi et al. (2022), used the ARDL approach between 1994 and 2019 to shed light on the ad hoc association between economic performance and energy prices in South Africa. In addition to the variables used in the reviewed studies, in a three-model framework, this study considers the impact of the exchange rates and energy prices. It appears this study is the first to incorporate the effects of energy prices into a monetary policy framework. Therefore, this study intends to contribute to developing literature on the feasibility of introducing a fully explicit dual mandate monetary policy framework in South Africa and other developing economies.

This study contributes to the literature on a blended monetary policy framework in South Africa. It also provides valuable insights for monetary policy officials on addressing long-term price stability challenges posed by energy price pressures and a weak currency. For instance, energy prices can be highly volatile and difficult to predict, making it harder to maintain a stable inflation rate over time (Rehman, 2014). This can lead to a situation where monetary authorities face a conundrum or a tug-of-war between controlling the inflation rate or stabilising economic growth and employment. This potentially leads to suboptimal outcomes due to higher interest rates meant to control inflationary pressures. Concerning the methodological contribution, this study adopts the ARDL approach to analyse the dynamic of relations among variables to achieve the set objectives using quarterly data collected from 2000 to 2022, two decades of the inflation-targeting framework. Unlike Kotsokoane and Rena (2021) and Takentsi et al. (2022), different econometric approaches like the Granger causality test to determine causal relations as well as VDC and IRF to forecast the path of the targeted variables in the face of shocks are employed.

1.8 STRUCTURE OF THE STUDY

The research is laid out as follows: The objectives are outlined in Chapter 1, along with the study background and introduction. An overview of macroeconomic analysis and macroeconomic policies is given in brief in Chapter 2. The theoretical and empirical literature is brought up in Chapter 3. On the other hand, the empirical literature is arranged according to the objectives. In Chapters 4 and 5, respectively, the study's methodology, results, and interpretation are briefly described. Eventually, Chapter 6 summarises the major results to wrap up the investigation.

CHAPTER 2

OVERVIEW OF MACROECONOMIC ANALYSIS AND MACROECONOMIC POLICIES

2.1 INTRODUCTION

The chapter provides a brief review of macroeconomic analysis and macroeconomic policies. This chapter highlights key linkages and performance among variables of model regressions in this study.

2.2 MACROECONOMIC ANALYSIS

Stable prices, reduced interest rates, and more stable currency rates are all benefits of a robust macroeconomic framework (National Treasury, 2024). A complex interplay of diverse economic indicators characterises the South African economy. The use of explicit inflation-targeting as a flagship of monetary policy to keep the cost of living low (Reid, Siklos, & Du Plessis, 2021). The inception of this policy instigated opposing perspectives among researchers due to its exclusion of other macroeconomic objectives. The complex web of macroeconomic variables influencing the South African economy is examined in this section, with particular attention paid to the inflation rates, economic growth, unemployment rate, exchange rate movements, interest rates, inflation expectations, and energy prices. South Africa is experiencing a high unemployment rate and low economic growth (Semosa & Ogujiuba, 2021). The National Treasury (2024) reports that GDP growth has only averaged 0.8% since 2012, which is insufficient to address the alarmingly high poverty and unemployment rates. It was projected that the headline inflation rate would decline from 6% in 2023 to 4.9% (National Treasury, 2024). This shows that the inflation rate is nearing the mid-point of 4.5. This highlights how difficult it is to achieve long term economic growth in this country while simultaneously lowering the unemployment and inflation rates on a macroeconomic level. Therefore, the subsequent subsections highlight an overview of the macroeconomic analysis of the variables under study.

2.2.1 Inflation rate and inflation expectations

As a barometer of price stability, the inflation rate holds significant implications for monetary policy formulation and economic performance. As already alluded to in Chapter 1, the inflation-targeting policy framework in South Africa was introduced in 2000. It was introduced to promote price stability and anchor inflation expectations, thereby supporting sustainable economic growth. However, every country endures an inflation rate, but each one has experienced it at a different rate (Semosa & Ogujiuba, 2021). Inflation expectations, or what businesses and consumers anticipate future inflation rates, play a significant role in shaping actual inflation rate dynamics. Central banks often communicate their monetary policy intentions to the public through forward guidance. The SARB through its QPM is not an exception.

Figure 2.1 below, shows trends in the annual inflation rate and inflation expectations and it illustrates how inflation expectations align with historical trends or if there are indications of diverging expectations of the actual inflation rate in the economy.

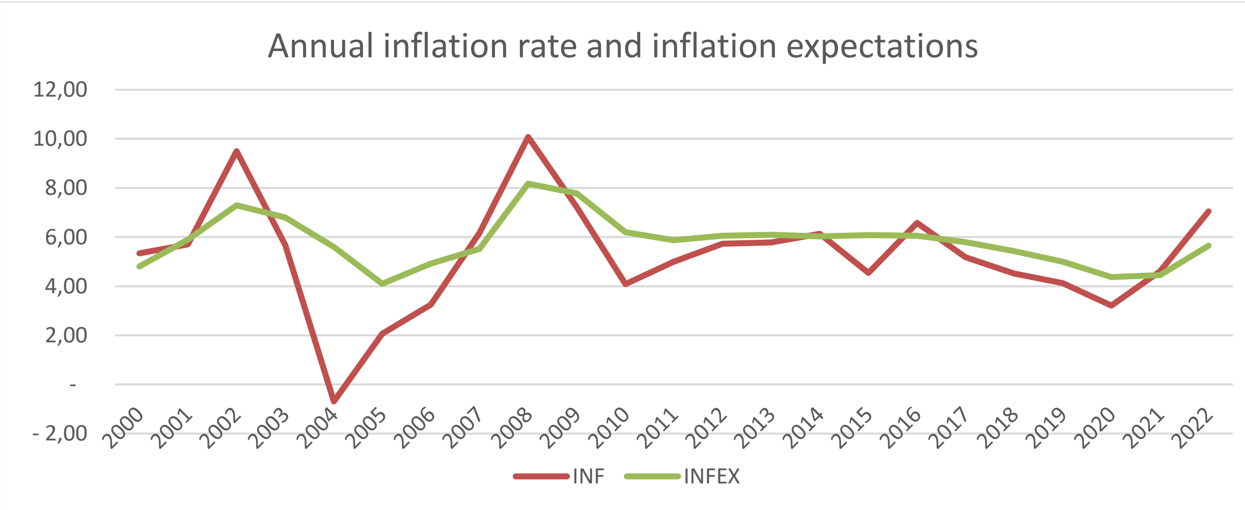


Figure 2.1: Inflation rate and Inflation expectations

Source: Author's computation with data from the World Bank Database

Globally, public expectations of inflation rate are becoming a more important tool for central banks to use when implementing monetary policy (Armantier, Bruine de Bruin, Potter, Topa, Van Der Klaauw, & Zafar, 2013). Werning (2022) asserts it is generally accepted that future inflation expectations rates have a significant impact on the inflation rate possibly having a nearly intimate relationship. Figure 2.1 reveals the inflation rate and expectations fluctuations in South Africa. From 2000 to 2008, both the inflation rate and expectations experienced significant fluctuations. The inflation rate surged from 5.34% in 2000 to a 10.07% peak in 2008, reflecting economic volatility and external shocks. Meanwhile, inflation expectations generally followed a similar trajectory, albeit with some deviations, reaching a peak of 8.175% in 2008. The period from 2009 to 2015 witnessed relatively stable inflationary conditions, with inflation rates ranging from 2.06% to 7.22%, and inflation expectations hovering around 4.1% to 6.1%. Such stability could be attributed to prudent monetary policy measures aimed at anchoring inflation expectations and fostering economic stability. However, from 2021 onwards, the inflation rate and expected inflation exhibited upward trends. Policymakers, business entities, and investors must comprehend these tendencies to develop strategies for navigating the changing economic environment and reducing the risks associated with the inflation rate (Mlangeni & Buthelezi, 2024).

Table 2.1: Projected BRICS countries' inflation rate outlook

Country	Actual	Projections	
	2023	2024	2025
Brazil	4.6	4.1	3.0
Russia	5.9	6.9	4.5
India	5.4	4.6	4.2
China	0.2	1.0	2.0
South Africa	5.9	4.9	4.5
Egypt	24.4	32.5	25.7
Ethiopia	30.2	25.6	18.2
Iran	41.5	37.5	32.5
United Arab Emirates	1.6	2.1	2.0

Source: World Bank Economic Outlook (2024)

Comparing South Africa's inflation rate outlook to other BRICS-plus countries and the selected emerging economies underscores the diverse inflationary dynamics within the group. Table 2.1 presents the projected inflation outlook for South Africa compared to other BRICS economies and reveals interesting trends and potential economic dynamics. South Africa's projected inflation rates show a gradual decline over the forecast period, from 5.9% in 2023 to 4.5% in 2025. This downward trend suggests a gradual easing of inflationary pressures in the country. The inflation rate is projected at the mid-point of the inflation target spectrum of 3% - 6% in 2025. Brazil's projected inflation rates have a downward trend albeit more modestly, compared to South Africa. From 4.6% in 2023, the inflation rate is projected to decrease to 3.0% by 2025. In contrast to South Africa and Brazil, Russia's projected inflation rates show an initial increase in 2024 to 6.9 before declining in 2025 to 4.5. This suggests short-term inflationary pressures followed by a gradual moderation. Factors such as geopolitical tensions, energy prices, and monetary policy adjustments could influence Russia's inflation rate dynamics during the forecast period (World Bank Economic Outlook, 2024)

China's projected inflation rates remain low and stable throughout the forecast period and increased slightly from 0.2% in 2023 to 2.0% in 2025. China's inflation rate outlook reflects the country's efforts to balance growth objectives with price stability. According to Qin (2025) China's inflation rate remained at a relatively low level with some fluctuations. However, for new group members, the data reveal that Egypt's inflation rate is projected to remain elevated, with a slight increase from 24.4% in 2023 to 25.7% in 2025. Considering the recent substantial increase in the dollar's exchange rate versus the Egyptian pound because of the local currency's devaluation (floating the Egyptian pound) and the corresponding increase in product pricing, which translate into inflation (Dahdouh & Kassem, 2024). Iran's inflation rate is projected to decline steadily from 41.5% in 2023 to 32.5% in 2025. According to Naghdi, Kaghazian and Efati Baran (2024). However, Ethiopia's inflation rate has been on a declining trend, dropping from 30.2% in 2023 to a projected 25.6% in 2024 and 18.2% in 2025. Despite this improvement, inflation remains significantly high compared to most BRICS nations, reflecting ongoing economic challenges. With inflation in Ethiopia exceeding 10% annually and incomes remaining constant, especially for retirees and government employees, many consumers struggle to afford the rising cost of living (Mulu, Bessie & Mulatu, 2024).

2.2.2 Economic growth

Analysing the growth rate of South Africa from 2000 to 2022 provides insights into the country's economic performance and challenges. Notable economic issues have persisted in South Africa, including stagnant growth (Pasara & Garidzirai, 2020). As stated by Khalid, Akalpler, Khan, Shah, and Khan (2021), achieving long-term sustainable economic growth is the main objective of every nation. This is accomplished by creating and putting into practice prudent macroeconomic policies that effectively address the issues facing the economy. For over a decade, the economy of South Africa has grown slowly (National Treasury, 2024). While inflation-targeting policy can play a crucial role in maintaining price stability as revealed above, its effectiveness in stimulating growth during periods of low economic activity warrants careful consideration.

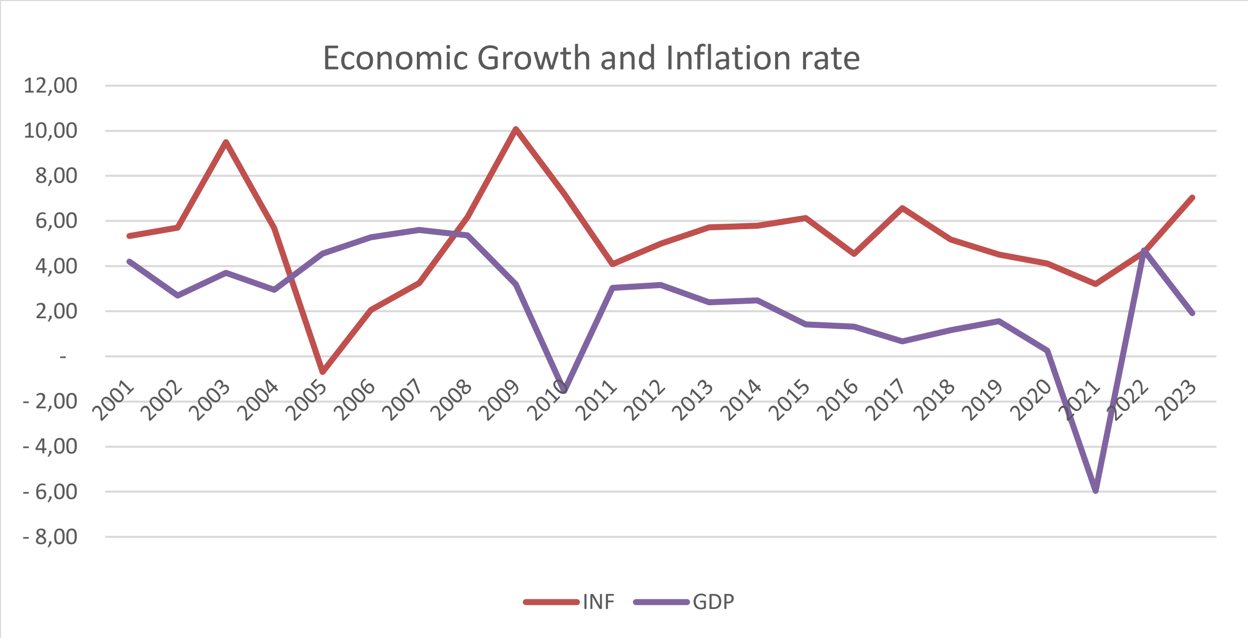


Figure 2.2: Economic Growth Rate and Inflation rate

Source: Author's computation with data from the World Bank Database

As seen in Figure 2.2 above, South Africa's economy grew very robustly between 2000 and 2007, averaging growth rates above 3% and reaching a peak of 5.60 percent in 2006. This period was characterised by strong global demand for commodities, favourable domestic conditions, and structural reforms. However, the 2008 global financial crisis significantly impacted South Africa's economy, leading to a sharp contraction in economic growth to 3.19% in 2008, followed by a recession in 2009 (-1.54% growth). The economy struggled to recover amidst global uncertainties and domestic challenges. Furthermore, subsequent years saw a mixed performance, with growth rates fluctuating around or below 3%. While there were brief periods of moderate growth, such as in 2011 (3.17%) and 2017 (1.16%), overall growth remained subdued. The COVID-19 pandemic further exacerbated South Africa's economic woes, resulting in a sharp contraction of 5.96% in 2020, followed by a partial recovery to 4.70% growth in 2021 and 1.91% growth in 2022. The trend analysis of economic growth and inflation in South Africa shows significant fluctuations over the years. Inflation peaked at 10% in 2003, dropped to 1% in 2005, and surged again to 10% in 2009 during the financial crisis. From 2011 to 2019, it remained between 4%-7%, before rising again to 8% in 2023, likely due to global inflationary pressures. Although most economists believe that maintaining low inflation is essential to boosting the economy's potential for expansion, some contend that low inflation might have the opposite effect (Meyer & Hassan, 2024).The data suggests that South Africa experiences a dynamic and sometimes unstable relationship between inflation and economic growth.

Table 2.2: Projected BRICS Plus Countries Real Economic Growth Outlook

Country	Actual	Projections	
	2023	2024	2025
Brazil	2.9	2.2	2.2
Russia	3.6	3.2	1.8
India	7.8	6.8	6.5
China	5.2	4.6	4.1
South Africa	0.8	0.9	1.2
Egypt	3.8	3.0	4.4
Ethiopia	7.2	6.2	6.5
Iran	4.7	3.3	3.1
United Arab Emirates	3.4	3.5	4.2

Source: World Bank Economic Outlook (2024)

Table 5.2 reveals that while South Africa's growth rates are positive, they are consistently lower than those of the BRICS Plus nations, indicating slower economic expansion. South Africa's projection growth rates are marginally increasing over the projection period, indicating a slight improvement in economic growth from 0.8% in 2023 to 0.9% and 1.2% in 2024 and 2025 respectively. Egypt's projection growth rates are generally higher than South Africa's, showing a more significant fluctuation from 3.8% in 2023 to a fall of 3.0% in 2024 and increased to 1.2% in 2025.

Ethiopia's growth rates are notably higher than South Africa's and some of the BRICS Plus nations. Ethiopia consistently maintains relatively high growth rates throughout the projected years. India and China consistently demonstrate higher growth rates compared to all other countries with a projected growth rate of 6.5% and 4.1% respectively. South Africa's economy seems to be growing slower than other BRICS Plus nations, and its growth rate is not as robust as that of India, China and other BRICS Plus economies.

While there has been some improvement in growth rates over the years, South Africa still faces challenges in achieving significant economic expansion. The data suggests a need for targeted policies and reforms to stimulate growth and improve the country's economic outlook to align with its peers.

2.2.3 Unemployment rate

Unemployment is considered a major macroeconomic issue in developing countries, and the South African economy is one of them (Bakhshi & Ebrahimi, 2016). All country's national policies are aligned with the macroeconomic objective of full employment. For example, South Africa's Vision 2030 articulates the necessity to enhance the economy to accommodate the workforce and augment the capacity of the populace and institutions within South Africa to effectively address both opportunities and challenges, with the overarching aim of decreasing the unemployment rate to 6 percent by the year 2030 (National Development Plan, 2011). According to Khalid et al. (2021), the economic landscape of South Africa is characterised by the youngest and most rapidly expanding youth demographic globally; nevertheless, within this framework, over 12 million young individuals are adversely impacted due to a lack of accessible employment opportunities. As noted, South Africa is facing a prolonged period of slow or no growth. Therefore, the economy may have challenges and difficulties in creating sustainable employment opportunities for unemployed youth in the country.

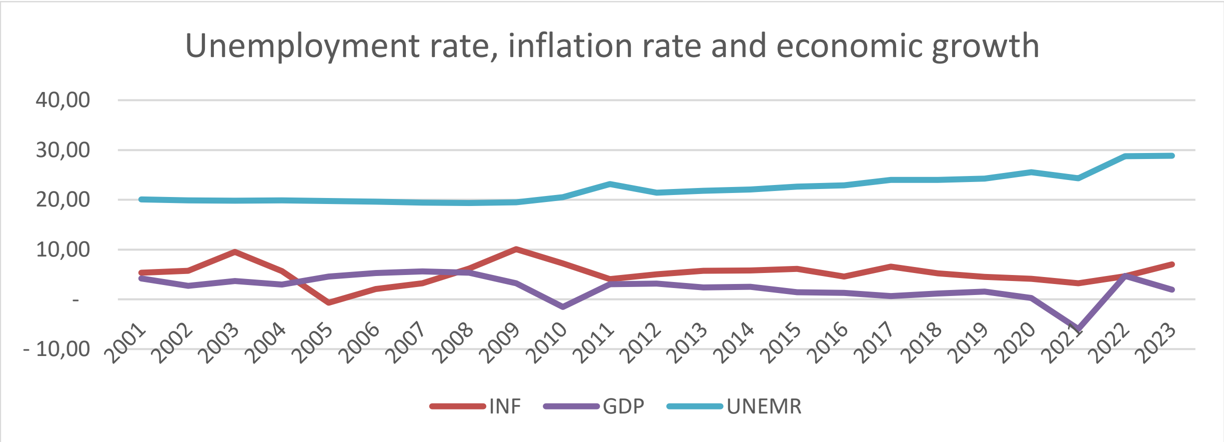


Figure 2.3: South Africa's annual average unemployment rate, inflation rate and economic growth

Source: Author's computation using World Bank database

Table 2.3 above presents South Africa's annual average unemployment rate, inflation rate and economic growth. Firstly, it reveals a general upward trend in the unemployment rate from 2000 to 2023, with fluctuations along the way. The unemployment rate starts relatively stable around 19-20% from 2000 to 2005, with minor fluctuations. From 2006 to 2010, there was a notable increase in the unemployment rate, particularly between 2008 and 2009. This period coincides with the global financial crisis, which could have contributed to the rise in the unemployment rate. The unemployment rate reached its highest point in 2021, reaching 28.77%. This is the highest rate observed in the dataset provided. There's a slight decrease in the unemployment rate in 2022 and 2023 compared to the peak in 2021, but it's still significantly higher than earlier years.

When comparing unemployment to inflation, the data does not fully align with the traditional Phillips Curve, which suggests an inverse relationship between these two variables. Inflation fluctuated between 3% and 10% over the years, with notable peaks in 2008 and 2022, where inflation exceeded 8%. Despite periods of rising inflation, unemployment continued to increase, particularly after the global financial crisis in 2008 and the COVID-19 pandemic in 2020. This suggests that inflationary pressures in South Africa have not been accompanied by significant job creation. While the economy recovered slightly in the following years, GDP growth remained below 2% for most of the 2010s. The most significant contraction occurred in 2020, when the economy shrank by nearly 7% due to the pandemic. Therefore, understanding the connection between inflation and unemployment, which results in slower economic growth, is necessary to develop better solutions (Sekwati & Dagume, 2023). The data shows that even in periods of moderate GDP growth, job creation has been insufficient to absorb new entrants into the labour market. According to Khalid, Akalpler, Khan, and Shah (2021) South Africa's economy has the youngest and fastest-growing youth population globally, with over 12 million young people severely affected by the lack of job opportunities. The South African economy struggles with high unemployment despite varying inflation and economic growth rates.

Table 2.3: Projected BRICS annual average unemployment rate

Country	Actual	Projections	
	2023	2024	2025
Brazil	8.0	8.0	7.9
Russia	3.2	3.1	3.2
China	5.2	5.1	5.1
South Africa	32.8	33.5	33.9
Egypt	7.2	7.1	7.0
Iran	9.0	8.9	8.8

Source: Author's computation using World Bank database

Table 2.3 shows that South Africa consistently exhibits the highest unemployment rate among the BRICS nations. With a projected rate of 33.9% in 2025, South Africa's unemployment rate remains significantly higher than all other BRICS nations listed. China's unemployment rate, while higher than Russia's, is projected to be moderate and stable at around 5.1%, indicating a large but stable labour force relative to its population size. However, South Africa's projected unemployment rate is significantly higher than Egypt's and Iran's, which are expected to maintain unemployment rates below 8% over the forecast period. South Africa's unemployment rate remains persistently high compared to other BRICS nations and additional countries. This highlights the need for concerted efforts to address underlying structural issues and foster inclusive economic growth and job creation in the country.

2.2.4 Interest rate

Major central banks increased policy interest rates to levels deemed restrictive to combat the growing inflation rate (World Bank Economic Outlook, 2024), and the SARB is not an exception in this regard. While the repurchase rate is a powerful tool for the SARB to maintain price stability, it is just one part of a broader monetary policy toolkit that includes other tools like open market operations, reserve requirements and others. According to SARB (2024), the QPM's predictions for inflation and repo rates continue to serve as a broad framework for policy, with adjustments made at each MPC meeting considering newly available information.

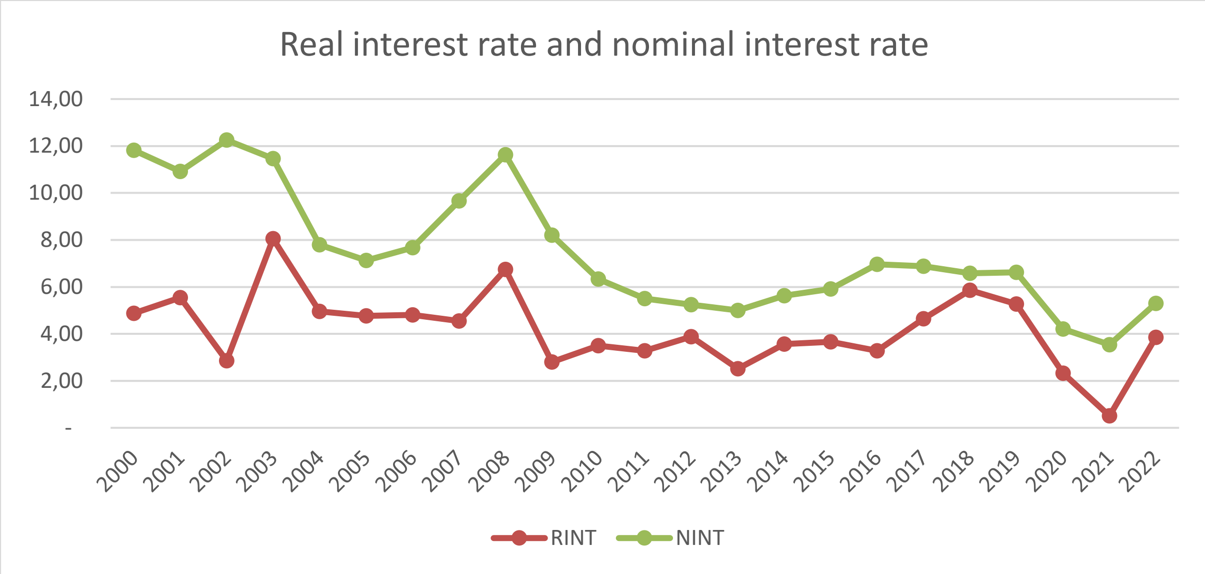


Figure 2.4: South Africa's annual real interest rate and nominal interest rate

Source: Author's computation using World Bank database

A trend analysis of South Africa's real and nominal interest rates over time is shown in Figure 2.4 above, where several patterns are evident. From 2000 to 2003, there was significant volatility in real interest rates, with fluctuations ranging from a low of 2.85% in 2002 to a high of 8.05% in 2003. In some years, such as 2004 to 2007, the actual and nominal interest rates are aligned rather closely. This implies that during these times, inflation expectations are comparatively steady, leading to little variation between nominal and real interest rates. From the mid-2000s to the early 2010s, there is a general trend of declining real and nominal interest rates. In recent years, particularly from 2022 onwards, there is a reversal of the declining trend, with both real and nominal interest rate showing an upward trend. However, as of January 2022, the South African Reserve Bank raised its benchmark repo rate to 4.25% after previously lowering interest rates to encourage investment (SARB, 2022). According to Maake, Semosa, Ogujiuba, and Maponya (2024) this affected the cost of conducting business, and stock prices were affected as a result.

Overall, the trend analysis of real and nominal interest rates in South Africa highlights the dynamic interplay between inflation rate, monetary policy, and economic conditions over the years. While there are periods of volatility and divergence, there are also instances of convergence and overarching trends reflecting broader economic cycles and policy responses. Nonetheless, the South African Reserve Bank had recently reduced interest rates in order to stimulate investment, however as of January 2022, the South African Reserve Bank lifted its benchmark repo rate to 4.25% (SARB, 2022).

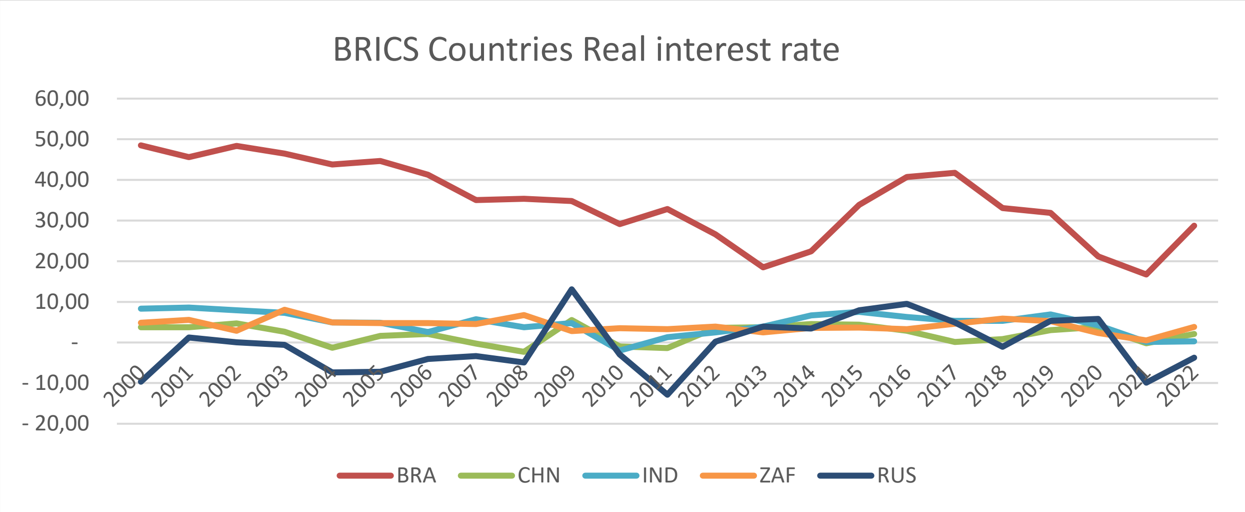


Figure 2.5: BRICS nation's real interest rate

Source: Author's computation using World Bank database

Figure 2.5 above shows the BRICS countries' real interest rates. The real interest rate data for BRICS countries and South Africa show interesting trends and comparative insight about the group. The real interest rate for Brazil demonstrates considerable fluctuations, starting at 41.24% in 2006 and peaking at 48.50% in 2000. Subsequently, there's a decline to 16.73% in 2021, with a noticeable upward trend to 28.74% in 2022. The real interest rate in China generally exhibits stability, with slight variations over the years. It ranges from a low of -2.31% in 2008 to a high of 5.53% in 2010, showing resilience amidst global economic changes. India's real interest rate displays a similar pattern, characterised by modest fluctuations. In 2006 it was approximately 2.57%, with intermittent increases and decreases, reaching 0.15% in 2021 before a slight upward trend of 0.32% in 2022. Comparatively, South Africa's real interest rate showcases a relatively stable trend compared to the other BRICS nations. Overall, while BRICS countries exhibit diverse economic landscapes and policy responses, South Africa's real interest rate trajectory suggests a balance between stability and adaptability in navigating economic challenges amidst global uncertainties.

2.2.5 Exchange rate

Exchange rates directly impact a country's competitiveness in international trade. The phenomenon of exchange rate pass-through refers to the influence exerted by fluctuations in exchange rates on the rate of domestic inflation rate (SARB, 2024). Fluctuations in exchange rates have significant ramifications for the domestic macroeconomic environment, encompassing the global propagation of business cycles and inflationary trends, the recalibration of both the current and financial accounts, as well as the formulation and implementation of monetary policy (Parsely, 2012). A weak exchange rate increases costs for households and businesses in the economy. According to the SARB (2024), the currency rate of the rand, through its effect on the import inflation rate, remains a significant source of inflationary pressure. Therefore, the cost of imported products becomes more expensive when the value of the rand gets weaker against the US dollar.

The increasing globalisation or open economies lead to various benefits and associated costs. The cost includes extreme volatility of domestic currency in developing countries (Ngondo & Khobai, 2018). Price stability is an important objective for inflation-targeting economies such as South Africa. Unexpected changes in the exchange rate can lead to comprise in the conduct of monetary policy by creating uncertainty in domestic prices (Mueller, Tahbaz-Salehi, & Vedolin, 2017). Figure 5.6 below shows fluctuations in nominal and real effective exchange rates in South Africa.

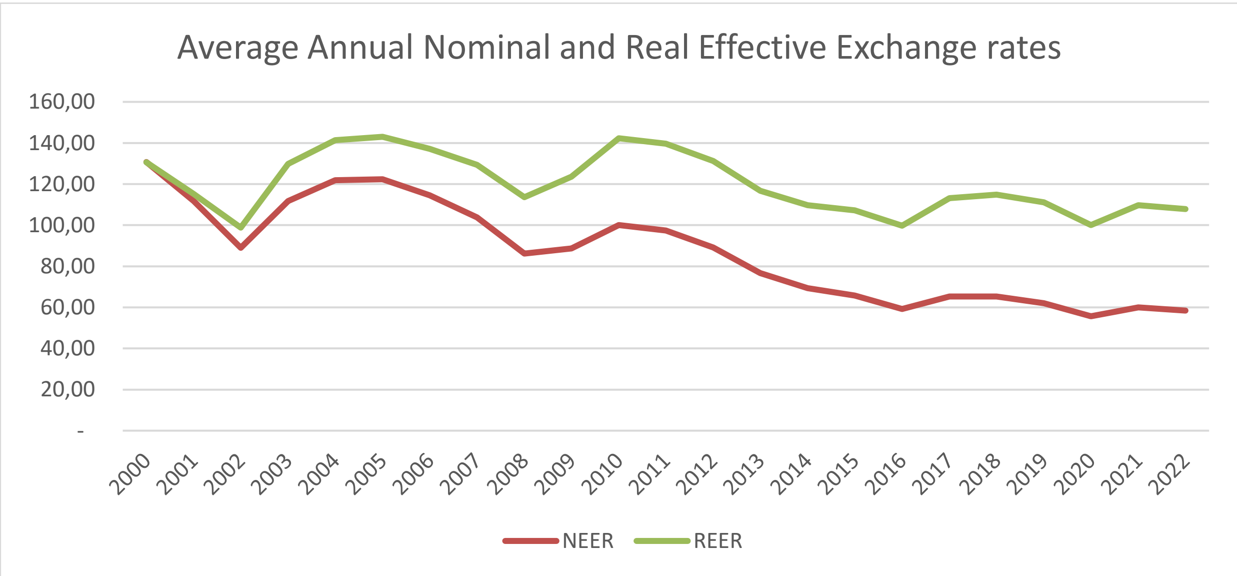


Figure 2.6: Nominal and Real Effective Exchange rates

Source: Author’s computation using World Bank database

Figure 2.6 above shows the Nominal Effective Exchange Rate (NEER) and Real Effective Exchange Rate (REER) in South Africa. Both NEER and REER follow a similar pattern, indicating that while South Africa's currency has depreciated nominally, the real effective exchange rate has also declined, suggesting a loss in competitiveness over time. NEER fluctuates over the years, indicating changes in the value of South Africa's currency relative to its major trading partners. It peaked in 2000 and experienced significant fluctuations until 2022, with a downward trend overall. REER also displays fluctuations, but it incorporates inflation rate adjustments. Like NEER, it peaked in 2000 and showed a general downward trend until 2022, with some fluctuations. The trends in NEER and REER for South Africa indicate fluctuations and a general decline over the years, signalling challenges in maintaining competitiveness in the international market. Understanding these trends is crucial for policymakers to implement appropriate measures to address economic imbalances and foster sustainable growth.

The REER started relatively high in 2000 at 130.64, but it experienced a sharp decline by 2002, reaching 98.81. This decline indicates a loss in competitiveness for South Africa's exports relative to its trading partners. However, from 2003 to 2006, there is a notable recovery in the REER, indicating an improvement in South Africa's competitiveness. In recent years, from 2016 to 2022, the REER shows a general trend of fluctuation around a relatively stable level, with minor variations. While the REER does not display a clear upward or downward trajectory during this period, the fluctuations suggest ongoing adjustments in South Africa's international competitiveness and exchange rate dynamics.

2.2.6 Energy prices

The cost of energy has a significant impact on a nation's economy (Takentsi, 2022). Energy prices play a crucial role in the economy due to their significant impact on various sectors and aspects of economic activity. For instance, high energy prices in the economy could translate to a high cost of living. According to the Energy Price Report (2023), at the core of every nation's economic prosperity lies energy, which is an essential component. Energy can be produced using coal, petroleum, electricity, natural gas, and uranium. In South Africa, energy prices are regulated by various government agencies or departments, hence they are referred to as administrated prices. Currently, South Africa is facing the persistent challenge of energy crisis, which forces Eskom (the primary supplier of electricity) to implement power cuts which affected the economy across various sectors. In 2022, the severity of power outages had the largest detrimental effect on economic sectors like agriculture (-0.27%). Mining (0%, 19%) Gas, water, and electricity (0,18%) Transportation (0,05%) and Manufacturing (0,09%) and the number of jobs in these sectors is still declining (Energy Price Report, 2023). Furthermore, the persistent power cuts are caused by the imbalance between the supply and demand of electricity in South Africa, due to the fact between 1994 and 2018, more than 7.4 million households were connected to the grid without a significant increase in generation capacity (Odhiambo, 2023).

The inflation rate pertaining to electricity prices escalated to 11.7% in the year 2023. This represents a percentage point rise from the average observed in 2022, and the National Energy Regulator of South Africa (NERSA) has sanctioned a 12.74% augmentation in electricity tariffs, which was implemented in July and is scheduled to be in effect until June of 2025 (SARB, 2024). The persistent increase in electricity prices over the years means that NERSA has a significant influence over the administrated prices. Eskom's tariffs are adjusted on an annual basis. Table 2.4 and Figure 2.7 provide data on Eskom's annual average tariff adjustments.

Table 2.4: Eskom's Average Tariff Adjustment

Year	Average price adjustment (%)	Consumer Price Index (%)
2013	16.00	5.20
2014	8.00	6.00
2015	8.00	6.00
2016	12.69	5.70
2017	9.40	6.59
2018	2.20	5.30
2019	5.23	4.5
2020	13.87	4.2
2021	8.76	3.9
2022	15.06	4.6

Source: Energy Price Report (2023)

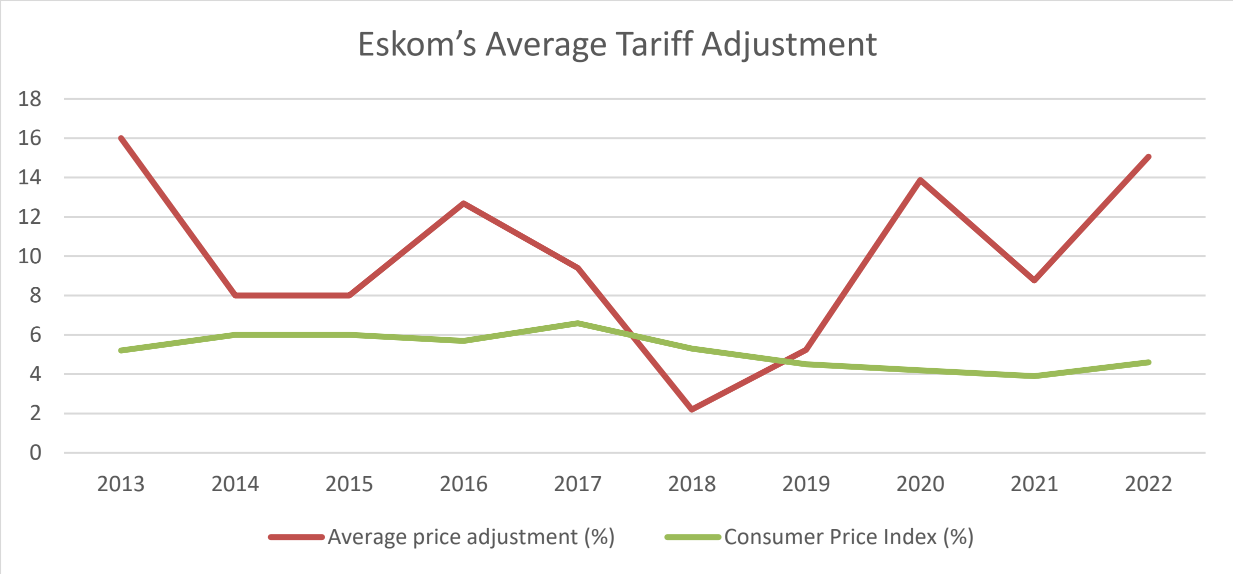


Figure 2.7: Eskom's Average Tariff Adjustment

Source: Author's computation using data from Energy Price Report (2023)

Table 2.4 and Figure 2.7 show the average price adjustment, which represents the percentage change in electricity tariffs implemented annually. From 2013 to 2022, fluctuations in the average price adjustment, ranging from as low as 2.2% in 2018 to as high as 16% in 2013 and 15.06% in 2022 have been observed. There are notable peaks in 2013, 2020, and 2022, indicating significant increases in electricity tariffs during those years. Over the period from 2013 to 2022, the CPI fluctuates between 3.9% and 6.59%. Generally, there is a moderate level of inflation rate, with CPI averaging around 5%. Notably, the CPI tends to be higher in years with higher electricity tariff adjustments, indicating a potential correlation between electricity tariff increases and overall inflationary pressures.

Monthly adjustments of fuel prices in South Africa are based on both domestic and global considerations. The fact that South Africa imports completed goods and crude oil at a price determined globally, including importation expenses, is one example of an international factor. However, the monthly fuel prices fluctuations are driven by the Rand/US Dollar exchange rate, crude oil prices, and the import costs of petroleum products (Energy Price Report, 2023). The war between Russia and Ukraine in February 2022 caused petrol prices to escalate until July 2022 where all prices reached a peak (SARB, 2024). Table 2.5 below shows changes in monthly petrol prices per litre in 2022, the year in which prices were at a highest peak.

Table 2.5: Monthly Petrol ULP 93/95 Prices in cents per litre (2022)

Period	Petrol (ULP) 93	Petrol (ULP) 95	Brent Crude Oil (US$/bbl)	Exchange Rate (R/US$)
	Petrol (ULP) 93 Coast	Petrol (ULP) 93 Gauteng	Petrol (ULP) 95 Coast	Petrol (ULP) 95 Gauteng
Jan	1874	1936	1889	1961
Feb	1927	1989	1942	2014
Mar	2073	2135	2088	2160
Apr	2101	2163	2124	2196
May	2086	2151	2109	2184
Jun	2329	2394	2352	2417
Jul	2566	2631	2609	2674
Aug	2434	2499	2477	2542
Sep	2230	2295	2273	2338
Oct	2141	2206	2171	2236
Nov	2192	2257	2222	2287
Dec	2251	2316	2281	2346

Source: Energy Price Report (2023)

Table 2.5 above shows that petrol prices, both for ULP 93 and ULP 95, exhibit monthly variations throughout the year. Prices tend to fluctuate monthly, reflecting changes in global oil prices, exchange rates, and domestic factors such as taxation and regulation. The ULP 93 and ULP 95 petrol prices show a general upward trend over the year, with occasional fluctuations. The lowest change in petrol price for Petrol (ULP) 93 occurred from September to October, with a difference of 89 cents (2206 - 2141). The highest change in petrol price for Petrol (ULP) 93 occurred from June to July, with a difference of 237 cents (2631 - 2394). In addition, the lowest change in petrol price for Petrol (ULP) 95 occurred from Oct to Nov, with a difference of 51 cents (2257 - 2206). The highest change in petrol price for Petrol (ULP) 95 occurred from June to July, with a difference of 265 cents (2674 - 2409). Therefore, the analysis of petrol price changes in South Africa reveals significant fluctuations, with the lowest and highest changes occurring at different times throughout the year. These fluctuations can be influenced by various factors such as changes in global oil prices, exchange rates, and domestic supply and demand dynamics. Figure 2.8 below compare the global energy price index and South Africa energy price index.

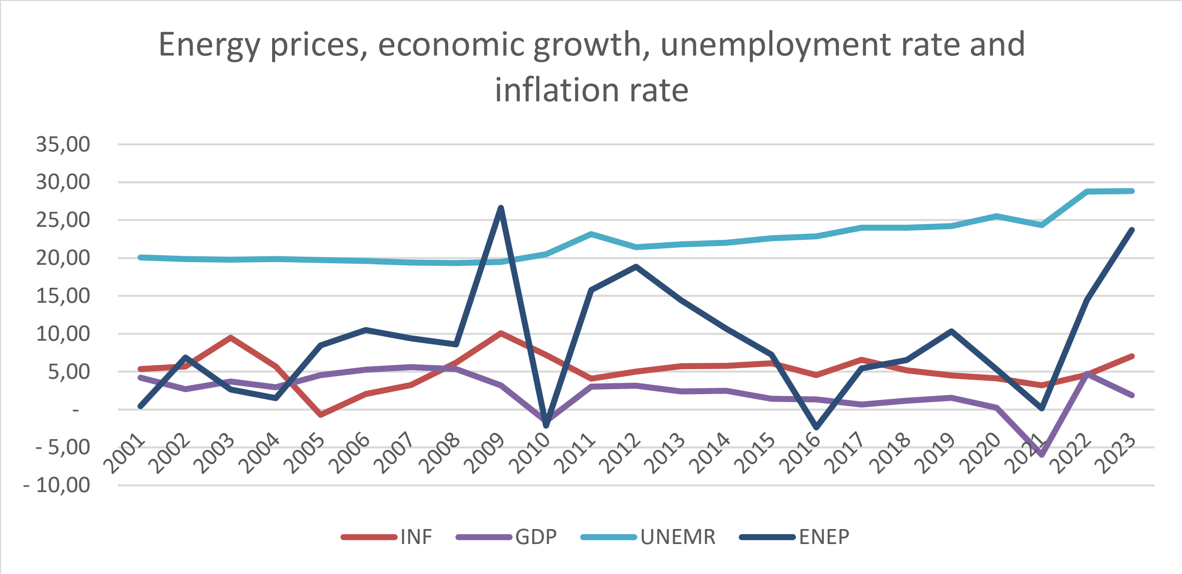


Figure 2.8: Energy prices, economic growth, unemployment rate and inflation rate

Source: Author's computation using data from Word Bank

Figure 2.8 shows that energy prices (ENEP) in South Africa have exhibited significant volatility over the years, with notable fluctuations that often correspond to movements in inflation (INF), economic growth (GDP), and the unemployment rate (UNEMR). The data shows that between 2000 and 2008, energy prices generally showed an increasing trend, peaking in 2008 at 26.63%, which coincided with a sharp rise in inflation to 10.07% and a slowdown in GDP growth to 3.19%. This suggests that inflationary pressures and economic uncertainty contributed to increased energy costs. However, in 2009, during the global financial crisis, energy prices plummeted to -2.13%, following a contraction in GDP growth (-1.54%) and a rise in unemployment to 20.51%. The decline in economic activity likely reduced energy demand, leading to lower energy price growth. From 2010 to 2014, energy prices remained relatively high, with notable peaks in 2010 (15.79%) and 2011 (18.86%). These increases coincided with moderate GDP growth (above 3%) and rising unemployment. However, from 2015 to 2017, energy prices declined significantly, even turning negative in 2015 (-2.35%), a period of slow GDP growth (1.32%) and rising unemployment (22.87%). This decline suggests that weak economic activity and lower demand may have put downward pressure on energy prices.

A sharp drop in energy prices occurred in 2020 (0.15%), corresponding with the economic recession caused by the COVID-19 pandemic, where GDP contracted by -5.96%, and unemployment remained high at 24.34%. As economic activity slowed dramatically, energy demand declined, leading to subdued price growth. However, in the post-pandemic recovery phase, energy prices surged to 14.48% in 2021 and reached a peak of 23.72% in 2022, alongside rising inflation (7.04%) and unemployment (28.84%). This suggests that supply chain disruptions, increased global energy costs, and domestic inflationary pressures contributed to the sharp rise in energy prices.

2.3 MACROECONOMIC POLICY

In South Africa, the National Treasury is responsible for developing and implementing a macroeconomic policy framework. There are two main types of macroeconomic policies, which are fiscal and monetary policy. This section focused mainly on monetary policy around inflation-targeting monetary policy framework and flexible exchange rate policy regime. Lastly, this section will cover aspects of energy policies and regulations in South Africa.

2.3.1 Monetary policy

Inflation rate control is the primary mandate of monetary policy (National Treasury, 2024). The SARB uses an Inflation-targeting framework to achieve its mandate. Another aspect of monetary policy is the exchange rate policy regime. Exchange rates influence import prices, which in turn affect the domestic inflation rate. Central banks often adjust exchange rates to control the inflation rate by influencing the cost of imports and managing aggregate demand.

2.3.1.1 Inflation-targeting monetary policy framework

The inflation-targeting policy has been praised due to its ability to contain price stability in the economy. Inflation targeting is straightforward, at least in theory (IMF, 2022). Countries like New Zealand played a significant role in the development and implementation of inflation-targeting monetary policy framework but later changed to dual mandate. However, in 2018 New Zealand adopted a dual mandate in its monetary policy framework, after the much-praised success of inflation-targeting the national government considered the variability of employment and output which resulted in an additional policy objective, supporting maximum sustainable employment (Reserve Bank of New Zealand, 2023). The additional policy objective is currently pursued alongside price stability, which makes it flexible to allow room to cover up the trade-offs between inflation rate and output.

In February 2015, the Reserve Bank of India (RBI) and the Government of India entered into a formal agreement known as the Monetary Policy Framework Agreement (MPFA) to officially adopt the flexible inflation-targeting framework (Dua, 2020). The inflation target for India is 2% - 6% (IMF, 2022). According to IMF (2022), Russia adopted an inflation-targeting framework in 2015, which targets a single rate of 4% as its price stability target rate. Furthermore, SARB indicated that the 3% - 6% inflation target band should be reduced to a point target of 3% (Ndou & Gumata, 2024). The sole objective of SARB is price stability since the introduction of the inflation targeting approach, the proposed adjustment to the framework is still excluding other objectives in the face of low growth, high unemployment rate, and extreme poverty.

IMF (2022) argues that inflation-targeting necessitates two things. Firstly, the central bank must have some degree of autonomy in its monetary policymaking. However, no central bank can be completely free from the influence of the government, but any inflation-targeting central bank must be free to choose the instruments required to obtain the appropriate inflation rate as determined by the government. Fiscal policy considerations cannot dictate monetary policy decisions. Secondly, the ability and readiness of the monetary authorities to stay away from other macroeconomic indicators like incomes, government expenditure, public debt, and employment levels

Upon fulfilling these fundamental necessitates, a nation is theoretically positioned to implement a monetary policy primarily focused on the objective of inflation-targeting. In practical application, the authorities may additionally engage in specific preliminary measures:

- Determine a precise quantitative inflation rate target over a defined number of forthcoming periods. In South Africa, the Minister of Finance is responsible for determining the explicit target rates that must be met by SARB when conducting monetary policy.
- It is imperative to communicate unequivocally to the public that achieving the inflation target is of paramount importance, superseding all other objectives associated with monetary policy. To hold SARB accountable, the public must know the target rates as well.

- Create an inflation rate forecasting model or approach that makes use of multiple indicators that provide information about future inflation rates. For instance, SARB uses QPM as a key tool in its monetary policy decision-making process. The QPM is a macroeconomic model that helps the SARB forecast and analyse key economic indicators like inflation rate, output, exchange rate and interest rates over a medium-term horizon.
- Create a forward-looking operational mechanism that allows for monetary policy tools adjustment to achieve the desired goal (based on an evaluation of future inflation rate).

2.3.1.2 Flexible exchange rate

All developing nations, including South Africa about the Rand (ZAR), are increasingly concerned about exchange rate volatility, particularly regarding major trading currencies like the US Dollar (USD), the British Pound (GBR), and the Euro (EUR) (Boateng, 2020). South Africa operates a flexible exchange rate system. South Africa adopted inflation-targeting and a floating exchange rate regime in February 2000 (Boateng, 2020). A floating exchange rate regime commonly is known as a flexible exchange rate regime. The flexibility of the exchange rate allows the rand to adjust to changes in economic conditions, such as shifts in trade balances, interest rates, inflation rates, and capital flows. However, SARB may intervene in the foreign exchange market occasionally to stabilise the currency or address extreme fluctuations, but overall, the exchange rate is largely market driven. The flexibility of the exchange rate allows the rand to adjust to changes in economic conditions, such as shifts in trade balances, interest rates, inflation rates, and capital flows (Dornbusch, 2019).

There has been an increase in the use of floating exchange rates since the breakdown of the system of Bretton Woods in 1970, but many nations have opted for flexible intermediate regimes, such as conventional pegs (Morina, Hysa, Ergün, Panait, & Voica, 2020). According to Duttagupta, Fernandez and Karadag (2005), some nations have smoothly and gradually moved from fixed to flexible exchange rates by implementing regimes that are in between, including soft pegs. Soft pegs ensure that in an exchange rate regime where a currency's value is primarily determined by market forces but with some degree of intervention or management by the central bank or government to keep the exchange rate within a certain range or band. This is a hybrid system that combines elements of both fixed and flexible exchange rate regimes.

2.3.2 Energy economics

The cost of energy is a major element in supporting economic expansion (Energy Price Report, 2023). In South Africa energy prices are highly regulated by the government. Electricity generation, distribution, service provision, tariffs and prices, are all regulated (SALGA, 2018). Therefore, in the context of South Africa there many stakeholders involved in the electricity sector. Similarly, the fuel energy sector is also highly regulated in South Africa. As noted above, the petrol and diesel retail prices are regulated by government and are adjusted every first Wednesday of the month. This subsection provides an overview of stakeholders and economic aspects involved in the electricity regulation and fuel prices in South Africa.

2.3.2.1 Electricity prices

NERSA is the entity established under the National Energy Regulator Act of 2004. NERSA has regulatory authority over the entire energy sector and derives its powers and functions from the Electricity Regulation Act (Energy Price Report, 2024). Eskom is the major electricity supplier in South Africa. However, changes in electricity tariffs are subject to NERSA approval. In a market dominated by three major corporations, Eskom for electricity, Petronet for petroleum, and Sasol for gas, the regulator is crucial because it will promote increased access and competition. Under perfect competition, efficient prices would be produced, according to economic theory. Efficient electricity prices are still important even though South Africa's electricity market is not set up to provide ideal competition.

The Electricity pricing policy of South Africa (2008) outlines the following aspects that will be achieved when electricity prices are determined efficiently:

- The best use of limited resources, such as money, people, and natural resources
- The best possible use of electricity
- Making the most use of the various energy sources
- A prosperous sector of the economy

2.3.2.2 Fuel prices

The prices of fuel in South Africa are determined monthly by Central Energy Fund (CEF). The CEF is a state-owned national energy utility entity with a focus on oil, gas, coal and renewable and clean energy options reporting to the Department of Mineral Resources and Energy (DMRE) (Energy Price Report, 2023). CEF sets the average monthly Basic Fuel Prices (BFP) in line with the rules and regulations of the BFP administration. The import parity pricing theory, which measures how much it would cost a South African importer of gasoline to purchase the fuel from an overseas refinery, transport the product from that refinery, insure the product against maritime losses, and land the product on South African soil, is the core of BFP (DMRE, 2022). Furthermore, foreign and local factors influence gasoline costs in South Africa, foreign considerations include the country's import of crude oil at a price determined by the world market (Energy Price Report, 2023).

The fuel price in South Africa includes taxes. The Road Accident Fund (RAF) fee and the general fuel duty are the largest levies (Stats SA, 2024). A tax on every litre of fuel is known as the general fuel levy. The RAF, which oversees paying compensation to victims of auto accidents, receives funding from the RAF tax. The economy is impacted when gasoline prices rise, whether because of increased taxes or the price of basic fuel within world markets. Therefore, increases in these levies lead to rising fuel prices, which can contribute to inflationary pressures within the economy. As the transportation cost increases, the prices of goods and services tend to rise, leading to a general increase in the overall price level.

2.4 SUMMARY

This chapter covered an overview of macroeconomic analysis of macroeconomic objectives, macroeconomic policy concerning monetary policy and a brief energy policy in South Africa. Macroeconomic analysis revealed that South Africa is facing a prolonged period of low growth, which is not sufficient to create jobs for the persistent increase in unemployment. However, inflation-targeting managed to contain the inflation rate within the target. Policymakers must navigate trade-offs between inflation targeting, unemployment rate reduction, and stimulating economic growth. This necessitates a nuanced approach that considers the unique dynamics of the South African economy and adopts policies that address both short term and medium challenges. Research on the interplay between inflation targeting, unemployment rate, and economic growth in the context of high energy prices and low growth in South Africa is crucial for understanding the complexities of the country's economic challenges and devising effective policy responses to promote sustainable and inclusive growth.

CHAPTER 3

LITERATURE REVIEW

3.1 INTRODUCTION

The theoretical framework underpinnings and empirical literature are provided in the two subsections that make up this chapter. Firstly, this chapter outlined various economic theories which provide the foundation of the topic. Secondly, this chapter provided evidence of previous literature.

3.2 THEORETICAL FRAMEWORK

The theoretical foundations of the explained and explanatory variables in the study are the main subject of this chapter. The following economic theories are tested in this study:

3.2.1 Inflation and Unemployment Rates Theories

Comprehending the connection between inflation and the rate of unemployment is crucial for the sensible coordination and execution of policies within the economy. Two traditional economic theories that explain the connection between unemployment and inflation rates were addressed in this subsection. The inflation-unemployment rate relationship is illustrated and compared below using the Phillips Curve and Expectation-Augmented Phillips Curve (EAPC).

3.2.1.1 The Phillips Curve

The inflation rate and unemployment rate are two of the key indicators of an economy (Alisa, 2015). Economic policymakers must comprehend the link between unemployment and inflation rate. An orthodox economic theory that can graphically illustrate the link between unemployment and inflation rate is the Phillips curve. This theory was born out of Phillips (1958), who discovered that wage inflation and the unemployment rate had an unfavourable connection. In addition, this theory is founded on the idea that as labour demand rises, salaries will rise to attract the necessary pool of labour services, even though higher wages may result in fewer individuals finding work. Other researchers have expanded the traditional Phillips Curve theory and discovered that a positive correlation exists between inflation and the unemployment rate (Alisa, 2021). For instance, Friedman (1968) and Phelps (1967) ascertained that the unemployment rate increases with a high inflation rate. This is contradicting the original Phillips Curve. However, the defenders of the Phillips Curve still claim that there is a conflict between inflation and unemployment rate (Eser, Karadi, Lane, Moretti & Osbat, 2020; Mcleay & Tenreyro, 2020; Vermeulen, 2017; Gordon, 2011). Consequently, this Phillips Curve shows a negative link between the unemployment and wage growth rates, with wage growth functioning as the economy's price level.

The claim that there is a conflict between unemployment and inflation rates was put forward by the Phillips curve's defenders (Vermeulen, 2017). Several researchers have attempted to expand the Phillips Curve theory to cover the trade-offs between inflation and unemployment rate and they concluded that the resultant effect is inflation rate wherever wage increases is higher than output increases (Carnevali, & Deleidi, 2023; Daniel, Israel, Chidubem & Quansah, 2021; Jeke, & Wanjuu, 2021; Ngalawa, & Komba, 2020).

Figure 3.1 below illustrates the Phillips curve:

Figure 3.1: Phillips curve
Source: Mohr (2015)

Figure 3.1 represents an example of the Phillips curve which explains the negative relationship between inflation and unemployment rate. The unemployment rate is expressed by the axis that runs horizontally, and the inflation rate is expressed by the axis that runs vertically. The Phillips curve above shows a clear inverse connection, with higher unemployment rates resulting in lower inflation rates. For instance, energy price increases can lead to a cost-push inflation rate (Rehman, 2014). Therefore, this increase in the inflation rate due to rising energy prices can shift the Phillips Curve outward, meaning there will be higher inflation rates at every level of the unemployment rate. This may induce the SARB to raise interest rates to reduce inflationary pressures, which can further influence the Phillips Curve. Therefore, high energy prices can create a more challenging economic environment with high inflation and unemployment rates in South Africa. Phillips Curve is a simplified model that postulates various other economic factors, including expectations, influence the relationship between inflation and unemployment rates. Moreover, as alluded to above EAPC refutes an a priori view of the Phillips curve on the inflation and unemployment rate nexus. The subsequent paragraphs outline such a priori for the interest of this study.

3.2.1.2 Expectations-Augmented Phillips Curve

The so-called Phillips curve, discovered by Phillips (1958) depicts the inverse relationship between the inflation and unemployment rates and has been crucial to macroeconomic modelling. The field of academia has given this link a lot of attention (Vermeulen, 2017; Ball and Mazumder, 2015; Coibion and Gorodnichenko, 2015). According to Gordon (2018), it is posited that the Phillips curve provides advantageous regulation for policymakers in augmenting output and diminishing the unemployment rate in pursuit of an elevated inflation rate through the expansion of aggregate demand, irrespective of the trade-off between inflation and unemployment rates. According to opposing views, this kind of trade-off might only be feasible in the short run because inflationary expectations are modified in response to variations in the real inflation rate. This results in a shift in the short-term Phillips curve and a vertical long-term Phillips curve at the natural unemployment rate point (Gordon, 2018; Richard & Burkett, 1988).

In support of the natural rate theory, Friedman (1968) and Phelps (1967) proposed a vertical long-run Phillips curve relationship. The significance of expectations in the Phillips curve was brought to light by their investigations. Therefore, a revision Phillips Curve, known as the EAPC, was independently proposed by Friedman (1968) and Phelps (1967). The EAPC introduces adaptive expectations into the Phillips curve (Gordon, 2018). Expectations are forward-looking and may influence policymakers and central banks about the trade-off between inflation and the unemployment rate. However, Friedman (1968) and Phelps (1967) in their works claimed that inflationary policies would not reduce the unemployment rate over the long term and that the Phillips curve was only relevant in the near term. The EAPC emphasizes that business and households' expectations about future inflation rates are critical determinants of the actual inflation rate. Based on adaptive expectations, the EAPC model produces better results than the Phillips Curve model, based on rational expectations, across all 50 economies (Payne, 2010). In context, exchange rate movements can be viewed as exogenous factors that influence the expectations of future inflation rates.

A domestic currency (Rand) depreciation may cause people to expect a higher future inflation rate. In addition, if individuals and businesses anticipate that energy price increases will persist for a prolonged period, they are more likely to incorporate this expectation into their inflation expectations. This can lead to higher wage demands and increased prices, further fuelling the inflation rate in the country. In such economically challenging conditions of persistently high energy prices and weak domestic currency, the central bank may resort to an increase in interest rates as a policy action aimed at influencing high inflationary expectations.

3.2.1.3 Aggregate Demand and Aggregate Supply (AD-AS) Model

The price and output levels in the economy can be linked in the AD-AS framework (Abel, Bernanke and Croushore, 2014). This model's fundamental assumptions are derived from the work of Keynes (1937). Therefore, the AD-AS model can be relied on issues related to the inflation rate, employment, and output (economic growth). The Keynesian model of the business cycle is demonstrated using this model. The two curves' movements can be employed to examine the impact of different economic events on price levels and real GDP. In the AD-AS framework, monetary neutrality is demonstrated in Figure 3.2 below.

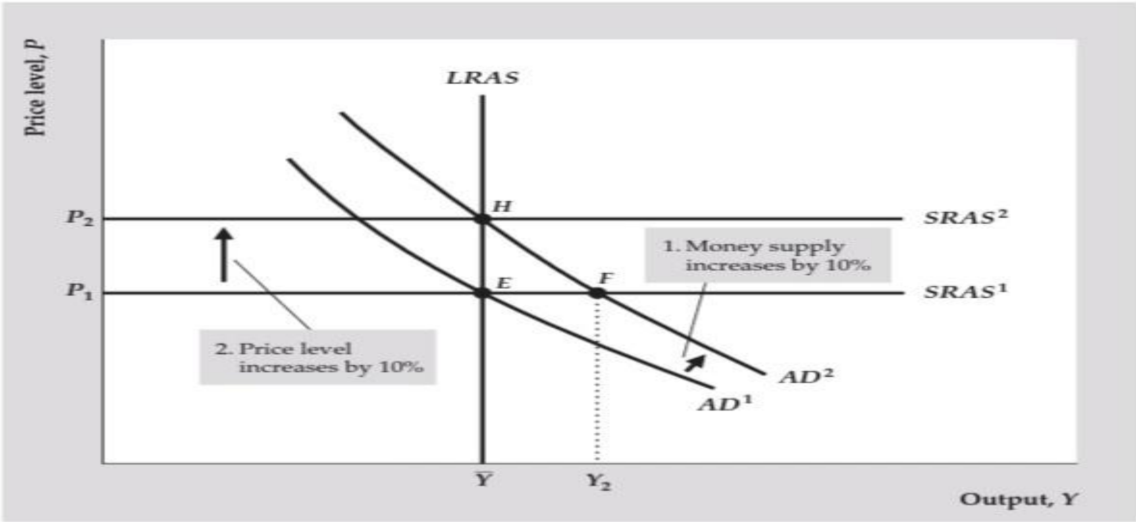


Figure 3.2: Monetary neutrality
Source: Abel, et al (2014)

The AD, SRAS, and LRAS curves must navigate to reflect long-run equilibrium, and this circumstance is not accidental. The above diagram shows how output and price level are affected when the money supply increases. In the above graph point E where $\bar{Y}$ and P_1 show the output and price levels respectively. Suppose there is a 10% increase in money supply, this will result in a shift of the AD curve from AD^1 to AD^2. Points H and F are located on the new AD curve whereby at each level of output the level of prices is 10% higher, the points on the new AD curve are those where the price level is 10% higher at each level of output demand because the actual money supply must expand by 10% to maintain the total amount of output needed. Therefore, point H on the new AD curve represents the long new run equilibrium point. Theoretically, regarding the AD-AS model, the inflation rate is typically associated with AD increase. When AD exceeds the economy's aggregate supply in the short run (i.e., AD shifts to the right of SRAS), it leads to demand-pull inflation.

The increased demand drives up prices. As a result, firms may hire more workers to meet higher production levels, reducing the unemployment rate temporarily. On the other hand, a decrease in AD can lead to an unemployment rate. For example, a decrease in consumer spending or business investment (a leftward shift in AD) can lead to a reduction in production and an increase in the unemployment rate. Therefore, the AD-AS model provides a useful framework for understanding the short and long run relationships between inflation rate, unemployment rate, and output in an economy, helping economists and policymakers analyse the impact of changes in aggregate demand and supply on these important macroeconomic variables.

3.2.2 The Keynesian theory of monetary policy

The popular Keynesian theory of monetary policy is the primary theoretical framework for explaining monetary policy effects on the economy. This theory recognises five primary avenues through which monetary policy activities might influence an economy. It was developed by Keynes (1930). When developing this theory Irving Fisher's influence on Keynes from the quantity theory of money which describes the relationship between money and inflation rate was profound (Bordo & Rockoff, 2013). The five monetary policy transmission channels are subsequently discussed:

- *Interest rate channel*

This channel demonstrates how shifts in the lending rate used by monetary policy impact employment, investment, and aggregate demand through interest rate movements (Uchendu, 1996). In modern economies, the most traditional method that emphasises the relevance of the aim given by central banks through monetary policy is the transmission of interest rates. It blends the ability of the central bank to affect interest rates with the intertemporal substitution elasticity of aggregate demand components (Lucky & Uzah, 2017). The interest rate channel affects the economy's production as seen in the following schematic:

$MPR \downarrow \Rightarrow i \downarrow \Rightarrow C \uparrow \Rightarrow I \uparrow \Rightarrow Y^d \uparrow \Rightarrow y \uparrow \Rightarrow \pi \uparrow$

Suppose Monetary Policy Rate (MPR) fall, which decreases interest rates in the economy (i), which results in a fall in borrowing costs for households and producers, subsequently leading to investment (i) and consumption (c) spending increases. Subsequently, demand and output (Y^d) increases, which will increase the level of income (y) and this will increase the inflation rate (π), which is driven by an excessive increase in aggregate demand (ceteris paribus).

- *Asset price channel*

Academics, central banks, and governments have all paid attention to how monetary policy affects asset prices (Boeckx & Cordemans, 2017). The asset price channel, as defined by Lucky and Uzah (2017), explains how adjustments in monetary policy determine the value of financial assets, which in turn affects household investment levels and overall wealth holdings. As a result, it is important to incorporate asset price movements as a component of the monetary authorities' reaction function (Lucky & Uzah, 2017). However, the so-called "q theory of investment" developed by Tobin (1969) can explain how monetary policy-driven asset price movements can impact aggregate demand. The following schematic shows how economic performance is impacted when the monetary policy rate of lending (repo rate) falls:

$MPR \downarrow \Longrightarrow i \downarrow \Longrightarrow Pe \uparrow \Longrightarrow q \uparrow \Longrightarrow I \uparrow \Longrightarrow y \uparrow \Longrightarrow \pi \uparrow$

Where:

Pe=equity price and q=ratio of market value. The decrease in the MPR will decrease the cost of credit (i), equity price (P_e) and the ratio of market value (q) will also increase. Investment spending (I)will increase which will lead to a higher output (y) level and lastly lead to an increase in the inflation rate (π).

- *Credit channel*

According to Modigliani and Miller (1958), the conventional transmission model eliminates the financial sector, and every viable project is done at the going interest rate. Keynes's (1930) monetary theory has a notion known as the "credit channel" that explains how changes in reserves impact credit availability. The credit availability to the private sector increases economic output, consumption, and investment. According to the credit channel, commercial banks are likely to boost loan interest rates and tighten creditworthiness requirements in reaction to rises in the cost of borrowing when the central bank raises its lending rate, which would result in the availability of credit. Reduced loan availability causes a decrease in investment and consumption, which lowers output. The sole distinction between the credit channel and conventional interest rate channel is how monetary policy changes affect decisions regarding investments and spending. Thus, the transmission mechanism will adhere to the identical schematic that is displayed in the interest rate channel:

$MPR \downarrow \Rightarrow i \downarrow \Rightarrow C \uparrow \Rightarrow I \uparrow \Rightarrow Y^d \uparrow \Rightarrow y \uparrow \Rightarrow \pi \uparrow$

This implies that a decrease in MPR will increase interest rates (i) which will lead to an increase in consumption spending (C) in the economy due relatively cheaper cost of borrowing and induce investment spending (I) to increase as well, consequently leading to an increase in aggregate demand (Y^d) and an increase in the level of output (y), which will increase the inflation rate (π).

- *Exchange rate channel*

The nominal interest rate's impact on the exchange rate and the resulting gap between domestic and international interest rates are explained by the monetary policy transmission channel of interest rate (Lucky & Uzah, 2017). This has an adverse effect on the nominal exchange rate, the balance of payments, and overall income level. According to Uchendu (1996), currency rate changes influence import demand, which then spreads monetary trends to the external sector. The following schematic illustrates the process of how a contractionary monetary policy (decrease in monetary policy lending rate) leading to the depreciation of the local currency can affect the inflation rate and output:

$MPR \downarrow i \downarrow \Longrightarrow e \downarrow \Longrightarrow NX \uparrow \Longrightarrow y \uparrow \Longrightarrow \pi \uparrow$

Lower interest rates (i) because the monetary policy lending rate fall causes the local currency to depreciate (e), results in competitiveness, and improvement in trade balance because of an increase in net exports (NX) and increase in output (y), and ultimately higher inflation rate (π).

- *Expectations channel*

The effectiveness of the monetary policy in promoting macroeconomic stability rests on its ability to stabilise the expectations of various economic actors. Guler (2016) claims that since the 1950s, the importance of economic agents' expectations in monetary policy transmission has been emphasized. The major challenge of monetary policy is correctly managing expectations because the outcomes of policies that need to be enacted vary depending on expectations. Central bank decisions have an impact on agents' expectations about how the economy will perform in the future. For instance, if there are high inflation expectations in the economy, workers may demand higher wages and if they succeed businesses may increase the prices of their goods or services so that they meet the salary, or wage demands of their respective employees, and this will translate in an increase in the general price level.

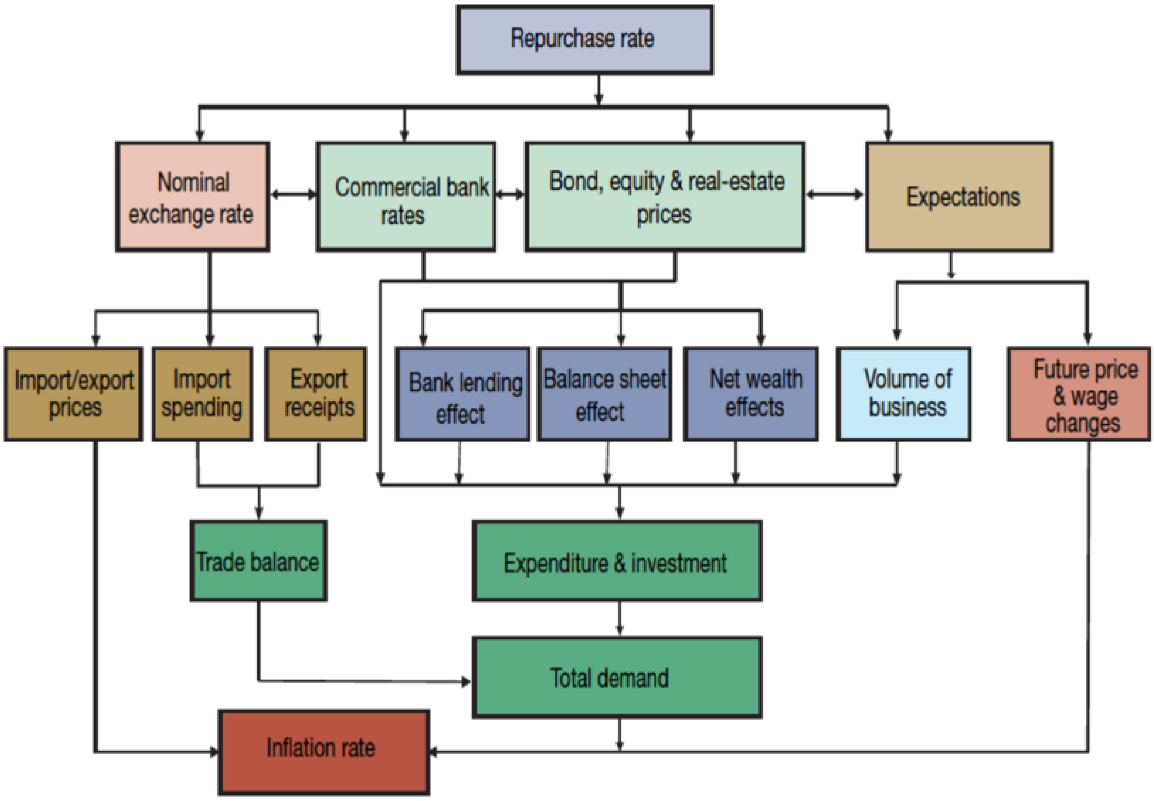


Figure 3.3 South African Reserve Bank Monetary Policy Transmission Mechanism
SOURCE: Isaacs (2014)

Figure 3.3 provides a visual illustration of the monetary policy transmission mechanism in South Africa together with various transmission channels. Overall, the transmission mechanism of monetary policy is complex and can influenced by various factors, including energy prices, exchange rates, and unemployment rates. Eventually, this study will test how changes in interest rates affect economic performance such as high energy prices, weak currency, and high unemployment rate in South Africa. Therefore, the results of the study should warrant whether the SARB to carefully consider these factors when implementing and adjusting monetary policy to achieve goals, such as price stability.

Countries have different monetary policy transmission mechanisms. It may be caused by differences in exchange rate regimes and monetary policy frameworks adopted across countries (Takáts & Vela, 2014). The monetary policy framework and instruments employed by central banks across various economies are different to accommodate the distinct characteristics of their economies and financial systems. According to Koop, Leon-Gonzalez and Strachan (2009), monetary policy transmission mechanisms may not be constant over time due to changes in economic conditions and persistent exogenous shocks. For instance, the Reserve Bank of New Zealand (RBNZ) was the first country to fully implement an inflation-targeting monetary policy framework in the 1990s through an act of law (The Reserve Bank of New Zealand Act) and it was later adopted by other economies, including South Africa (Ntshangase, 2019). Since 1990, price stability has been the primary objective of RBNZ, the Act was amended in 2018 to add supporting maximum employment as an objective of monetary policy in New Zealand. Therefore, the RBNW is now charged with a dual mandate, to pursue price stability (through inflation targets of 1% – 3%, with a midpoint of 2% annual inflation rate deemed desirable and support maximum employment. Therefore, the great pioneers of the prudent inflation-targeting monetary policy framework made significant changes in their monetary policy due to changes in economic developments and to improve the socioeconomic well-being of New Zealanders.

Figure 3.4 below depicts the hierarchical structure of the monetary policy transmission mechanism of RBNW. The starting point is the change in the Official Cash Rate (OCR) which is point number 1. The OCR is the interest rate at which banks in New Zealand can borrow or lend funds overnight with the RBNZ. Changes in the OCR have a direct impact on short-term interest rates throughout the economy. The hierarchical structure shows how changes in OCR are transmitted across the economy through various macroeconomic indicators (direct and indirect) to affect the overall inflation rate, which is visually positioned at point number 17 in Figure 3.4 below. As already alluded, even in RBNZ inflation expectations can have a major bearing on the ease or difficulty with which the Reserve Bank achieves its inflation rate objectives (Drew & Sethi, 2007). If economic agents have uncertainty about future inflation rate increases, they are more like to be conservatives in their decision-making. However, according to Coleman and Mckenzie (2020) the interest rate, credit, and exchange rate channels are the main monetary policy transmission channels in New Zealand. The main monetary policy instrument RBNZ is the OCR.

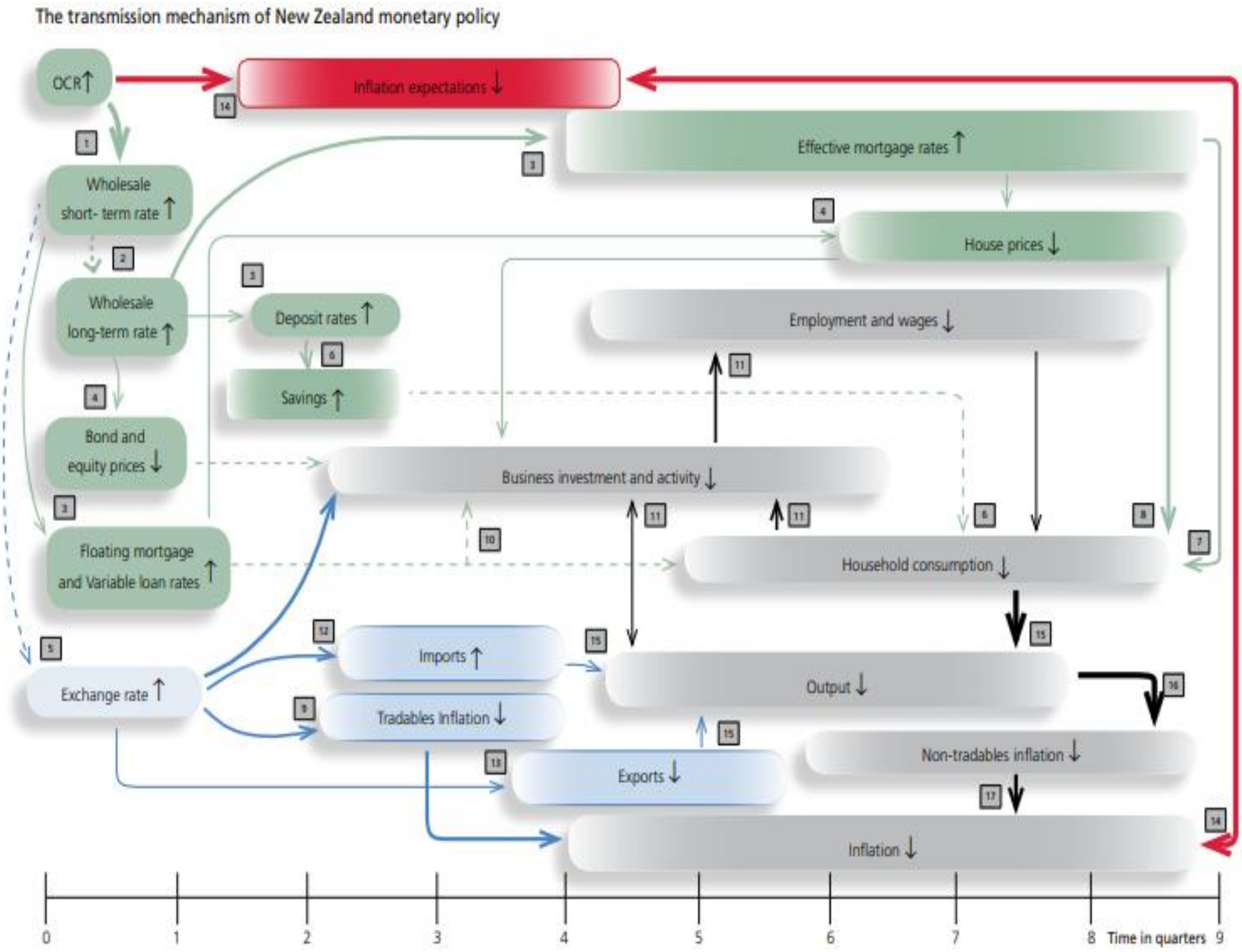


Figure 3.4: Transmission mechanism of New Zealand monetary policy
Source: Drew and Sethi (2007)

3.2.3 The Fisher Effect

There is a general view that when the inflation rate is increasing and there are lower growth levels, higher interest rates would be the appropriate policy response. Conversely, when the inflation rate is falling growth prospects are falling, and lower interest rates may be deemed as an appropriate policy response. A classical economic theory that describes the long run relationship between the nominal interest rate and the expected inflation rate was developed by Fisher (1930). Many studies have attempted to test whether the full effect of the Fisher effect was evident (Sunal, 2022; Panopoulou,2005; Christopoulos and León-Ledesma,2007). Fisher (1930) proposed that nominal interest rates move one-for-one with inflation expectations in the long run.

3.2.4 Okun's Law

The history of economic growth and unemployment rate theories spans several centuries and reflects the evolution of economic thought in response to changing economic conditions and events. For instance, the Solow Model of Growth describes how equilibrium growth is a steady state, and the key components are domestic saving rate and investment developed by Solow (1956). Even Harrod (1939) and Domar (1946), independently developed a similar long run economic growth model in their work, which outlines how economic growth in the long run can achieve a steady state through the influence of the level of capital accumulation and investment in the economy. However, the model assumes that a steady state can be achieved during full employment. Their economic growth model is called the Harrod-Domar Growth Model. Those are some of the economic growth theories that have been evaluated over time, however, for the interest of this study, Okun's Law will be tested in the context of South Africa. Okun's Law is an economic theory that explains a negative relationship between unemployment and output (Amor & Hassine, 2017). This theory suggests that growth slowdowns coincide with a rising unemployment rate. This theory is relevant in this study because it gives a clear and direct priori expectation of the dynamic relationship between the unemployment rate and output. This theory was named after Arthur Okun in 1962 for his work on potential GDP: its measurement and significance (Okun, 1962).

Okun's Law is normally measured by the correlation between real economic growth and the unemployment rate. Okun, Teeters, Smith, and Gordon (1970), stated that a 1% change in the unemployment rate is associated with a 3% change in output in the opposite direction. This implies that a 3% increase in economic growth is expected to cause a 1% fall in the unemployment rate (ceteris paribus). This three-to-one ratio rule of thumb is a benchmark for policymakers to measure the cost of higher unemployment rates in the economy (Stiassny, 2010). However, some economists do not consider asymmetry when analysing the implications of Okun's Law. This means that they assume that there is no change in effect on the unemployment rate when the economy expands and contracts Batavia & Salam, 2012). Therefore, some economists consider asymmetry and believe the dynamic models explain the relationship between the unemployment rate and economic growth (Batavia & Salam, 2012). In addition, Silvapulle, Moosa and Silvapulle (2004), also supported the notion that the economic growth and unemployment rate relationship is asymmetric as represented by Okun's Law. Due to this perception by economists, the three-to-one ratio on the dynamic relationship between output and unemployment rate ascertained by Okun (1970), varies across economies depending on economic conditions and various economic factors. For instance, Soylu, Çakmak, and Okur (2018), tested Okun's Law validity using data from Eastern European Countries the results conflicted with the expected priori of an inverse association between economic growth and unemployment rate in Okun's Law. Their results show that a 1% increase in economic growth is associated with a 0.08% fall in the unemployment rate. Moreover, Abu (2017), went on to test the existence of Okun's Law in Nigeria. The results revealed a negative and significant relationship between economic growth and the unemployment rate, with a 0.18 unemployment rate coefficient. This shows that a Three-to-one ratio Okun's Law is unstable, but an inverse relationship exists between economic growth and the unemployment rate. This further, supports the perception that the conditions of Okun's are different across economies.

Ting and Ling (2011) and Lee (2000), outlined Okun's Law specification model estimation as follows:

Gap Model

$$y_t - y_t^* = -\beta_1(u_t - u_t^*) + \varepsilon_t \quad (3.1)$$

Where by:

y_t = Output

u_t^* =potential output

β_1=Okun's coefficient

u_t=natural level of unemployment rate

u_t^*=potential unemployment rate

ε_t=error term

In equation (3.1) $y_t - y_t^*$ captures the cyclical level of output (output gap) and $u_t - u_t^*$ captures the cyclical level of the unemployment rate (unemployment rate gap), β_1 measures the responsiveness of Okun's coefficient multiplied by the unemployment rate gap.

The first difference model

Given as a linear regression model, the different version is provided by:

$$\Delta y_t = \beta_0 - \beta_1 \Delta u_t + \varepsilon_t \tag{3.2}$$

This model in equation (3.2) expresses output (y_t) and unemployment rate (u_t) at first difference. Whereby Δ is a difference operator and β_0 is an intercept capturing the mean growth rate, β_1 is what is commonly known as the Okun coefficient and ε_t is a white-noise disturbance term.

3.2.5 Purchasing Power Parity Exchange Rate Theory

The proposed theory of Purchasing Power Parity (PPP) is traced back to the work of Cassel (1918). Dornbusch and Krugman (1976), noted that in every international economics researcher, there is some deep-rooted belief in the PPP theory. The PPP theory is based on the premise that the price of any given product is the same between different countries, as stated by Appleyard and Field (2014). The PPP is also called the "law of one price." It is also referred to as the ratio of two nations' prices expressed in their respective currencies which determines the exchange rate between them (Nápoles, 2004). As a result, commodity prices are significantly influenced by the value of the domestic currency. Energy commodities like oil are imported into South Africa.

In context, PPP exchange rate theory is closely related to the concept of relative price levels. If a country's exchange rate is in line with its PPP, it implies that prices for identical goods in different countries are roughly equivalent. In such a scenario, exchange rate movements are not expected to be a source of inflation rate. However, deviations from PPP can lead to an inflation rate. When a country's currency depreciates significantly, it can make imported goods more expensive, leading to an imported inflation rate. Concerning the influence of economic growth, in terms of this theory the priori expectation is that when an economy experiences higher economic growth, foreign investment may increase the demand for domestic currency, which will lead to an appreciation of the currency. This will cause a variance between the country’s currency and its PPP. Concerning the unemployment rate, if a country has a high unemployment rate, it could be a sign of instability in either political or policy formulation and coordination aspects in the economy and this may depreciate the currency. This will cause a variance between a country’s currency and its PPP.

3.3 EMPIRICAL LITERATURE

The empirical studies reviewed are categorised into five subsections as per research objectives.

3.3.1 Energy prices, interest rate, exchange rate, inflation expectations, economic growth, and unemployment rate on inflation-targeting

In economic literature, price stability is a pivotal macroeconomic objective (Taylor, 2019; Mundaca, 2018; Hayo & Neumeir, 2017). This subsection provides the current literature that reveals the impact of energy price pressures, interest rate, exchange rate, inflation expectations, economic growth and unemployment rate on the inflation-targeting monetary policy framework, which is proxied by the inflation rate. Kotsokoane and Rena (2021) used data from 2000 to 2018 to investigate the relationship between South Africa's inflation-targeting policy and growth. A vector Error Correction Model (VECM) test was performed, and the results showed that growth and inflation targeting have an enduring adverse connection.

Using data from 17 chosen African countries encompassing the sub-region from 1980 to 2022, Babangida, Belonwu, Abubakar, Pennap, Wilfred, Okafor, Eyinla, and Onuogu (2024) examined the relationship between output and inflation rates in a subset of African nations. The GARCH-MIDAS approach was used, and the results showed that the level of output growth in the economy appears to moderate inflation rate volatilities, as indicated by the negative and statistically significant coefficients in Cameroon of the West African sub-region and Egypt and South Africa of the North and South African sub-regions. This discovery suggests that output growth is likely to reduce inflationary pressures. This corroborates Beckworth and Hendrickson (2020). However, Narayan, and Narayan (2013) also contributed to the output and inflation rate nexus using evidence from India, South Africa, and Brazil based on data from 1960 to 2006. They revealed that output volatility reduces the Indian and South African inflation rates, while there is no significant relationship between the same variables in Brazil.

From 2013 to 2018, Şen, Kaya, Kaptan, and Cömert (2020) examined the relationship between interest rates, exchange rates, and inflation rates in five emerging economies: Brazil, Indonesia, India, South Africa, and Turkey. Their study employed ARDL Tests for Threshold Cointegration to examine the relationship. The results revealed that inflation and exchange rates co-move in all economies under study implying a positive correlation. In addition, the findings showed a positive link between exchange and interest rates over the long term in Turkey, Brazil and India. On the contrary, no relationship was found between the same variables in South Africa and Indonesia.

The potential of commodity prices to predict inflation rates in South Africa and Nigeria, the two biggest African countries, was investigated by Fasanya and Awodimila (2020) using data spanning from 1980 to 2017. The Feasible Quasi Generalized Least Square (FQGLS) estimator of Westerlund and Narayan (2015) was used in this study. The results revealed that energy prices in both economies are not good predictors of the domestic inflation rate. Contrary to the results, Rizvi and Sahminan (2020), investigated the impact of global commodity prices on the domestic inflation rate in BRICS countries using quarterly data from 2006 to 2020. The study used a commodity-augmented Phillips curve to investigate the topic, the results indicated that Oil and energy prices have positive inflationary pressure in all BRICS countries, except Russia, where they cause deflationary pressures.

The study analysed the relationship between fuel prices and the inflation rate in South Africa from 1976 to 2015, utilizing the Autoregressive Distributed Lag (ARDL) approach to examine the dynamics of this connection (Rangasamy, 2017). A positive short and long run relationship between petrol prices and headline inflation rate was revealed in the study. This shows that petrol price changes have an adverse effect on inflation outcomes in South Africa. With the help of dynamic models with penal data gathered from 1970 to 2017, Mohan and Ray (2018), looked at how oil price shocks affected the inflation rate in 38 countries (11 developed and 27 developing). They ascertained whether the country has inflation targets or not, oil price increases have a significant long-term effect on the inflation rate in both countries. In addition, the study results alluded that the nature of the relation is affected by an inflation-targeting framework.

Using quarterly data from 2001 to 2018, Meyer (2018) examined how changes in fuel prices affected South Africa's inflation rate and economic growth. Both the inflation and economic growth models were estimated in the study. The VECM results revealed that fuel prices have a negative impact on the economy in the short and long run. The results showed that rising fuel prices, in the long run, will translate into lower growth, this is indicated by a negative fuel price coefficient in the economic growth model, while in the inflation rate model, the coefficient of fuel prices is positive, which means an increase in fuel prices will increase inflation rate. This dual negative impact on the economy through high inflation rate and low output has resulted in low growth for the South African economy, and the cost-push inflation rate is also having a big effect on the regional economy.

Using data from the Nordic countries of Norway, Sweden, and Denmark from 1994 to 2019 and the ARDL approach, Nasir, Huynh, and Yarovaya (2020), investigated how oil shocks affected inflation expectations. The long run estimates revealed that oil shocks and prices influence expectations of inflation rate outcomes for Sweden and Denmark. For Norway, there is a statistically insignificant negative long run impact of oil price pressures on inflation expectations. This is in line with the findings by Salisu and Isah (2018). Amaefula (2016), attempted to examine the existence of a long run relationship between interest and inflation rates using data from 1995 to 2014 in Nigeria. Johansen cointegration test was adopted and the findings ascertained the presence of a negative long run relationship between interest rate and inflation rate in Nigeria.

3.3.2 Energy prices, interest rate, exchange rate, inflation expectations, inflation-targeting, and unemployment rate on economic growth

The current body of literature aims to close the knowledge gap between research on the effects of energy costs, currency exchange rates, and interest rates on economic growth. Takentsi, Sibanda, and Hosu (2022), used ARDL to investigate the relationship between energy prices and economic performance in South Africa using data from 1994 to 2019. The findings revealed that electricity prices have a significant negative impact on economic growth in the long and short run, while crude oil prices show a significant positive linkage with economic growth in the long and short run in South Africa. Furthermore, Khobai, Mugano, and Le Roux (2017), analysed the influence of changes in the price of electricity on output using data covering the period from 1985 to 2014 in South Africa. The study revealed a significant short run link between growth and electricity prices at a 5% significance level. Additionally, the study discovered a long run link between growth and electricity prices at a 1% significance level.

The dynamics of oil prices, electricity consumption, and economic growth were studied by Shahbaz, Sarwar, Wei, and Malik (2017) using data from 157 countries from 1960 to 2014. A Pool Mean Group test was used to determine whether there were any short- and long-term associations following the grouping of the data by income, OECD, and regional levels. According to the findings, the price of oil favourably influences economic growth. This correlation demonstrates how oil exporting nations in the OECD, high-income, lower-middle-income, and the entire panel of income levels can all experience positive economic growth in response to rising oil prices.

Ajayi, Oladipo, Ajayi and Nwanji (2017), looked at the relationship between interest rates and economic development in Nigeria from 1980 to 2012 using the Error Correction Model (ECM). The study's conclusions showed that both short and long run inflation rates had a negative impact on economic growth. Maduku and Kaseeram (2018), researched inflation-targeting monetary policy and unemployment rate from 1970 to 2017 using data from South Africa. ARDL technique was used in their research investigation. Their results showed a long-term, statistically significant negative link between unemployment and the inflation rate. This can be interpreted by stating that provided that all other factors remain unchanged, a decrease in the inflation rate increases the unemployment rate in South Africa. The idea that a lower inflation rate creates a conducive economic condition to pull investment does not hold for South Africa. Furthermore, the study also showed a negative correlation between exchange rates and economic growth in the long run.

A study attempting to investigate the effects of the exchange rates on economic growth in Malaysia covering the period from 1971 to 2009 using the ARDL data analysis method was carried out by Kogid, Asid, Lily, Mulok and Loganathan (2012), the results revealed that a long run significant positive relationship between both nominal and real exchange rate and economic growth exist. Thus, their findings align with Akinbobola and Oyetayo (2010). Jeke and Wanjuu (2021), examined the effects of inflation and unemployment rates on South Africa's economic growth from 1994 to 2019. The Autoregressive Distributed Lag (ARDL) model was used in the investigation. In line with Tenzin (2019), they determined the inflation rate affects growth negatively. This then suggests that the inflation rate causes economic uncertainty. Furthermore, Njie and Badjie (2021) used VECM to examine the effects of interest rates on economic growth in Cambia from 1993 to 2017. They discovered a positive and insignificant relationship between interest rates and economic growth. The findings were contrary to Moyo and Pierre (2018) who revealed that interest rates have a negative and statistically weak influence over economic growth in SADC countries.

3.3.3 Energy prices, exchange rate, interest rate, inflation expectations, inflation-targeting and economic growth on the unemployment rate

Addressing the unemployment rate is of critical importance, as it not only affects individual livelihoods but also has broader socio-economic implications. Azunna and Botes (2024), examined the relationship between inflation and the unemployment rate in South Africa from 2000 to 2022. The study applied the Markov-Switching Dynamic Regression Model (MSDRM). The results showed no correlation between inflation and unemployment rates. Maduku and Kaseeram (2018), investigated the inflation and unemployment rate in South Africa from 1980 to 2017. Using the ARDL, it was found that a 1% increase in inflation results in a 0.3245% fall in the unemployment rate. These results are contrary to those of Vermeulen (2017). In 26 OECD nations, a study was done on the correlation between changes in oil prices and macroeconomic aggregates like the unemployment rate, economic growth, and inflation rate (Katircioglu, Sertoglu, Candemir & Mercan, 2015). The results showed that oil price fluctuations and the inflation rate have a favourable short-term link with the unemployment rate and economic growth. However, the findings indicated that in the long run, there is no relationship between the movements of oil prices and inflation rate with unemployment rates in all 26 OECD countries examined.

Using linear and nonlinear ARDL techniques, Raifu, Aminu, and Folawewo (2020), investigated the link between oil price changes and the unemployment rate in Nigeria from 1979 to 2018. Their results showed that short-term fluctuations in oil prices have an insignificant but favourable impact on the unemployment rate. In addition, they discovered that, over time, there is an asymmetric relation between oil prices and the unemployment rate. An increase in oil prices exhibits an advantageous correlation with the unemployment rate, while a fall has a negative relationship with the unemployment rate. The results of this study intertwine with Löschel and Oberndorfer's (2009) findings.

Ncanywa and Mgwangqa (2018), investigated the impact of the fuel tax on the economy in South Africa from 1988 to 2016 using VECM in a multivariate setting. The study proved an overtime inverse association between fuel tax and employment. This implies that raising the fuel levy will result in a higher unemployment rate. A multivariate analysis of growth's short- and long-term effects on job creation conducted by Meyer (2017) provided evidence from the South African economy using VECM from 2002 to 2016. In contrast with Vermeulen (2017), Meyer's (2017) findings showed no association between employment rate and economic growth in South Africa. Furthermore, Meyer's (2017), results indicated long-term correlation between employment and interest rates.

In a multivariate VAR study from 1980 to 2018, Khalid, Akalpler, Khan, and Shah (2021), delved into the connection between unemployment and economic growth in South Africa. Their findings showed no co-integrating link between the investigated variables. The variables include growth, inflation rate, and interest rate. Nyahokwe and Ncwadi (2013), used data from 2000 to 2010 to investigate the effects of variations in exchange rates on the unemployment rate in the South African economy using the VAR and GARCH models. They discovered a favourable link between long-term growth and the unemployment rate.

The above literature has shown that a currency depreciation may result in an unemployment rate reduction and an unfavourable relationship between the two variables over time. In contrast, the short-term impact of the exchange rate on the unemployment rate is the opposite. This contradicts Khalid et al.'s (2021), findings regarding the lack of a long-term link between the exchange and unemployment rates. Rehman (2017) investigated how Egypt's unemployment rate changed from 1985 to 2015 due to changes in the currency rate. The ARDL approach was used to analyse the dynamics between the exchange rate and the unemployment rate, and the results showed that over time, the exchange rate has a considerable and favourable impact on the unemployment rate. These outcomes are consistent with those of Nyahokwe and Ncwadi (2013).

3.3.4 Causality analysis of the variables

Using the Granger causality approach, Takentsi et al. (2022) investigated the relationship between the price of energy and South Africa's economic performance between 1994 and 2019. Granger's research showed that energy costs and economic growth are not causally related in South Africa, which support the findings of Lean and Smyth (2010), who found no link between economic development and growing electricity prices. Meyer (2017) also showed that changes in employment generate changes in the inflation rate and changes in economic growth drive changes in interest rates.

From 1980 to 2012, Kelikime and Evans (2015) used the Granger causality test to examine inflation-targeting as a potential monetary framework for Nigeria. The findings demonstrated that real exchange rates are more causally related to economic growth than they are to inflation. The results showed that in the case of Nigeria, the exchange rates have a greater impact on economic growth than energy prices. Furthermore, the findings exhibit the causation of inflation rate to economic growth. This implies that economic growth is determined by the inflation rate. However, causal relations are more likely to differ across economies.

From 1990 to 2010, Hartmann and Roestel (2013) used data from inflation-targeting economies to analyse the causal link. The results indicated a significant causal relationship between output and inflation rate across inflation-targeting countries. This suggests that the effects of an excess inflation rate might be more significant in economies with a low inflation rate. Using data from 2001 to 2013, Erdal (2018), assessed the connection between monetary variables and economic growth in Turkey under an inflation-targeting regime. The real economic growth rate, inflation rate, exchange rate, and interest rate in Turkey were all examined using the Granger Causality Test to establish the direction of the causal relationship. It was discovered that there was no causal relationship between any of these variables. Additionally, Mohammed and Mansur (2014), used data from South Africa between 1970 and 2012 to examine the likelihood of any causation between the inflation rate and FDI in an inflation-targeting regime. The results showed that the foreign exchange and inflation rates are exogenous in South Africa. Furthermore, the results indicated another crucial finding consistent with the relative rank of exogeneity throughout time. The ranking did not change between 15 and 30 years, while financial development, trade liberalisation, and economic expansion are endogenous. Utilizing the Grange causality test, Enejoh and Tsauni (2017) investigated inflation's implications on Nigeria's economic growth from 1970 to 2016. The findings showed that economic growth is not Granger-caused by the inflation rate. The findings also show that foreign exchange does not drive economic growth.

Olgun (2022) inspected the relationship between interest rates and inflation rates using data from Turkey from 2012 to 2021 to ascertain whether a Fisher or neo-fisher effect existed. The results demonstrate a two-way causal relationship between Turkey's inflation rate and the average cost of borrowing (interest rate). From 1965 to 2016 the primary factors influencing the inflation rate in Nigeria between 1986 and 2011 were examined by Andow and Danpome (2015). Granger causality analyses showed a bidirectional causal relationship between inflation rate, exchange rate and economic growth.

3.3.5 The inflation rate, economic growth, and unemployment rate path amidst economic shocks

Using data from South Africa between 1970 and 2012, Mohammed and Mansur (2014) inquired about the likelihood of any causation between the inflation rate and an FDI inflation-targeting regime. The Impulse Response Function (IRF) and Variance Decomposition (VDC) tests were employed in the investigation. The VDC test findings revealed that the inflation rate is more exogenous than real foreign exchange. The IRF test results indicated that the inflation rate is the least responsive to the individual shocks given to the other variables in the study. This means that the inflation rate is the most exogenous variable in South Africa among all other variables under study. Iran's exchange rate and inflation rate were compared from 1997 to 2011 by Monfared and Akin (2017).

The VDC test was conducted, and the results showed that Iran's foreign currency rate contributed 1% to the inflation rate in the second period and continued to do so in the second and twentieth periods. When an inflation rate shock of one standard deviation is applied, the IRF test reveals the inflation rate favourably throughout the 40th period. Additionally, the inflation rate responds favourably to the exchange rate's standard deviation. Alexander, Andow, and Danpome (2015), examined the main causes of the inflation rate in Nigeria from 1986 to 2011. They determined that the inflation rate's internal shock ranged from 100% to 17%, but the exchange rate's internal shock was the main cause of variance in the inflation rate. Moreover, this may suggest that variables impacting exchange rates are able to predict inflation rate innovation. In addition, the results further indicated that shocks to real economic growth have a positive influence on the inflation rate.

Using data from 1999 to 2016, Chen, Zhu, and Li (2020), conducted a study on the effects of oil price shocks on China's inflation rate. Their results indicated that the impact of oil price shocks on China's inflation rate is ineffective at every step and diminishes as one moves up the economic food chain. Mohammed and Mansur (2014), using data from South Africa between 1970 and 2012, examined whether there may be a causal relationship between FDI and inflation rate under an inflation-targeting system. The VDC test revealed that the inflation rate was more exogenous than real foreign exchange, while the IRF test results indicated that the inflation rate is the least responsive to the individual shocks given to the other variables in the study. This means that the inflation rate is the most exogenous variable in South Africa among all other variables under study.

In a multivariate framework from 2001 to 2014, Kim, Hammoudeh, Hyun, and Gupta (2017) investigated the impact of oil price shocks on the Chinese economy using VDC and IRF. The results indicated that the oil price shock accounted for 11% of interest rate volatility and its influence is statistically inconsequential. The long-term impact of China's inflation rate shock (16.95%) on interest rate volatility is statistically significant. Furthermore, the findings showed that the oil price shocks on China's economic growth and inflation rate were statistically significant and favourable. Ha, Stocker and Yilmazkuday (2020), studied how currency rates affected consumer pricing using data from 55 countries: 29 advanced economies and 26 emerging economies from 1998 to 2017. The study performed a VDC test to examine shocks against variables. The results revealed that internal shocks in many countries are responsible for more than half of the variation in inflation and exchange rates.

3.4 ASSESSMENT OF THE LITERATURE

The literature review provides a comprehensive overview of the theoretical and empirical foundations of the relationship between inflation-targeting, economic growth, unemployment rate, energy price pressures, and monetary policy in South Africa. It covers a wide range of economic theories, including the Phillips Curve, EAPC, AD-AS model, Keynesian theory of monetary policy, Okun’s Law, and PPP theory. Additionally, it reviews empirical studies on the impact of energy prices, interest rates, exchange rates, inflation expectations, and other macroeconomic variables on inflation-targeting, economic growth, and unemployment rates.

While the literature provides a broad overview of global and regional studies, there is a lack of in-depth analysis tailored specifically to South Africa's unique economic challenges. South Africa faces distinct issues such as high unemployment rates, energy crises (load-shedding), and a volatile currency (Rand). There is a need for more localized studies that focus on South Africa's specific economic conditions, particularly the interplay between energy price pressures, monetary policy, and socio-economic outcomes like unemployment and economic growth. Although some studies examine the impact of energy prices on inflation and economic growth, there is limited research on how energy price shocks specifically affect South Africa's inflation-targeting framework and unemployment rate. South Africa's reliance on energy imports and its domestic energy challenges make this a critical area for further investigation. Therefore, more research is needed to explore the direct and indirect effects of energy price pressures on South Africa's inflation-targeting monetary policy, particularly how these pressures influence inflation expectations, exchange rates, and unemployment.

There is a need for studies that utilize advanced econometric techniques (such as VCEM and VAR) to model the complex interactions between inflation-targeting, economic growth, unemployment, and energy price pressures in South Africa. In addition, the literature often identifies relationships between variables but provides limited actionable policy recommendations for South Africa. Given the country's unique challenges, there is a need for research that translates empirical findings into practical policy solutions. More research is needed to provide targeted policy recommendations for South Africa, particularly on how to manage inflation-targeting, energy price shocks, and unemployment in a way that promotes sustainable economic growth and social welfare.

3.5 SUMMARY

This chapter reflected on several theories grounding this study in the form of the Phillips Curve and EAPC. The Phillips Curve ascertained a negative relationship between inflation and the unemployment rate, while the EAPC promoted a positive relationship between the inflation and unemployment rates. Therefore, in the context of this study, both theories will be tested. The AD-AS model and the Keynesian theory of monetary policy are also tested in this study. The monetary transmission mechanism will be tested to determine the nature and existence of transmission channels in South Africa. They are the interest rate, credit, asset price, exchange rate and expectations channels. Okun's Law theory describes the negative relationship between economic growth and unemployment was also interrogated in this study. Empirical studies are also reflected in this chapter. Conflicting empirical evidence revealed that the short and long run relationship, causality and forecasting between inflation rate, economic growth, unemployment rate, interest rate, exchange rate, energy prices and inflation expectation is inconsistent and other researchers revealed contradicting results.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 INTRODUCTION

This chapter presents the research methodology and estimation techniques conducted in the study, which provided answers to the research questions formulated in Chapter 1. The chapter focuses on the data sources, model specifications and estimation techniques.

4.2 DATA

The study used annual time series data from 2000 to 2022 sourced from the SARB historical macroeconomic indicators online database, World Bank, Quantec and St. Louis Fed for all macroeconomic variables understudy. Since it is an annual time series data, the frequency is 1, meaning each observation represents a single year. Therefore, the total time span covered by the dataset is 23 years. For empirical analysis, the study utilised the Econometric Views (EViews) package. Table 4.1 presents a complete description of the data and variables understudy.

Table 4.1: Data description

Variable name	**Unit of measure**	**Variable description**	**Source**
INF	Index (percentage change)	Consumer prices: South Africa, All urban areas - Headline History: All Items	SARB
GDP	R million Constant prices 2010	Gross Domestic product indicator for economic growth	SARB
UNEMR	Percentage	Official rate of unemployment	SARB
EX	Rand (R) per US dollar ($)	The value of the spot exchange rate of the Rand against the US dollar	The Federal Reserve Bank of St. Louis
EX_PER	Percentage	Percentage change of the value of the Rand against the US dollar	The Federal Reserve Bank of St. Louis
INT	Percentage	Real interest	Quantec
ENEP	Index (average of quarterly values)	CPI: Electricity and other fuels	The Federal Reserve Bank of St. Louis
INFEX	Percentage	Inflection expectations	Quantec

Source: Author’s computation

4.3 MODEL SPECIFICATION

In attempting to answer the primary research questions of this study, three model specifications are proposed. The three multivariate models are used to investigate the reaction of inflation rate, economic growth and unemployment rate amidst energy price pressures and monetary policy implications. Mohammed and Mansur (2014), Vermeulen (2017), Kotsokoane and Rena (2021), Takentsi et al. (2022), and others attempted to explore the paradox of inflation-targeting, economic growth, and unemployment rate in South Africa considering other macroeconomic factors. Therefore, the following functional form model specifications are put forward:

4.3.1 Inflation-targeting model

$$INF = f(EX, INT, ENEP, INFEX, GDP, UNEMR) \quad (4.1)$$

Equation 4.1 is the inflation-targeting model, which shows the relationship between the inflation-targeting policy framework, price pressures and the selected macroeconomic variables. This specified model dependent variable is inflation rate, which serve as the primary benchmark for SARB's inflation-targeting policy. Therefore, inflation in this regard is the main reference point for assessing whether inflation is within the range of 3% - 6%. The model is based on Kotsokoane and Rena (2021), Huang et al. (2019) and Vermeulen (2017). The economic growth and unemployment rate variables are included in the model to determine their influence on the inflation rate.

4.3.2 Economic Growth Model

$$GDP = f(EXPER, INT, ENEP, INFEX, INF, UNEMR) \quad (4.2)$$

Equation 4.2 is the economic growth model, which shows how economic growth proxied by GDP is affected by price pressures and monetary policy outcomes. This model draws on some of the aspects of research by Makaringe and Khobai (2018) and Tenzin (2019), who attempted to investigate the nexus between economic growth, inflation rate, and unemployment rate. Moreover, inflation and unemployment rates are integrated into the model to ascertain the pressure on economic performance.

4.3.3 Unemployment model

$$UNEMR = f(EX, INT, ENEP, INFEX, GDP, INF) \quad (4.3)$$

Equation 4.3 is the unemployment model, which attempts to investigate how unemployment is affected by price pressures and monetary policy implications in the economy. Furthermore, in this model, economic growth and inflation rates are included to test their influence on the unemployment rate.

Furthermore, the general models are specified in a linear form as follows:

$LINF_t = \propto + \beta_1 EX_t + \beta_2 ENEP_t + \beta_3 INT_t + \beta_4 INFEX_t + \beta_5 LGDP_t + \beta_6 UNEMR_t + \varepsilon_t$ (4.4)

$LGDP_t = \propto + \beta_1 EXPER_t + \beta_2 ENEP_t + \beta_3 INT_t + \beta_4 INFEX_t + \beta_5 LINF_t + \beta_6 UNEMR_t + \varepsilon_t$ (4.5)

$UNEMR_t = \propto + \beta_1 EX_t + \beta_2 ENEP_t + \beta_3 INT_t + \beta_4 INFEX_t + \beta_5 LGDP_t + \beta_6 LINF_t + \varepsilon_t$ (4.6)

Equations 4.4, 4.5 and 4.6 above are expressed in linear forms. Symbol L denotes the variables that are transformed into logarithms, which is economic growth ($LGDP_t$) and consumer prices ($LINF_t$). Often in practice time series have exponential trends captured by modelling the natural logarithm of the series as a linear trend (Wooldridge, 2013). In simple terms, it converts exponential trends to linear trends. The rationale for logarithm transformation is that the behaviour of variables growing exponentially over time can be explained with linear models and reduces heteroskedasticity.

It is worth noting that inflation rate data in this study is proxied by the Consumer Price Index (CPI) in natural logarithm. Ajmi, Gupta, Babalos, and Hefer (2015), employed the CPI data in the natural logarithm to compute the growth rates of CPI when analysing oil price and consumer price nexus in South Africa. Taking the natural logarithm of the CPI converts the data into a form that allows for easier interpretation, especially when dealing with growth rates like CPI (Gujarati, & Porter, 2009). Therefore, the natural logarithm of CPI makes it easy to study percentage changes in the inflation rate.

4.4 ESTIMATION TECHNIQUES

Several techniques discussed from 4.4.1 to 4.4.9 were employed to ascertain the relationship between inflation rate, economic growth and unemployment rate and the selected macroeconomic variables.

4.4.1 Descriptive statistics

The study performed a comprehensive descriptive analysis of all variables. According to Kaliyadan and Kulkarni (2019), without making any deductions based on probability theory, the descriptive analysis provides an overview of the variables under investigation. Descriptive analysis can aid in the data summary as a basic quantitative measure like means or percentages (Khan & Gupta, 2020).

4.4.2 Correlation test

This study used the correlation matrix for the three models to investigate the degree of correlation between the dependent and independent variables. When two-time series, or two variables, are correlated and related. A correlation test can determine the presence of multicollinearity. According to Alin (2010), multicollinearity is a data problem that can seriously impair the dependability of model parameter estimates, and it is defined as the linear relationship between two or more variables. When two or more independent variables in the regression model are correlated, multicollinearity occurs (Daoud, 2017). When two or more predictors have a high degree of correlation, the strong correlation between the independent variables distorts the link between the independent and dependent variables, increasing the likelihood that our interpretation of the associations will be erroneous. Therefore, if multicollinearity is discovered after establishing a model, particularly one with a high correlation among the independent variables, ignore, discard or improve the model since it is uninterpretable.

4.4.3 Stationarity/Unit Root Test

Stationarity of variables is an important feature in applied econometric analysis of time series data. Therefore, when working with time series data it is critical to conduct unit root tests to eradicate any evidence of non-stationary variables. In most cases when dealing with non-stationary time series data, and if such data is used in a simple regression, they may result in counterfeit regression (Moreputla & Moffat, 2017 and Brooks, 2008). As a result, it is important to determine the stationarity of the data before regressing the variables by performing a unit root test. The study employed the most common unit root tests in the form of the ADF and PP tests to test the stationarity of annual time series data from 2000 to 2022 for this study.

4.4.3.1 Augmented Dickey-Fuller (ADF) test

The ADF test is a formal unit root test developed in 1970 and named after two statisticians Dickey and Fuller (Fah & Nasir, 2012). The ADF unit root test relies on rejecting the null hypothesis of unit root (non-stationary) against the alternative hypothesis, of which variables understudy are stationary (Imoudu, 2012). The null hypothesis is rejected to avoid estimating inconsistent models that may produce spurious regression. The ADF test is the most common procedure to ensure the series is stationary at an order of integration (level, 1st and 2nd differences).

The ADF test tests for the presence of unit root in an Autoregressive Model (Cheng & Annuar, 2012). It is an augmented version of the Dickey-Fuller test for more complicated time series models (Fah & Nasir, 2012). However, the procedure of both ADF and Dickey-Fuller tests is the same. Therefore, the null hypothesis (H_0) and alternative hypothesis (H_1) are written as follows:

$H_0: \beta = 0$ and

$H_1: \beta < 0.$

In addition, to cater for the four explanatory variables (X) following the same sequence in the application of the ADF test, firstly the null and alternative hypotheses are as follows, (H_0):X_t contains a unit root and (H_1):X_t is stationary. The general ADF test model is as follows,

$$\Delta X_t = \alpha + \beta X_{t-1} + \sum_{i=1}^{n} \delta_t \Delta X_{t-1} + \varepsilon_t \qquad (4.1)$$

Where, X_t denote the respective independent variable of interest in the study. One of the criticisms of ADF is that it cannot provide a clear difference between unit root and near-unit root processes (Naik, 2013).

4.4.3.2 Phillips-Perron (PP) test

The PP unit root test is an alternative test for detecting the presence of a unit root in time series models. The PP test approach is non-parametric and accommodates models with a fitted drift and a time trend to make it possible to discriminate between nonstationary and stationary deterministic trends (Phillips & Perron, 1988). According to Fah and Nasir (2012), it is a comprehensively developed unit root non-stationary theory. The conditions of the PP tests allow for a weakly dependent and heterogeneously distributed time series

(Phillips & Perron, 1988). However, the distribution theory underlying this procedure is asymptotic and critical values provided by Fuller (1976). The PP test includes an automatic correction to the Dickey-Fuller procedure to allow auto-correlated residuals (Fah & Nasir, 2012). The applications of both ADF and PP are similar, and they usually have the same conclusion. For example, the null and alternative hypotheses in the unit root test will be as follows, $H_0 : Y_t$ is non-stationary and $H_1 : Y_t$ is stationary.

Fah & Nasir (2012) proposed that the PP test can be conducted as follows:

$$Y_t = \mu + \alpha Y_{t-1} + \varepsilon_t \quad (4.2)$$

α = estimator of equilibrium parameter

ε = disturbance term

μ = intercept

t = time or trend variable

4.4.4 Lag length selection test

The Auto-Regressive (AR) process for time series data is a crucial econometric exercise to estimate the lag length after the unit root analysis. The foremost exercise in Auto-Regressive model application is the correct lag length determination. Several lag length selection criteria have been employed in economic studies to determine the auto-regressive lag length of time series variables (Liew, 2004). Liew (2004) stressed that an AR (p) lag length is always unknown. It must be estimated via various lag length selection criteria such as the Aikaike Information Criterion (AIC), Schwarz Information Criterion (SIC), Hannan-Quinn Criterion (HQC), Final Prediction Error (FPE) and Bayesian Information Criterion (BIC). However, in practice when using a higher lag length than the optimal order leads to a higher mean square forecast error of VAR, on the other hand using a lower lag length than the correct order leads to the computation of autocorrelation errors (Lutkekepohi, 1993). Therefore, a lag length test is conducted to estimate the optimal lag length for the time series variables of interest.

In time series analysis, lags are essential since variables do not impact one another instantaneously but within a time called a lag. The most common lag criterion is AIC and

SIC, the standard practice is to use the minimised criterion among various lag selection criteria in the overall VAR estimate system.

4.4.5 ARDL Bounds test of cointegration

The Autoregressive Distributive Lag (ARDL) bounds test is used to detect long run relationships among the variables. To ascertain the long-term link between non-stationary series, the ARDL cointegration approach, also known as the bound test of cointegration by Pesaran and Shin (1999), has become the go-to method. Although pre-testing for unit roots is not necessary for the ARDL cointegration technique, the procedure is that a unit root test should be conducted to determine the number of unit roots in the series under consideration to prevent an ARDL model crash in the event of an integrated stochastic trend of I (2) (Ghulam, Saud & Artiq Ur, 2018). Thus, the ARDL technique can be used regardless of whether the underlying variables are I (0), I (1), or a combination of both. This lessens the need for the variables to be categorised into I (0) and I (1) to avoid the pretesting issues that come with normal cointegration analysis. According to Shrestha and Bhatta (2018), the ARDL model is particularly well-suited for analysing relationships in datasets with a limited number of observations, making it a reliable choice for small-sample econometric studies. Given the limited number of observations in this study, employing ARDL is acceptable, but it will certain limitations in terms of the degrees of freedom.

According to Ghulam et al. (2018), the general ARDL cointegration model is presented as follows:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 X_{t-1} + \beta_3 Y_{t-1} + \varepsilon_t \qquad (4.3)$$

In equation 7.4, the dependent (Y) and independent (X) variables are lagged by one year ($t-1$). This means that the values of the previous periods affect the values of the current period. According to Ghulam et al. (2018), if the calculated F-statistics value is greater than the critical value for the upper bound, the conclusion is there is cointegration.

4.4.6 Error correction model

The study continued using the ARDL-based Error Correction Model (ECM) to assess the short-run dynamics of variables under investigation. The ECM can be derived from the ARDL model through a simple linear transformation, which integrates short run adjustments with long run equilibrium without losing long run information (Nkoro and Uko, 2016). The ECM coefficient determines the speed of adjustment towards long run equilibrium after any shocks (Wooldridge, 2013).

Should cointegration be affirmed in all models, the subsequent phase involves a short run ECM estimation. Vermeulen (2024) explains the dynamics of the model concerning its long- and short-term trajectories; and ECM_{t-1} denotes the lagged error-correction term obtained from (1):

$$\Delta Y_t = \beta + \sum_{i=1}^{n} \beta_{0i} \Delta Y_{t-i} + \sum_{i=1}^{n} \beta_{1i} \Delta X_{1,t-i} + \sum_{i=1}^{n} \beta_{2i} \Delta X_{2,t-i} + \ldots \sum_{i=1}^{n} \beta_{ji} \Delta X_{j,t-i} + \delta ECM_{t-1} + \mu_t \quad (4.5)$$

Where:

ΔY_t: The dependent variable's first difference at the time

β: The intercept term

$\beta_{0i,}\ \beta_{1i,}\ \beta_{2i,\ldots.}\beta_{ji,}$: Coefficients associated with the lagged values of Y and the exogenous variables $X_1, X_2, \ldots\ldots X_j$

$\Delta X_{1,t-i,}\ \Delta X_{2,t-i,\ldots\ldots}\ \Delta X_{j,t-i,}$: The first differences of exogenous variables with lags

δECM_{t-1}: The error correction term represents the adjustment toward long-term equilibrium.

μ_t: The error term (or residual).

The speed of adjustment parameter or feedback effect obtained as the error term from the cointegration models is referred to as the error correction in this model. It displays the amount of disequilibrium correction or the degree to which any disequilibrium from the prior period is changed in Y_t. However, this model is useful when variables are cointegrated, meaning there’s a long-term relationship, even though they may deviate in the short term. The inclusion of the ECM helps adjust deviations from the equilibrium.

4.4.7 Diagnostic and stability test

Diagnostic tests are carried out to check the fitted model's reliability and to determine if any assumptions of the Classical Linear Regression Model (CLRM) are violated. The study performed a set of residual tests to prevent the possibility of spurious results within the regressed model such as the normality test (distribution of residuals), serial correlation, heteroskedasticity, Omitted variables test and lastly CUSUM and CUSUM of squares tests of stability.

4.4.7.1 Normality test

The normality of residuals is a basic assumption of CLRM. Various characteristics of the normal distribution serve as the foundation for normality tests, and the degree of non-normality influences the test's efficacy (Bonett & Seier, 2002). Normality tests are usually used to determine the difference between empirical and normal distributions. The Jarque-Bera test is one of the most widely used tests for normality focused on statistical coefficients of skewness and kurtosis (Jarque & Bera, 1980).

The null hypothesis of skewness is zero and the null hypothesis of kurtosis is excess of zero. Skewness measures the extent to which residuals are not systematically distributed around their mean value and kurtosis measures how fat the tails of the distribution of residuals are (Brooks, 2008). Normality tests are important for supporting any inference derived from the regressed model. Residuals are assumed to be normally distributed around their mean. The normally distributed results are detected visually through the histogram when is bell-shaped and the Jarque-Bera statistic (probability value or p-value) would not be significant.

4.4.7.2 Serial correlation

Serial correlation is also known as autocorrelation. In time series data serial correlation occurs when error terms for one period are correlated with error terms for a subsequent period. The autocorrelation assumption violation may lead to inefficient coefficient estimates which could result in wrong inference. Therefore, the test for autocorrelation is important. The Lagrange Multiplier (LM) test approach is computational simplicity, which makes it more attractive (Ljung and Box, 1979).

4.4.7.3 Heteroskedasticity

The CLRM assumes that the variance of residuals or error terms is constant and if the variance of the residuals is not constant, then there is heteroskedasticity (Brooks, 2008). This is the assumption of homoskedasticity in terms of the CLRM basic assumptions. If violated any inference in the presence of heteroskedasticity usually drawn from Ordinary

Least Squares (OLS) analysis may be faulty. The existence of heteroskedasticity is detected using the Harvey, White and ARCH tests. This study will test:

$H_0: Var(e|x1, x2, \dots, xk) = s^2$, which is equivalent to the following:

$H_0: E(e2|x1, x2, \dots, xk) = E(e^2) = s^2$

Where, $e^2 = d0 + d1x1 + d2x2 + \cdots + dkxk + v$ this means that the null hypothesis that is being tested in this study is $H_0: d1 = d2 = \cdots = dk = 0$. The null hypothesis of homoskedasticity can be rejected if the probability value is significantly small. In addition, this will indicate that the model under study has a heteroskedasticity problem.

4.4.7.4 Omitted variable test

In numerous nonexperimental investigations, the researcher may lack access to all essential variables, and this absence may result in skewed estimates of model parameters. By leveraging the hierarchical structure of multilevel data, a comprehensive array of statistical methodologies is devised to examine diverse types of model misspecification as well as to derive estimators that exhibit robustness in the presence of omitted variables (Kim & Frees, 2006). To ensure that all model specifications are correct, omitted variable test will be conducted on selected independent variables to confirm whether those variables have a significant influence in the regressed models. According to Beccarini (2024) if significant explanatory variables are omitted, the model may suffer from omitted variable bias, leading to biased and inconsistent estimates of regression coefficients. This test checks for general model misspecification, including omitted variables as follows:

- Null Hypothesis (H_0): The omitted variables are not jointly significant; they do not add explanatory power to the model.
- Alternative Hypothesis (H_1): The omitted variables are jointly significant, their exclusion causes omitted variable bias.

4.4.7.5 Stability test

There are two parameter constancy tests as recommended by Brown, Durbin and Evens (1975), those tests are mainly based on residuals and are known as CUSUM and CUSUMSQ tests. Both tests are based on plotting recursive coefficient estimates. According to Awan and Asghar (2011), the plot of recursive residuals provides beneficial for depth analysis of parameter variations. They are used to test the null hypothesis of stability of the estimated model. The CUSUM test depends on the CUSUM of recursive residuals (Awan & Asghar, 2011). The CUSUM test is utilised to check the stability of the model throughout the regressed period. In practice, the visual plot of the CUSUM test lies within two critical lines of 5% significance and cumulative sum both are plotted. If the cumulative sum of residuals bisects the 5% critical lines, it means the parameters are unstable.

The second test employed to check the constancy of parameters is the CUSUMSQ test. The test relies on the CUSUMSQ recursive residuals (Awan & Asghar, 2011). Just like the CUSUM test, the CUSUMSQ test is also employed to check the steadiness of the model, however, it varies from the CUSUM test in the sense that squared residuals are plotted against time and critical lines. In the CUSUMSQ test the significance of deviation from the mean value line is checked by parallel critical lines around the mean value. Fluctuation outside the 5% significance critical lines indicates instability of the regression parameters.

4.4.8 Granger Causality Test

The standard Granger causality test developed by Granger (1969) strives to determine whether past values of a variable assist in predicting changes in another variable. It is only permissible and valid to perform causality tests if there is cointegration among variables involved in the study (Granger, 1988). To determine the causality between inflation rate, economic growth, unemployment rate, exchange rate, interest rate, oil prices and energy prices, the VAR Granger causality test will be performed in the study to capture all possible channels of causality among variables. If the variables are cointegrated at I (1) order of integration, Engle & Granger (1987) claim that causality must exist in, at least, one direction. The direction of causality among economic time series variables can be unidirectional, bidirectional, or neutral. A long run causality is confirmed through the significance of the lagged error term coefficient and short run causality is confirmed through the joint significance of coefficients of lagged variables (Awan & Asghar, 2011). The Granger causality analysis involves the estimation of the following general equations.

$$Y_t = \sum_{i=1}^{P} \beta_i X_{t-i} + \sum_{j=1}^{P} \delta_j Y_{t-j} + \varepsilon_{1t} \qquad (4.6)$$

$$X_t = \sum_{i=1}^{P} \vartheta_i X_{t-i} + \sum_{j=1}^{P} \omega_j Y_{t-j} + \varepsilon_{2t} \qquad (4.7)$$

Where $\beta_i\ \delta_j \vartheta_i \omega_j$ are coefficients of the lagged variables, ε_t is the error term and it should be noted that in the context of this analysis Y_t and X_t represent dependent variables and various independent variables respectively. According to Gujarati and Porter (2009), there are four possible cases in the direction of causality:

- Unidirectional causality is indicated when the direction of causality of the estimated coefficients on the lagged X in Equation (4.6) are statistically different from zero as a group while the estimated coefficients on lagged Y in Equation (4.7) is not statistically different from zero.
- Contrary, unidirectional causality exists if the estimated coefficients on lagged X in Equation (4.6) is not statistically different from zero while on the other hand, the set of lagged Y coefficients in Equation (4.7) are statistically different from zero.
- Feedback or bilateral causality occurs in the case whereby sets of X and Y coefficients in both regressions are statistically significantly different from zero.
- Independent or neutrality, implies that the sets of X and Y coefficients are not statistically significant in both regressions.

4.4.9 Forecast tests

In econometric analysis, forecasting tests are pivotal for understanding the dynamic interactions and the relative importance of variables within an economic system. This research employed two robust techniques: the Impulse Response Function (IRF) and Variance Decomposition (VDC), to forecast and analyse the behaviour of economic variables over time.

4.4.9.1 Impulse response function (IRF) test

This study employed the Impulse Response Function (IRF) to examine the dynamic analysis to strengthen empirical evidence of the causality test. According to Gujarati and Porter (2009), IRF traces out the response of the dependent variable in the VAR system to shocks in the error terms. However, IRF traces the impact of those shocks over several years in the future (normally ten years). Like the variance decomposition, the IRF is based on vector moving average (VMA) representation (Lau & Arip, 2015). This means that VAR is expressed as VMA, to accomplish IRF. The IRF is a fundamental tool used to assess the reaction of endogenous variables in a VAR model to a shock in one of the variables. By tracing the effects of a one-time shock to one of the innovations on current and future values of the endogenous variables, IRF provides a dynamic view of the transmission mechanisms and interdependencies among the variables under study.

4.4.9.2 Variance Decomposition (VDC) test

The dynamic analysis of the system is examined, to strengthen the empirical evidence of causality analysis (Lau & Arip, 2015). The study utilised the variance decomposition test by Sims (1980) in multivariate analysis to uncover simplifying structures in large variables (Lutkepohl, 2010). The VDC provides useful information about the relative importance of different shocks of variables in the VAR model. Such information is economically meaningful regarding forecasting analysis. A variable optimally forecast from its own lagged values will have all its forecast error variance accounted for by its disturbances (Sims, 1982). In addition, forecast error variance decomposition is noted that own time series shocks explain most of the error variance in the VAR system (Brooks, 2008). Usually based on the Moving Average (MA) of the VAR (p) process with p as the order of the VAR. Therefore, VDC breaks down the forecast error variance of each variable into proportions attributable to shocks to each variable in the system. This technique offers a quantitative measure of the relative importance of different shocks in explaining the variability of each variable in the model, thereby highlighting the sources of economic fluctuations.

4.5 SUMMARY

This chapter detailed the nature, and sources of the data utilized in this study, providing a comprehensive specification of the linear models under investigation. Central to this chapter was a thorough review of the research methodology and the estimation techniques. The ADF and PP unit root tests were applied to test for the stationarity in the variables. The ARDL Bounds test for cointegration, and ARDL-based error correction were proposed to analyse the effects of monetary policy variables on South African economic growth. Additionally, the Granger causality test was selected to determine the causal relationships among the variables. Diagnostic checks, including tests for serial correlation, heteroskedasticity, normality, and stability, were identified to ensure the reliability of the estimated parameters. For forecasting purposes, IRF and VDC analyses are performed.

CHAPTER 5

DISCUSSION / PRESENTATION / INTERPRETATION OF FINDINGS

5.1 INTRODUCTION

Following the methodology delineated in Chapter 4, this chapter unveils the empirical results and presents findings. The presentation of empirical results follows the sequential order outlined in Chapter 4, ensuring a systematic examination of each estimation technique.

5.2 EMPIRICAL RESULTS

This section presents results from the data analysis following methods outlined in the preceding chapter; further the chapter interprets and discusses the results.

5.2.1 Descriptive analysis

The initial stage of empirical analysis involves unpacking a detailed descriptive analysis of all variables. This process aims to systematically explore the fundamental characteristics and trends within the dataset, providing a foundational understanding of the variables under investigation.

Table 5.1: Summary of Descriptive Analysis

	LINF	LGDP	UNEMR	EX	EX_PER	INT	ENEP	INFEX
Mean	1.724297	6.480748	26.13043	10.26955	0.445249	4.167010	5493.138	5.825000
Median	1.735599	6.522059	25.10000	8.609300	0.827718	3.882873	5531.970	5.875000
Maximum	2.029384	6.821419	34.30000	16.49320	2.045643	8.047848	17349.96	8.175000
Minimum	1.385606	6.022485	22.30000	6.360600	-2.962557	0.774484	-1531.872	4.100000
Std. Dev.	0.198188	0.245785	3.063040	3.446697	1.354069	1.607007	5178.508	1.016260
Skewness	-0.148606	-0.380449	1.304591	0.517474	-0.829749	0.290708	0.598272	0.504482
Kurtosis	1.769845	1.915861	4.411376	1.773723	2.917738	3.316337	2.729739	3.107024
Jarque-Bera	1.534882	1.681225	8.433157	2.467588	2.645668	0.419859	1.442062	0.986567
Probability	0.464199	0.431446	0.014749	0.291186	0.266379	0.810641	0.486251	0.610618
Sum	39.65884	149.0572	601.0000	236.1996	10.24073	95.84123	126342.2	133.9750
Sum Sq. Dev.	0.864129	1.329031	206.4087	261.3539	40.33704	56.81434	5.90E+08	22.72125
Observations	23	23	23	23	23	23	23	23

Source: Author’s Computation

Table 5.1 above presents a summary of the descriptive analysis results. The results reveal that UNEMR, EX, INT, ENEP and INFEX are positively skewed, while LINF, LGDP, and EXPER are negatively skewed. Furthermore, the estimated kurtosis coefficients of LINF, LGPD, EX, EXPER, and ENEP are platykurtic as their values are less than 3.00 indicating that the tail of the variables is thinner compared to the normal distribution. The estimated kurtosis coefficients of UNEMR, INT and INFEX are leptokurtic as their values are greater than 3.00, which indicates that the tail is flatter than the normal distribution. In addition, the probability value of the Jarque-Bera statistics of LINF, LGDP, EX, EX_PER, INT, ENEP and INFEX is greater than 5% (0.05), while UNEMR has a probability value of less than 5% (0.05). Therefore, the residual of all the variables is normally distributed except for UNEMR. Unusually high or low unemployment rates during certain periods can create outliers that affect the distribution. For instance, in 2021 South Africa experienced a notable increase in its headline unemployment rate, reaching an unprecedented 34.4% in the second quarter compared to 32.6% in the initial quarter, attributable to companies reducing their workforce in response to the severe economic repercussions of the COVID-19 pandemic (Stats SA, 2021).

5.2.2 Correlation test results

This study performed a correlation test to ascertain the degree of association between dependent variables (LINF, LGDP and UNEMR) and independent variables (EX, EXPER, INT, ENEP, INFEX, LINF, LGDP and UNEMR) in their respective models. The results are jointly presented in Table 5.2 below:

Table 5.2: Summary of correlation matrix

Model A: Inflation-targeting Model							
	LINF	EX	ENEP	INT	INFEX	LGDP	UNEMR
LINF	1.000000						
EX	0.835650	1.000000					
ENEP	0.278990	-0.038087	1.000000				
INT	-0.432801	-0.390049	0.025443	1.000000			
INFEX	-0.183653	-0.218068	0.064123	0.218242	1.000000		
LGDP	0.994098	0.784586	0.315503	-0.436118	-0.184231	1.000000	
UNEMR	0.614825	0.788901	0.100011	-0.372023	-0.320885	0.544091	1.000000
Model B: Economic Growth Model							
	LGDP	EX_PER	ENEP	INT	INFEX	LINF	UNEMR
LGDP	1.000000						
EX_PER	0.126499	1.000000					
ENEP	0.315503	-0.117412	1.000000				
INT	-0.436118	-0.278076	0.025443	1.000000			
INFEX	-0.184231	0.059503	0.064123	0.218242	1.000000		
LINF	0.994098	0.126141	0.278990	-0.432801	-0.183653	1.000000	
UNEMR	0.544091	-0.075718	0.100011	-0.372023	-0.320885	0.614825	1.000000

Model C: Unemployment Model							
	UNEMR	EX	ENEP	INT	INFEX	LINF	LGDP
UNEMR	1.000000						
EX	0.788901	1.000000					
ENEP	0.100011	-0.038087	1.000000				
INT	-0.372023	-0.390049	0.025443	1.000000			
INFEX	-0.320885	-0.218068	0.064123	0.218242	1.000000		
INFEX	-0.320885	-0.183652	-0.184231	-0.218068	0.218242	0.064122	1.000000

Source: Author’s Computation

Table 5.2 presents a summary of correlation results for inflation-targeting, economic growth, and unemployment rate models under investigation. The results ascertained that the independent variables LGDP and EX in Model A have a high correlation with LINF of approximately 99% and 84% respectively, while UNEMR has an above-average correlation with LINF of approximately 61%. In contrast, the INT, ENEP and INFEX have a low correlation with LINF of approximately -43%, 28% and -18% respectively. These results show that among all the six independent variables under Model A, only two variables are highly correlated with LINF, which are LGDP and EX.

Furthermore, the results revealed that in Model B the independent variable LINF is highly correlated with LGDP at approximately 99%, which is concurrent with the findings of Model A. The high correlation between LGDP and LINF suggests potential multicollinearity in the models. LGDP and LINF are serially correlated, however, they can still be modelled in this study but with caution. High correlation does not necessarily mean one must be removed from model. If both LGDP and LINF are significant in the long run coefficient estimates, they can be deemed as meaningful but If one becomes insignificant due to multicollinearity, consider dropping one variable that is highly correlated. However, the results above further revealed that UNEMR is moderately correlated with LGDP at approximately 54%. Contrarily, EXPER, INT, ENEP, and INFEX have a low correlation with LGDP at approximately 13%, -44%, 32% and -18% respectively. Therefore, only the LINF variable is highly correlated with LGDP. In Model C the results indicated that LGDP has an average correlation, LINF exhibits the above average correlation, and EX has a high correlation against UNEMR at approximately 54%, 61%, and 79% respectively. The INT, ENEP, and INFEX have a low correction rate of 37%, 10% and 32% respectively with UNEMR.

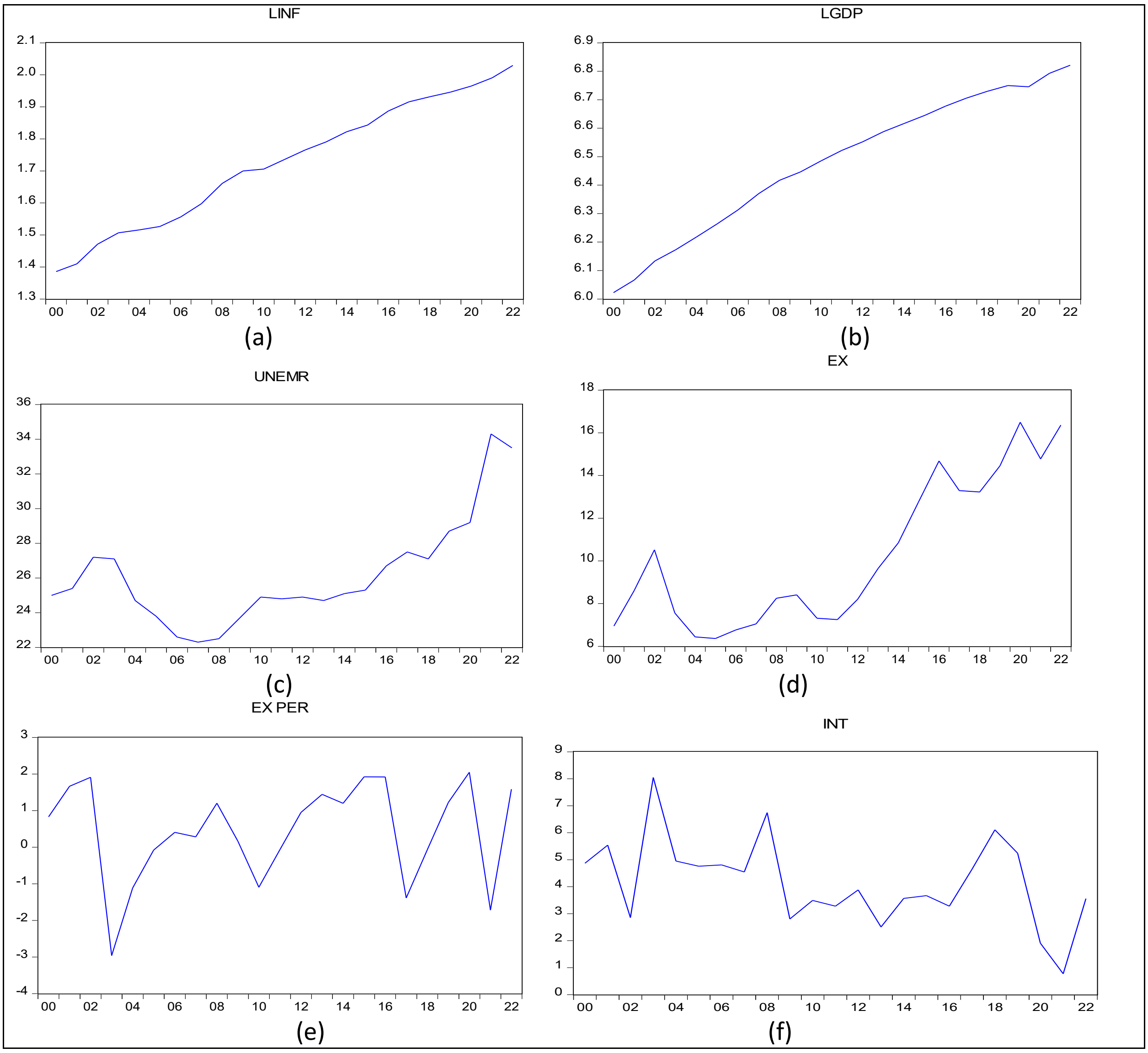
Finally, the correlation test results above suggest that there is enough evidence given most of the results in the three models reflect a lower correlation against the dependent variables. Therefore, multicollinearity in the three models under investigation appears too inconsequential.

5.2.3 Unit root test results

This section presents the informal and formal unit root test results.

5.2.3.1 Informal unit root

The informal presentation of unit root results is in visual or graphical form. The informal unit root results of all the variables under study at their level form and first difference form are presented in Figure 5.1 (a) to (h).



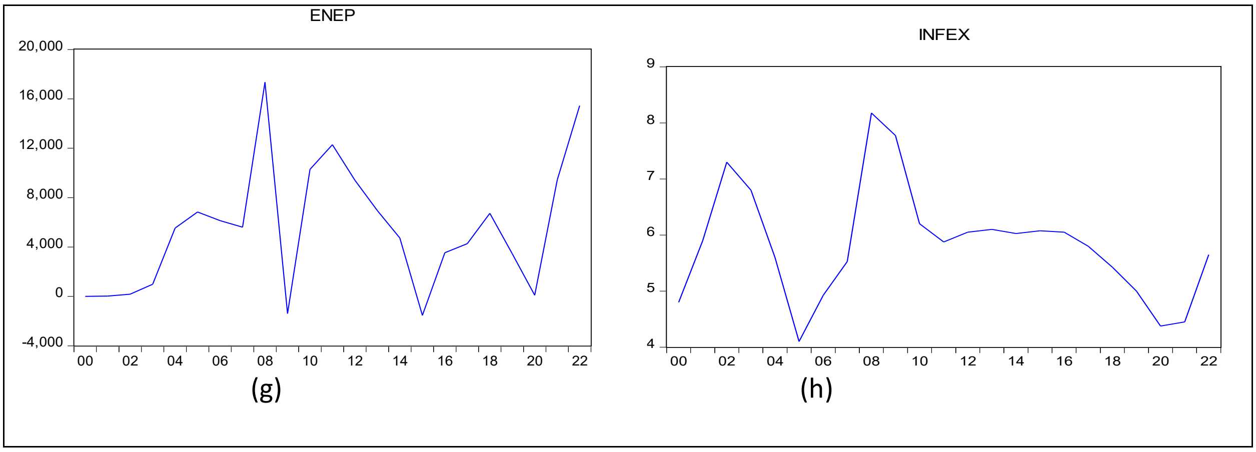
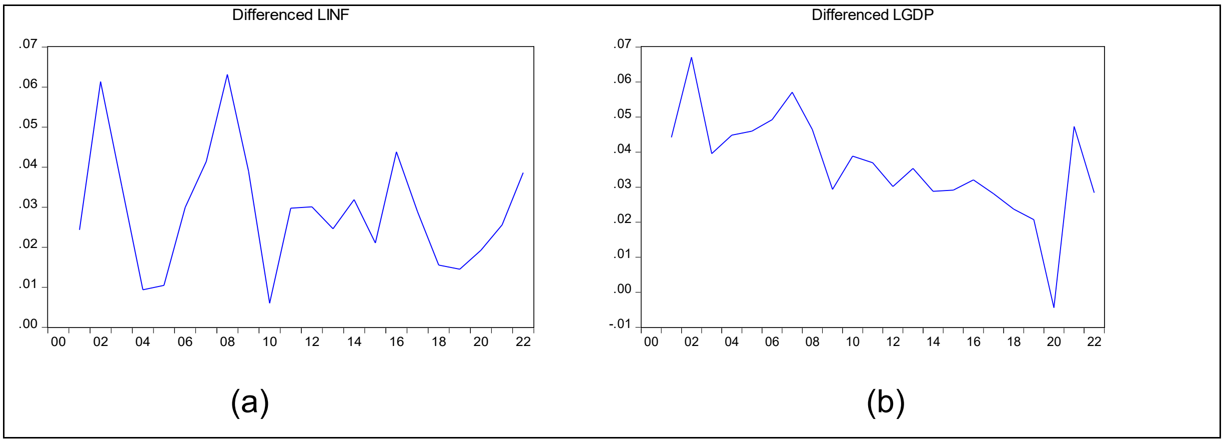


Figure 5.1: Informal unit root test results at level

Source: Author's Computation

Figure 5.1 shows a combined graphical representation of a trend analysis of all variables under study from the panels (a) to (h) in their level form. From the visual observation, the results show that the LINF, LGDP, UNEMR and EX data in panels (a), (b), (c) and (d) respectively appear to be exhibiting an upward trend, drifting away from zero mean in their respective graphs. This suggests that the variables are non-stationary at level and should be subjected to the first difference. Moreover, EXPER, INT, ENEP and INFEX variables (e), (f), (g), and (h) show upward and downward trends which suggest non-stationary.

Therefore, based on the above results, all variables under study appear to be non-stationary at I (0) order of integration. Subsequently, a first difference was performed on all the variables of interest and their outcomes are presented in Figure 5.2 (a) to (h).



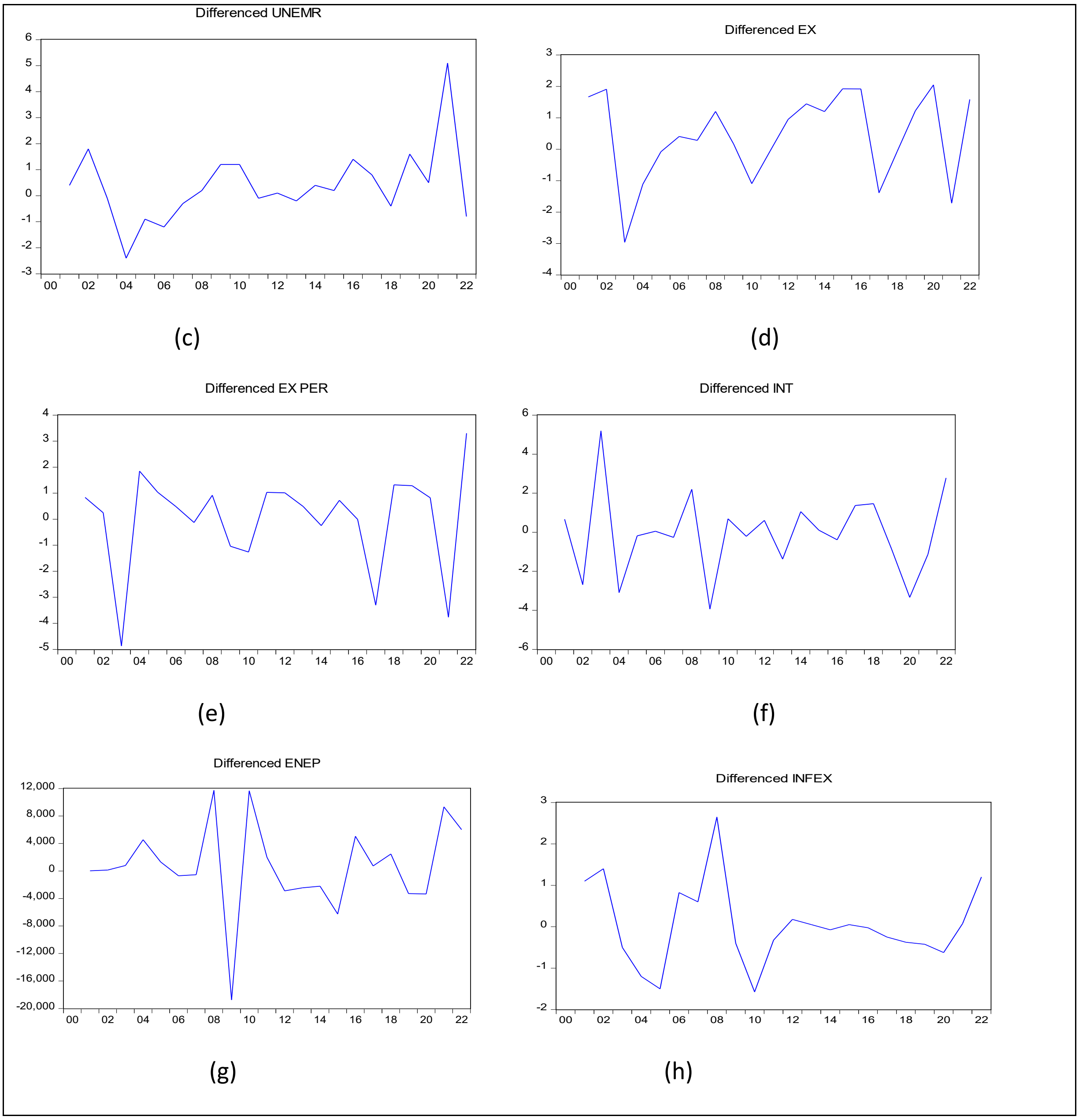


Figure 5.2: Informal unit root test at first difference

Source: Author's Computation

The results in Figure 5.2 revealed that all variables appear non-stationary at level, subsequently, all variables were subjected to first differencing. This is because all variables appear to be hovering around the mean of zero after performing the first difference.

Due to inconclusive evidence revealed in the above results regarding the stationarity of the variables, is necessary to interrogate the data further through a formal unit root test to confirm the results and the order of integration. The ADF and PP unit root test results will be interrogated in the subsequent section, which is commonly used unit root tests to check the presence of a unit root in a time series data.

5.2.3.2 Formal unit root

The well-known. The formal unit root tests in the form of the ADF and PP unit root tests were performed at level and first difference. The results are summarised in Table 5.3.

Table 5.3: Summary of unit root results

		Augmented Dickey-Fuller			Phillips-Perron			
Variables		None	Intercept	Intercept & trend	None	Intercep t	Intercept & trend	Conclusion
LINF	Level	1.0000 [8.429]	0.3847 [-1.764]	0.0585 [-3.560]	1.0000 [7.367]	0.3513 [-1.843]	0.4648 [-2.203]	Non-Stationary I(0)
	1st difference	0.2142 [-1.166]	0.0010* [-4.869]	0.0276** [-4.022]	0.3431 [0.833]	0.0227** [-3.402]	0.0439** [-3.714]	Stationary I(1)
LGDP	Level	1.0000 [10.888]	0.0024 [-4.413]	0.9048 [-1.107]	1.0000 [7.356]	1.0000 [-9.540]	1.0000 [-1.110]	Non-stationary I(0)
	1st difference	0.1875 [-1.248]	0.0471** [-3.042]	0.0336** [-3.553]	0.2965 [-0.944]	0.0370** [-2.945]	0.0000* [-7.170]	Stationary I(1)
UNEMR	Level	0.9446 [1.287]	0.9864 [0.625]	0.9502 [-0.800]	0.9428 [1.269]	0.9750 [0.340]	0.9502 [-0800]	Non-stationary I(0)
	1st difference	0.0085* [-1.721]	0.0035* [-1.825]	0.0062* [-4.784]	0.0004* [-3.933]	0.0052* [-4.084]	0.0051* [-4.799]	Stationary I(1)
INT	Level	0.1975 [-1.218]	0.0099* [-3.773]	0.0088* [-4.500]	0.3010 [-0.934]	0.0099* [-3.773]	0.0089* [-4.496]	Stationary I (0)
ENEP	Level	0.0937 [-1.642]	0.0178** [-3.504]	0.0563 [-3.570]	0.0937 [-1.642]	0.0194** [-3.462]	0.0563 [-3.570]	Non-stationary I (0)
	1st difference	0.0000* [-7.142]	-	0.0001* [-6.907]	0.0000* [-8.072]	-	0.0000* [-7.990]	Stationary I (1)
EX	Level	0.9433 [1.274]	0.9090 [-0.307]	0.6896 [-1.759]	0.9861 [2.001]	0.9307 [-0.158]	0.7555 [1.610]	Non-stationary I (0)
	1st difference	0.0003* [-4.069]	0.0037* [-4.240]	0.0120* [-4.377]	0.0003* [-4.057]	0.0038* [-4.233]	0.0032* [-5.026]	Stationary I (1)
EX PER	Level	0.0004* [-3.942]	0.0037* [-4.213]	0.0161* [-4.208]	0.0005* [-3.880]	0.0039* [-4.190]	0.0074* [-4.584]	Stationary I(0)
INFEX	Level	0.5081 [8.429]	0.0049* [-1.764]	0.0144* [-3.560]	0.6256 [7.366]	0.1170 [-1.843]	0.1568 [-2.203]	Non-stationary I(0)
	1st difference	0.0000* [-1.166]	-	-	0.0023* [0.823]	0.0359** [-3.402]	0.0467** [-3.714]	Stationary I(1)

Notes: * and ** represents significance at 1% and 5% respectively

Source: Author's Computation

As a general guideline, the calculated probability value for the variable's stationarity should be 0.05 or less. As a result, for every variable, the null hypothesis that the variable has a unit root is rejected as presented in Table 5.3 above. The results indicate that most of the variables (LINF, LGDP, UNEMR, ENEP, EX, INFEX) are non-stationary at level (probability value > 0.05) but become stationary after first differencing (probability value

< 0.05), indicating they are integrated at order one, I(1). However, variables such as INT and EXPER are stationary at level (probability value > 0.05), indicating they are integrated of order zero, I (0). Therefore, since there is a combination of integration orders, and no variable that integrates at I (2), the ARDL approach is the proper estimate technique for all models under study.

5.2.4 Lag length selection test

This section presents a summary of lag length criteria for the respective models under investigation. Selecting an appropriate lag length is a critical step in time series analysis, influencing the accuracy and reliability of model forecasts.

Table 5.4: Summary of lag length selection criteria

Model A: Inflation-targeting Model						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-291.5540	NA	1446.016	27.14127	27.48842	27.22305
1	-121.8642	215.9688*	0.031695*	16.16947*	18.94667*	16.82370*
Model B: Economic Growth Model						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-293.9959	NA	1805.445	27.36326	27.71041	27.44504
1	-130.0652	208.6390*	0.066800*	16.91502*	19.69222*	17.56924*
Model C: Unemployment rate Model						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-291.5540	NA	1446.016	27.14127	27.48842	27.22305
1	-121.8642	215.9688*	0.031695*	16.16947*	18.94667*	16.82370*

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

Source: Author's Computation

Table 5.4 summarises the lag length selection criterion for VAR, which is based on LR, FPE, AIC, SC, and HQ. The results reveal that for both inflation-targeting, economic growth, and unemployment rate models, all five criteria (LR, FPE, AIC, SC, and HQ) corroborate the lag length. The lag selection results consistently indicate that the optimal lag length for all three models is one. All point to the same lag length, highlighting the robustness of this finding across different model specifications. This uniformity suggests that a single lag is adequate to account for the temporal dependencies in the variables under consideration in these models. In addition, given the number of limitations in the observations for variables lag is deemed necessary. The inclusion of lags in the analysis of time series data given the limited number of observations is pivotal for the precise elucidation of temporal relationships, enhancing model fit, mitigating autocorrelation, and ultimately yielding more dependable and interpretable outcomes (Amornbunchornvej, Zheleva, & Berger-Wolf, 2021). Therefore, it is critical to choose the ideal lag length since it impacts the ARDL Bounds test of cointegration analysis, which is discussed in the following section.

5.2.5 ARDL Bounds Test of Cointegration

This section presents the empirical test results, which determine the presence of a long run relationship among the variables estimated in the three models under investigation. The results are presented in Table 5.5 as follows,

Table 5.5: Summary of ARDL Bounds test.

	Model A: Inflation-targeting		Model B: Economic growth		Model C: Unemployment rate	
Test Statistic	Value	K	Value	k	Value	K
F-statistic	15.99849	6	46.23283	6	8.963725	6
Critical Value Bounds						
Significance	I0 Bound	I1 Bound	I0 Bound	I1 Bound	I0 Bound	I1 Bound
10%	1.99	2.94	1.99	2.94	1.99	2.94
5%	2.27	3.28	2.27	3.28	2.27	3.28
2.5%	2.55	3.61	2.55	3.61	2.55	3.61
1%	2.88	3.99	2.88	3.99	2.88	3.99

Source: Author's Computation

The results above indicate that the calculated F-Statistics for Models A, B, and C. For instance, in Model A, the computed F-statistic of 15.99849 is significantly higher than the upper bound (I1 Bound) at all significance levels (10%, 5%, 2.5%, 1%). This suggests a strong rejection of the null hypothesis, indicating a significant long run relationship in the model. Furthermore, in Model B the computed F-statistic of 46.23283 is also far above the upper bound (I1 Bound) at all significance levels, indicating rejection of the null hypothesis and a significant long run relationship in the model. The findings also suggest that there is a long run relationship among variables in Model C. The F-statistic of 8.963725, like the other models, is significantly higher than the upper bound (I1 Bound) across all significance levels. This indicates a strong rejection of the null hypothesis and suggests a significant long run relationship in Model C. Therefore, all three models show F-statistics values significantly higher than the critical values at all considered significance levels. This consistent pattern strongly indicates that there is a significant long run relationship present in all three models.

Table 5.6: Summary of ARDL estimates.

MODEL A: INFLATION-TARGETING			
R-squared	0.999998	Mean dependent var	1.755395
Adjusted R-squared	0.999956	S.D. dependent var	0.177522
S.E. of regression	0.001176	Akaike info criterion	-11.79317
Sum squared resid	1.38E-06	Schwarz criterion	-10.79838
Log-likelihood	143.8283	Hannan-Quinn criterion	-11.57727
F-statistic	23986.78	Durbin-Watson stat	2.519160
Prob(F-statistic)	0.005084		
MODEL B: ECONOMIC GROWTH			
R-squared	0.999327	Mean dependent var	6.501578
Adjusted R-squared	0.998586	S.D. dependent var	0.229853
S.E. of regression	0.008642	Akaike info criterion	-6.361889
Sum squared resid	0.000747	Schwarz criterion	-5.766775
Log-likelihood	81.98078	Hannan-Quinn criterion	-6.221698
F-statistic	1349.570	Durbin-Watson stat	2.366499
Prob(F-statistic)	0.000000		
MODEL C: UNEMPLOYMENT RATE			
R-squared	0.976779	Mean dependent var	26.18182
Adjusted R-squared	0.955670	S.D. dependent var	3.124959
S.E. of regression	0.657953	Akaike info criterion	2.307487
Sum squared resid	4.761928	Schwarz criterion	2.853008
Log-likelihood	-14.38236	Hannan-Quinn criterion	2.435996
F-statistic	46.27157	Durbin-Watson stat	1.961812
Prob(F-statistic)	0.000000		

Source: Author’s Computation

Table 5.6 provides a summary of the ARDL estimates used to detect the presence of spurious regression and serial correlation problems. The results revealed Durbin-Watson statistics of 2.519160, 2.366499, and 1.961812 for Models A, B, and C respectively. Therefore, in Models A and B the Durbin-Watson statistics are slightly above 2, suggesting a slight negative autocorrelation in the residuals. However, it is close enough to 2 suggesting autocorrelation is not a significant issue for these models. However, in Model C the Durbin-Watson statistics is very close to 2 at 1.961812, suggesting almost no autocorrelation in the residuals of this model. This indicates that the model is well-specified in handling serial correlation. Model C is particularly strong in this aspect.

Furthermore, the results revealed that the estimated value for R-squared in Models A, B, and C is approximately 0.999998, 0.999327, and 0.976779 respectively. Thus, R-squared values lean towards 1 in all models, which suggests that the regressed models' parameters are robust and may appear reliable in their predictions. The results imply that the models with approximately 99.9998%, 99.9327%, and 97.6779% of the variance in the dependent variables are explained by the independent variables in the models accordingly. Those extremely high values suggest a good fit in the regressed models.

5.2.6 Long run coefficient estimates

This section presents a joint results analysis of long run relationship between dependent and independent variables in both models.

Table 5.7: Summary of long run coefficient results

Independent variables	Model A: inflation-targeting	Model B: Economic growth	Model C: Unemployment rate
EX (EX_PER)	-0.001977 (0.0000) [34.007073]*	-0.020393 (0.2066) [-1.350682]	-0.252424 (0.3064) [-1.077980]
INT	-0.001108 (0.2281) [-1.276440]	-0.014029 (0.1084) [-1.762826]	-0.535045 (0.0180) [-2.824324]**
ENEP	0.000002 (0.0146) [2.895578]**	-0.000001 (0.7660) [-0.305780]	0.000005 (0.9399) [0.077375]
INFEX	0.007618 (0.0002) [5.617309]*	-0.011100 (0.0490) [-2.240450]**	-0.838090 (0.0150) [-2.931241]**
UNEMR	0.001977 (0.1142) [1.715837]	-0.013336 (0.0009) [-4.671328]*	-
LGDP	0.661356 (0.0000) [34.007073]*	-	-105.8976 (0.0000) [-7.821592]*
INF	-	1.225019 (0.0000) [14.967853]*	144.640330 (0.0000) [7.166882]*
Constant	-2.736624 (0.0000) [-20.661386]*	1.225019 (0.0000) [14.967853]*	470.314215 (0.0000) [8.379044]*

Notes: * and ** denotes 1% and 5% significance levels respectively.

Source: Author's Computation

Table 5.7 presents the long run estimated coefficients in the three set models However, each independent variable's estimated coefficients' influence on the dependent variables will be given due attention in the subsequent paragraphs below.

The results in Table 5.7 reveal that the foreign exchange rate has a statistically significant inverse influence over the inflation rate in Model A in the long run at a 1% significance level. While in both Models B and C, the foreign exchange rate inflicts an insignificant impact on the inflation rate in the long run. The estimated coefficients of the foreign exchange rate in Model A is approximately -0.0020. For instance, in terms of the inflation rate, which is controlled through the inflation-targeting framework, this implies that a 1% change in appreciation of the domestic currency is likely to lead to a 0.2% fall in price levels. The results are also in line with Semosa and Ogujiuba (2021) who investigated a nexus between inflation, exchange and unemployment rates in South Africa. Similarly, the adverse influence on the exchange rate over the inflation rate implies that a 1% depreciation in the value of the Rand against the US dollar will increase the inflation rate. This will give rise to cost-push inflation conditions in the economy.

In Model C, the relationship between the foreign exchange rate and the unemployment rate is negative but not statistically significant. These findings contrast with the results reported by Nyahokwe and Ncwadi (2013), who found a significant positive relationship between the foreign exchange rate and the unemployment rate in South Africa. Therefore, the lack of statistical significance in the current model implies that the effect of foreign exchange rates on the unemployment rate may vary over time, depend on other economic conditions, or be influenced by various economic factors. The foreign exchange rate has a statistically significant relationship in Model A as opposed to Models B and C.

Interest rate has a negative relationship with inflation rate, economic growth, and unemployment rate in the long run. However, only the interest rate exhibits a statistically significant influence over the unemployment rate at a 5% level of significance, and the interest rate has a statistically insignificant impact on the inflation rate and economic growth. The estimated coefficient of interest rate influence over unemployment rate in model C is approximately -0.5350. This suggests that the unemployment rate will decline by 53.5%, with every 1% increase in interest rates. Moreover, Moyo and Pierre (2018) and Tederera et al. (2021), established that interest rate depresses economic growth in the long run using evidence from SADC countries and SACU respectively. Precious and Palesa (2014), also ascertained that interest rate has an insignificant negative effect on the South African economy. The negative coefficient of interest rate influence over the unemployment rate suggests that higher interest rates are associated with a decrease in the unemployment rate, and this relationship is statistically significant. This is somewhat counterintuitive, as traditional economic theory often posits that higher interest rates slow economic activity and potentially increase unemployment. This is well documented by the work of Keynes (1936) interest rate channel of monetary policy transmission mechanism. However, the significant negative relationship between interest rates and the unemployment rate in Model C is best explained by the Phillips Curve theory by Phillips (1958) indirectly, which suggests that lower interest rates can reduce the unemployment rate by boosting economic activity and job creation. This relationship highlights the role of monetary policy in influencing labour market outcomes. Monetary policymakers can lower interest rates to help reduce the unemployment rate by stimulating economic activity.

The long run estimated coefficients results show that energy prices exhibit an affirmative association in Models A and C, while Model B shows a negative influence. However, only in Model A, does energy prices have a statistically significant impact on the inflation rate at a 5% significance level. In both Models B and C energy prices have an insignificant impact. The results revealed that the estimated coefficient of energy prices is approximately 0.000002, -0.000001 and 0.000005 in inflation-targeting respectively. Therefore, changes in energy prices impact are near neutral, because of the degree of magnitude in the estimated coefficients. For instance, in Model A the results imply that a 1% change in energy prices will translate into 0.0002% increase in inflation rate.

The results are partially in concurrence with the findings substantiated by Nasir et al. (2020) in a study investigating oil price shocks, which is a component of energy prices on inflation expectations established a beneficial impact on inflation expectations outcomes in both Sweden and Denmark. Furthermore, the results also align with Rizvi and Sahminan's (2020) findings. They revealed that oil and energy prices induce inflationary pressures in all BRICS countries except Russia. Khobai et al. (2017) went on to establish that there is a long run beneficial link between electricity prices and economic growth in South Africa. However, the significant positive coefficient of energy prices over the inflation rate in Model A indicates that a unit increase in energy prices is associated with a very small, but significant increase in inflation rate. From an economic theory perspective, this result aligns with the cost-push inflation theory. Energy prices are a significant component of production costs for many goods and services. When energy prices increase, production cost also increases, which may be passed to consumers at higher prices, leading to an inflation rate. This relationship highlights the sensitivity of the inflation rate to changes in energy prices, supporting the view that energy price fluctuations can significantly influence overall price levels in an economy.

In Model A the inflation expectations estimated coefficient shows that it has a statistically significant positive influence over the inflation rate in the long run at a 5% level of significance of approximately 0.00476, which is expected. This aligns with the EAPC theory, which suggests that higher inflation expectations can lead to a higher actual inflation rate as workers demand higher wages and firms increase prices in anticipation of higher future costs. In contrast, the inflation expectations in Model B and C show that inflation expectations have a statistically significant adverse effect on economic growth and the unemployment rate at a 5% significance level, estimated at approximately -001111 and -0.8381 respectively. However, in Model A the influence of inflation expectations over the inflation rate implies that a 1% change will increase the inflation rate by 0.76%.

Model B and C results projected the impact of inflation expectations on both dependent variables indicating that a 1% change in inflation expectation will result in a corresponding decrease of 1.11% and 83.81% in economic growth and unemployment rate respectively. High inflation expectations can erode purchasing power, affecting economic stability and growth. The results of a negative relationship between inflation expectations and economic growth are contrary to the findings by Mandeya and Ho (2021) which established that inflation expectations have no bearing effect on economic growth in the long run. The results show a negative relationship between inflation expectations and the unemployment rate, contrary to the expected a priori of EAPC from the work of Friedman (1968) and Phelps (1967). EAPC states that the unemployment rate increases at higher inflation expectations, which opposes the traditional Phillips Curve theory developed by Phillips (1958).

In Model A, the coefficient of the unemployment rate is positive, suggesting a positive relationship between the unemployment rate and the inflation rate. However, the results indicate that this relationship is not statistically significant at 0. 0020. The relationship may be positive, but the unemployment rate has no bearing link over the inflation rate in the long run. Buthelezi (2023) revealed a positive relationship between the inflation rate and the unemployment rate in South Africa. In contrast, Semosa and Ogujiuba (2021), established a negative relationship between the inflation rate and the unemployment rate in South Africa. The results further revealed that the unemployment rate depresses economic growth in South Africa over the long run at a 1% level of significance at an estimated coefficient of -0.013336 in Model B. This implies that a 1% change in the unemployment rate results in a 1.33% decrease in economic growth. In Model B, the negative coefficient of the unemployment rate is statistically significant, indicating a strong inverse relationship between the unemployment rate and economic growth. This aligns with Okun's Law developed from the work of Okun (1963; 1970), which postulates an inverse relationship between the unemployment rate and economic output.

A higher unemployment rate is associated with lower economic growth, suggesting that as the unemployment rate decreases the economy improves and vice versa. Furthermore, Khalid et al. (2021) showed no co-integrating link between the unemployment rate and economic growth in South Africa. Such a discovery is consistent with the findings by Meyer (2017), based on evidence from South Africa. Therefore, in Model A the unemployment rate does not have a statistically significant impact on inflation-targeting, indicating that unemployment rate changes are not strongly associated with inflation rate outcomes in this model. While, in Model B, the unemployment rate significantly negatively impacts economic growth, supporting the theory that a lower unemployment rate is associated with higher economic growth. This suggests that policies aimed at reducing the unemployment rate could positively affect economic growth.

The Model A results show that economic growth has a statistically significant positive influence over the inflation rate at a 1% significance level. Therefore, the estimated coefficient of economic growth over the inflation rate in model A is approximately 0.6614. The results imply that a 1% change in economic growth is associated with a 0.6614 unit increase in the inflation rate. It is worth noting that the independent variable of economic growth in model A was subject to log transformation, hence the coefficient of economic growth is analysed as elasticity. However, a positive and statistically significant economic growth coefficient in Model A suggests that higher economic growth is associated with higher inflation rates. The result shows a trade-off between controlling the inflation rate and increasing economic growth. This relationship is consistent with the demand-pull inflation theory, when economic growth is robust, aggregate demand for goods and services increases. If this demand outpaces the economy's productive capacity, it can lead to demand-pull inflation, where the increased demand raises prices. This suggests that inflation-targeting regimes must account for growth dynamics when managing inflation expectations.

Like the Model B results, the Model C results also revealed that economic growth has a statistically significant negative relationship with the unemployment rate. The estimated economic growth coefficient in Model C is 105.8976. This implies that a 1% change in economic growth is associated with a 105.90 unit decrease in the unemployment rate. The negative relationship with the unemployment rate is in line with the expected a priori theory of Okun's Law developed by Okun (1963, 1970), alluded to in Model B.

The results established an affirmative influence that the inflation rate has over economic growth and unemployment rate in Models B and C at a 1% level of significance in the long run. The estimated coefficients of inflation rate in Model B and C are 1.223 and 144.64 respectively. Inflation rate data was transformed into logarithms; hence its coefficient was analysed as elasticity. The results indicate that a 1% change in the inflation rate may cause a 1.225% and 144.64% change in economic growth and unemployment rate. The Model B results are in line with the Model A results. This relationship is consistent with the demand-pull inflation theory as well. Furthermore, these results conflict Tenzins (2019) and Jeke and Wanjuu's (2021) who revealed that the inflation rate negatively affects economic growth in the long run. However, a positive relationship in the long run between inflation and unemployment rates is substantiated by the EAPC theory but opposes the traditional Phillips Curve theory. The inflation rate 144.64 coefficient suggests a much larger impact on the unemployment rate.

The long-run results highlight the complex interplay between inflation-targeting, economic growth, and the unemployment rate in South Africa. While the inflation-targeting framework has been effective in managing the inflation rate, it shows that the interest rates as the primary monetary tool negatively affect other macroeconomic objectives. Also, the influence of foreign exchange rates and energy prices over the inflation rate, economic growth and unemployment rate outcomes in the long run is a concern. The results indicated that managing inflation expectations is particularly important, as they significantly influence the inflation rate, economic growth, and unemployment rate.

5.2.7 Short run coefficients and ECM estimates

This section presents a summary of short run coefficients and ECM estimates for the three models.

Table 5.8: Summary of short run coefficients and ECM estimates

Independent variables	Model A: inflation-targeting	Model B: Economic growth	Model C: Unemployment rate
EX (EX_PER)	0.005948 (0.0002) [5.416508]*	-0.005914 (0.0065) [-3.422347]*	-0.030927 (0.3307) [-1.022275]
INT	-0.001321 (0.1464) [-1.562557]	-0.004198 (0.0126) [-3.033717]**	-0.174946 (0.0261) [-2.607880]**
ENEP	0.000124 (0.0012) [4.342523]*	-0.000007 (0.9009) [-0.127775]	0.000008 (0.7739) [0.295107]
INFEX	-0.000124 (0.9401) [-0.076896]	0.010515 (0.0022) [4.090800]*	-0.733897 (0.0076) [-3.334276]*
UNEMR	-0.000123 (0.5841) [-0.563920]	-0.003012 (0.1858) [-1.420655]	-
LGDP	0.228954 (0.0401) [2.327426]**	-	-5.120080 (0.5714) [-0.585181]
INF	-	0.011879 (0.0005) [4.996220]*	107.891883 (0.0001) [5.916679]*
CointEq(-1)	-0.977742 (0.0000) [-7.097109]*	-0.456592 (0.0002) [-5.596674]*	-0.963955 (0.0000) [-9.556467]*

Notes: * and ** denotes 1% and 5% significance levels respectively.

Source: Author's Computation

Table 5.8 presents the ARDL ECM summary of results, and the short run coefficient estimates for Models A, B, and C. The summary results further provide an ECM estimation for all models. The speed of adjustment coefficients are estimated at -0.977742, -0.456592, and -0.963955 for Models A, B, and C respectively and all estimates are statistically significant at 1%. This implies that the systems will converge to the long run equilibrium at a speed of adjustment of approximately 97.78%, 45.66%, and 96.40% respectively. This shows that the respective models will continue to converge to long run equilibrium at different adjustment rates. However, the inflation and unemployment rate models adjust twice as much as the growth model.

The results of ECM do not show the effect of short run coefficients on the dependent variables in each model, it only reflects on the speed it will take short run pressure of variables to translate into long run effects. However, in the short run exchange rate affects the inflation rate in Model A positively significant of which in the long run its influence was negative. These results contradict Semosa, and Ogujiuba (2021).

The results imply that when the rand appreciates, the inflation rate may increase, and this will create inflationary pressures on domestic prices in the short run. Furthermore, the positive affirmation between the exchange rate and inflation rate corroborates the results by Şen, et al (2020). However, the short run results revealed that foreign exchange rate pressure on both economic growth and unemployment rate in Models B and C is consistent with the long run effects, which exhibit a significant negative influence in Model B over economic growth only. Due to the statistically significant exchange rate influences economic growth. This implies that when currency appreciates economic growth is likely to shrink. The exports may become more expensive in foreign markets when the rand appreciates. Goods priced in rands will cost more for foreign buyers, which can lead to a decline in demand for South African exports. Therefore, it creates purchasing power disparity as outlined by the Purchasing Power Parity theory in the work of Cassel (1918). A statistically significant negative relationship between the foreign exchange rate and economic growth also implies that when the value of the South African rand depreciates (the exchange rate increases), economic growth tends to slow down. Therefore, addressing the root causes of currency depreciation and fostering a stable economic environment are crucial steps in mitigating the inflation rate and its adverse effects on economic growth.

The results indicated that the estimated interest rate coefficients in all three models are still in concurrence with long run results, which reflect a negative relationship with the inflation rate, economic growth, and unemployment rate. However, only in Models B and C does the negative influence of interest rate over economic growth and unemployment rate appear to be statistically significant in the short run. About Model B, the negative influence implies that an increase in interest rate, which intends to control price levels is likely to depress economic growth in the short run. This is in line with the famous theory of Monetary Policy Transmission Mechanism through the interest rate and credit channel by the work of Keynes (1936). Additionally, the negative significant effect of interest rate over the unemployment rate in the short run corroborates long run results. It seems to be somewhat counterintuitive to the economic theories such as the Keynesian Model (AD-AS) of Keynes (1937) and The Monetary Policy Transmission Mechanism theory of Keynes (1936). The theories are based on the premise that a decrease in interest rate will stimulate economic activity spending will increase, and aggregate demand will increase, in turn, output levels will increase, and jobs will be created of which the unemployment rate is likely to fall. However, based on the results it appears that a decrease in interest rate will increase the unemployment rate in South Africa in the short run. This substantiates that by using interest rates as the primary monetary policy tool to control the inflation rate in South Africa, policymakers face a trade-off when setting interest rates. While higher interest rates can help control the inflation rate, they can dampen economic growth and increase the unemployment rate in the short run.

The energy prices pressure effect on all models indicates that the estimated coefficients in the long run co-move with short run estimated coefficients, which shows that Models A and C have a positive effect, while Model B reflects a negative effect. Even the energy prices significance level corroborates with long run results, which shows that is only significant in model A over inflation. Energy prices' positive relationship with the inflation rate in the short is in line with the results of Khobai et al. (2017) and Rehman (2014). This implies that an energy price increase will cause inflationary pressure in the short run, and this leads to cost-push inflation. However, it is worth noting that the influence of energy prices over economic growth in the short run is negatively insignificant, which means it does not have any bearing effect on economic growth. This is contrary to Takentsi et al. (2022) which showed that whereas crude oil prices significantly and positively correlate with economic growth, electricity prices negatively affect it in South Africa. Higher energy prices increase transportation and manufacturing costs, often passed on to consumers as higher prices for goods and services. This strongly contributes directly to the inflation rate.

Inflation expectations in the short run show a negative effect on the inflation rate and a positive effect on economic growth, contrary to long run estimates in Mmodels A and B. However, the unemployment rate is still consistent with a negative influence in the short run like in the long run in Model C. This substantiates the negative relationship between inflation and the unemployment rate, which is best explained through the Phillips Curve theory by Phillips (1958). Higher inflation expectations are associated with lower unemployment rates. When businesses expect a higher inflation rate, they might expand their operations to lock in current prices, which can lead to more hiring and thus reduce the unemployment rate. Policymakers might consider how inflation expectations are managed and communicated to the public to harness their potential positive effects on economic growth and employment.

Unemployment's influence over the inflation rate and economic growth in Models A and B appears insignificant in the short run, while it seems negative. The results of a negative relationship between the unemployment rate and inflation in model A still affirm the results revealed by Semosa and Ogujiuba (2021), in South Africa, the unemployment rate is negatively related to inflation, and it was statistically significant, and it meets the a priori of Phillips Curve theory in the short run as well. Subsequently, economic growth relation with the inflation rate in Model A is statistically significant and positive, which is in line with long run results. This corroborates the findings revealed by Wanjuu (2021) and Tenzins (2019). In the context of South Africa, the positive and significant relationship between economic growth and the inflation rate in Model A suggests that efforts to boost economic growth could lead to higher inflation. However, given the current low economic growth and high unemployment, inflation rates might remain subdued. Policymakers need to balance measures to stimulate economic growth with the potential inflationary pressures such growth could generate.

5.2.8 Summary of diagnostic and stability test results

This subsection presents the diagnostic and stability test results of the three models. The results will be outlined in subsequent paragraphs following Chapter 4.

Table 5.9: Summary of diagnostic tests

Diagnostic	Null hypothesis	Model A: Inflation-targeting	Model B: Economic growth	Model C: Unemployment
Jarque-Bera	Residuals are normally distributed	J.B statistic: 0.584853 Kurtosis: 2.233292 P-value: 0.746450	J.B statistic: 1.023384 Kurtosis: 2.583954 P-value: 0.599480	J.B statistic: 2.927594 Kurtosis: 4.698369 P-value: 0.231356
Serial correlation	No serial correlation	Breusch-Godfrey Serial Correlation LM Test: F-Statistic: 0.528170 Obs*R-squared: 2.310930 P-value: 0.6069	Breusch-Godfrey Serial Correlation LM Test: F-Statistic: 2.981814 Obs*R-squared: 5.474957 P-value: 0.1183	Breusch-Godfrey Serial Correlation LM Test: F-Statistic: 0.001054 Obs*R-squared: 0.002576 P-value: 0.9748

Breusch-Pagan Godfrey	Homoskedasticity	F-statistic: 1.150437 Obs*R-squared: 11.24653 P-value: 0.4084	F-statistic: 1.417560 Obs*R-squared: 13.40395 P-value: 0.2951	F-statistic: 2.445188 Obs*R-squared:16.03747 P-value: 0.1051
Harvey	Homoskedasticity	F-statistic: 0.712524 Obs*R-squared: 8.648454 P-value: 0.6995	F-statistic: 2.213108 Obs*R-squared: 15.59426 P-value: 0.1108	F-statistic: 3.231954 Obs*R-squared:17.17030 P-value: 0.1375
Glejser	Homoskedasticity	F-statistic: 0.968735 Obs*R-squared:10.30203 P-value: 0.5161	F-statistic: 1.630993 Obs*R-squared:14.12624 P-value: 0.2247	F-statistic: 4.307524 Obs*R-squared:18.16610 P-value: 0.2144
ARCH	Homoskedasticity	F-statistic: 0.434130 Obs*R-squared: 0.469110 P-value: 0.5179	F-statistic: 0.080978 Obs*R-squared: 0.089012 P-value: 0.7792	F-statistic: 2.100098 Obs*R-squared: 2.090135 P-value: 0.1636

Source: Author’s Computation

5.2.8.1 Serial correlation

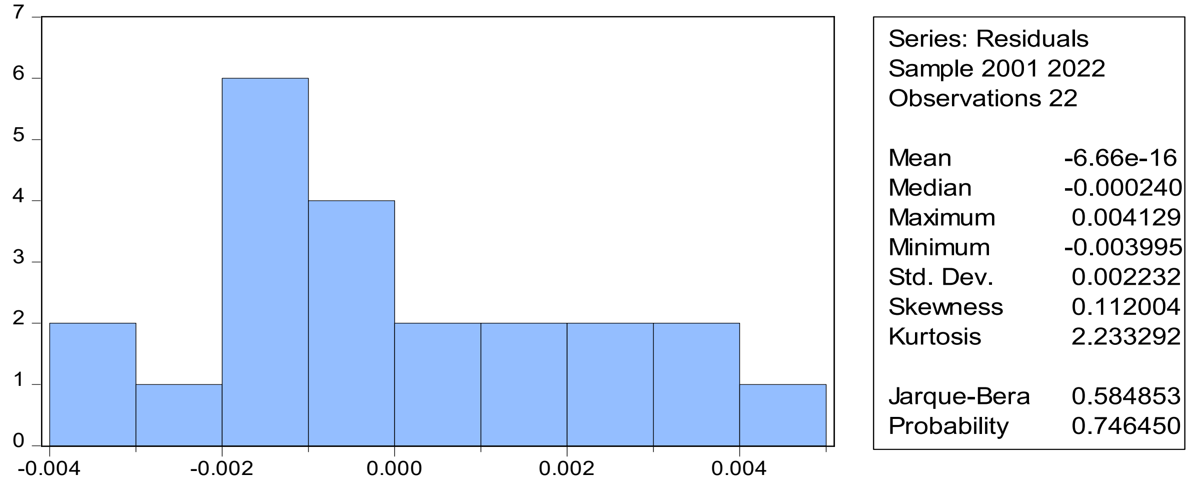
The Breusch-Godfrey residual serial correlation LM Test presented in Table 5.9 offers a concise overview of the results of the serial correlation tests. The analysis indicates that the models under consideration do not exhibit any issues related to serial correlation. This is evidenced by the LM F-statistics being calculated at approximately 0.528170, 2.981814, and 0.001054 for Models A, B, and C correspondingly, along with associated p-values of 0.6069, 0.1183, and 0.9748, exceeding the threshold of 5%. Consequently, the null hypothesis, positing the absence of serial correlation, is upheld for both models.

5.2.8.2 Heteroskedasticity

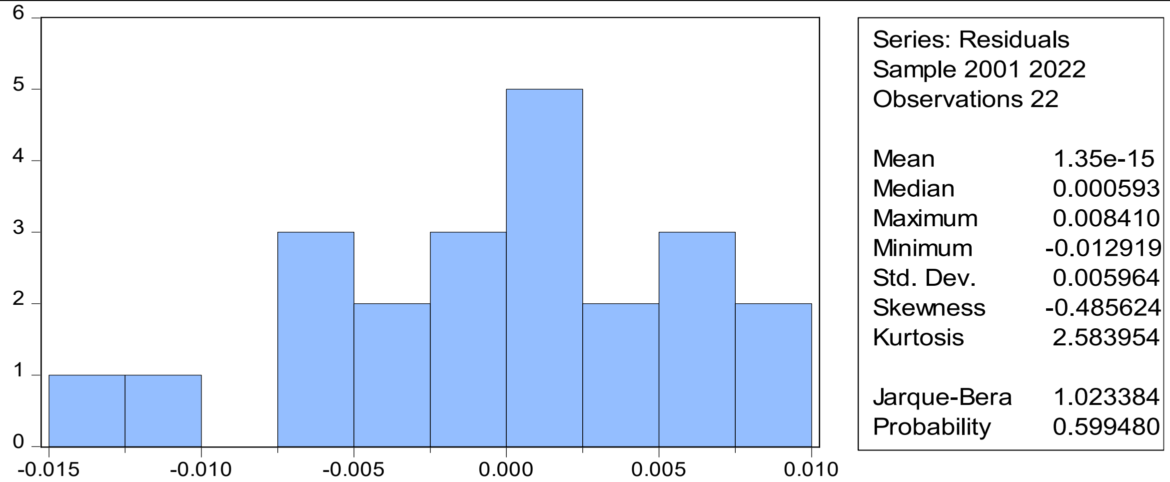
Table 5.9 presents the outcomes from four diagnostic tests designed to identify heteroskedasticity. They are Breusch-Pagan Godfrey, Harvey, Glejser, and ARCH tests. The estimated F-statistics in model A are 0.150437, 0.712524, 0.968735, and 0.434130, coupled with probability values of 0.4084, 0.6995, 0.5161, and 0.5179, respectively. These results suggest the presence of homoskedasticity as the probability values exceed 5%.

In contrast, the results from Model B display F-statistics of 1.417560, 2.213108, 1.630993, and 0.080978, alongside corresponding probability values of 0.2951, 0.1108, 0.2247, and 0.7792, indicating homoskedasticity given the probability values exceed 5%. Similarly, outcomes from Model C reveal estimated F-statistics of 2.445188, 3.231954, 4.307524, and 2.100098, with accompanying probability values of 0.1051, 0.1375, 0.2144, and 0.1636, suggesting homoskedasticity as the probability values are greater than 5%. Embracing the null hypothesis of homoscedasticity is preferred over its rejection in both models. Consequently, the absence of heteroskedasticity serves as a positive signal for the dependability of the estimated coefficients in the respective models.

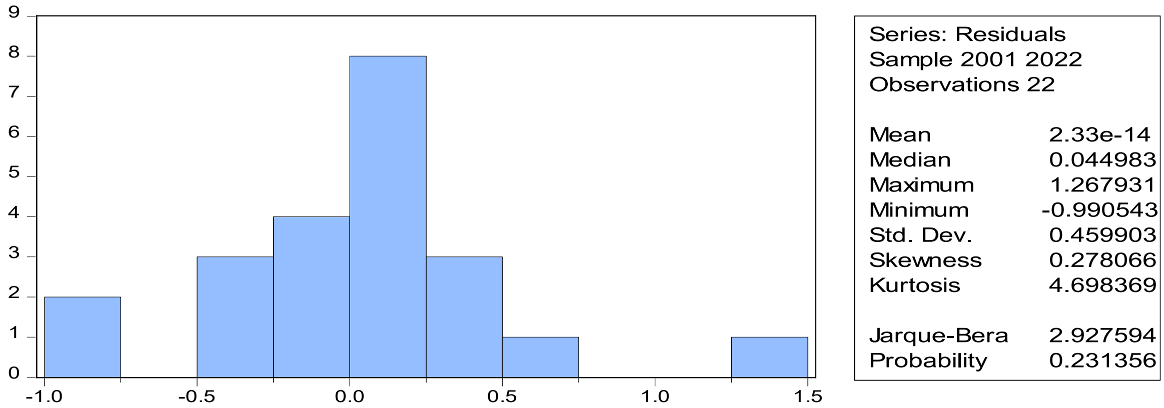
5.2.8.3 Normality test



(a) Inflation-targeting model



(b) Economic growth model



(c) Unemployment rate model

Figure 5.3: Normality test result

Source: Author’s Computation

Figure 5.3 illustrates the outcomes of the normality assessment for Models A, B, and C depicted in panels (a), (b), and (c) respectively. The Jarque-Bera (J.B) test results for assessing the normality of residual distribution reveal that the calculated J.B statistics are around 0.584853, 1.023384, and 2.927594 for Models A, B, and C respectively, accompanied by the respective probability values of 0.746450, 0.599480, and 0.231356, all exceeding 5%. Consequently, the null hypothesis of normally distributed residuals is upheld in two models. Moreover, the kurtosis statistics record 2.2333292 and 2.583954 in Models A and B correspondingly, edging closer to a kurtosis of 3, signifying normal distribution of residuals. Conversely, the findings for Model C surpass 3 marginally, standing at roughly 4.698369. Despite this, the graphical representation implies a normal distribution of residuals due to the bell-shaped curve observed, affirming normality in the unemployment rate model.

5.2.8.4 *Omitted variables test results*

This section presents a summary of omitted variables test.

Table 5.10: summary of omitted variable test results

Model A			
	Value	df	Probability
F-statistic	7.003313	(3, 15)	0.0036
Likelihood ratio	20.14213	3	0.0002
Model B			
	Value	df	Probability
F-statistic	2.025974	(3, 14)	0.0065
Likelihood ratio	7.932398	3	0.0474
Model C			
	Value	df	Probability
F-statistic	0.248180	(3, 15)	0.0014
Likelihood ratio	1.114199	3	0.0036

Source: Author's Computation

Table 5.10 presents a summary of the omitted variable test results for Model A, B, and C, examining whether the exclusion of specific variables introduces bias. In Model A, the omitted variables energy prices, economic growth, and unemployment are found to be statistically significant, with an F-statistic P-value of 0.0036 and a likelihood ratio (LR) test value P-value of 0.0002, indicating that their exclusion leads to model misspecification. Similarly, in Model B, the omission of energy prices, inflation rate, and unemployment rate also proves significant, with an F-statistic P-value of 0.0065 and an LR test value P-value of 0.0474, suggesting that these variables play a crucial role in explaining economic growth. Model C, which excludes energy prices, economic growth, and inflation rate, now shows a significant F-statistic P-value of 0.0014 and an LR test P-value of 0.0036, confirming the presence of omitted variable bias. These results highlight the necessity of including the omitted variables in all three models to ensure robust and unbiased estimations. The significance of the omitted variables across all models suggests that energy prices, economic growth, unemployment rate, and inflation rate interact in ways that cannot be ignored in macroeconomic modelling, reinforcing the importance of a comprehensive approach to econometric specification.

5.2.8.5 *CUSUM and CUSUM of Squares test of stability*

This section covers CUSUM and CUSUM of Squares test of stability results for Models A, B, and C. Figure 5.4 presents stability test results for the three models. Figures 5.4(a) and (b) provide the CUSUM and CUSUM of Squares results.

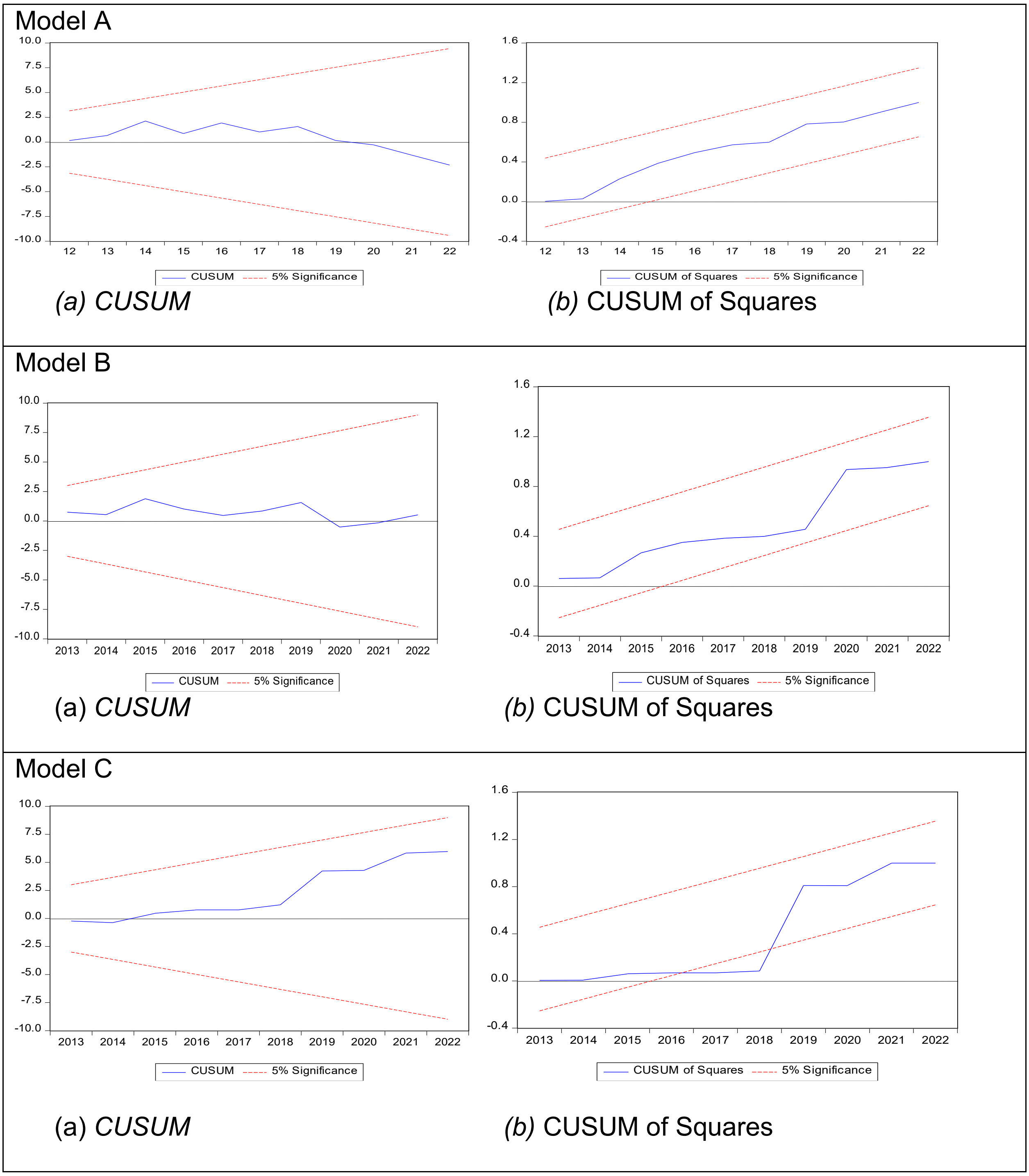


Figure 5.4: CUSUM and CUSUM of Squares results

Source: Author's Computation

In Model A, the results show that the movement of the CUSUM stability line is within the critical line of 5% significance level in the long run, in (a). The line is fluctuating within the critical line of 5%. Figure (b) shows that the movement of CUSUM of Squares line of stability is within the critical line of 5% significance level in the long run without any structural breaks. Secondly, in Model B, the results indicate that the movement of the CUSUM stability line is within the critical line of a 5% significance level in the long run. The line is fluctuating within the critical line of 5% without any structural breaks in Figure (a). Furthermore, the results show movement of CUSUM of squares line of stability is within the critical line of 5% significance level in the long run without any structural breaks in diagram (b). Thirdly, in Model C the results reveal that in Figure (a) the movement of the CUSUM stability line is within the critical line of a 5% significance level in the long run. The line graph fluctuates within the 5% critical lines. Furthermore, in diagram (b) the results indicate that the movement of CUSUM of Squares line of stability is within the critical line of 5% significance level in the long run with structural breaks from 2016 to 2019. After the structural break, the critical line of stability becomes stable. Therefore, from the observations in Table 5.12, all three models seem stable over the long run.

5.2.9 Granger Causality Results

The Granger causality test results for Models A, B, and C are analysed below, due to their uniformity in the regressed variables for all models.

Table 5.11: Granger Causality test results

Null Hypothesis:	Obs	F-Statistic	Prob.	Conclusion
EX does not Granger Cause LINF	21	1.64669	0.2237	Accept the null H_0
LINF does not Granger Cause EX	21	3.91309**	0.0414	Reject the null H_0
INFEX does not Granger Cause LINF	21	8.52452*	0.0030	Reject the null H_0
LINF does not Granger Cause INFEX	21	0.69350	0.5142	Accept the null H_0
UNEMR does not Granger Cause LGDP	21	0.00795	0.9921	Accept the null H_0
LGDP does not Granger Cause UNEMR	21	6.57902*	0.0082	Reject the null H_0
INT does not Granger Cause LGDP	21	3.89135*	0.0420	Reject the null H_0
LGDP does not Granger Cause INT	21	6.96361*	0.0067	Reject the null H_0

EX does not Granger Cause UNEMR	21	11.3340*	0.0009	Reject the null H_0
UNEMR does not Granger Cause EX	21	0.00116	0.9988	Accept the null H_0
INFEX does not Granger Cause UNEMR	21	0.47365	0.6312	Accept the null H_0
UNEMR does not Granger Cause INFEX	21	6.52243*	0.0085	Reject the null H_0

Notes: * and ** denotes 1% and 5% significance level respectively

Source: Author's Computation

The above results in Table 5.10 show a unidirectional causality, running from LINF to EX at a 5% significance level. This shows that LINF significantly has a causal effect over EX. The presence of causal relation between the two variables was evident in the correlation test, which reflected that LINF and EX are highly correlated in both Models A and B. Takentsi et al. (2022) also found a causal effect from inflation rate to the exchange rate in a South African setting. This suggests that changes in inflation rates can lead to changes in exchange rates. A high inflation rate in a country typically depreciates its currency as purchasing power declines and investors seek more stable currencies. This aligns with the theory that the inflation rate influences exchange rate movements through the purchasing power parity mechanism.

There is unidirectional causality between INFEX and INF at a 1% significance level, running from INFEX to INF. This is highly expected because INFEX and INF are highly correlated in principle. The results are in line with Kelikime and Evans (2015). This implies that inflation expectations are a leading indicator of the actual inflation rate. If people expect a higher inflation rate in the future, they may act in ways (demanding higher wages, increasing prices) that bring about a higher inflation rate. This supports the rational expectations theory, which states that people's expectations about inflation can influence the actual inflation rate.

The results revealed that there is a causal effect that runs from EX to UNEMR, the null hypothesis is rejected at 1% of significance. It is worth noting that this only applies to Models A and C. The results substantiate that changes in exchange rates can impact unemployment rates. A depreciating currency can boost exports by making them cheaper, which can increase production levels, and reduce the unemployment rate. Conversely, an appreciated currency can hurt export competitiveness and increase unemployment. Similarly, the results indicate that causality from UNEMR to INFEX in both models, the null hypothesis is rejected at a 1% significance level. This suggests that changes in unemployment rates can influence inflation expectations. For instance, a higher unemployment rate might lead to lower inflation expectations due to reduced demand pressures.

The results show unidirectional causality between LGDP and UNEMR at a 1% significance level, from LGDP to UNEMR. This aligns with Okun's Law theory, which suggests that higher economic growth leads to lower unemployment rates. As the economy grows, businesses expand and create more jobs, reducing unemployment rates. Furthermore, a bidirectional causality between INT and LGDP is determined, and the null hypothesis is rejected at a 1% significance level. The economic implications of such discoveries can be in two ways. Firstly, the causality from interest rates to economic growth indicates that changes in interest rates can predict economic growth. The results are consistent with the Keynesian economic theory which postulates that lower interest rates reduce borrowing costs, stimulate investment and consumption, and hence, boost economic growth. Secondly, the causality from economic growth to interest rates implies that economic growth can influence interest rates, possibly through the central bank's monetary policy response. For example, higher economic growth might lead the central bank to raise interest rates to control the inflation rate. This leads to demand-pull inflation, which South Africa is not experiencing due to prolonged periods of low growth.

The results show a causal link between LGDP and LINF, which runs from LGDP to UNEMR, subsequently from UNEMR to INFEX, and from INFEX to INF. This implies that Economic growth directly reduces the unemployment rate by creating more job opportunities. Then, changes in the unemployment rate might influence future inflation expectations, possibly due to changes in wage pressures and consumer demand. Inflation expectations are likely to shape actual inflation rate outcomes, as businesses and consumers adjust their behaviour based on what they anticipate will happen to prices. Therefore, Granger causality results highlight an indirect causal pathway linking economic growth to the inflation rate through intermediate variables such as unemployment and inflation expectations. Recognising these relationships helps to formulate comprehensive economic policies that consider the broader impact of economic growth on the inflation rate, thereby allowing for more effective management of stability and growth.

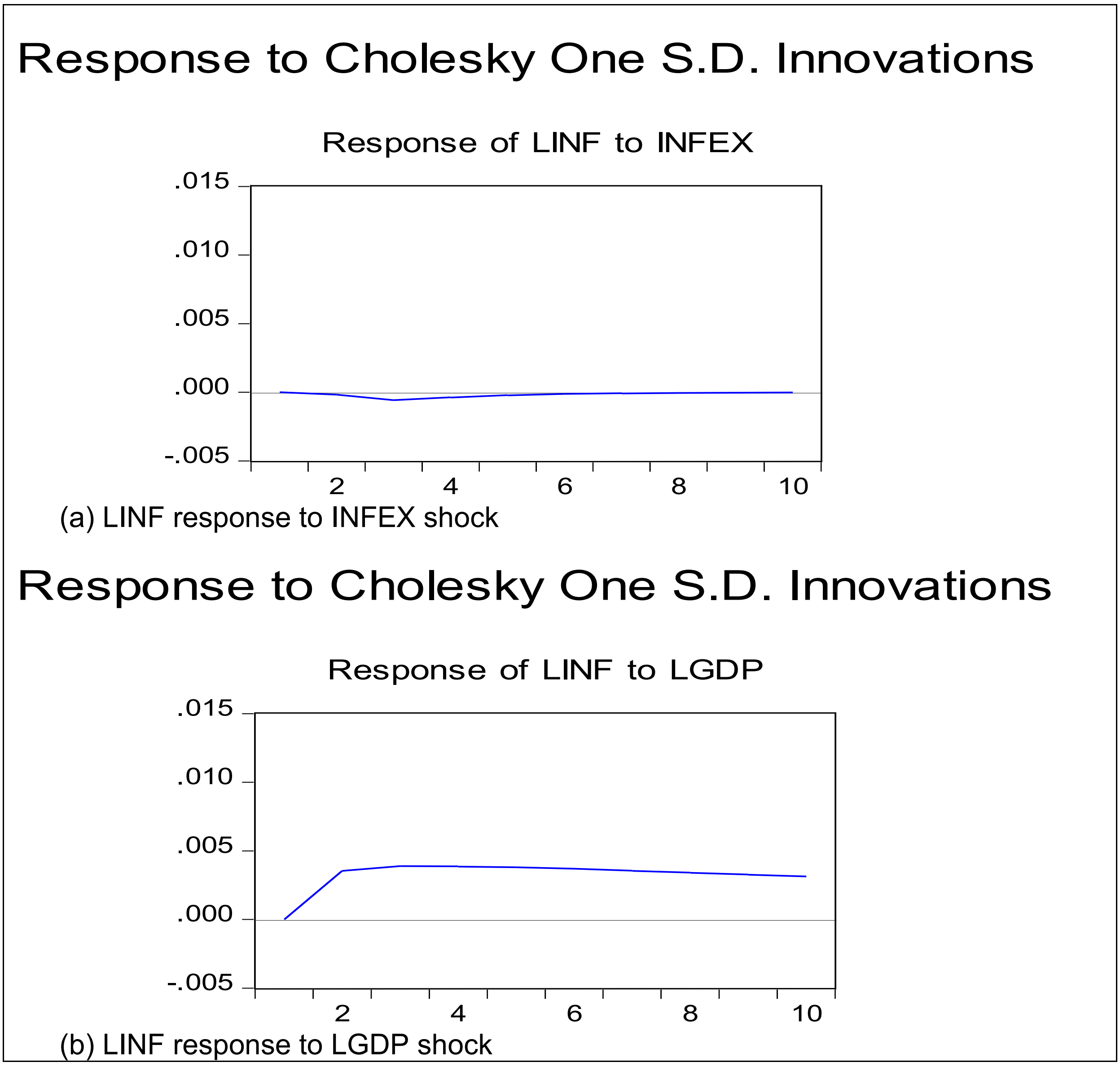
5.2.10 Forecasting Results

This section presents the IRF and VDC forecasting techniques outcomes. They show the innovation or shock responses emanating from the independent variables.

5.2.10.1 Impulse Response Function (IRF)

The IRF results are used to scrutinise the nature of short run causal influence, either positive or negative influence over the dependent variables. They are presented in Figures 5.5 to 5.7 (a) and (b) as follows,

The inflation rate was used as the Model A dependent variable and its response to innovation is presented in Figures 5.5 (a) and (b).



(a) LINF response to INFEX shock

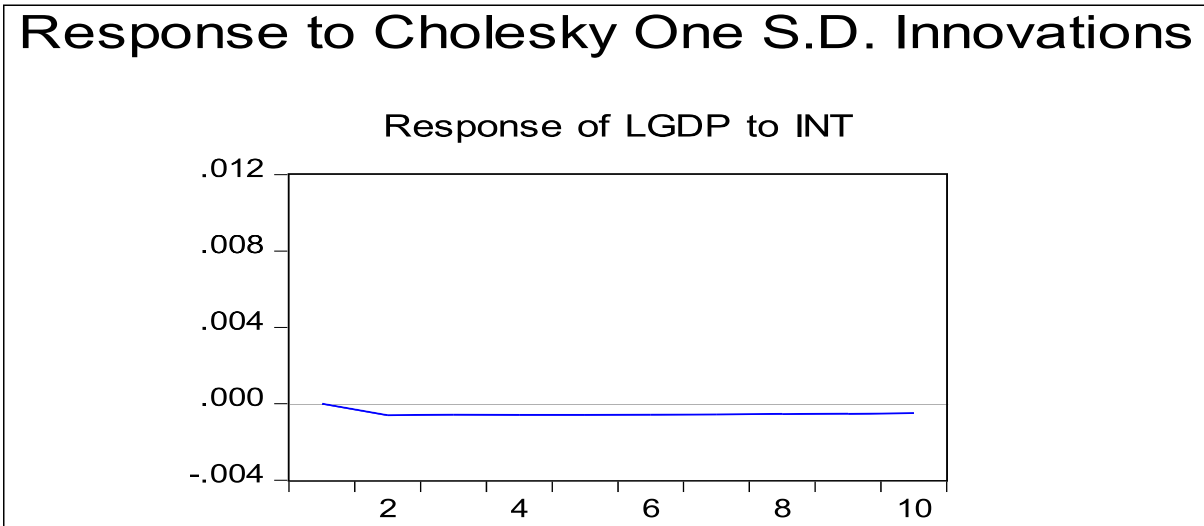
(b) LINF response to LGDP shock

Figure 5.5: IFR results for model A

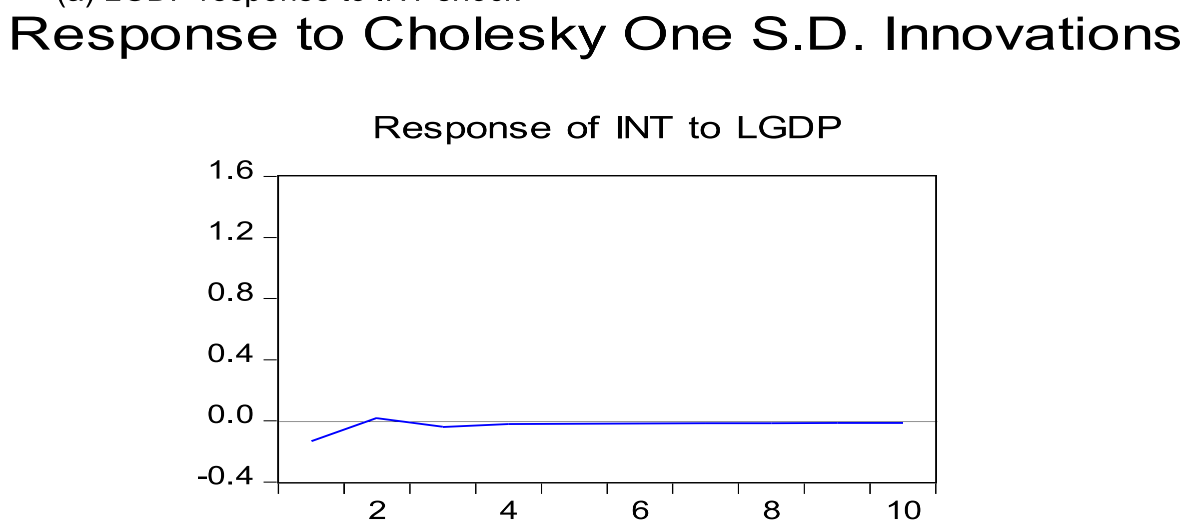
Source: Author's Computation

Figures 5.5. (a) and (b) show how LINF reacts to shock emanating from INFEX and LGDP respectively. In Figure 5.5 (a) the LINF response to INFEX shock, which indicates that from period one to mid-period six LINF is reacting negatively. However, from the mid-period, LINF is reacting neutrally throughout period 10. The INFEX appears to be bearing no effect on LINF. This substantiates the idea that the inflation rate is a monetary variable, which is attributed to several factors in the economy it cannot be attributed significantly by households and businesses' sentiments on future expected inflation rate outcomes. The results in Figure 5.5 (b) reflect how LINF behave towards pressure from LGDP. LINF is exhibiting a constant positive reaction towards LGDP shock. This implies that higher levels of economic growth are associated with higher levels of inflation rate in the long run.

Figure 5.6s (a), and (b) presents IRF Model B results, which show how economic growth reacts to shocks from independent variables.



(a) LGDP response to INT shock



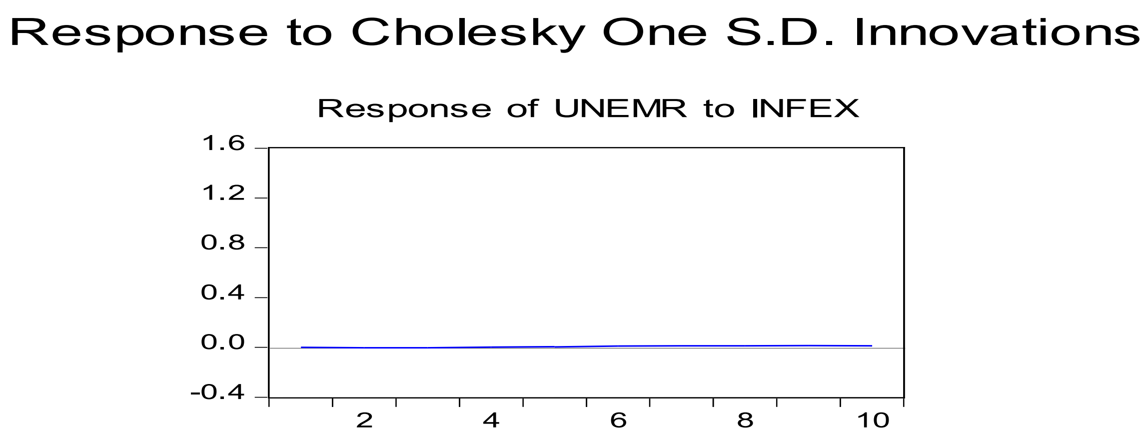
(b) INT response to LGDP shock

Figure 5.6: IFR Model B results

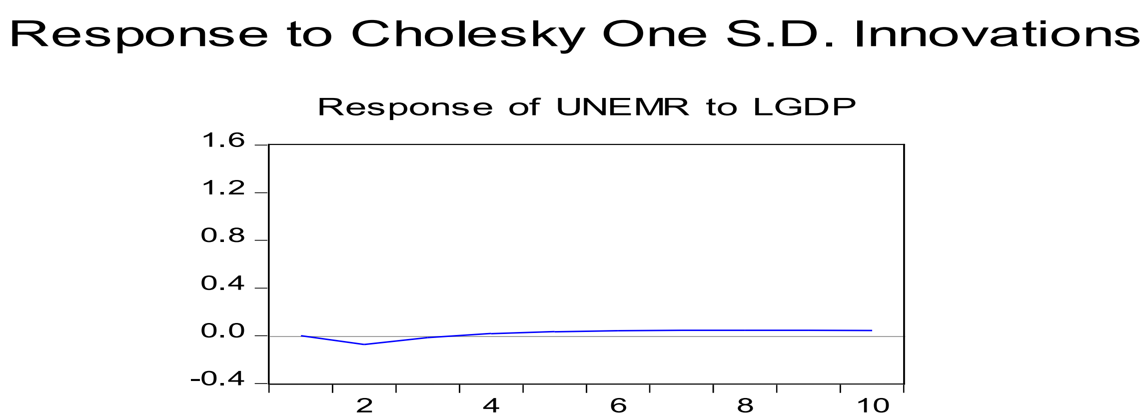
Source: Author's Computation

The INT is a prominent monetary policy tool used by the SARB in its pursuit of controlling the level of inflation rate in the economy. Figure 5.6 (a) and (b) reveal how LGDP behave towards INT shock and how INT behave towards LGDP shock accordingly. Figure 5.6 (a) shows that LGDP reacts negatively towards a shock in INT from period 1 to period 10. This implies that in the short run and long run persistent increases in interest rates can depress economic growth. Figure 5.6 (b) reveals that a shock in LGDP has a negative influence over INT from period one, which becomes slightly neutral from mid-period five and persists in exhibiting a neutral reaction up until period ten. This implies that changes in economic growth do not have a negligible effect on interest rates in the short run and the long run.

Figures 5.7s (a) and (b) presents the Model C IRF results.



(a) UNEMR response to INFEX shock



(b) UNEMR response to LGDP shock

Figure 5.7: IFR results for model C

Source: Author's Computation

The UNERM's response to INFEX shocks in Figure 5.7 (a) indicate that INFEX has a negligible effect on UNEMR in the short and long run. This implies that changes in inflation expectations do not affect the unemployment rate in the economy. Subsequently, diagram (b) shows how UNEMR react to a shock in LGDP. The IFR results reveal that LGDP shock has a futile impact on UNEMR, hence UNMER reaction appears neutral. However, in the short run from period one to period three, UNEMR exhibits a negative response towards LGDP pressure, while from period three up until period it translates to an affirmative response.

5.2.10.2 Variance Decomposition (VDC)

This section presents a joint summary of VDC results for all Models under study.

Table 5.12: Summary of Variance Decomposition Test Results

Model A: Inflation-targeting model								
Period	S.E.	LINF	LGDP	UNEMR	INT	EX	ENEP	INFEX
1	0.013246	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
3	0.016583	86.32714	9.786598	0.963823	0.635134	2.120419	0.035633	0.131255
10	0.020986	65.33128	30.14636	1.297919	0.777652	2.042640	0.032283	0.371875
Period	S.E.	LGDP	LINF	UNEMR	INT	EX_PER	ENEP	INFEX
1	0.010576	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
3	0.014363	97.13470	1.989109	0.194308	0.318101	0.021551	0.012820	0.329415
10	0.020751	92.05792	5.927092	0.731458	0.550679	0.075664	0.071048	0.586140
Model B: Economic growth model								
Period	S.E.	LGDP	LINF	UNEMR	INT	EX_PER	ENEP	INFEX
1	0.010576	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
3	0.014363	97.13470	1.989109	0.194308	0.318101	0.021551	0.012820	0.329415
10	0.020751	92.05792	5.927092	0.731458	0.550679	0.075664	0.071048	0.586140
Model C: Unemployment rate								
Period	S.E.	UNEMR	LINF	LGDP	INT	EX	ENEP	INFEX
1	1.556718	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
3	1.739323	92.28616	1.884869	1.774302	0.818050	3.042982	0.116014	0.077624
10	1.766876	90.90863	2.399937	2.104650	0.856591	3.486068	0.135625	0.108495

Source: Author's Computation

Table 5.11 presents the VDC Models A, B, and C results. The VDC technique assisted in determining how much the variance of forecast error in the dependent variables is attributable to its shock (Brooks, 2008). To simplify the analysis a short run indicator is represented by a 3rd period and long run indicator is represented by a 10th period in this study.

The results show that in Model A in the short run a shock in either LGDP, UNEMR, INT, EX, ENEP, and INFEX account for approximately 978.66%, 96.28%, 63.51%, 212.04%, 3.56% and 13.13% fluctuations in LINF respectively. It is notable that in the short run, LGDP and EX account for significant pressure in the fluctuations of LINF at 978.66% and 212.04% respectively. INFEX exhibits the least amount of pressure in the fluctuations of LINF in the short run at 13.13%. However, in the long run, a shock in either LGDP, UNEMR, INT, EX, ENEP, and INFEX is responsible for close to 3014.63%, 129.79%, 77.77%, 204.26%, 8.2283%, and 37.19% fluctuations in LINF respectively. Furthermore, even in the long run LGDP and EX still account for more pressure to changes in LINF, at a magnitude of 3014.63% and 204.26% respectively.

Subsequently, the VDC Model B results revealed that in the short run, shocks in LINF, UNEMR, INT, EXPER, ENEP, and INFEX caused around 198.91%, 19.43%, 31.81%, 2.16%, 1.28%, and 32.94% fluctuations in LGDP accordingly. The results reveal that LINF, INT, and INFEX attribute significantly to fluctuations in LGDP at around 198.91%, 31.81% and 32.94% respectively. ENEP causes a negligible effect at approximately 1.28% changes in LGDP. In the long run, shocks in LINF, UNEMR, INT, EXPER, ENEP, and INFEX resulted in 592.79%, 73.15%, 55.07%, 7.57%, 7.10%, and 58.61% fluctuations in LGDP respectively. Moreover, the result indicates that in the long run the LINF and UNEMR pose a significant pressure towards the LGDP fluctuations at about 592.79% and 73.15% is explained by shocks in LINF and UNERM respectively.

Lastly, the short run Model C VDC results show that fluctuations in the unemployment rate are attributable to shocks in LINF, LGDP, INT, EX, ENEP, and INFEX at approximately 188.49%, 177.43%, 81.81%, 304.30%, 11.60%, and 7.76% respectively. The results reflect that in the short run LINF, LGDP, and INT exert more pressure towards fluctuations in the unemployment rate at around 188.49%, 177.43%, and 81.81% in that order. Although, the VDC results reveal that in the long run the unemployment rate fluctuations are explained by shocks in LINF, LGDP, INT, EX, ENEP, and INFEX, which account for approximately 239.99%, 210.47%, 85.66%, 348.61%, 13.56%, and 10.85% fluctuations in unemployment rate. Shocks EX, LINF, LGDP, and INT appear to be attributed to more pressure that induces changes in the unemployment rate at approximately 348.61%, 239.99%, 210.47%, and 85.66% respectively.

5.3 SUMMARY

Adhering to the methodology described in Chapter 4, this chapter presented the study's empirical results. A detailed descriptive analysis of all variables was unpacked. The unit root test results revealed a mixed order of cointegration. Based on the unit root results, the ARDL Bounds test was employed to determine the existence of long run relationships in all models. Furthermore, the ARDL short and long run coefficient estimates were used to analyse the nature of the relationship in all models together with ECM. The normality test results revealed that residuals are normally distributed. The Breusch-Godfrey LM test showed no serial correlation and no significant heteroskedasticity evidence. Furthermore, CUSUM and CUSUM of Squares results indicated that all model parameters are stable. The Granger causality test was performed, to determine the cause and effect among the variables in all models. Finally, the two forecast techniques, the Impulse Response Function and Variance Decomposition were performed, and the results were analysed.

CHAPTER 6

SUMMARY, RECOMMENDATIONS, CONCLUSION

6.1 INTRODUCTION

This chapter presents a synopsis and analysis of the research, along with a final section encompassing contributions, policy recommendations, and constraints.

6.2 SUMMARY AND INTERPRETATION OF FINDINGS

The study analysed inflation-targeting, economic growth and unemployment rate conundrum amidst energy price pressures and monetary policy in South Africa. The prevailing agreement among policymakers and economists in South Africa is centred on the effects of inflation-targeting on the economy's progression. Therefore, the ARDL long run empirical results revealed the following:

6.2.1 Model A: Inflation-targeting

The long run relationship between various economic factors and the inflation rate reveals a complex interplay of influences. Foreign exchange rates exhibit a significant negative relationship with the inflation rate. This suggests a depreciation in the exchange rate, which makes imports more expensive and increases domestic inflation. On the other hand, interest rates show a negative influence on the inflation rate, although this effect is statistically insignificant. In theory, higher interest rates are expected to lower inflation by reducing consumer spending and business investment, as borrowing becomes more expensive. Energy prices play a critical role, as they display a significant positive relationship with the inflation rate. Rising energy costs directly increase production and transportation expenses, which then get passed on to consumers at higher prices, contributing to the overall inflation rate. Inflation expectations also have a significant positive impact on the inflation rate. When businesses and consumers anticipate a rising inflation rate, they adjust their prices and wages accordingly driving the actual inflation rate higher immediately. The unemployment rate shows an insignificant affirmative influence on the inflation rate. While traditional economic theory, particularly the Phillips Curve, suggests that a lower unemployment rate could lead to higher inflation due to increased demand for goods and services, the data here indicates that the relationship is weak or not statistically robust. Economic growth has a statistically significant positive influence on the inflation rate. As the economy expands and demand for goods and services rises, prices increase, leading to upward pressure on the inflation rate.

6.2.2 Model B: Economic growth

The relationship between key macroeconomic variables and economic growth in this study is characterised by varying degrees of influence, both significant and insignificant. Foreign exchange rates exhibit an insignificant negative relationship with economic growth, suggesting that fluctuations in currency values may not play a substantial role in shaping the overall growth trajectory. Although a weaker currency could theoretically boost exports, the observed data suggests this effect is minimal in this study. Similarly, interest rates also show an insignificant negative influence on economic growth. Higher interest rates typically raise borrowing costs, which can dampen investment and consumption, but the lack of statistical significance implies that other factors may mitigate this influence in the short term. Energy prices display an insignificant negative relationship with economic growth as well. While higher energy prices increase production costs and reduce disposable income for consumers, the data suggests that these effects do not have a significant overall impact on economic growth. In contrast, inflation expectations have a significant negative impact on economic growth. When the inflation rate is anticipated to rise, businesses and consumers may alter their spending and investment behaviour, often reducing demand and curbing economic activity. This can slow growth, as inflation expectations create uncertainty and hesitation in economic decision-making. The unemployment rate shows a significant adverse influence on economic growth, underscoring the critical role of labour markets in economic performance. The inflation rate has a statistically significant positive effect on economic growth. While the inflation rate is often viewed as an obstacle to economic stability, a moderate inflation rate can signal healthy economic demand and encourage spending and investment, fostering growth. However, an excessive inflation rate could have the opposite effect, so the relationship between inflation rate and growth needs to be carefully monitored to manage the trade-off between inflation rate and economic growth.

6.2.3 Model C: Unemployment rate

The relationship between various macroeconomic factors and the unemployment rate reveals a mix of significant and insignificant influences in this study. The foreign exchange rate has an insignificant negative relationship with the unemployment rate, indicating that fluctuations in the value of a country's currency do not have a strong or measurable impact on joblessness. Interest rates, however, show a statistically significant negative influence on the unemployment rate. As interest rates increase, borrowing becomes more expensive for businesses, potentially slowing down investment in new projects and expansion, which can result in reduced hiring and, therefore, a higher unemployment rate. Energy prices exhibit an insignificant positive relationship with the unemployment rate. Although higher energy costs can increase operational expenses for businesses and affect profitability, potentially leading to layoffs, this influence appears weak or not statistically meaningful. Inflation expectations, in contrast, have a significant negative impact on the unemployment rate. When the inflation rate is expected to rise, businesses may anticipate higher costs and adjust by moderating wage increases or reducing staff to maintain profitability. Economic growth has a significant positive influence on the unemployment rate. As the economy expands and businesses grow, more job opportunities are created, reducing the level of unemployment rate. This relationship underscores the importance of strong economic performance in maintaining low unemployment rate levels. The inflation rate has a statistically significant positive relationship with the unemployment rate. Higher inflation rate can reduce consumer purchasing power and disrupt economic stability, leading to job losses as businesses face decreasing demand for goods and services.

The Granger causality test results revealed a bi-directional causality between interest rates and economic growth in both models. Bi-directional causality occurs when two variables have a cause and effect on each other. Additionally, the results indicate the presence of the following unidirectional causality among the variables:

- Unidirectional causality from inflation rate to foreign exchange rate in models A and C.
- Unidirectional causality from inflation expectations to the inflation rate in all models.
- Unidirectional causality from economic growth to unemployment rate in all models.
- Unidirectional causality from foreign exchange rate to unemployment rate in models A and C only.
- Unidirectional causality from the unemployment rate to inflation expectations in all models.

The IRF and variance decomposition analyses provided valuable insights into the dynamics between the selected economic variables in the models. Model A IRF results demonstrated how the inflation rate responds to shocks from inflation expectations and economic growth. Model B's IRF results show the relationship between economic growth and interest rates. Model C reveals how the unemployment rate responds to inflation expectations and economic growth shocks.

The VD Model A results showed that, in the short run (third period), shocks in economic growth and exchange rates account for significant fluctuations in the inflation rate, with economic growth and foreign exchange rate contributing approximately 9.79% and 2.12% to the variance, respectively. In the long run (tenth period), economic growth and foreign exchange rates continue to play significant roles. They accounted for 30.15% and 2.04% of the variance in the inflation rate, respectively. In Model B, the short-run (third period) variance decomposition indicates that shocks in inflation rate and interest rates significantly impact economic growth; accounting for about 1.99% and 0.32% of its variance, respectively. In the long run (tenth period), the inflation and unemployment rates are the primary factors affecting economic growth, contributing approximately 5.93% and 0.73% to its variance, respectively. The short-run (third period) r Model C variance decomposition results show that the inflation rate and economic growth shocks, which account for 1.88% and 1.77% of its variance, respectively influence unemployment rate fluctuations significantly. In the long run (tenth period), the inflation rate and economic growth continue to be significant, contributing approximately 2.40% and 2.10% to the variance in the unemployment rate, respectively.

6.3 CONCLUSIONS

Model A focused on inflation-targeting and its results revealed that the foreign exchange rate significantly reduces the inflation rate, while energy prices and inflation expectations exert considerable upward pressure on inflation. Interestingly, while the unemployment rate showed a positive influence on the inflation rates, and the relationship was not statistically significant. Economic growth, however, positively and significantly impacts the inflation rate, suggesting that as the economy grows, inflationary pressures also increase.

Model B examined economic growth and highlighted the significant adverse impact of the unemployment rate and inflation expectations on growth. While the foreign exchange rates, interest rates, and energy prices also showed negative relationships with economic growth, these were not statistically significant. The inflation rate, however, positively influenced economic growth, indicating that a moderate inflation rate might coincide with or contribute to economic expansion. Model C analysed the unemployment rate and found that interest rates significantly reduce the unemployment rate. The influences of foreign exchange rates and energy prices were not statistically significant. Inflation expectations negatively impacted the unemployment rate, and economic growth showed a significant positive influence, indicating that as the economy expands, the unemployment rate also increases, which may seem counterintuitive but could reflect structural issues within the labour market.

The Granger Causality test results underscored several key causal relationships. Notably, a bi-directional causality between interest rates and economic growth indicates a feedback loop where each influences the other. Additionally, unidirectional causality was observed from the inflation rate to the foreign exchange rate, inflation expectations to the inflation rate, economic growth to the unemployment rate, and foreign exchange rate to the unemployment rate. These findings emphasize the interconnected nature of these variables and the importance of considering multiple factors when formulating economic policy. The IRF and VDC analyses further illuminated the dynamic responses of inflation rate, economic growth, and unemployment rate to various shocks. For instance, the IRF results demonstrated how the inflation rate reacts to inflation expectations and economic growth. The VDC results highlighted the significant roles of economic growth and foreign exchange rates in driving fluctuations in inflation and economic growth over the short and long term.

This study provides valuable insights into the complex interconnections among inflation-targeting, economic growth, and unemployment rates in South Africa. The results indicate that although inflation-targeting can aid in managing inflationary pressures, its effects on economic growth and unemployment are intricate and influenced by various economic factors. The results analysis backs the plausibility of a dual monetary policy framework mandate that seeks to balance price stability with economic growth and/or employment goals. Nevertheless, the success of such an approach would rely on a thorough examination of the underlying economic dynamics and the specific circumstances of the South African economy. As a result, policymakers should embrace a nuanced approach that integrates these findings to promote sustainable economic progress and stability.

6.4 POLICY RECOMMENDATIONS

Based on the findings, several policy recommendations can be made to enhance the economic stability and growth of South Africa while addressing inflation rate, economic growth, and unemployment rate concerns. The findings suggest that a dual mandate policy focusing on inflation rate control and economic growth could be beneficial to the South African economy. This approach would help balance the trade-offs between controlling the inflation rate and fostering economic growth. Furthermore, given the significant negative impact of exchange rates on the inflation rate, economic growth and unemployment rate, it is crucial to enhance exchange rate stability. Policies aimed at reducing exchange rate volatility, such as foreign exchange rate interventions and maintaining adequate foreign exchange reserves, can help mitigate inflationary pressures and support economic growth.

With energy prices having a significant and positive relationship with the inflation rate, improving the efficiency and stability of the energy sector is essential. Investments in energy sources, upgrading existing infrastructure, and promoting energy efficiency can help reduce energy costs and stabilise prices, easing inflationary pressures. Inflation expectations have a significant impact on both the inflation rate and economic growth. Therefore, the SARB should continue to use targeted inflation rate control measures such as interest rate adjustments and communication strategies to manage inflation expectations effectively. Clear and consistent communication about monetary policy goals and actions can help anchor inflation expectations and maintain economic stability.

The significant and positive influence outcomes of the unemployment rate on economic growth suggest structural issues in the labour market. Investing in education and skills development can help align the workforce with the demands of a growing economy. Policies that promote vocational training, higher education, and continuous professional development can enhance employability and reduce the unemployment. Therefore, prudent measures and decisions from policymakers need to be implemented when dealing with inflation and unemployment rates for the progressive realisation of macroeconomic stability.

6.5 LIMITATIONS OF THE STUDY

This research provides valuable insights into inflation-targeting, economic growth, and unemployment rate amidst energy price pressures and monetary policy in South Africa. However, several limitations must be acknowledged. The study relied on the secondary annual data from 2000 to 2022. More observations can make it possible to produce different outcomes. The analysis focused on energy prices, exchange rates, interest rates, inflation expectations, inflation rate, economic growth, and unemployment rate. However, other relevant variables such as government expenditure, domestic investment, technological advancements, global economic conditions, and social factors were not included.

6.6 AREAS FOR FURTHER RESEARCH

This study provides a comprehensive analysis of the inflation-targeting, economic growth, and unemployment rate dynamics in South Africa amidst energy price pressures and monetary policy. However, several areas warrant further research to build on these findings and address the study's limitations:

- Future research could extend the dataset beyond 2000–2022 for a more comprehensive analysis of long-term trends.
- Additional variables such as government expenditure, fiscal policy, and technological advancements should be explored to provide a broader perspective.
- A sectoral analysis could assess the varying impacts of inflation-targeting across industries.
- Alternative econometric methods like VAR could enhance forecasting accuracy.
- Comparative studies with other emerging economies would offer insights into optimizing monetary policy for sustainable growth.
- Assessing the interplay between monetary and fiscal policy, including government expenditure, taxation, and debt levels, in influencing macroeconomic stability.

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APPENDICES

Appendix A: Data

YEARS	LINF	LGDP	UNEMR	INF	ENEP	EX	EX_PER	INFEX
2000	1.385606	6.022485	25.0	24.3	5.467779	6.9468	0.827718	4.800
2001	1.409933	6.066677	25.4	25.7	30.83882	8.6093	1.662546	5.900
2002	1.471292	6.133756	27.2	29.6	173.9341	10.5176	1.908218	7.300
2003	1.506505	6.173303	27.1	32.1	981.0055	7.5550	-2.962557	6.800
2004	1.515874	6.218124	24.7	32.8	5531.970	6.4402	-1.114791	5.600
2005	1.526339	6.264109	23.8	33.6	6831.928	6.3606	-0.079596	4.100
2006	1.556303	6.313360	22.6	36.0	6138.682	6.7668	0.406223	4.925
2007	1.597695	6.370448	22.3	39.6	5605.927	7.0477	0.280847	5.525
2008	1.660865	6.416912	22.5	45.8	17349.96	8.2480	1.200277	8.175
2009	1.699838	6.446262	23.7	50.1	-1389.188	8.4117	0.163685	7.775
2010	1.705864	6.485098	24.9	50.8	10283.95	7.3159	-1.095781	6.200
2011	1.735599	6.522059	24.8	54.4	12286.63	7.2510	-0.064854	5.875
2012	1.765669	6.552228	24.9	58.3	9395.457	8.2014	0.950341	6.050
2013	1.790285	6.587557	24.7	61.7	6945.768	9.6436	1.442273	6.100
2014	1.822168	6.616357	25.1	66.4	4736.420	10.8420	1.198408	6.025
2015	1.843233	6.645500	25.3	69.7	-1531.872	12.7645	1.922483	6.075
2016	1.887054	6.677566	26.7	77.1	3531.047	14.6821	1.917575	6.050
2017	1.915927	6.705709	27.5	82.4	4265.314	13.2943	-1.387830	5.800
2018	1.931458	6.729423	27.1	85.4	6732.441	13.2255	-0.068755	5.425
2019	1.945961	6.750139	28.7	88.3	3452.673	14.4475	1.222020	5.000
2020	1.965202	6.745697	29.2	92.3	100.0000	16.4932	2.045643	4.375
2021	1.990783	6.793007	34.3	97.9	9432.266	14.7751	-1.718033	4.450
2022	2.029384	6.821419	33.5	107.0	15451.55	16.3598	1.584672	5.650

Appendix B: Descriptive analysis

	LINF	LGDP	UNEMR	INF	ENEP	EX	EX_PER	INFEX
Mean	1.724297	6.480748	26.13043	58.31739	5493.138	10.26955	0.445249	5.825000
Median	1.735599	6.522059	25.10000	54.40000	5531.970	8.609300	0.827718	5.875000
Maximum	2.029384	6.821419	34.30000	107.0000	17349.96	16.49320	2.045643	8.175000
Minimum	1.385606	6.022485	22.30000	24.30000	-1531.872	6.360600	-2.962557	4.100000
Std. Dev.	0.198188	0.245785	3.063040	25.22877	5178.508	3.446697	1.354069	1.016260
Skewness	-0.148606	-0.380449	1.304591	0.341327	0.598272	0.517474	-0.829749	0.504482
Kurtosis	1.769845	1.915861	4.411376	1.883547	2.729739	1.773723	2.917738	3.107024
Jarque-Bera	1.534882	1.681225	8.433157	1.641131	1.442062	2.467588	2.645668	0.986567
Probability	0.464199	0.431446	0.014749	0.440183	0.486251	0.291186	0.266379	0.610618
Sum	39.65884	149.0572	601.0000	1341.300	126342.2	236.1996	10.24073	133.9750
Sum Sq. Dev.	0.864129	1.329031	206.4087	14002.79	5.90E+08	261.3539	40.33704	22.72125

Observations	23	23	23	23	23	23	23	23

Appendix C: Correlation test results

Appendix C1: Model A

	LINF	EX	ENEP	INT	INFEX	LGDP	UNEMR
LINF	1.000000	0.835650	0.278990	-0.432801	-0.183653	0.994098	0.614825
EX	0.835650	1.000000	-0.038087	-0.390049	-0.218068	0.784586	0.788901
ENEP	0.278990	-0.038087	1.000000	0.025443	0.064123	0.315503	0.100011
INT	-0.432801	-0.390049	0.025443	1.000000	0.218242	-0.436118	-0.372023
INFEX	-0.183653	-0.218068	0.064123	0.218242	1.000000	-0.184231	-0.320885
LGDP	0.994098	0.784586	0.315503	-0.436118	-0.184231	1.000000	0.544091
UNEMR	0.614825	0.788901	0.100011	-0.372023	-0.320885	0.544091	1.000000

Appendix C2: Model B

	LGDP	EX_PER	ENEP	INT	INFEX	LINF	UNEMR
LGDP	1.000000	0.126499	0.315503	-0.436118	-0.184231	0.994098	0.544091
EX_PER	0.126499	1.000000	-0.117412	-0.278076	0.059503	0.126141	-0.075718
ENEP	0.315503	-0.117412	1.000000	0.025443	0.064123	0.278990	0.100011
INT	-0.436118	-0.278076	0.025443	1.000000	0.218242	-0.432801	-0.372023
INFEX	-0.184231	0.059503	0.064123	0.218242	1.000000	-0.183653	-0.320885
LINF	0.994098	0.126141	0.278990	-0.432801	-0.183653	1.000000	0.614825
UNEMR	0.544091	-0.075718	0.100011	-0.372023	-0.320885	0.614825	1.000000

Appendix C3: Model C

	UNEMR	EX	ENEP	INT	INFEX	LINF	LGDP
UNEMR	1.000000	0.788901	0.100011	-0.372023	-0.320885	0.614825	0.544091
EX	0.788901	1.000000	-0.038087	-0.390049	-0.218068	0.835650	0.784586
ENEP	0.100011	-0.038087	1.000000	0.025443	0.064123	0.278990	0.315503
INT	-0.372023	-0.390049	0.025443	1.000000	0.218242	-0.432801	-0.436118
INFEX	-0.320885	-0.218068	0.064123	0.218242	1.000000	-0.183653	-0.184231
LINF	0.614825	0.835650	0.278990	-0.432801	-0.183653	1.000000	0.994098
LGDP	0.544091	0.784586	0.315503	-0.436118	-0.184231	0.994098	1.000000

Appendix D: Unit root /stationarity test results

Augmented Dickey-Fuller: Inflation rate at level form

- None

Null Hypothesis: LINF has a unit root
Exogenous: None

Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		8.428712	1.0000
Test critical values:	1% level	-2.674290	
	5% level	-1.957204	
	10% level	-1.608175	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LINF)
Method: Least Squares
Date: 07/04/24 Time: 20:47
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF(-1)	0.016697	0.001981	8.428712	0.0000

R-squared	-0.145207	Mean dependent var	0.029263
Adjusted R-squared	-0.145207	S.D. dependent var	0.014939
S.E. of regression	0.015987	Akaike info criterion	-5.389663
Sum squared resid	0.005367	Schwarz criterion	-5.340070
Log likelihood	60.28630	Hannan-Quinn criter.	-5.377981
Durbin-Watson stat	1.380077		

- Intercept

Null Hypothesis: LINF has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.764271	0.3847
Test critical values:	1% level	-3.857386	
	5% level	-3.040391	
	10% level	-2.660551	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 18

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LINF)
Method: Least Squares
Date: 07/04/24 Time: 20:54
Sample (adjusted): 2005 2022
Included observations: 18 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF(-1)	-0.033381	0.018921	-1.764271	0.1031
D(LINF(-1))	0.107352	0.246291	0.435875	0.6707
D(LINF(-2))	-0.418054	0.245164	-1.705205	0.1139

D(LINF(-3))	-0.289885	0.219658	-1.319709	0.2116
D(LINF(-4))	-0.334020	0.214266	-1.558900	0.1450
C	0.114950	0.040159	2.862349	0.0143

R-squared	0.517927	Mean dependent var	0.028528
Adjusted R-squared	0.317063	S.D. dependent var	0.013702
S.E. of regression	0.011323	Akaike info criterion	-5.862762
Sum squared resid	0.001539	Schwarz criterion	-5.565972
Log likelihood	58.76486	Hannan-Quinn criter.	-5.821839
F-statistic	2.578498	Durbin-Watson stat	2.191957
Prob(F-statistic)	0.083038		

- Intercept and trend

Null Hypothesis: LINF has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.560197	0.0585
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LINF)
Method: Least Squares
Date: 07/04/24 Time: 20:59
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF(-1)	-0.627590	0.176280	-3.560197	0.0024
D(LINF(-1))	0.518697	0.208911	2.482861	0.0238
C	0.881764	0.239309	3.684620	0.0018
@TREND("2000")	0.017995	0.005205	3.457081	0.0030

R-squared	0.472429	Mean dependent var	0.029498
Adjusted R-squared	0.379328	S.D. dependent var	0.015267
S.E. of regression	0.012027	Akaike info criterion	-5.833618
Sum squared resid	0.002459	Schwarz criterion	-5.634661
Log likelihood	65.25299	Hannan-Quinn criter.	-5.790439
F-statistic	5.074386	Durbin-Watson stat	1.522277
Prob(F-statistic)	0.010860		

Augmented Dickey-Fuller: Inflation rate at first difference

- None

Null Hypothesis: D(LINF) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*

			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-1.165814	0.2142
Test critical values:	1% level		-2.679735	
	5% level		-1.958088	
	10% level		-1.607830	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LINF,2)
Method: Least Squares
Date: 07/04/24 Time: 21:05
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LINF(-1))	-0.145136	0.124493	-1.165814	0.2574

R-squared	0.062385	Mean dependent var	0.000680
Adjusted R-squared	0.062385	S.D. dependent var	0.019085
S.E. of regression	0.018480	Akaike info criterion	-5.097786
Sum squared resid	0.006830	Schwarz criterion	-5.048047
Log likelihood	54.52676	Hannan-Quinn criter.	-5.086992
Durbin-Watson stat	1.808772		

- Intercept

Null Hypothesis: D(LINF) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.869213	0.0010
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LINF,2)
Method: Least Squares
Date: 07/04/24 Time: 21:06
Sample (adjusted): 2003 2022
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LINF(-1))	-1.101143	0.226144	-4.869213	0.0001
D(LINF(-1),2)	0.449466	0.181200	2.480497	0.0239
C	0.030814	0.007085	4.349137	0.0004

R-squared	0.587482	Mean dependent var	-0.001138
Adjusted R-squared	0.538950	S.D. dependent var	0.017618
S.E. of regression	0.011963	Akaike info criterion	-5.876596

Sum squared resid	0.002433	Schwarz criterion	-5.727236
Log likelihood	61.76596	Hannan-Quinn criter.	-5.847439
F-statistic	12.10515	Durbin-Watson stat	2.073710
Prob(F-statistic)	0.000539		

- Intercept and trend

Null Hypothesis: D(LINF) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.022149	0.0276
Test critical values:	1% level	-4.571559	
	5% level	-3.690814	
	10% level	-3.286909	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 18

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LINF,2)
Method: Least Squares
Date: 07/04/24 Time: 21:08
Sample (adjusted): 2005 2022
Included observations: 18 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LINF(-1))	-2.012452	0.500342	-4.022149	0.0017
D(LINF(-1),2)	1.093337	0.371260	2.944938	0.0123
D(LINF(-2),2)	0.650987	0.287322	2.265707	0.0428
D(LINF(-3),2)	0.347293	0.216610	1.603315	0.1348
C	0.071430	0.018935	3.772356	0.0027
@TREND("2000")	-0.000990	0.000569	-1.738456	0.1077

R-squared	0.657887	Mean dependent var	0.001624
Adjusted R-squared	0.515340	S.D. dependent var	0.016313
S.E. of regression	0.011357	Akaike info criterion	-5.856761
Sum squared resid	0.001548	Schwarz criterion	-5.559970
Log likelihood	58.71085	Hannan-Quinn criter.	-5.815838
F-statistic	4.615223	Durbin-Watson stat	2.192076
Prob(F-statistic)	0.013987		

Phillips-Perron: Inflation rate at level form

- None

Null Hypothesis: LINF has a unit root
Exogenous: None
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	7.366496	1.0000

Test critical values:	1% level	-2.674290	
	5% level	-1.957204	
	10% level	-1.608175	

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

Residual variance (no correction)	0.000244
HAC corrected variance (Bartlett kernel)	0.000319

Phillips-Perron Test Equation
Dependent Variable: D(LINF)
Method: Least Squares
Date: 07/04/24 Time: 21:13
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF(-1)	0.016697	0.001981	8.428712	0.0000

R-squared	-0.145207	Mean dependent var	0.029263
Adjusted R-squared	-0.145207	S.D. dependent var	0.014939
S.E. of regression	0.015987	Akaike info criterion	-5.389663
Sum squared resid	0.005367	Schwarz criterion	-5.340070
Log likelihood	60.28630	Hannan-Quinn criter.	-5.377981
Durbin-Watson stat	1.380077		

- Intercept

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.842787	0.3513
Test critical values:	1% level	-3.769597	
	5% level	-3.004861	
	10% level	-2.642242	

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

Residual variance (no correction)	0.000202
HAC corrected variance (Bartlett kernel)	4.94E-05

Phillips-Perron Test Equation
Dependent Variable: D(LINF)
Method: Least Squares
Date: 07/04/24 Time: 21:14
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.

LINF(-1)	-0.017803	0.017022	-1.045890	0.3081
C	0.059714	0.029288	2.038840	0.0549

R-squared	0.051858	Mean dependent var	0.029263
Adjusted R-squared	0.004451	S.D. dependent var	0.014939
S.E. of regression	0.014906	Akaike info criterion	-5.487591
Sum squared resid	0.004444	Schwarz criterion	-5.388405
Log likelihood	62.36350	Hannan-Quinn criter.	-5.464226
F-statistic	1.093885	Durbin-Watson stat	1.617447
Prob(F-statistic)	0.308089		

- Trend and intercept

Null Hypothesis: LINF has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.203233	0.4648
Test critical values:	1% level	-4.440739	
	5% level	-3.632896	
	10% level	-3.254671	

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

Residual variance (no correction)	0.000167
HAC corrected variance (Bartlett kernel)	0.000191

Phillips-Perron Test Equation
Dependent Variable: D(LINF)
Method: Least Squares
Date: 07/04/24 Time: 21:15
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF(-1)	-0.365258	0.174079	-2.098234	0.0495
C	0.535935	0.239162	2.240884	0.0372
@TREND("2000")	0.010267	0.005123	2.004306	0.0595

R-squared	0.217339	Mean dependent var	0.029263
Adjusted R-squared	0.134954	S.D. dependent var	0.014939
S.E. of regression	0.013895	Akaike info criterion	-5.588486
Sum squared resid	0.003668	Schwarz criterion	-5.439708
Log likelihood	64.47335	Hannan-Quinn criter.	-5.553438
F-statistic	2.638077	Durbin-Watson stat	1.439284
Prob(F-statistic)	0.097488		

Phillips-Perron: Inflation rate at first difference

- None

Null Hypothesis: D(LINF) has a unit root
Exogenous: None
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.832854	0.3431
Test critical values:	1% level	-2.679735	
	5% level	-1.958088	
	10% level	-1.607830	

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

Residual variance (no correction)	0.000325
HAC corrected variance (Bartlett kernel)	0.000191

Phillips-Perron Test Equation
Dependent Variable: D(LINF,2)
Method: Least Squares
Date: 07/04/24 Time: 21:16
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LINF(-1))	-0.145136	0.124493	-1.165814	0.2574

R-squared	0.062385	Mean dependent var	0.000680
Adjusted R-squared	0.062385	S.D. dependent var	0.019085
S.E. of regression	0.018480	Akaike info criterion	-5.097786
Sum squared resid	0.006830	Schwarz criterion	-5.048047
Log likelihood	54.52676	Hannan-Quinn criter.	-5.086992
Durbin-Watson stat	1.808772		

- Intercept

Null Hypothesis: D(LINF) has a unit root
Exogenous: Constant
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.401753	0.0227
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

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

Residual variance (no correction)	0.000212
HAC corrected variance (Bartlett kernel)	7.46E-05

Phillips-Perron Test Equation
Dependent Variable: D(LINF,2)
Method: Least Squares
Date: 07/04/24 Time: 21:18
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LINF(-1))	-0.785440	0.225749	-3.479259	0.0025
C	0.023314	0.007313	3.188221	0.0048

R-squared	0.389171	Mean dependent var	0.000680
Adjusted R-squared	0.357022	S.D. dependent var	0.019085
S.E. of regression	0.015304	Akaike info criterion	-5.431070
Sum squared resid	0.004450	Schwarz criterion	-5.331592
Log likelihood	59.02624	Hannan-Quinn criter.	-5.409481
F-statistic	12.10525	Durbin-Watson stat	1.473895
Prob(F-statistic)	0.002511		

- Trend and intercept

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.714088	0.0439
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

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

Residual variance (no correction)	0.000204
HAC corrected variance (Bartlett kernel)	4.61E-05

Phillips-Perron Test Equation
Dependent Variable: D(LINF,2)
Method: Least Squares
Date: 07/04/24 Time: 21:19
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LINF(-1))	-0.835226	0.235922	-3.540264	0.0023
C	0.030362	0.011396	2.664235	0.0158
@TREND("2000")	-0.000468	0.000576	-0.811506	0.4277

R-squared	0.410729	Mean dependent var	0.000680
Adjusted R-squared	0.345255	S.D. dependent var	0.019085
S.E. of regression	0.015443	Akaike info criterion	-5.371764
Sum squared resid	0.004293	Schwarz criterion	-5.222547

Log likelihood	59.40353	Hannan-Quinn criter.	-5.339380
F-statistic	6.273119	Durbin-Watson stat	1.475875
Prob(F-statistic)	0.008567		

Augmented Dickey-Fuller: economic growth at level form

- None

Null Hypothesis: LGDP has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		10.88839	1.0000
Test critical values:	1% level	-2.674290	
	5% level	-1.957204	
	10% level	-1.608175	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGDP)
Method: Least Squares
Date: 07/04/24 Time: 21:55
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGDP(-1)	0.005554	0.000510	10.88839	0.0000

R-squared	-0.138225	Mean dependent var	0.036315
Adjusted R-squared	-0.138225	S.D. dependent var	0.014508
S.E. of regression	0.015478	Akaike info criterion	-5.454409
Sum squared resid	0.005031	Schwarz criterion	-5.404816
Log likelihood	60.99850	Hannan-Quinn criter.	-5.442727
Durbin-Watson stat	1.144462		

- Intercept

Null Hypothesis: LGDP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.413278	0.0024
Test critical values:	1% level	-3.769597	
	5% level	-3.004861	
	10% level	-2.642242	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LGDP)
Method: Least Squares
Date: 07/04/24 Time: 21:58
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGDP(-1)	-0.042493	0.009628	-4.413278	0.0003
C	0.311045	0.062292	4.993370	0.0001

R-squared	0.493376	Mean dependent var	0.036315
Adjusted R-squared	0.468045	S.D. dependent var	0.014508
S.E. of regression	0.010581	Akaike info criterion	-6.172957
Sum squared resid	0.002239	Schwarz criterion	-6.073771
Log likelihood	69.90252	Hannan-Quinn criter.	-6.149592
F-statistic	19.47703	Durbin-Watson stat	2.449826
Prob(F-statistic)	0.000268		

- Trend intercept

Null Hypothesis: LGDP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.106673	0.9048
Test critical values:	1% level	-4.440739	
	5% level	-3.632896	
	10% level	-3.254671	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGDP)
Method: Least Squares
Date: 07/04/24 Time: 21:59
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGDP(-1)	-0.074688	0.067488	-1.106673	0.2823
C	0.505371	0.408001	1.238650	0.2306
@TREND("2000")	0.001202	0.002492	0.482167	0.6352

R-squared	0.499500	Mean dependent var	0.036315
Adjusted R-squared	0.446816	S.D. dependent var	0.014508
S.E. of regression	0.010790	Akaike info criterion	-6.094209
Sum squared resid	0.002212	Schwarz criterion	-5.945431
Log likelihood	70.03630	Hannan-Quinn criter.	-6.059162
F-statistic	9.481033	Durbin-Watson stat	2.403873
Prob(F-statistic)	0.001394		

Augmented Dickey-Fuller: economic growth at first difference

- None

Null Hypothesis: D(LGDP) has a unit root
Exogenous: None
Lag Length: 1 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.248407	0.1875
Test critical values:	1% level	-2.685718	
	5% level	-1.959071	
	10% level	-1.607456	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGDP,2)
Method: Least Squares
Date: 07/04/24 Time: 22:07
Sample (adjusted): 2003 2022
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGDP(-1))	-0.096966	0.077672	-1.248407	0.2279
D(LGDP(-1),2)	-0.520399	0.185781	-2.801141	0.0118

R-squared	0.380969	Mean dependent var	-0.001933
Adjusted R-squared	0.346579	S.D. dependent var	0.016416
S.E. of regression	0.013269	Akaike info criterion	-5.712064
Sum squared resid	0.003169	Schwarz criterion	-5.612491
Log likelihood	59.12064	Hannan-Quinn criter.	-5.692627
Durbin-Watson stat	2.092911		

- Intercept

Null Hypothesis: D(LGDP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.042386	0.0471
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGDP,2)
Method: Least Squares
Date: 07/04/24 Time: 22:09
Sample (adjusted): 2002 2022

Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGDP(-1))	-0.655210	0.215360	-3.042386	0.0067
C	0.023289	0.008489	2.743570	0.0129

R-squared	0.327579	Mean dependent var	-0.000751
Adjusted R-squared	0.292189	S.D. dependent var	0.016892
S.E. of regression	0.014211	Akaike info criterion	-5.579152
Sum squared resid	0.003837	Schwarz criterion	-5.479674
Log likelihood	60.58110	Hannan-Quinn criter.	-5.557563
F-statistic	9.256113	Durbin-Watson stat	2.070425
Prob(F-statistic)	0.006701		

- Trend and intercept

Null Hypothesis: D(LGDP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.553104	0.0636
Test critical values:	1% level	-4.571559	
	5% level	-3.690814	
	10% level	-3.286909	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 18

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGDP,2)
Method: Least Squares
Date: 07/04/24 Time: 22:10
Sample (adjusted): 2005 2022
Included observations: 18 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGDP(-1))	-3.356907	0.944781	-3.553104	0.0040
D(LGDP(-1),2)	1.851918	0.787507	2.351620	0.0366
D(LGDP(-2),2)	1.154643	0.635983	1.815524	0.0945
D(LGDP(-3),2)	0.536985	0.374887	1.432391	0.1776
C	0.199928	0.058470	3.419330	0.0051
@TREND("2000")	-0.005984	0.001796	-3.331081	0.0060

R-squared	0.718548	Mean dependent var	-0.000912
Adjusted R-squared	0.601277	S.D. dependent var	0.016077
S.E. of regression	0.010152	Akaike info criterion	-6.081159
Sum squared resid	0.001237	Schwarz criterion	-5.784368
Log likelihood	60.73043	Hannan-Quinn criter.	-6.040235
F-statistic	6.127221	Durbin-Watson stat	2.071925
Prob(F-statistic)	0.004821		

Phillips-Perron: economic growth at level form

- None

Null Hypothesis: LGDP has a unit root
Exogenous: None
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		7.356164	1.0000
Test critical values:	1% level	-2.674290	
	5% level	-1.957204	
	10% level	-1.608175	

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

Residual variance (no correction)	0.000229
HAC corrected variance (Bartlett kernel)	0.000500

Phillips-Perron Test Equation
Dependent Variable: D(LGDP)
Method: Least Squares
Date: 07/04/24 Time: 22:20
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGDP(-1)	0.005554	0.000510	10.88839	0.0000

R-squared	-0.138225	Mean dependent var	0.036315
Adjusted R-squared	-0.138225	S.D. dependent var	0.014508
S.E. of regression	0.015478	Akaike info criterion	-5.454409
Sum squared resid	0.005031	Schwarz criterion	-5.404816
Log likelihood	60.99850	Hannan-Quinn criter.	-5.442727
Durbin-Watson stat	1.144462		

- Intercept

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-9.539670	0.0000
Test critical values:	1% level	-3.769597	
	5% level	-3.004861	
	10% level	-2.642242	

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

Residual variance (no correction)	0.000102

HAC corrected variance (Bartlett kernel)	2.10E-05

Phillips-Perron Test Equation
Dependent Variable: D(LGDP)
Method: Least Squares
Date: 07/04/24 Time: 22:21
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGDP(-1)	-0.042493	0.009628	-4.413278	0.0003
C	0.311045	0.062292	4.993370	0.0001

R-squared	0.493376	Mean dependent var	0.036315
Adjusted R-squared	0.468045	S.D. dependent var	0.014508
S.E. of regression	0.010581	Akaike info criterion	-6.172957
Sum squared resid	0.002239	Schwarz criterion	-6.073771
Log likelihood	69.90252	Hannan-Quinn criter.	-6.149592
F-statistic	19.47703	Durbin-Watson stat	2.449826
Prob(F-statistic)	0.000268		

- Trend and intercept

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.096920	0.9066
Test critical values:	1% level	-4.440739	
	5% level	-3.632896	
	10% level	-3.254671	

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

Residual variance (no correction)	0.000101
HAC corrected variance (Bartlett kernel)	3.97E-05

Phillips-Perron Test Equation
Dependent Variable: D(LGDP)
Method: Least Squares
Date: 07/04/24 Time: 22:22
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGDP(-1)	-0.074688	0.067488	-1.106673	0.2823
C	0.505371	0.408001	1.238650	0.2306
@TREND("2000")	0.001202	0.002492	0.482167	0.6352

R-squared	0.499500	Mean dependent var	0.036315

Adjusted R-squared	0.446816	S.D. dependent var	0.014508
S.E. of regression	0.010790	Akaike info criterion	-6.094209
Sum squared resid	0.002212	Schwarz criterion	-5.945431
Log likelihood	70.03630	Hannan-Quinn criter.	-6.059162
F-statistic	9.481033	Durbin-Watson stat	2.403873
Prob(F-statistic)	0.001394		

Phillips-Perron: economic growth at first difference

- None

Null Hypothesis: D(LGDP) has a unit root
Exogenous: None
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.944202	0.2965
Test critical values:	1% level	-2.679735	
	5% level	-1.958088	
	10% level	-1.607830	

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

Residual variance (no correction)	0.000255
HAC corrected variance (Bartlett kernel)	9.15E-05

Phillips-Perron Test Equation
Dependent Variable: D(LGDP,2)
Method: Least Squares
Date: 07/04/24 Time: 22:23
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGDP(-1))	-0.105195	0.090612	-1.160941	0.2593

R-squared	0.061188	Mean dependent var	-0.000751
Adjusted R-squared	0.061188	S.D. dependent var	0.016892
S.E. of regression	0.016367	Akaike info criterion	-5.340660
Sum squared resid	0.005358	Schwarz criterion	-5.290921
Log likelihood	57.07693	Hannan-Quinn criter.	-5.329865
Durbin-Watson stat	2.794315		

- Intercept

Null Hypothesis: D(LGDP) has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*

Phillips-Perron test statistic		-2.945356	0.0570
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

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

Residual variance (no correction)	0.000183
HAC corrected variance (Bartlett kernel)	0.000154

Phillips-Perron Test Equation
Dependent Variable: D(LGDP,2)
Method: Least Squares
Date: 07/04/24 Time: 22:24
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGDP(-1))	-0.655210	0.215360	-3.042386	0.0067
C	0.023289	0.008489	2.743570	0.0129

R-squared	0.327579	Mean dependent var	-0.000751
Adjusted R-squared	0.292189	S.D. dependent var	0.016892
S.E. of regression	0.014211	Akaike info criterion	-5.579152
Sum squared resid	0.003837	Schwarz criterion	-5.479674
Log likelihood	60.58110	Hannan-Quinn criter.	-5.557563
F-statistic	9.256113	Durbin-Watson stat	2.070425
Prob(F-statistic)	0.006701		

- Trend and intercept

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.169890	0.0000
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

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

Residual variance (no correction)	0.000101
HAC corrected variance (Bartlett kernel)	3.10E-05

Phillips-Perron Test Equation
Dependent Variable: D(LGDP,2)
Method: Least Squares
Date: 07/04/24 Time: 22:25
Sample (adjusted): 2002 2022

Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGDP(-1))	-1.254273	0.227927	-5.502966	0.0000
C	0.070009	0.013894	5.038652	0.0001
@TREND("2000")	-0.002062	0.000542	-3.803452	0.0013

R-squared	0.627195	Mean dependent var	-0.000751
Adjusted R-squared	0.585772	S.D. dependent var	0.016892
S.E. of regression	0.010872	Akaike info criterion	-6.073744
Sum squared resid	0.002127	Schwarz criterion	-5.924526
Log likelihood	66.77431	Hannan-Quinn criter.	-6.041360
F-statistic	15.14132	Durbin-Watson stat	1.838825
Prob(F-statistic)	0.000139		

Augmented Dickey-Fuller: unemployment rate at level form

- None

Null Hypothesis: UNEMR has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.286781	0.9446
Test critical values:	1% level	-2.674290	
	5% level	-1.957204	
	10% level	-1.608175	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(UNEMR)
Method: Least Squares
Date: 07/04/24 Time: 22:30
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UNEMR(-1)	0.015226	0.011833	1.286781	0.2122

R-squared	0.003309	Mean dependent var	0.386364
Adjusted R-squared	0.003309	S.D. dependent var	1.441327
S.E. of regression	1.438941	Akaike info criterion	3.610081
Sum squared resid	43.48157	Schwarz criterion	3.659674
Log likelihood	-38.71089	Hannan-Quinn criter.	3.621763
Durbin-Watson stat	1.912314		

- Intercept

Null Hypothesis: UNEMR has a unit root
Exogenous: Constant

Lag Length: 3 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.624635	0.9864
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 19

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(UNEMR)
Method: Least Squares
Date: 07/04/24 Time: 22:35
Sample (adjusted): 2004 2022
Included observations: 19 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UNEMR(-1)	0.153130	0.245152	0.624635	0.5423
D(UNEMR(-1))	-0.120642	0.385736	-0.312759	0.7591
D(UNEMR(-2))	0.379304	0.407444	0.930937	0.3677
D(UNEMR(-3))	-0.616983	0.447289	-1.379383	0.1894
C	-3.522129	6.156089	-0.572137	0.5763

R-squared	0.163859	Mean dependent var	0.336842
Adjusted R-squared	-0.075038	S.D. dependent var	1.515553
S.E. of regression	1.571386	Akaike info criterion	3.962728
Sum squared resid	34.56957	Schwarz criterion	4.211264
Log likelihood	-32.64591	Hannan-Quinn criter.	4.004790
F-statistic	0.685899	Durbin-Watson stat	1.720472
Prob(F-statistic)	0.613466		

- Trend and intercept

Null Hypothesis: UNEMR has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.800027	0.9502
Test critical values:	1% level	-4.440739	
	5% level	-3.632896	
	10% level	-3.254671	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(UNEMR)
Method: Least Squares
Date: 07/04/24 Time: 22:38
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UNEMR(-1)	-0.111063	0.138824	-0.800027	0.4336
C	2.016787	3.260722	0.618509	0.5436
@TREND("2000")	0.107348	0.057066	1.881108	0.0754

R-squared	0.161509	Mean dependent var	0.386364
Adjusted R-squared	0.073247	S.D. dependent var	1.441327
S.E. of regression	1.387537	Akaike info criterion	3.619062
Sum squared resid	36.57993	Schwarz criterion	3.767840
Log likelihood	-36.80968	Hannan-Quinn criter.	3.654109
F-statistic	1.829879	Durbin-Watson stat	2.014926
Prob(F-statistic)	0.187601		

Augmented Dickey-Fuller: unemployment rate at first difference

- None

Null Hypothesis: D(UNEMR) has a unit root
Exogenous: None
Lag Length: 1 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.721044	0.0805
Test critical values:	1% level	-2.685718	
	5% level	-1.959071	
	10% level	-1.607456	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(UNEMR,2)
Method: Least Squares
Date: 07/04/24 Time: 22:39
Sample (adjusted): 2003 2022
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UNEMR(-1))	-0.612028	0.355615	-1.721044	0.1024
D(UNEMR(-1),2)	-0.357811	0.351895	-1.016813	0.3227

R-squared	0.489132	Mean dependent var	-0.130000
Adjusted R-squared	0.460750	S.D. dependent var	2.046846
S.E. of regression	1.503073	Akaike info criterion	3.747540
Sum squared resid	40.66613	Schwarz criterion	3.847114
Log likelihood	-35.47540	Hannan-Quinn criter.	3.766978
Durbin-Watson stat	1.810316		

- Intercept

Null Hypothesis: D(UNEMR) has a unit root
Exogenous: Constant

Lag Length: 1 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.825089	0.3584
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(UNEMR,2)
Method: Least Squares
Date: 07/04/24 Time: 22:39
Sample (adjusted): 2003 2022
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UNEMR(-1))	-0.686180	0.375970	-1.825089	0.0856
D(UNEMR(-1),2)	-0.325519	0.359948	-0.904352	0.3784
C	0.251847	0.359578	0.700396	0.4932

R-squared	0.503460	Mean dependent var	-0.130000
Adjusted R-squared	0.445044	S.D. dependent var	2.046846
S.E. of regression	1.524806	Akaike info criterion	3.819093
Sum squared resid	39.52557	Schwarz criterion	3.968452
Log likelihood	-35.19093	Hannan-Quinn criter.	3.848249
F-statistic	8.618462	Durbin-Watson stat	1.797052
Prob(F-statistic)	0.002604		

- Trend and intercept

Null Hypothesis: D(UNEMR) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.784255	0.0062
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 19

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(UNEMR,2)
Method: Least Squares
Date: 07/04/24 Time: 22:40
Sample (adjusted): 2004 2022
Included observations: 19 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.

D(UNEMR(-1))	-1.886635	0.394342	-4.784255	0.0003
D(UNEMR(-1),2)	0.407000	0.336528	1.209410	0.2465
D(UNEMR(-2),2)	0.643701	0.271014	2.375158	0.0324
C	-2.641114	0.793028	-3.330416	0.0050
@TREND("2000")	0.248862	0.062966	3.952297	0.0014

R-squared	0.779902	Mean dependent var	-0.036842
Adjusted R-squared	0.717016	S.D. dependent var	2.058913
S.E. of regression	1.095264	Akaike info criterion	3.240801
Sum squared resid	16.79443	Schwarz criterion	3.489338
Log likelihood	-25.78761	Hannan-Quinn criter.	3.282864
F-statistic	12.40198	Durbin-Watson stat	1.939676
Prob(F-statistic)	0.000162		

Phillips-Perron: unemployment rate at level form

- None

Null Hypothesis: UNEMR has a unit root
Exogenous: None
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		1.268795	0.9428
Test critical values:	1% level	-2.674290	
	5% level	-1.957204	
	10% level	-1.608175	

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

Residual variance (no correction)	1.976435
HAC corrected variance (Bartlett kernel)	2.023344

Phillips-Perron Test Equation
Dependent Variable: D(UNEMR)
Method: Least Squares
Date: 07/04/24 Time: 22:44
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UNEMR(-1)	0.015226	0.011833	1.286781	0.2122

R-squared	0.003309	Mean dependent var	0.386364
Adjusted R-squared	0.003309	S.D. dependent var	1.441327
S.E. of regression	1.438941	Akaike info criterion	3.610081
Sum squared resid	43.48157	Schwarz criterion	3.659674
Log likelihood	-38.71089	Hannan-Quinn criter.	3.621763
Durbin-Watson stat	1.912314		

- Intercept

Null Hypothesis: UNEMR has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		0.339844	0.9750
Test critical values:	1% level	-3.769597	
	5% level	-3.004861	
	10% level	-2.642242	

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

Residual variance (no correction)	1.972390
HAC corrected variance (Bartlett kernel)	1.955999

Phillips-Perron Test Equation
Dependent Variable: D(UNEMR)
Method: Least Squares
Date: 07/04/24 Time: 22:45
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UNEMR(-1)	0.039488	0.120416	0.327934	0.7464
C	-0.632258	3.122019	-0.202516	0.8416

R-squared	0.005348	Mean dependent var	0.386364
Adjusted R-squared	-0.044384	S.D. dependent var	1.441327
S.E. of regression	1.472966	Akaike info criterion	3.698941
Sum squared resid	43.39259	Schwarz criterion	3.798127
Log likelihood	-38.68836	Hannan-Quinn criter.	3.722307
F-statistic	0.107540	Durbin-Watson stat	1.963176
Prob(F-statistic)	0.746370		

- Trend and intercept

Null Hypothesis: UNEMR has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.800027	0.9502
Test critical values:	1% level	-4.440739	
	5% level	-3.632896	
	10% level	-3.254671	

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

Residual variance (no correction)	1.662724
HAC corrected variance (Bartlett kernel)	1.662724

Phillips-Perron Test Equation
Dependent Variable: D(UNEMR)
Method: Least Squares
Date: 07/04/24 Time: 22:45
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UNEMR(-1)	-0.111063	0.138824	-0.800027	0.4336
C	2.016787	3.260722	0.618509	0.5436
@TREND("2000")	0.107348	0.057066	1.881108	0.0754

R-squared	0.161509	Mean dependent var	0.386364
Adjusted R-squared	0.073247	S.D. dependent var	1.441327
S.E. of regression	1.387537	Akaike info criterion	3.619062
Sum squared resid	36.57993	Schwarz criterion	3.767840
Log likelihood	-36.80968	Hannan-Quinn criter.	3.654109
F-statistic	1.829879	Durbin-Watson stat	2.014926
Prob(F-statistic)	0.187601		

Phillips-Perron: unemployment rate at first difference

- None

Null Hypothesis: D(UNEMR) has a unit root
Exogenous: None
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.933081	0.0004
Test critical values:	1% level	-2.679735	
	5% level	-1.958088	
	10% level	-1.607830	

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

Residual variance (no correction)	2.194376
HAC corrected variance (Bartlett kernel)	2.124489

Phillips-Perron Test Equation
Dependent Variable: D(UNEMR,2)
Method: Least Squares
Date: 07/04/24 Time: 22:51
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.

D(UNEMR(-1))	-0.879836	0.223152	-3.942768	0.0008

R-squared	0.436868	Mean dependent var	-0.057143
Adjusted R-squared	0.436868	S.D. dependent var	2.022763
S.E. of regression	1.517924	Akaike info criterion	3.719013
Sum squared resid	46.08189	Schwarz criterion	3.768752
Log likelihood	-38.04963	Hannan-Quinn criter.	3.729807
Durbin-Watson stat	1.953775		

- Intercept

Null Hypothesis: D(UNEMR) has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.086402	0.0052
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

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

Residual variance (no correction)	2.073018
HAC corrected variance (Bartlett kernel)	2.058274

Phillips-Perron Test Equation
Dependent Variable: D(UNEMR,2)
Method: Least Squares
Date: 07/04/24 Time: 22:51
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UNEMR(-1))	-0.953196	0.233146	-4.088406	0.0006
C	0.364987	0.346073	1.054651	0.3048

R-squared	0.468012	Mean dependent var	-0.057143
Adjusted R-squared	0.440012	S.D. dependent var	2.022763
S.E. of regression	1.513681	Akaike info criterion	3.757359
Sum squared resid	43.53338	Schwarz criterion	3.856837
Log likelihood	-37.45227	Hannan-Quinn criter.	3.778948
F-statistic	16.71506	Durbin-Watson stat	1.922887
Prob(F-statistic)	0.000626		

- Trend and intercept

Null Hypothesis: D(UNEMR) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*

Phillips-Perron test statistic		-4.798648	0.0051
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

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

Residual variance (no correction)	1.706411
HAC corrected variance (Bartlett kernel)	1.589698

Phillips-Perron Test Equation
Dependent Variable: D(UNEMR,2)
Method: Least Squares
Date: 07/04/24 Time: 22:50
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UNEMR(-1))	-1.181196	0.246318	-4.795411	0.0001
C	-0.894022	0.716906	-1.247056	0.2284
@TREND("2000")	0.113332	0.057631	1.966503	0.0649

R-squared	0.562092	Mean dependent var	-0.057143
Adjusted R-squared	0.513436	S.D. dependent var	2.022763
S.E. of regression	1.410962	Akaike info criterion	3.657984
Sum squared resid	35.83464	Schwarz criterion	3.807201
Log likelihood	-35.40883	Hannan-Quinn criter.	3.690368
F-statistic	11.55226	Durbin-Watson stat	1.896052
Prob(F-statistic)	0.000592		

Augmented Dickey-Fuller: Inflation rate at level form

- None

Null Hypothesis: INT has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.218314	0.1975
Test critical values:	1% level	-2.674290	
	5% level	-1.957204	

	10% level	-1.608175	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INT)
Method: Least Squares
Date: 07/04/24 Time: 23:02
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INT(-1)	-0.118080	0.096921	-1.218314	0.2366

R-squared	0.065233	Mean dependent var	-0.059683
Adjusted R-squared	0.065233	S.D. dependent var	2.111186
S.E. of regression	2.041166	Akaike info criterion	4.309309
Sum squared resid	87.49355	Schwarz criterion	4.358902
Log likelihood	-46.40240	Hannan-Quinn criter.	4.320991
Durbin-Watson stat	2.676083		

- Intercept

Null Hypothesis: INT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.773257	0.0099
Test critical values:	1% level	-3.769597	
	5% level	-3.004861	
	10% level	-2.642242	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INT)
Method: Least Squares
Date: 07/04/24 Time: 23:03
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INT(-1)	-0.830543	0.220113	-3.773257	0.0012
C	3.424205	0.988315	3.464689	0.0024

R-squared	0.415845	Mean dependent var	-0.059683
Adjusted R-squared	0.386637	S.D. dependent var	2.111186
S.E. of regression	1.653428	Akaike info criterion	3.930087
Sum squared resid	54.67651	Schwarz criterion	4.029273
Log likelihood	-41.23096	Hannan-Quinn criter.	3.953452
F-statistic	14.23747	Durbin-Watson stat	2.010587
Prob(F-statistic)	0.001195		

- Trend and intercept

Null Hypothesis: INT has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.500166	0.0088
Test critical values:	1% level	-4.440739	
	5% level	-3.632896	
	10% level	-3.254671	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INT)
Method: Least Squares
Date: 07/04/24 Time: 23:04
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INT(-1)	-1.033129	0.229576	-4.500166	0.0002
C	5.595066	1.432250	3.906486	0.0009
@TREND("2000")	-0.114876	0.057952	-1.982245	0.0621

R-squared	0.515949	Mean dependent var	-0.059683
Adjusted R-squared	0.464996	S.D. dependent var	2.111186
S.E. of regression	1.544205	Akaike info criterion	3.833020
Sum squared resid	45.30684	Schwarz criterion	3.981798
Log likelihood	-39.16322	Hannan-Quinn criter.	3.868068
F-statistic	10.12602	Durbin-Watson stat	1.993837
Prob(F-statistic)	0.001015		

Phillips-Perron: inflation rate at level form

- None

Null Hypothesis: INT has a unit root
Exogenous: None
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.934247	0.3010
Test critical values:	1% level	-2.674290	
	5% level	-1.957204	
	10% level	-1.608175	

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

Residual variance (no correction)	3.976980
HAC corrected variance (Bartlett kernel)	1.557904

Phillips-Perron Test Equation
Dependent Variable: D(INT)
Method: Least Squares
Date: 07/04/24 Time: 23:04
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INT(-1)	-0.118080	0.096921	-1.218314	0.2366

R-squared	0.065233	Mean dependent var	-0.059683
Adjusted R-squared	0.065233	S.D. dependent var	2.111186
S.E. of regression	2.041166	Akaike info criterion	4.309309
Sum squared resid	87.49355	Schwarz criterion	4.358902
Log likelihood	-46.40240	Hannan-Quinn criter.	4.320991
Durbin-Watson stat	2.676083		

- Intercept

Null Hypothesis: INT has a unit root
Exogenous: Constant
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.773257	0.0099
Test critical values:	1% level	-3.769597	
	5% level	-3.004861	
	10% level	-2.642242	

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

Residual variance (no correction)	2.485296
HAC corrected variance (Bartlett kernel)	2.485296

Phillips-Perron Test Equation
Dependent Variable: D(INT)
Method: Least Squares
Date: 07/04/24 Time: 23:06
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INT(-1)	-0.830543	0.220113	-3.773257	0.0012
C	3.424205	0.988315	3.464689	0.0024

R-squared	0.415845	Mean dependent var	-0.059683
Adjusted R-squared	0.386637	S.D. dependent var	2.111186
S.E. of regression	1.653428	Akaike info criterion	3.930087

Sum squared resid	54.67651	Schwarz criterion	4.029273
Log likelihood	-41.23096	Hannan-Quinn criter.	3.953452
F-statistic	14.23747	Durbin-Watson stat	2.010587
Prob(F-statistic)	0.001195		

- Trend and intercept

Null Hypothesis: INT has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.496005	0.0089
Test critical values:	1% level	-4.440739	
	5% level	-3.632896	
	10% level	-3.254671	

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

Residual variance (no correction)	2.059402
HAC corrected variance (Bartlett kernel)	1.886543

Phillips-Perron Test Equation
Dependent Variable: D(INT)
Method: Least Squares
Date: 07/04/24 Time: 23:06
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INT(-1)	-1.033129	0.229576	-4.500166	0.0002
C	5.595066	1.432250	3.906486	0.0009
@TREND("2000")	-0.114876	0.057952	-1.982245	0.0621

R-squared	0.515949	Mean dependent var	-0.059683
Adjusted R-squared	0.464996	S.D. dependent var	2.111186
S.E. of regression	1.544205	Akaike info criterion	3.833020
Sum squared resid	45.30684	Schwarz criterion	3.981798
Log likelihood	-39.16322	Hannan-Quinn criter.	3.868068
F-statistic	10.12602	Durbin-Watson stat	1.993837
Prob(F-statistic)	0.001015		

Augmented Dickey-Fuller: Energy prices at level form

- None

Null Hypothesis: ENEP has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

	t-Statistic	Prob.*

Augmented Dickey-Fuller test statistic		-1.642363	0.0937
Test critical values:	1% level	-2.674290	
	5% level	-1.957204	
	10% level	-1.608175	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ENEP)
Method: Least Squares
Date: 07/04/24 Time: 23:16
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ENEP(-1)	-0.311198	0.189482	-1.642363	0.1154

R-squared	0.102885	Mean dependent var	702.0945
Adjusted R-squared	0.102885	S.D. dependent var	6467.708
S.E. of regression	6125.964	Akaike info criterion	20.32285
Sum squared resid	7.88E+08	Schwarz criterion	20.37244
Log likelihood	-222.5513	Hannan-Quinn criter.	20.33453
Durbin-Watson stat	2.324437		

- Intercept

Null Hypothesis: ENEP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.504331	0.0178
Test critical values:	1% level	-3.769597	
	5% level	-3.004861	
	10% level	-2.642242	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ENEP)
Method: Least Squares
Date: 07/04/24 Time: 23:17
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ENEP(-1)	-0.828984	0.236560	-3.504331	0.0022
C	4880.575	1630.562	2.993186	0.0072

R-squared	0.380428	Mean dependent var	702.0945
Adjusted R-squared	0.349449	S.D. dependent var	6467.708
S.E. of regression	5216.642	Akaike info criterion	20.04360

Sum squared resid	5.44E+08	Schwarz criterion	20.14279
Log likelihood	-218.4796	Hannan-Quinn criter.	20.06697
F-statistic	12.28034	Durbin-Watson stat	1.925109
Prob(F-statistic)	0.002233		

- Trend and intercept

Null Hypothesis: ENEP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.570090	0.0563
Test critical values:	1% level	-4.440739	
	5% level	-3.632896	
	10% level	-3.254671	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ENEP)
Method: Least Squares
Date: 07/04/24 Time: 23:20
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ENEP(-1)	-0.859791	0.240832	-3.570090	0.0020
C	3275.404	2489.265	1.315812	0.2039
@TREND("2000")	153.0826	178.4716	0.857742	0.4017

R-squared	0.403525	Mean dependent var	702.0945
Adjusted R-squared	0.340738	S.D. dependent var	6467.708
S.E. of regression	5251.454	Akaike info criterion	20.09652
Sum squared resid	5.24E+08	Schwarz criterion	20.24530
Log likelihood	-218.0617	Hannan-Quinn criter.	20.13157
F-statistic	6.426894	Durbin-Watson stat	1.930841
Prob(F-statistic)	0.007381		

Augmented Dickey-Fuller: energy prices at first difference

- None

Null Hypothesis: D(ENEP) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.142071	0.0000
Test critical values:	1% level	-2.679735	
	5% level	-1.958088	

	10% level	-1.607830	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ENEP,2)
Method: Least Squares
Date: 07/04/24 Time: 23:20
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ENEP(-1))	-1.457623	0.204090	-7.142071	0.0000

R-squared	0.718155	Mean dependent var	285.4242
Adjusted R-squared	0.718155	S.D. dependent var	11228.15
S.E. of regression	5960.920	Akaike info criterion	20.27029
Sum squared resid	7.11E+08	Schwarz criterion	20.32002
Log likelihood	-211.8380	Hannan-Quinn criter.	20.28108
Durbin-Watson stat	2.091506		

- Intercept

Null Hypothesis: D(ENEP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.087214	0.0000
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ENEP,2)
Method: Least Squares
Date: 07/04/24 Time: 23:21
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ENEP(-1))	-1.468060	0.207142	-7.087214	0.0000
C	944.4291	1320.233	0.715350	0.4831

R-squared	0.725547	Mean dependent var	285.4242
Adjusted R-squared	0.711102	S.D. dependent var	11228.15
S.E. of regression	6035.044	Akaike info criterion	20.33895
Sum squared resid	6.92E+08	Schwarz criterion	20.43842
Log likelihood	-211.5589	Hannan-Quinn criter.	20.36054
F-statistic	50.22861	Durbin-Watson stat	2.131402
Prob(F-statistic)	0.000001		

- Trend and intercept

Null Hypothesis: D(ENEP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.906578	0.0001
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ENEP,2)
Method: Least Squares
Date: 07/04/24 Time: 23:21
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ENEP(-1))	-1.467619	0.212496	-6.906578	0.0000
C	310.5557	3001.100	0.103481	0.9187
@TREND("2000")	52.80632	223.1092	0.236684	0.8156

R-squared	0.726398	Mean dependent var	285.4242
Adjusted R-squared	0.695998	S.D. dependent var	11228.15
S.E. of regression	6190.792	Akaike info criterion	20.43108
Sum squared resid	6.90E+08	Schwarz criterion	20.58029
Log likelihood	-211.5263	Hannan-Quinn criter.	20.46346
F-statistic	23.89455	Durbin-Watson stat	2.137229

Phillips-Perron: energy prices rate at level form

- None

Null Hypothesis: ENEP has a unit root
Exogenous: None
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.642363	0.0937
Test critical values:	1% level	-2.674290	
	5% level	-1.957204	
	10% level	-1.608175	

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

Residual variance (no correction)	35821638
HAC corrected variance (Bartlett kernel)	35821638

Phillips-Perron Test Equation
Dependent Variable: D(ENEP)
Method: Least Squares
Date: 07/04/24 Time: 23:22
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ENEP(-1)	-0.311198	0.189482	-1.642363	0.1154

R-squared	0.102885	Mean dependent var	702.0945
Adjusted R-squared	0.102885	S.D. dependent var	6467.708
S.E. of regression	6125.964	Akaike info criterion	20.32285
Sum squared resid	7.88E+08	Schwarz criterion	20.37244
Log likelihood	-222.5513	Hannan-Quinn criter.	20.33453
Durbin-Watson stat	2.324437		

- Intercept

Null Hypothesis: ENEP has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.462418	0.0194
Test critical values:	1% level	-3.769597	
	5% level	-3.004861	
	10% level	-2.642242	

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

Residual variance (no correction)	24739414
HAC corrected variance (Bartlett kernel)	23307317

Phillips-Perron Test Equation
Dependent Variable: D(ENEP)
Method: Least Squares
Date: 07/04/24 Time: 23:23
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ENEP(-1)	-0.828984	0.236560	-3.504331	0.0022
C	4880.575	1630.562	2.993186	0.0072

R-squared	0.380428	Mean dependent var	702.0945
Adjusted R-squared	0.349449	S.D. dependent var	6467.708
S.E. of regression	5216.642	Akaike info criterion	20.04360
Sum squared resid	5.44E+08	Schwarz criterion	20.14279
Log likelihood	-218.4796	Hannan-Quinn criter.	20.06697
F-statistic	12.28034	Durbin-Watson stat	1.925109

Prob(F-statistic)	0.002233

- Trend and intercept

Null Hypothesis: ENEP has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.570090	0.0563
Test critical values:	1% level	-4.440739	
	5% level	-3.632896	
	10% level	-3.254671	

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

Residual variance (no correction)	23817161
HAC corrected variance (Bartlett kernel)	23817161

Phillips-Perron Test Equation
Dependent Variable: D(ENEP)
Method: Least Squares
Date: 07/04/24 Time: 23:24
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ENEP(-1)	-0.859791	0.240832	-3.570090	0.0020
C	3275.404	2489.265	1.315812	0.2039
@TREND("2000")	153.0826	178.4716	0.857742	0.4017

R-squared	0.403525	Mean dependent var	702.0945
Adjusted R-squared	0.340738	S.D. dependent var	6467.708
S.E. of regression	5251.454	Akaike info criterion	20.09652
Sum squared resid	5.24E+08	Schwarz criterion	20.24530
Log likelihood	-218.0617	Hannan-Quinn criter.	20.13157
F-statistic	6.426894	Durbin-Watson stat	1.930841
Prob(F-statistic)	0.007381		

Phillips-Perron: energy prices at first difference

- None

Null Hypothesis: D(ENEP) has a unit root
Exogenous: None
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.072148	0.0000
Test critical values:	1% level	-2.679735	

	5% level	-1.958088	
	10% level	-1.607830	

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

Residual variance (no correction)	33840538
HAC corrected variance (Bartlett kernel)	20884987

Phillips-Perron Test Equation
Dependent Variable: D(ENEP,2)
Method: Least Squares
Date: 07/04/24 Time: 23:25
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ENEP(-1))	-1.457623	0.204090	-7.142071	0.0000

R-squared	0.718155	Mean dependent var	285.4242
Adjusted R-squared	0.718155	S.D. dependent var	11228.15
S.E. of regression	5960.920	Akaike info criterion	20.27029
Sum squared resid	7.11E+08	Schwarz criterion	20.32002
Log likelihood	-211.8380	Hannan-Quinn criter.	20.28108
Durbin-Watson stat	2.091506		

- Intercept

Null Hypothesis: D(ENEP) has a unit root
Exogenous: Constant
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.816922	0.0000
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

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

Residual variance (no correction)	32953016
HAC corrected variance (Bartlett kernel)	15085038

Phillips-Perron Test Equation
Dependent Variable: D(ENEP,2)
Method: Least Squares
Date: 07/04/24 Time: 23:25
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.

D(ENEP(-1))	-1.468060	0.207142	-7.087214	0.0000
C	944.4291	1320.233	0.715350	0.4831

R-squared	0.725547	Mean dependent var	285.4242
Adjusted R-squared	0.711102	S.D. dependent var	11228.15
S.E. of regression	6035.044	Akaike info criterion	20.33895
Sum squared resid	6.92E+08	Schwarz criterion	20.43842
Log likelihood	-211.5589	Hannan-Quinn criter.	20.36054
F-statistic	50.22861	Durbin-Watson stat	2.131402
Prob(F-statistic)	0.000001		

- Trend and intercept

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.990434	0.0000
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

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

Residual variance (no correction)	32850778
HAC corrected variance (Bartlett kernel)	18579615

Phillips-Perron Test Equation
Dependent Variable: D(ENEP,2)
Method: Least Squares
Date: 07/04/24 Time: 23:26
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ENEP(-1))	-1.467619	0.212496	-6.906578	0.0000
C	310.5557	3001.100	0.103481	0.9187
@TREND("2000")	52.80632	223.1092	0.236684	0.8156

R-squared	0.726398	Mean dependent var	285.4242
Adjusted R-squared	0.695998	S.D. dependent var	11228.15
S.E. of regression	6190.792	Akaike info criterion	20.43108
Sum squared resid	6.90E+08	Schwarz criterion	20.58029
Log likelihood	-211.5263	Hannan-Quinn criter.	20.46346
F-statistic	23.89455	Durbin-Watson stat	2.137229
Prob(F-statistic)	0.000009		

Augmented Dickey-Fuller: Exchange rate at level form

- None

Null Hypothesis: EX has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.273739	0.9433
Test critical values:	1% level	-2.674290	
	5% level	-1.957204	
	10% level	-1.608175	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EX)
Method: Least Squares
Date: 07/04/24   Time: 23:35
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EX(-1)	0.036202	0.028422	1.273739	0.2167

R-squared	-0.021318	Mean dependent var	0.427864
Adjusted R-squared	-0.021318	S.D. dependent var	1.383322
S.E. of regression	1.397989	Akaike info criterion	3.552336
Sum squared resid	41.04184	Schwarz criterion	3.601929
Log likelihood	-38.07569	Hannan-Quinn criter.	3.564018
Durbin-Watson stat	1.895971		

- Intercept

Null Hypothesis: EX has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.306916	0.9090
Test critical values:	1% level	-3.769597	
	5% level	-3.004861	
	10% level	-2.642242	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EX)
Method: Least Squares
Date: 07/04/24   Time: 23:38
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EX(-1)	-0.029092	0.094789	-0.306916	0.7621
C	0.718574	0.994026	0.722893	0.4781

R-squared	0.004688	Mean dependent var	0.427864
Adjusted R-squared	-0.045078	S.D. dependent var	1.383322
S.E. of regression	1.414157	Akaike info criterion	3.617452
Sum squared resid	39.99678	Schwarz criterion	3.716637
Log likelihood	-37.79197	Hannan-Quinn criter.	3.640817
F-statistic	0.094198	Durbin-Watson stat	1.822122
Prob(F-statistic)	0.762080		

- Trend and intercept

Null Hypothesis: EX has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.759025	0.6896
Test critical values:	1% level	-4.440739	
	5% level	-3.632896	
	10% level	-3.254671	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EX)
Method: Least Squares
Date: 07/04/24 Time: 23:39
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EX(-1)	-0.278144	0.158124	-1.759025	0.0947
C	1.469127	1.013925	1.448951	0.1637
@TREND("2000")	0.151144	0.079276	1.906544	0.0718

R-squared	0.164524	Mean dependent var	0.427864
Adjusted R-squared	0.076579	S.D. dependent var	1.383322
S.E. of regression	1.329300	Akaike info criterion	3.533306
Sum squared resid	33.57375	Schwarz criterion	3.682085
Log likelihood	-35.86637	Hannan-Quinn criter.	3.568354
F-statistic	1.870759	Durbin-Watson stat	1.702660
Prob(F-statistic)	0.181290		

Augmented Dickey-Fuller: Exchange rate at first difference

- None

Null Hypothesis: D(EX) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.068653	0.0003
Test critical values:	1% level	-2.679735	
	5% level	-1.958088	
	10% level	-1.607830	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EX,2)
Method: Least Squares
Date: 07/04/24 Time: 23:39
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EX(-1))	-0.902687	0.221864	-4.068653	0.0006

R-squared	0.452861	Mean dependent var	-0.003705
Adjusted R-squared	0.452861	S.D. dependent var	1.936926
S.E. of regression	1.432722	Akaike info criterion	3.603477
Sum squared resid	41.05383	Schwarz criterion	3.653216
Log likelihood	-36.83651	Hannan-Quinn criter.	3.614272
Durbin-Watson stat	1.958431		

- Intercept

Null Hypothesis: D(EX) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.240128	0.0037
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EX,2)
Method: Least Squares
Date: 07/04/24 Time: 23:40
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EX(-1))	-0.969862	0.228734	-4.240128	0.0004
C	0.357837	0.322327	1.110167	0.2808

R-squared	0.486190	Mean dependent var	-0.003705
Adjusted R-squared	0.459148	S.D. dependent var	1.936926
S.E. of regression	1.424467	Akaike info criterion	3.635865
Sum squared resid	38.55301	Schwarz criterion	3.735343
Log likelihood	-36.17658	Hannan-Quinn criter.	3.657454

F-statistic	17.97869	Durbin-Watson stat	1.984921
Prob(F-statistic)	0.000443		

- Trend and intercept

Null Hypothesis: D(EX) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.377197	0.0120
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EX,2)
Method: Least Squares
Date: 07/04/24 Time: 23:40
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EX(-1))	-0.998892	0.228203	-4.377197	0.0004
C	-0.338658	0.684391	-0.494831	0.6267
@TREND("2000")	0.058943	0.051215	1.150890	0.2648

R-squared	0.521408	Mean dependent var	-0.003705
Adjusted R-squared	0.468231	S.D. dependent var	1.936926
S.E. of regression	1.412455	Akaike info criterion	3.660099
Sum squared resid	35.91050	Schwarz criterion	3.809316
Log likelihood	-35.43104	Hannan-Quinn criter.	3.692483
F-statistic	9.805169	Durbin-Watson stat	2.092305
Prob(F-statistic)	0.001317		

Phillips-Perron: Exchange rate at level form

- None

Null Hypothesis: EX has a unit root
Exogenous: None
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		2.001236	0.9861
Test critical values:	1% level	-2.674290	
	5% level	-1.957204	
	10% level	-1.608175	

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

Residual variance (no correction)	1.865538
HAC corrected variance (Bartlett kernel)	0.945139

Phillips-Perron Test Equation
Dependent Variable: D(EX)
Method: Least Squares
Date: 07/04/24 Time: 23:42
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EX(-1)	0.036202	0.028422	1.273739	0.2167

R-squared	-0.021318	Mean dependent var	0.427864
Adjusted R-squared	-0.021318	S.D. dependent var	1.383322
S.E. of regression	1.397989	Akaike info criterion	3.552336
Sum squared resid	41.04184	Schwarz criterion	3.601929
Log likelihood	-38.07569	Hannan-Quinn criter.	3.564018
Durbin-Watson stat	1.895971		

- Intercept

Null Hypothesis: EX has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.157836	0.9307
Test critical values:	1% level	-3.769597	
	5% level	-3.004861	
	10% level	-2.642242	

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

Residual variance (no correction)	1.818035
HAC corrected variance (Bartlett kernel)	1.520758

Phillips-Perron Test Equation
Dependent Variable: D(EX)
Method: Least Squares
Date: 07/04/24 Time: 23:43
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EX(-1)	-0.029092	0.094789	-0.306916	0.7621
C	0.718574	0.994026	0.722893	0.4781

R-squared	0.004688	Mean dependent var	0.427864

Adjusted R-squared	-0.045078	S.D. dependent var	1.383322
S.E. of regression	1.414157	Akaike info criterion	3.617452
Sum squared resid	39.99678	Schwarz criterion	3.716637
Log likelihood	-37.79197	Hannan-Quinn criter.	3.640817
F-statistic	0.094198	Durbin-Watson stat	1.822122
Prob(F-statistic)	0.762080		

- Trend and intercept

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.610264	0.7555
Test critical values:	1% level	-4.440739	
	5% level	-3.632896	
	10% level	-3.254671	

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

Residual variance (no correction)	1.526079
HAC corrected variance (Bartlett kernel)	1.230480

Phillips-Perron Test Equation
Dependent Variable: D(EX)
Method: Least Squares
Date: 07/04/24 Time: 23:43
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EX(-1)	-0.278144	0.158124	-1.759025	0.0947
C	1.469127	1.013925	1.448951	0.1637
@TREND("2000")	0.151144	0.079276	1.906544	0.0718

R-squared	0.164524	Mean dependent var	0.427864
Adjusted R-squared	0.076579	S.D. dependent var	1.383322
S.E. of regression	1.329300	Akaike info criterion	3.533306
Sum squared resid	33.57375	Schwarz criterion	3.682085
Log likelihood	-35.86637	Hannan-Quinn criter.	3.568354
F-statistic	1.870759	Durbin-Watson stat	1.702660
Prob(F-statistic)	0.181290		

Phillips-Perron: Exchange rate at first difference

- None

Null Hypothesis: D(EX) has a unit root
Exogenous: None
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.056995	0.0003
Test critical values:	1% level	-2.679735	
	5% level	-1.958088	
	10% level	-1.607830	

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

Residual variance (no correction)	1.954944
HAC corrected variance (Bartlett kernel)	1.849876

Phillips-Perron Test Equation
Dependent Variable: D(EX,2)
Method: Least Squares
Date: 07/04/24 Time: 23:44
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EX(-1))	-0.902687	0.221864	-4.068653	0.0006

R-squared	0.452861	Mean dependent var	-0.003705
Adjusted R-squared	0.452861	S.D. dependent var	1.936926
S.E. of regression	1.432722	Akaike info criterion	3.603477
Sum squared resid	41.05383	Schwarz criterion	3.653216
Log likelihood	-36.83651	Hannan-Quinn criter.	3.614272
Durbin-Watson stat	1.958431		

- Intercept

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.232988	0.0038
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

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

Residual variance (no correction)	1.835858
HAC corrected variance (Bartlett kernel)	1.417488

Phillips-Perron Test Equation
Dependent Variable: D(EX,2)
Method: Least Squares
Date: 07/04/24 Time: 23:44
Sample (adjusted): 2002 2022

Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EX(-1))	-0.969862	0.228734	-4.240128	0.0004
C	0.357837	0.322327	1.110167	0.2808

R-squared	0.486190	Mean dependent var	-0.003705
Adjusted R-squared	0.459148	S.D. dependent var	1.936926
S.E. of regression	1.424467	Akaike info criterion	3.635865
Sum squared resid	38.55301	Schwarz criterion	3.735343
Log likelihood	-36.17658	Hannan-Quinn criter.	3.657454
F-statistic	17.97869	Durbin-Watson stat	1.984921
Prob(F-statistic)	0.000443		

- Trend and intercept

Null Hypothesis: D(EX) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.026408	0.0032
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

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

Residual variance (no correction)	1.710024
HAC corrected variance (Bartlett kernel)	0.567029

Phillips-Perron Test Equation
Dependent Variable: D(EX,2)
Method: Least Squares
Date: 07/04/24 Time: 23:45
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EX(-1))	-0.998892	0.228203	-4.377197	0.0004
C	-0.338658	0.684391	-0.494831	0.6267
@TREND("2000")	0.058943	0.051215	1.150890	0.2648

R-squared	0.521408	Mean dependent var	-0.003705
Adjusted R-squared	0.468231	S.D. dependent var	1.936926
S.E. of regression	1.412455	Akaike info criterion	3.660099
Sum squared resid	35.91050	Schwarz criterion	3.809316
Log likelihood	-35.43104	Hannan-Quinn criter.	3.692483
F-statistic	9.805169	Durbin-Watson stat	2.092305
Prob(F-statistic)	0.001317		

Augmented Dickey-Fuller: exchange rate (percentage change) at level form

- None

Null Hypothesis: EX_PER has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.942826	0.0004
Test critical values:	1% level	-2.674290	
	5% level	-1.957204	
	10% level	-1.608175	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EX_PER)
Method: Least Squares
Date: 07/04/24 Time: 23:54
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EX_PER(-1)	-0.871781	0.221106	-3.942826	0.0007

R-squared	0.425182	Mean dependent var	0.034407
Adjusted R-squared	0.425182	S.D. dependent var	1.898644
S.E. of regression	1.439490	Akaike info criterion	3.610844
Sum squared resid	43.51478	Schwarz criterion	3.660437
Log likelihood	-38.71929	Hannan-Quinn criter.	3.622527
Durbin-Watson stat	1.893490		

- Intercept

Null Hypothesis: EX_PER has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.213042	0.0037
Test critical values:	1% level	-3.769597	
	5% level	-3.004861	
	10% level	-2.642242	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EX_PER)
Method: Least Squares
Date: 07/04/24 Time: 23:57
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EX_PER(-1)	-0.955592	0.226818	-4.213042	0.0004
C	0.410392	0.314829	1.303540	0.2072

R-squared	0.470195	Mean dependent var	0.034407
Adjusted R-squared	0.443704	S.D. dependent var	1.898644
S.E. of regression	1.416108	Akaike info criterion	3.620210
Sum squared resid	40.10724	Schwarz criterion	3.719395
Log likelihood	-37.82231	Hannan-Quinn criter.	3.643575
F-statistic	17.74972	Durbin-Watson stat	1.928333
Prob(F-statistic)	0.000427		

- Trend and intercept

Null Hypothesis: EX_PER has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.208318	0.0161
Test critical values:	1% level	-4.440739	
	5% level	-3.632896	
	10% level	-3.254671	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EX_PER)
Method: Least Squares
Date: 07/04/24 Time: 23:57
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EX_PER(-1)	-0.968614	0.230167	-4.208318	0.0005
C	0.008024	0.634164	0.012653	0.9900
@TREND("2000")	0.035434	0.048291	0.733758	0.4721

R-squared	0.484794	Mean dependent var	0.034407
Adjusted R-squared	0.430562	S.D. dependent var	1.898644
S.E. of regression	1.432738	Akaike info criterion	3.683176
Sum squared resid	39.00205	Schwarz criterion	3.831954
Log likelihood	-37.51494	Hannan-Quinn criter.	3.718224
F-statistic	8.939229	Durbin-Watson stat	1.965608
Prob(F-statistic)	0.001836		

Phillips-Perron: exchange rate (percentage change) at level form

- None

Null Hypothesis: EX_PER has a unit root
Exogenous: None
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.879995	0.0005
Test critical values:	1% level	-2.674290	
	5% level	-1.957204	
	10% level	-1.608175	

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

Residual variance (no correction)	1.977945
HAC corrected variance (Bartlett kernel)	1.607956

Phillips-Perron Test Equation
Dependent Variable: D(EX_PER)
Method: Least Squares
Date: 07/04/24 Time: 23:58
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EX_PER(-1)	-0.871781	0.221106	-3.942826	0.0007

R-squared	0.425182	Mean dependent var	0.034407
Adjusted R-squared	0.425182	S.D. dependent var	1.898644
S.E. of regression	1.439490	Akaike info criterion	3.610844
Sum squared resid	43.51478	Schwarz criterion	3.660437
Log likelihood	-38.71929	Hannan-Quinn criter.	3.622527
Durbin-Watson stat	1.893490		

- Intercept

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.189000	0.0039
Test critical values:	1% level	-3.769597	
	5% level	-3.004861	
	10% level	-2.642242	

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

Residual variance (no correction)	1.823056

HAC corrected variance (Bartlett kernel)	1.213196

Phillips-Perron Test Equation
Dependent Variable: D(EX_PER)
Method: Least Squares
Date: 07/04/24 Time: 23:59
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EX_PER(-1)	-0.955592	0.226818	-4.213042	0.0004
C	0.410392	0.314829	1.303540	0.2072

R-squared	0.470195	Mean dependent var	0.034407
Adjusted R-squared	0.443704	S.D. dependent var	1.898644
S.E. of regression	1.416108	Akaike info criterion	3.620210
Sum squared resid	40.10724	Schwarz criterion	3.719395
Log likelihood	-37.82231	Hannan-Quinn criter.	3.643575
F-statistic	17.74972	Durbin-Watson stat	1.928333
Prob(F-statistic)	0.000427		

- Trend and intercept

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.584217	0.0074
Test critical values:	1% level	-4.440739	
	5% level	-3.632896	
	10% level	-3.254671	

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

Residual variance (no correction)	1.772820
HAC corrected variance (Bartlett kernel)	0.583360

Phillips-Perron Test Equation
Dependent Variable: D(EX_PER)
Method: Least Squares
Date: 07/05/24 Time: 00:00
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EX_PER(-1)	-0.968614	0.230167	-4.208318	0.0005
C	0.008024	0.634164	0.012653	0.9900
@TREND("2000")	0.035434	0.048291	0.733758	0.4721

R-squared	0.484794	Mean dependent var	0.034407

Adjusted R-squared	0.430562	S.D. dependent var	1.898644
S.E. of regression	1.432738	Akaike info criterion	3.683176
Sum squared resid	39.00205	Schwarz criterion	3.831954
Log likelihood	-37.51494	Hannan-Quinn criter.	3.718224
F-statistic	8.939229	Durbin-Watson stat	1.965608
Prob(F-statistic)	0.001836		

Augmented Dickey-Fuller: inflation expectations at level form

- None

Null Hypothesis: LINF has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		8.428712	1.0000
Test critical values:	1% level	-2.674290	
	5% level	-1.957204	
	10% level	-1.608175	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LINF)
Method: Least Squares
Date: 07/05/24 Time: 00:08
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF(-1)	0.016697	0.001981	8.428712	0.0000

R-squared	-0.145207	Mean dependent var	0.029263
Adjusted R-squared	-0.145207	S.D. dependent var	0.014939
S.E. of regression	0.015987	Akaike info criterion	-5.389663
Sum squared resid	0.005367	Schwarz criterion	-5.340070
Log likelihood	60.28630	Hannan-Quinn criter.	-5.377981
Durbin-Watson stat	1.380077		

- Intercept

Null Hypothesis: LINF has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.764271	0.3847
Test critical values:	1% level	-3.857386	
	5% level	-3.040391	
	10% level	-2.660551	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 18

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LINF)
Method: Least Squares
Date: 07/05/24 Time: 00:11
Sample (adjusted): 2005 2022
Included observations: 18 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF(-1)	-0.033381	0.018921	-1.764271	0.1031
D(LINF(-1))	0.107352	0.246291	0.435875	0.6707
D(LINF(-2))	-0.418054	0.245164	-1.705205	0.1139
D(LINF(-3))	-0.289885	0.219658	-1.319709	0.2116
D(LINF(-4))	-0.334020	0.214266	-1.558900	0.1450
C	0.114950	0.040159	2.862349	0.0143

R-squared	0.517927	Mean dependent var	0.028528
Adjusted R-squared	0.317063	S.D. dependent var	0.013702
S.E. of regression	0.011323	Akaike info criterion	-5.862762
Sum squared resid	0.001539	Schwarz criterion	-5.565972
Log likelihood	58.76486	Hannan-Quinn criter.	-5.821839
F-statistic	2.578498	Durbin-Watson stat	2.191957
Prob(F-statistic)	0.083038		

- Trend and intercept

Null Hypothesis: LINF has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.560197	0.0585
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LINF)
Method: Least Squares
Date: 07/05/24 Time: 00:12
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF(-1)	-0.627590	0.176280	-3.560197	0.0024
D(LINF(-1))	0.518697	0.208911	2.482861	0.0238
C	0.881764	0.239309	3.684620	0.0018
@TREND("2000")	0.017995	0.005205	3.457081	0.0030

R-squared	0.472429	Mean dependent var	0.029498

Adjusted R-squared	0.379328	S.D. dependent var	0.015267
S.E. of regression	0.012027	Akaike info criterion	-5.833618
Sum squared resid	0.002459	Schwarz criterion	-5.634661
Log likelihood	65.25299	Hannan-Quinn criter.	-5.790439
F-statistic	5.074386	Durbin-Watson stat	1.522277
Prob(F-statistic)	0.010860		

Augmented Dickey-Fuller: inflation expectations at first difference

- None

Null Hypothesis: D(LINF) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.165814	0.2142
Test critical values:	1% level	-2.679735	
	5% level	-1.958088	
	10% level	-1.607830	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LINF,2)
Method: Least Squares
Date: 07/05/24 Time: 00:13
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LINF(-1))	-0.145136	0.124493	-1.165814	0.2574

R-squared	0.062385	Mean dependent var	0.000680
Adjusted R-squared	0.062385	S.D. dependent var	0.019085
S.E. of regression	0.018480	Akaike info criterion	-5.097786
Sum squared resid	0.006830	Schwarz criterion	-5.048047
Log likelihood	54.52676	Hannan-Quinn criter.	-5.086992
Durbin-Watson stat	1.808772		

- Intercept

Null Hypothesis: D(LINF) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.869213	0.0010
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LINF,2)
Method: Least Squares
Date: 07/05/24 Time: 00:13
Sample (adjusted): 2003 2022
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LINF(-1))	-1.101143	0.226144	-4.869213	0.0001
D(LINF(-1),2)	0.449466	0.181200	2.480497	0.0239
C	0.030814	0.007085	4.349137	0.0004

R-squared	0.587482	Mean dependent var	-0.001138
Adjusted R-squared	0.538950	S.D. dependent var	0.017618
S.E. of regression	0.011963	Akaike info criterion	-5.876596
Sum squared resid	0.002433	Schwarz criterion	-5.727236
Log likelihood	61.76596	Hannan-Quinn criter.	-5.847439
F-statistic	12.10515	Durbin-Watson stat	2.073710
Prob(F-statistic)	0.000539		

- Trend and intercept

Null Hypothesis: D(LINF) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.022149	0.0276
Test critical values:	1% level	-4.571559	
	5% level	-3.690814	
	10% level	-3.286909	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 18

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LINF,2)
Method: Least Squares
Date: 07/05/24 Time: 00:14
Sample (adjusted): 2005 2022
Included observations: 18 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LINF(-1))	-2.012452	0.500342	-4.022149	0.0017
D(LINF(-1),2)	1.093337	0.371260	2.944938	0.0123
D(LINF(-2),2)	0.650987	0.287322	2.265707	0.0428
D(LINF(-3),2)	0.347293	0.216610	1.603315	0.1348
C	0.071430	0.018935	3.772356	0.0027
@TREND("2000")	-0.000990	0.000569	-1.738456	0.1077

R-squared	0.657887	Mean dependent var	0.001624
Adjusted R-squared	0.515340	S.D. dependent var	0.016313

S.E. of regression	0.011357	Akaike info criterion	-5.856761
Sum squared resid	0.001548	Schwarz criterion	-5.559970
Log likelihood	58.71085	Hannan-Quinn criter.	-5.815838
F-statistic	4.615223	Durbin-Watson stat	2.192076
Prob(F-statistic)	0.013987		

Phillips-Perron: inflation expectations at level form

- None

Null Hypothesis: LINF has a unit root
Exogenous: None
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		7.366496	1.0000
Test critical values:	1% level	-2.674290	
	5% level	-1.957204	
	10% level	-1.608175	

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

Residual variance (no correction)	0.000244
HAC corrected variance (Bartlett kernel)	0.000319

Phillips-Perron Test Equation
Dependent Variable: D(LINF)
Method: Least Squares
Date: 07/05/24 Time: 00:15
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF(-1)	0.016697	0.001981	8.428712	0.0000

R-squared	-0.145207	Mean dependent var	0.029263
Adjusted R-squared	-0.145207	S.D. dependent var	0.014939
S.E. of regression	0.015987	Akaike info criterion	-5.389663
Sum squared resid	0.005367	Schwarz criterion	-5.340070
Log likelihood	60.28630	Hannan-Quinn criter.	-5.377981
Durbin-Watson stat	1.380077		

- Intercept

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

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-1.842787	0.3513

Test critical values:	1% level	-3.769597	
	5% level	-3.004861	
	10% level	-2.642242	

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

Residual variance (no correction)	0.000202
HAC corrected variance (Bartlett kernel)	4.94E-05

Phillips-Perron Test Equation
Dependent Variable: D(LINF)
Method: Least Squares
Date: 07/05/24 Time: 00:16
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF(-1)	-0.017803	0.017022	-1.045890	0.3081
C	0.059714	0.029288	2.038840	0.0549

R-squared	0.051858	Mean dependent var	0.029263
Adjusted R-squared	0.004451	S.D. dependent var	0.014939
S.E. of regression	0.014906	Akaike info criterion	-5.487591
Sum squared resid	0.004444	Schwarz criterion	-5.388405
Log likelihood	62.36350	Hannan-Quinn criter.	-5.464226
F-statistic	1.093885	Durbin-Watson stat	1.617447
Prob(F-statistic)	0.308089		

- Trend and intercept

Null Hypothesis: LINF has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.203233	0.4648
Test critical values:	1% level	-4.440739	
	5% level	-3.632896	
	10% level	-3.254671	

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

Residual variance (no correction)	0.000167
HAC corrected variance (Bartlett kernel)	0.000191

Phillips-Perron Test Equation
Dependent Variable: D(LINF)
Method: Least Squares
Date: 07/05/24 Time: 00:17
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF(-1)	-0.365258	0.174079	-2.098234	0.0495
C	0.535935	0.239162	2.240884	0.0372
@TREND("2000")	0.010267	0.005123	2.004306	0.0595

R-squared	0.217339	Mean dependent var	0.029263
Adjusted R-squared	0.134954	S.D. dependent var	0.014939
S.E. of regression	0.013895	Akaike info criterion	-5.588486
Sum squared resid	0.003668	Schwarz criterion	-5.439708
Log likelihood	64.47335	Hannan-Quinn criter.	-5.553438
F-statistic	2.638077	Durbin-Watson stat	1.439284
Prob(F-statistic)	0.097488		

Phillips-Perron: inflation expectations at first difference

- None

Null Hypothesis: D(LINF) has a unit root
Exogenous: None
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.832854	0.3431
Test critical values:	1% level	-2.679735	
	5% level	-1.958088	
	10% level	-1.607830	

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

Residual variance (no correction)	0.000325
HAC corrected variance (Bartlett kernel)	0.000191

Phillips-Perron Test Equation
Dependent Variable: D(LINF,2)
Method: Least Squares
Date: 07/05/24 Time: 00:19
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LINF(-1))	-0.145136	0.124493	-1.165814	0.2574

R-squared	0.062385	Mean dependent var	0.000680
Adjusted R-squared	0.062385	S.D. dependent var	0.019085
S.E. of regression	0.018480	Akaike info criterion	-5.097786
Sum squared resid	0.006830	Schwarz criterion	-5.048047
Log likelihood	54.52676	Hannan-Quinn criter.	-5.086992
Durbin-Watson stat	1.808772		

- Intercept

Null Hypothesis: D(LINF) has a unit root
Exogenous: Constant
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.401753	0.0227
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

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

Residual variance (no correction)	0.000212
HAC corrected variance (Bartlett kernel)	7.46E-05

Phillips-Perron Test Equation
Dependent Variable: D(LINF,2)
Method: Least Squares
Date: 07/05/24 Time: 00:19
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LINF(-1))	-0.785440	0.225749	-3.479259	0.0025
C	0.023314	0.007313	3.188221	0.0048

R-squared	0.389171	Mean dependent var	0.000680
Adjusted R-squared	0.357022	S.D. dependent var	0.019085
S.E. of regression	0.015304	Akaike info criterion	-5.431070
Sum squared resid	0.004450	Schwarz criterion	-5.331592
Log likelihood	59.02624	Hannan-Quinn criter.	-5.409481
F-statistic	12.10525	Durbin-Watson stat	1.473895
Prob(F-statistic)	0.002511		

- Trend and intercept

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.714088	0.0439
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

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

Residual variance (no correction)	0.000204
HAC corrected variance (Bartlett kernel)	4.61E-05

Phillips-Perron Test Equation
Dependent Variable: D(LINF,2)
Method: Least Squares
Date: 07/05/24 Time: 00:20
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LINF(-1))	-0.835226	0.235922	-3.540264	0.0023
C	0.030362	0.011396	2.664235	0.0158
@TREND("2000")	-0.000468	0.000576	-0.811506	0.4277

R-squared	0.410729	Mean dependent var	0.000680
Adjusted R-squared	0.345255	S.D. dependent var	0.019085
S.E. of regression	0.015443	Akaike info criterion	-5.371764
Sum squared resid	0.004293	Schwarz criterion	-5.222547
Log likelihood	59.40353	Hannan-Quinn criter.	-5.339380
F-statistic	6.273119	Durbin-Watson stat	1.475875
Prob(F-statistic)	0.008567		

Appendix E: Lag length selection test

Appendix E1: Model A

VAR Lag Order Selection Criteria
Endogenous variables: LINF ENEP INT EX INFEX LGDP UNEMR
Exogenous variables: C
Date: 07/06/24 Time: 13:27
Sample: 2000 2022
Included observations: 22

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-291.5540	NA	1446.016	27.14127	27.48842	27.22305
1	-121.8642	215.9688*	0.031695*	16.16947*	18.94667*	16.82370*

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

Appendix E2: Model B

VAR Lag Order Selection Criteria
Endogenous variables: LGDP ENEP EX_PER INT INFEX LINF UNEMR
Exogenous variables: C
Date: 07/06/24 Time: 13:31
Sample: 2000 2022
Included observations: 22

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-293.9959	NA	1805.445	27.36326	27.71041	27.44504
1	-130.0652	208.6390*	0.066800*	16.91502*	19.69222*	17.56924*

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

Appendix E3: Model C

VAR Lag Order Selection Criteria
Endogenous variables: UNEMR ENEP EX INT INFEX LINF LGDP
Exogenous variables: C
Date: 07/06/24 Time: 13:33
Sample: 2000 2022
Included observations: 22

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-291.5540	NA	1446.016	27.14127	27.48842	27.22305
1	-121.8642	215.9688*	0.031695*	16.16947*	18.94667*	16.82370*

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

Appendix F: ARDL Bounds test

Appendix F1: Model A

ARDL Bounds Test
Date: 07/06/24 Time: 21:03
Sample: 2002 2022
Included observations: 21
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	15.99849	6

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	1.99	2.94
5%	2.27	3.28
2.5%	2.55	3.61
1%	2.88	3.99

Test Equation:
Dependent Variable: D(LINF)
Method: Least Squares
Date: 07/06/24 Time: 21:03
Sample: 2002 2022
Included observations: 21

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ENEP)	3.86E-06	5.34E-07	7.215356	0.0877
D(ENEP(-1))	-4.06E-07	2.62E-07	-1.551050	0.3646
D(INT)	-0.002528	0.002225	-1.136071	0.4595
D(INT(-1))	0.010503	0.002514	4.177919	0.1496
D(EX)	0.009641	0.001386	6.956719	0.0909
D(EX(-1))	-0.000383	0.000995	-0.385179	0.7659
D(INFEX)	-0.013349	0.003443	-3.877346	0.1607
D(INFEX(-1))	0.006695	0.001738	3.851187	0.1617
D(LGDP)	-0.883546	0.280188	-3.153407	0.1955
D(LGDP(-1))	0.679078	0.689138	0.985401	0.5047
D(UNEMR)	0.005578	0.001812	3.077752	0.2000
D(UNEMR(-1))	0.000628	0.001119	0.561136	0.6745
C	2.439270	2.091799	1.166111	0.4513
ENEP(-1)	5.65E-06	1.01E-06	5.613004	0.1122
INT(-1)	-0.016396	0.004956	-3.308287	0.1869
EX(-1)	0.014310	0.003061	4.675147	0.1341
INFEX(-1)	-0.015240	0.007088	-2.150003	0.2772
LGDP(-1)	-0.377624	0.460928	-0.819270	0.5630
UNEMR(-1)	-0.011660	0.004380	-2.662164	0.2288
LINF(-1)	0.187713	0.625904	0.299906	0.8145

R-squared	0.999703	Mean dependent var	0.029498
Adjusted R-squared	0.994066	S.D. dependent var	0.015267
S.E. of regression	0.001176	Akaike info criterion	-11.79317
Sum squared resid	1.38E-06	Schwarz criterion	-10.79838
Log likelihood	143.8283	Hannan-Quinn criter.	-11.57727
F-statistic	177.3448	Durbin-Watson stat	2.519160
Prob(F-statistic)	0.059073		

Appendix F2: Model B

ARDL Bounds Test
Date: 07/06/24 Time: 21:20
Sample: 2001 2022
Included observations: 22
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	46.23283	6

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	1.99	2.94
5%	2.27	3.28

2.5%	2.55	3.61
1%	2.88	3.99

Test Equation:
Dependent Variable: D(LGDP)
Method: Least Squares
Date: 07/06/24 Time: 21:20
Sample: 2001 2022
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EX_PER)	-0.003405	0.002178	-1.563308	0.1490
D(INT)	-0.002451	0.001935	-1.266822	0.2339
D(INFEX)	0.005509	0.003864	1.425868	0.1844
D(UNEMR)	0.003522	0.003331	1.057454	0.3152
C	-0.290695	1.130083	-0.257233	0.8022
ENEP(-1)	-6.43E-07	5.70E-07	-1.128025	0.2856
EX_PER(-1)	-0.007899	0.002826	-2.794979	0.0190
INT(-1)	-0.003698	0.002701	-1.368893	0.2010
INFEX(-1)	-0.000479	0.002681	-0.178518	0.8619
LINF(-1)	-0.196032	0.332864	-0.588925	0.5690
UNEMR(-1)	-0.000257	0.002721	-0.094451	0.9266
LGDP(-1)	0.107032	0.251055	0.426328	0.6789

R-squared	0.819048	Mean dependent var	0.036315
Adjusted R-squared	0.620001	S.D. dependent var	0.014508
S.E. of regression	0.008943	Akaike info criterion	-6.293402
Sum squared resid	0.000800	Schwarz criterion	-5.698288
Log likelihood	81.22743	Hannan-Quinn criter.	-6.153211
F-statistic	4.114841	Durbin-Watson stat	2.169677
Prob(F-statistic)	0.016898		

Appendix F3: Model C

ARDL Bounds Test
Date: 07/06/24 Time: 21:28
Sample: 2001 2022
Included observations: 22
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	8.963725	6

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	1.99	2.94
5%	2.27	3.28
2.5%	2.55	3.61
1%	2.88	3.99

Test Equation:
Dependent Variable: D(UNEMR)

Method: Least Squares
Date: 07/06/24 Time: 21:28
Sample: 2001 2022
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INT)	-0.255631	0.114206	-2.238324	0.0468
D(LINF)	43.04496	20.01646	2.150478	0.0546
D(LGDP)	12.74307	18.70252	0.681356	0.5097
C	317.8626	91.84438	3.460883	0.0053
ENEP(-1)	4.42E-05	5.01E-05	0.882165	0.3966
EX(-1)	0.145446	0.222319	0.654219	0.5264
INT(-1)	-0.542121	0.169214	-3.203762	0.0084
INFEX(-1)	-0.338856	0.194555	-1.741696	0.1094
LINF(-1)	93.79754	29.64714	3.163797	0.0090
LGDP(-1)	-70.54698	21.24528	-3.320596	0.0068
UNEMR(-1)	-0.812889	0.154890	-5.248156	0.0003

R-squared	0.875995	Mean dependent var	0.386364
Adjusted R-squared	0.763263	S.D. dependent var	1.441327
S.E. of regression	0.701287	Akaike info criterion	2.435055
Sum squared resid	5.409843	Schwarz criterion	2.980576
Log likelihood	-15.78560	Hannan-Quinn criter.	2.563563
F-statistic	7.770591	Durbin-Watson stat	1.741058
Prob(F-statistic)	0.001089		

Appendix G: ARDL estimates

Appendix G1: Model A

Dependent Variable: LINF
Method: ARDL
Date: 07/06/24 Time: 20:47
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): ENEP INT EX INFEX LGDP UNEMR
Fixed regressors: C
Number of models evaluated: 729
Selected Model: ARDL(1, 2, 2, 2, 2, 2, 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LINF(-1)	1.187713	0.625904	1.897595	0.3088
ENEP	3.86E-06	5.34E-07	7.215357	0.0877
ENEP(-1)	1.38E-06	6.53E-07	2.118332	0.2808
ENEP(-2)	4.06E-07	2.62E-07	1.551050	0.3646
INT	-0.002528	0.002225	-1.136071	0.4595
INT(-1)	-0.003365	0.000739	-4.555578	0.1376
INT(-2)	-0.010503	0.002514	-4.177919	0.1496
EX	0.009641	0.001386	6.956719	0.0909
EX(-1)	0.004285	0.001935	2.214106	0.2701
EX(-2)	0.000383	0.000995	0.385179	0.7659
INFEX	-0.013349	0.003443	-3.877345	0.1607
INFEX(-1)	0.004803	0.004486	1.070699	0.4783
INFEX(-2)	-0.006695	0.001738	-3.851187	0.1617
LGDP	-0.883546	0.280188	-3.153407	0.1955

LGDP(-1)	1.184999	0.507710	2.334009	0.2577
LGDP(-2)	-0.679077	0.689138	-0.985401	0.5047
UNEMR	0.005578	0.001812	3.077752	0.2000
UNEMR(-1)	-0.016611	0.006416	-2.589062	0.2347
UNEMR(-2)	-0.000628	0.001119	-0.561136	0.6745
C	2.439270	2.091799	1.166111	0.4513

R-squared	0.999998	Mean dependent var	1.755395
Adjusted R-squared	0.999956	S.D. dependent var	0.177522
S.E. of regression	0.001176	Akaike info criterion	-11.79317
Sum squared resid	1.38E-06	Schwarz criterion	-10.79838
Log likelihood	143.8283	Hannan-Quinn criter.	-11.57727
F-statistic	23986.78	Durbin-Watson stat	2.519160
Prob(F-statistic)	0.005084		

*Note: p-values and any subsequent tests do not account for model selection.

Appendix G2: Model B

Dependent Variable: LGDP
Method: ARDL
Date: 07/06/24 Time: 21:18
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (1 lag, automatic): ENEP EX_PER INT INFEX LINF UNEMR
Fixed regressors: C
Number of models evalulated: 64
Selected Model: ARDL(1, 0, 1, 1, 1, 0, 1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LGDP(-1)	0.491308	0.330558	1.486300	0.1680
ENEP	-2.78E-07	8.83E-07	-0.315106	0.7592
EX_PER	-0.003544	0.002331	-1.520404	0.1594
EX_PER(-1)	-0.006830	0.004017	-1.700081	0.1200
INT	-0.002948	0.001744	-1.690503	0.1218
INT(-1)	-0.004189	0.002467	-1.697614	0.1204
INFEX	0.001093	0.005399	0.202498	0.8436
INFEX(-1)	-0.006740	0.003870	-1.741586	0.1122
LINF	0.623158	0.443418	1.405351	0.1902
UNEMR	-0.000668	0.003667	-0.182291	0.8590
UNEMR(-1)	-0.006115	0.002970	-2.059016	0.0665
C	2.484743	1.485986	1.672118	0.1254

R-squared	0.999327	Mean dependent var	6.501578
Adjusted R-squared	0.998586	S.D. dependent var	0.229853
S.E. of regression	0.008642	Akaike info criterion	-6.361889
Sum squared resid	0.000747	Schwarz criterion	-5.766775
Log likelihood	81.98078	Hannan-Quinn criter.	-6.221698
F-statistic	1349.570	Durbin-Watson stat	2.366499
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

Appendix G3: Model C

Dependent Variable: UNEMR

Method: ARDL
Date: 07/06/24 Time: 21:28
Sample (adjusted): 2001 2022
Included observations: 22 after adjustments
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (1 lag, automatic): ENEP EX INT INFEX LINF LGDP
Fixed regressors: C
Number of models evaluated: 64
Selected Model: ARDL(1, 0, 0, 1, 0, 1, 1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
UNEMR(-1)	0.112806	0.150151	0.751286	0.4682
ENEP	2.45E-05	4.78E-05	0.511643	0.6190
EX	-0.125513	0.171080	-0.733646	0.4785
INT	-0.217972	0.107269	-2.032021	0.0670
INT(-1)	-0.250412	0.113181	-2.212486	0.0490
INFEX	-0.700449	0.288086	-2.431392	0.0333
LINF	102.4193	29.74307	3.443468	0.0055
LINF(-1)	19.34390	17.84069	1.084257	0.3014
LGDP	-4.918399	20.81554	-0.236285	0.8176
LGDP(-1)	-84.89033	18.62460	-4.557968	0.0008
C	400.0550	71.68251	5.580930	0.0002

R-squared	0.976779	Mean dependent var	26.18182
Adjusted R-squared	0.955670	S.D. dependent var	3.124959
S.E. of regression	0.657953	Akaike info criterion	2.307487
Sum squared resid	4.761928	Schwarz criterion	2.853008
Log likelihood	-14.38236	Hannan-Quinn criter.	2.435996
F-statistic	46.27157	Durbin-Watson stat	1.961812
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

Appendix H: Long run and ECM estimates

Appendix H1: Model A

ARDL Cointegrating And Long Run Form
Original dep. variable: LINF
Selected Model: ARDL(1, 1, 1, 0, 0, 1, 0)
Date: 07/08/24 Time: 10:39
Sample: 2000 2022
Included observations: 22

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ENEP)	0.000001	0.000000	4.342523	0.0012
D(EX)	0.005948	0.001098	5.416508	0.0002
INT	-0.001321	0.000845	-1.562557	0.1464
INFEX	-0.000124	0.001607	-0.076896	0.9401
D(LGDP)	0.228954	0.098372	2.327426	0.0401
UNEMR	-0.000123	0.000219	-0.563920	0.5841
CointEq(-1)	-0.977742	0.137766	-7.097109	0.0000

Cointeq = LINF - (0.0000*ENEP + 0.0099*EX -0.0011*INT + 0.0076*INFEX

+ 0.6614*LGDP + 0.0020*UNEMR -2.7366)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ENEP	0.000002	0.000001	2.895578	0.0146
EX	0.009885	0.002059	4.800195	0.0006
INT	-0.001108	0.000868	-1.276440	0.2281
INFEX	0.007618	0.001356	5.617309	0.0002
LGDP	0.661356	0.019448	34.007074	0.0000
UNEMR	0.001977	0.001152	1.715837	0.1142
C	-2.736624	0.132451	-20.661386	0.0000

Appendix H2: Model B

ARDL Cointegrating And Long Run Form
Original dep. variable: LGDP
Selected Model: ARDL(1, 0, 1, 1, 1, 0, 1)
Date: 07/08/24   Time: 10:40
Sample: 2000 2022
Included observations: 22

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ENEP	-0.000000	0.000001	-0.127775	0.9009
D(EX_PER)	-0.005914	0.001728	-3.422347	0.0065
D(INT)	-0.004198	0.001384	-3.033717	0.0126
D(INFEX)	0.010515	0.002570	4.090800	0.0022
LINF	0.011879	0.002378	4.996220	0.0005
D(UNEMR)	-0.003012	0.002120	-1.420655	0.1858
CointEq(-1)	-0.456592	0.081583	-5.596674	0.0002

Cointeq = LGDP - (-0.0000*ENEP -0.0204*EX_PER -0.0140*INT -0.0111
*INFEX + 1.2250*LINF -0.0133*UNEMR + 4.8846)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ENEP	-0.000001	0.000002	-0.305780	0.7660
EX_PER	-0.020393	0.015099	-1.350682	0.2066
INT	-0.014029	0.007958	-1.762826	0.1084
INFEX	-0.011100	0.004955	-2.240450	0.0490
LINF	1.225019	0.081843	14.967853	0.0000
UNEMR	-0.013336	0.002855	-4.671328	0.0009
C	4.884574	0.267645	18.250215	0.0000

Appendix H3: Model C

ARDL Cointegrating And Long Run Form

Original dep. variable: UNEMR
Selected Model: ARDL(1, 0, 0, 1, 0, 1, 1)
Date: 07/08/24 Time: 10:42
Sample: 2000 2022
Included observations: 22

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ENEP	0.000002	0.000033	0.061244	0.9523
EX	0.013512	0.043857	0.308090	0.7638
D(INT)	-0.201804	0.082818	-2.436717	0.0330
INFEX	0.151169	0.146976	1.028527	0.3258
D(LINF)	51.748028	13.919244	3.717733	0.0034
D(LGDP)	4.225953	12.364524	0.341780	0.7390
CointEq(-1)	-0.871330	0.125244	-6.957048	0.0000

Cointeq = UNEMR - (0.0000*ENEP -0.1415*EX -0.5279*INT -0.7895 *INFEX + 137.2453*LINF -101.2279*LGDP + 450.9218)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ENEP	0.000028	0.000052	0.530093	0.6066
EX	-0.141471	0.193631	-0.730624	0.4803
INT	-0.527940	0.189413	-2.787246	0.0177
INFEX	-0.789511	0.281967	-2.800013	0.0173
LINF	137.245323	17.912669	7.661914	0.0000
LGDP	-101.227867	12.211325	-8.289671	0.0000
C	450.921816	50.705384	8.892977	0.0000

Appendix I: Short run coefficients and ECM estimates

Appendix I1: Model A

ARDL Cointegrating And Long Run Form

Original dep. variable: LINF
Selected Model: ARDL(1, 1, 1, 0, 0, 1, 0)
Date: 08/01/24 Time: 20:23
Sample: 2000 2022
Included observations: 22

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ENEP)	0.000001	0.000000	4.342523	0.0012
D(EX)	0.005948	0.001098	5.416508	0.0002
INT	-0.001321	0.000845	-1.562557	0.1464
INFEX	-0.000124	0.001607	-0.076896	0.9401
D(LGDP)	0.228954	0.098372	2.327426	0.0401
UNEMR	-0.000123	0.000219	-0.563920	0.5841
CointEq(-1)	-0.977742	0.137766	-7.097109	0.0000

Cointeq = LINF - (0.0000*ENEP + 0.0099*EX -0.0011*INT + 0.0076*INFEX
+ 0.6614*LGDP + 0.0020*UNEMR -2.7366)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ENEP	0.000002	0.000001	2.895578	0.0146
EX	0.009885	0.002059	4.800195	0.0006
INT	-0.001108	0.000868	-1.276440	0.2281
INFEX	0.007618	0.001356	5.617309	0.0002
LGDP	0.661356	0.019448	34.007074	0.0000
UNEMR	0.001977	0.001152	1.715837	0.1142
C	-2.736624	0.132451	-20.661386	0.0000

Appendix i2: Model B

ARDL Cointegrating And Long Run Form
Original dep. variable: LGDP
Selected Model: ARDL(1, 0, 1, 1, 1, 0, 1)
Date: 08/01/24 Time: 21:57
Sample: 2000 2022
Included observations: 22

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ENEP	-0.000000	0.000001	-0.127775	0.9009
D(EX_PER)	-0.005914	0.001728	-3.422347	0.0065
D(INT)	-0.004198	0.001384	-3.033717	0.0126
D(INFEX)	0.010515	0.002570	4.090800	0.0022
LINF	0.011879	0.002378	4.996220	0.0005
D(UNEMR)	-0.003012	0.002120	-1.420655	0.1858
CointEq(-1)	-0.456592	0.081583	-5.596674	0.0002

Cointeq = LGDP - (-0.0000*ENEP -0.0204*EX_PER -0.0140*INT -0.0111
*INFEX + 1.2250*LINF -0.0133*UNEMR + 4.8846)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ENEP	-0.000001	0.000002	-0.305780	0.7660
EX_PER	-0.020393	0.015099	-1.350682	0.2066
INT	-0.014029	0.007958	-1.762826	0.1084
INFEX	-0.011100	0.004955	-2.240450	0.0490
LINF	1.225019	0.081843	14.967853	0.0000
UNEMR	-0.013336	0.002855	-4.671328	0.0009
C	4.884574	0.267645	18.250215	0.0000

Appendix i3: Model C

ARDL Cointegrating And Long Run Form

Original dep. variable: UNEMR
Selected Model: ARDL(1, 0, 0, 1, 1, 1, 1)
Date: 08/01/24 Time: 21:30
Sample: 2000 2022
Included observations: 22

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ENEP	0.000008	0.000028	0.295107	0.7739
EX	-0.030927	0.030253	-1.022275	0.3307
D(INT)	-0.174946	0.067084	-2.607880	0.0261
D(INFEX)	-0.733897	0.220107	-3.334276	0.0076
D(LINF)	107.891883	18.235209	5.916679	0.0001
D(LGDP)	-5.120080	8.749574	-0.585181	0.5714
CointEq(-1)	-0.963955	0.100869	-9.556467	0.0000

Cointeq = UNEMR - (0.0000*ENEP -0.2524*EX -0.5350*INT -0.8381
*INFEX + 144.6403*LINF -105.8976*LGDP + 470.3142)

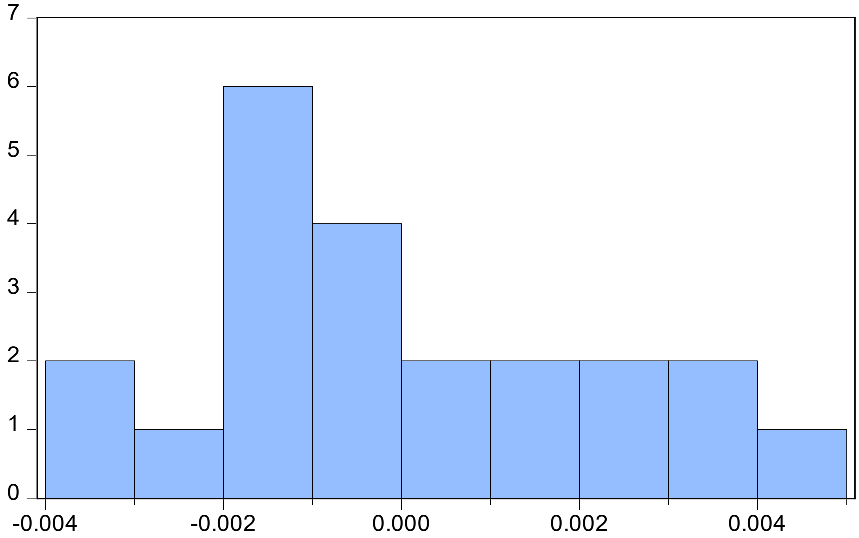
Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ENEP	0.000005	0.000060	0.077375	0.9399
EX	-0.252424	0.234164	-1.077980	0.3064
INT	-0.535045	0.189442	-2.824324	0.0180
INFEX	-0.838090	0.285917	-2.931241	0.0150
LINF	144.640330	20.181764	7.166882	0.0000
LGDP	-105.897648	13.539142	-7.821592	0.0000
C	470.314215	56.129819	8.379044	0.0000

Appendix J: Diagnostic test results

Appendix j1: Model A

Normality test results



Series: Residuals	
Sample 2001 2022	
Observations 22	
Mean	-3.63e-16
Median	-0.000240
Maximum	0.004129
Minimum	-0.003995
Std. Dev.	0.002232
Skewness	0.112004
Kurtosis	2.233292
Jarque-Bera	0.584853
Probability	0.746450

Serial correlation test results

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.528170	Prob. F(2,9)	0.6069
Obs*R-squared	2.310930	Prob. Chi-Square(2)	0.3149

Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 08/01/24 Time: 20:39
Sample: 2001 2022
Included observations: 22
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF(-1)	0.012953	0.097191	0.133270	0.8969
ENEP	-4.37E-08	2.87E-07	-0.151927	0.8826
ENEP(-1)	2.24E-08	2.52E-07	0.089229	0.9309
EX	-0.000103	0.000742	-0.138662	0.8928
EX(-1)	-0.000146	0.001206	-0.120735	0.9066
INT	0.000269	0.000756	0.355574	0.7304
INFEX	7.51E-05	0.000881	0.085314	0.9339
LGDP	0.020737	0.096502	0.214885	0.8346
LGDP(-1)	-0.027288	0.138998	-0.196323	0.8487
UNEMR	0.000122	0.001095	0.111539	0.9136
C	0.017370	0.337401	0.051480	0.9601
RESID(-1)	-0.285681	0.405294	-0.704872	0.4987
RESID(-2)	0.179546	0.424489	0.422969	0.6822

R-squared	0.105042	Mean dependent var	-3.63E-16
Adjusted R-squared	-1.088235	S.D. dependent var	0.002232
S.E. of regression	0.003225	Akaike info criterion	-8.347779
Sum squared resid	9.36E-05	Schwarz criterion	-7.703072
Log likelihood	104.8256	Hannan-Quinn criter.	-8.195905
F-statistic	0.088028	Durbin-Watson stat	1.846450
Prob(F-statistic)	0.999869		

Heteroskedasticity test results

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.150437	Prob. F(10,11)	0.4084
Obs*R-squared	11.24653	Prob. Chi-Square(10)	0.3386
Scaled explained SS	1.733782	Prob. Chi-Square(10)	0.9980

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 08/01/24 Time: 20:43
Sample: 2001 2022
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.38E-05	0.000518	-0.046016	0.9641
LINF(-1)	0.000108	0.000147	0.737900	0.4760
ENEP	-6.59E-10	4.55E-10	-1.448025	0.1755
ENEP(-1)	-8.43E-10	4.02E-10	-2.094548	0.0602
EX	-3.84E-07	1.11E-06	-0.345437	0.7363
EX(-1)	-4.47E-06	1.90E-06	-2.357940	0.0380
INT	1.32E-06	1.13E-06	1.166957	0.2679
INFEX	1.90E-06	1.36E-06	1.397262	0.1899
LGDP	9.66E-05	0.000152	0.633620	0.5393
LGDP(-1)	-0.000120	0.000216	-0.558454	0.5877
UNEMR	1.28E-06	1.73E-06	0.742754	0.4732

R-squared	0.511206	Mean dependent var	4.75E-06
Adjusted R-squared	0.066848	S.D. dependent var	5.40E-06
S.E. of regression	5.22E-06	Akaike info criterion	-21.18124
Sum squared resid	3.00E-10	Schwarz criterion	-20.63572
Log likelihood	243.9937	Hannan-Quinn criter.	-21.05273
F-statistic	1.150437	Durbin-Watson stat	2.782961
Prob(F-statistic)	0.408443		

Heteroskedasticity Test: Harvey

F-statistic	0.712524	Prob. F(10,11)	0.6995
Obs*R-squared	8.648454	Prob. Chi-Square(10)	0.5658
Scaled explained SS	6.913214	Prob. Chi-Square(10)	0.7336

Test Equation:
Dependent Variable: LRESID2
Method: Least Squares
Date: 08/01/24 Time: 20:44
Sample: 2001 2022
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	161.7137	217.1827	0.744598	0.4721
LINF(-1)	74.79451	61.55604	1.215064	0.2498
ENEP	-2.89E-05	0.000191	-0.151471	0.8823

ENEP(-1)	-8.15E-05	0.000169	-0.483353	0.6383
EX	0.503213	0.465946	1.079981	0.3033
EX(-1)	-1.229287	0.794858	-1.546550	0.1502
INT	0.398570	0.474718	0.839595	0.4190
INFEX	0.396513	0.569487	0.696264	0.5007
LGDP	66.30526	63.91410	1.037412	0.3218
LGDP(-1)	-111.8915	90.36994	-1.238150	0.2414
UNEMR	-0.269872	0.724848	-0.372314	0.7167

R-squared	0.393112	Mean dependent var	-13.38159
Adjusted R-squared	-0.158605	S.D. dependent var	2.032859
S.E. of regression	2.188140	Akaike info criterion	4.710833
Sum squared resid	52.66751	Schwarz criterion	5.256355
Log likelihood	-40.81917	Hannan-Quinn criter.	4.839342
F-statistic	0.712524	Durbin-Watson stat	2.523908
Prob(F-statistic)	0.699529		

Heteroskedasticity Test: Glejser

F-statistic	0.968735	Prob. F(10,11)	0.5161
Obs*R-squared	10.30203	Prob. Chi-Square(10)	0.4144
Scaled explained SS	4.585633	Prob. Chi-Square(10)	0.9171

Test Equation:
Dependent Variable: ARESID
Method: Least Squares
Date: 08/01/24 Time: 20:45
Sample: 2001 2022
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.047949	0.126934	0.377745	0.7128
LINF(-1)	0.037114	0.035977	1.031613	0.3244
ENEP	-1.00E-07	1.12E-07	-0.899810	0.3875
ENEP(-1)	-1.51E-07	9.86E-08	-1.529850	0.1543
EX	8.00E-05	0.000272	0.293894	0.7743
EX(-1)	-0.000993	0.000465	-2.138103	0.0558
INT	0.000290	0.000277	1.047003	0.3176
INFEX	0.000403	0.000333	1.209313	0.2519
LGDP	0.031333	0.037355	0.838792	0.4194
LGDP(-1)	-0.047858	0.052817	-0.906106	0.3843
UNEMR	0.000112	0.000424	0.263954	0.7967

R-squared	0.468274	Mean dependent var	0.001793
Adjusted R-squared	-0.015113	S.D. dependent var	0.001269
S.E. of regression	0.001279	Akaike info criterion	-10.17882
Sum squared resid	1.80E-05	Schwarz criterion	-9.633295
Log likelihood	122.9670	Hannan-Quinn criter.	-10.05031
F-statistic	0.968735	Durbin-Watson stat	2.703802
Prob(F-statistic)	0.516054		

Heteroskedasticity Test: ARCH

F-statistic	0.434130	Prob. F(1,19)	0.5179
Obs*R-squared	0.469110	Prob. Chi-Square(1)	0.4934

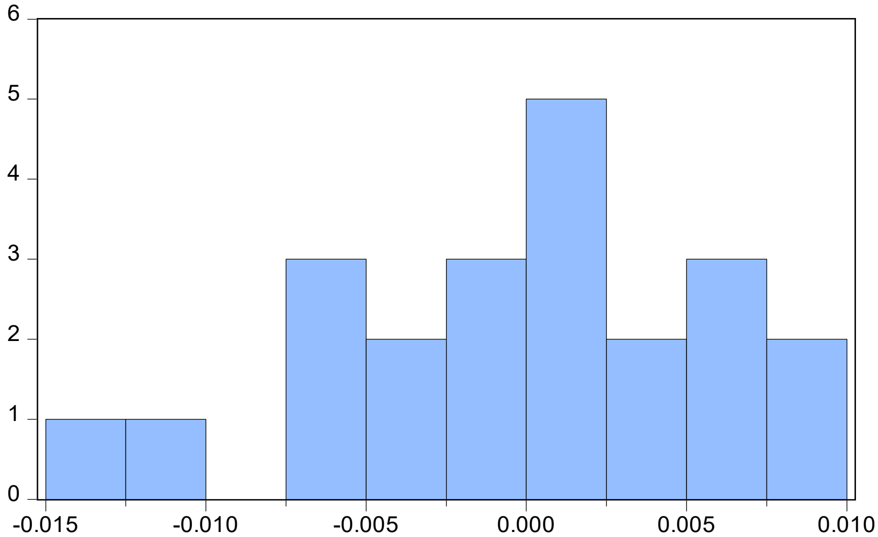
Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 08/01/24 Time: 20:47
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.64E-06	1.62E-06	3.477787	0.0025
RESID^2(-1)	-0.147866	0.224418	-0.658886	0.5179

R-squared	0.022339	Mean dependent var	4.93E-06
Adjusted R-squared	-0.029117	S.D. dependent var	5.47E-06
S.E. of regression	5.55E-06	Akaike info criterion	-21.27538
Sum squared resid	5.85E-10	Schwarz criterion	-21.17590
Log likelihood	225.3914	Hannan-Quinn criter.	-21.25379
F-statistic	0.434130	Durbin-Watson stat	1.956391
Prob(F-statistic)	0.517875		

Appendix J2: Model B

Normality test results



Series: Residuals
Sample 2001 2022
Observations 22

Mean	-1.37e-15
Median	0.000593
Maximum	0.008410
Minimum	-0.012919
Std. Dev.	0.005964
Skewness	-0.485624
Kurtosis	2.583954
Jarque-Bera	1.023384
Probability	0.599480

Serial correlation test results

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	2.981814	Prob. F(1,9)	0.1183
Obs*R-squared	5.474957	Prob. Chi-Square(1)	0.0193

Test Equation:
Dependent Variable: RESID
Method: ARDL

Date: 08/01/24 Time: 21:08
Sample: 2001 2022
Included observations: 22
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGDP(-1)	-0.140645	0.312777	-0.449666	0.6636
ENEP	7.11E-07	9.05E-07	0.785050	0.4526
EX_PER	0.000882	0.002190	0.402545	0.6967
EX_PER(-1)	0.004609	0.004538	1.015608	0.3363
INT	0.001244	0.001748	0.711533	0.4948
INT(-1)	0.000756	0.002296	0.329366	0.7494
INFEX	-0.004303	0.005526	-0.778770	0.4561
INFEX(-1)	0.002147	0.003748	0.572979	0.5807
LINF	0.194303	0.420428	0.462156	0.6549
UNEMR	-0.004924	0.004399	-1.119209	0.2920
UNEMR(-1)	0.003811	0.003498	1.089655	0.3042
C	0.599936	1.401295	0.428130	0.6786
RESID(-1)	-0.900711	0.521609	-1.726793	0.1183

R-squared	0.248862	Mean dependent var	-1.37E-15
Adjusted R-squared	-0.752656	S.D. dependent var	0.005964
S.E. of regression	0.007895	Akaike info criterion	-6.557146
Sum squared resid	0.000561	Schwarz criterion	-5.912439
Log likelihood	85.12860	Hannan-Quinn criter.	-6.405272
F-statistic	0.248485	Durbin-Watson stat	1.894898
Prob(F-statistic)	0.986024		

Heteroskedasticity test results

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.417560	Prob. F(11,10)	0.2951
Obs*R-squared	13.40395	Prob. Chi-Square(11)	0.2677
Scaled explained SS	2.193310	Prob. Chi-Square(11)	0.9977

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 08/01/24 Time: 21:10
Sample: 2001 2022
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.008221	0.006811	-1.207000	0.2552
LGDP(-1)	0.001821	0.001515	1.201960	0.2571
ENEP	6.29E-10	4.05E-09	0.155501	0.8795
EX_PER	1.92E-05	1.07E-05	1.795702	0.1028
EX_PER(-1)	2.22E-05	1.84E-05	1.203433	0.2565
INT	4.21E-06	7.99E-06	0.526221	0.6102
INT(-1)	1.92E-05	1.13E-05	1.698602	0.1202
INFEX	2.93E-06	2.47E-05	0.118585	0.9080
INFEX(-1)	2.12E-06	1.77E-05	0.119667	0.9071
LINF	-0.002490	0.002033	-1.224861	0.2487
UNEMR	1.49E-05	1.68E-05	0.883542	0.3977

UNEMR(-1)	1.07E-05	1.36E-05	0.782548	0.4520

R-squared	0.609271	Mean dependent var	3.39E-05
Adjusted R-squared	0.179468	S.D. dependent var	4.37E-05
S.E. of regression	3.96E-05	Akaike info criterion	-17.13238
Sum squared resid	1.57E-08	Schwarz criterion	-16.53727
Log likelihood	200.4562	Hannan-Quinn criter.	-16.99219
F-statistic	1.417560	Durbin-Watson stat	1.945966
Prob(F-statistic)	0.295065		

Heteroskedasticity Test: Harvey

F-statistic	2.213108	Prob. F(11,10)	0.1108
Obs*R-squared	15.59426	Prob. Chi-Square(11)	0.1569
Scaled explained SS	13.14074	Prob. Chi-Square(11)	0.2842

Test Equation:
Dependent Variable: LRESID2
Method: Least Squares
Date: 08/01/24 Time: 21:11
Sample: 2001 2022
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-126.3773	280.6352	-0.450326	0.6621
LGDP(-1)	24.34394	62.42737	0.389956	0.7047
ENEP	-9.40E-05	0.000167	-0.563696	0.5854
EX_PER	1.015017	0.440264	2.305474	0.0438
EX_PER(-1)	-0.187522	0.758668	-0.247172	0.8098
INT	0.130434	0.329327	0.396062	0.7004
INT(-1)	0.455992	0.465963	0.978602	0.3509
INFEX	0.448109	1.019575	0.439505	0.6696
INFEX(-1)	0.009214	0.730867	0.012607	0.9902
LINF	-31.85844	83.74149	-0.380438	0.7116
UNEMR	0.187589	0.692559	0.270863	0.7920
UNEMR(-1)	0.117363	0.560898	0.209241	0.8385

R-squared	0.708830	Mean dependent var	-11.51443
Adjusted R-squared	0.388543	S.D. dependent var	2.087200
S.E. of regression	1.632101	Akaike info criterion	4.120066
Sum squared resid	26.63755	Schwarz criterion	4.715180
Log likelihood	-33.32072	Hannan-Quinn criter.	4.260257
F-statistic	2.213108	Durbin-Watson stat	2.539527
Prob(F-statistic)	0.110756		

Heteroskedasticity Test: Glejser

F-statistic	1.630993	Prob. F(11,10)	0.2247
Obs*R-squared	14.12624	Prob. Chi-Square(11)	0.2261
Scaled explained SS	6.219992	Prob. Chi-Square(11)	0.8583

Test Equation:
Dependent Variable: ARESID
Method: Least Squares
Date: 08/01/24 Time: 21:12

Sample: 2001 2022
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.545503	0.527434	-1.034258	0.3254
LGDP(-1)	0.121268	0.117328	1.033582	0.3257
ENEP	-8.77E-08	3.13E-07	-0.279826	0.7853
EX_PER	0.001645	0.000827	1.987787	0.0749
EX_PER(-1)	0.000740	0.001426	0.519195	0.6149
INT	0.000268	0.000619	0.432264	0.6747
INT(-1)	0.001263	0.000876	1.442757	0.1797
INFEX	0.000766	0.001916	0.399986	0.6976
INFEX(-1)	-3.43E-05	0.001374	-0.024975	0.9806
LINF	-0.164065	0.157386	-1.042436	0.3218
UNEMR	0.001193	0.001302	0.916684	0.3809
UNEMR(-1)	0.000355	0.001054	0.336478	0.7435

R-squared	0.642102	Mean dependent var	0.004690
Adjusted R-squared	0.248414	S.D. dependent var	0.003538
S.E. of regression	0.003067	Akaike info criterion	-8.433510
Sum squared resid	9.41E-05	Schwarz criterion	-7.838396
Log likelihood	104.7686	Hannan-Quinn criter.	-8.293319
F-statistic	1.630993	Durbin-Watson stat	2.128952
Prob(F-statistic)	0.224667		

Heteroskedasticity Test: ARCH

F-statistic	0.080878	Prob. F(1,19)	0.7792
Obs*R-squared	0.089012	Prob. Chi-Square(1)	0.7654

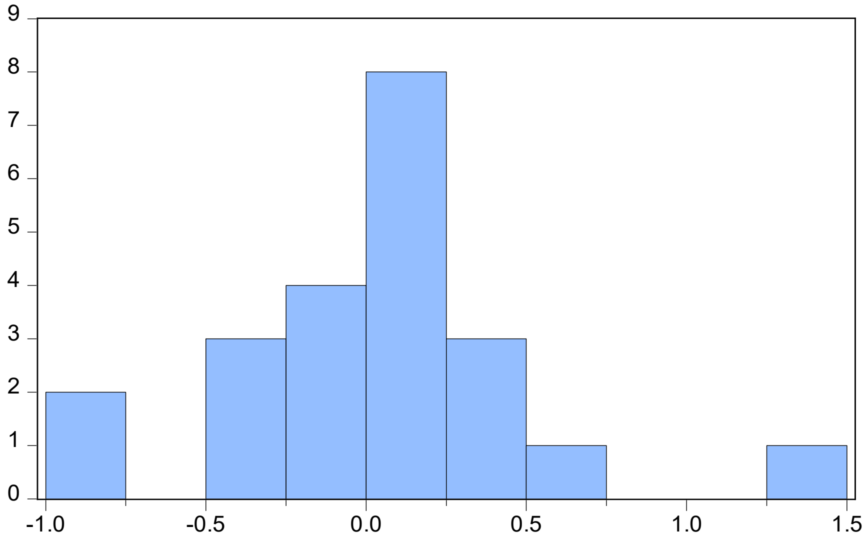
Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 08/01/24 Time: 21:13
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.72E-05	1.11E-05	2.443847	0.0245
RESID^2(-1)	0.056757	0.199574	0.284390	0.7792

R-squared	0.004239	Mean dependent var	2.92E-05
Adjusted R-squared	-0.048170	S.D. dependent var	3.87E-05
S.E. of regression	3.96E-05	Akaike info criterion	-17.34572
Sum squared resid	2.98E-08	Schwarz criterion	-17.24624
Log likelihood	184.1300	Hannan-Quinn criter.	-17.32413
F-statistic	0.080878	Durbin-Watson stat	2.017562
Prob(F-statistic)	0.779188		

Appendix J3: Model C

Normality test results



Series: Residuals	
Sample 2001 2022	
Observations 22	
Mean	1.03e-13
Median	0.044983
Maximum	1.267931
Minimum	-0.990543
Std. Dev.	0.459903
Skewness	0.278066
Kurtosis	4.698369
Jarque-Bera	2.927594
Probability	0.231356

Serial correlation test results

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.001054	Prob. F(1,9)	0.9748
Obs*R-squared	0.002576	Prob. Chi-Square(1)	0.9595

Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 08/01/24 Time: 21:39
Sample: 2001 2022
Included observations: 22
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UNEMR(-1)	0.001276	0.166014	0.007688	0.9940
ENEP	7.45E-07	6.14E-05	0.012138	0.9906
EX	-0.000250	0.222423	-0.001124	0.9991
INT	-0.004035	0.169863	-0.023755	0.9816
INT(-1)	9.23E-05	0.120873	0.000764	0.9994
INFEX	-0.001982	0.418445	-0.004736	0.9963
INFEX(-1)	0.001383	0.348084	0.003974	0.9969
LINF	0.260703	32.84058	0.007938	0.9938
LINF(-1)	-0.321996	25.14688	-0.012805	0.9901
LGDP	-0.646407	30.21170	-0.021396	0.9834
LGDP(-1)	0.649711	28.30383	0.022955	0.9822
C	0.084558	82.14102	0.001029	0.9992
RESID(-1)	-0.018957	0.583886	-0.032467	0.9748

R-squared	0.000117	Mean dependent var	1.03E-13
Adjusted R-squared	-1.333060	S.D. dependent var	0.459903
S.E. of regression	0.702472	Akaike info criterion	2.419578
Sum squared resid	4.441204	Schwarz criterion	3.064285
Log likelihood	-13.61536	Hannan-Quinn criter.	2.571452
F-statistic	8.78E-05	Durbin-Watson stat	1.998347
Prob(F-statistic)	1.000000		

Heteroskedasticity test results

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	2.445188	Prob. F(11,10)	0.1851
Obs*R-squared	16.03747	Prob. Chi-Square(11)	0.1397
Scaled explained SS	6.127321	Prob. Chi-Square(11)	0.8647

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 08/01/24 Time: 21:45
Sample: 2001 2022
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	33.26449	35.03983	0.949334	0.3648
UNEMR(-1)	-0.068930	0.068839	-1.001317	0.3403
ENEP	-1.77E-05	2.43E-05	-0.727692	0.4835
EX	-0.037736	0.094872	-0.397753	0.6992
INT	0.178130	0.049418	3.604554	0.0048
INT(-1)	0.085588	0.051574	1.659516	0.1280
INFEX	-0.049919	0.176680	-0.282540	0.7833
INFEX(-1)	-0.024361	0.147443	-0.165220	0.8721
LINF	4.450129	13.59079	0.327437	0.7501
LINF(-1)	9.863134	9.862627	1.000051	0.3409
LGDP	9.656935	9.698175	0.995748	0.3429
LGDP(-1)	-18.38247	8.542756	-2.151819	0.0569

R-squared	0.728976	Mean dependent var	0.201897
Adjusted R-squared	0.430849	S.D. dependent var	0.397407
S.E. of regression	0.299812	Akaike info criterion	0.731131
Sum squared resid	0.898874	Schwarz criterion	1.326245
Log likelihood	3.957556	Hannan-Quinn criter.	0.871322
F-statistic	2.445188	Durbin-Watson stat	2.628318
Prob(F-statistic)	0.085056		

Heteroskedasticity Test: Harvey

F-statistic	3.231954	Prob. F(11,10)	0.1375
Obs*R-squared	17.17030	Prob. Chi-Square(11)	0.1029
Scaled explained SS	22.18681	Prob. Chi-Square(11)	0.0230

Test Equation:
Dependent Variable: LRESID2
Method: Least Squares
Date: 08/01/24 Time: 21:46
Sample: 2001 2022
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	402.2447	205.1001	1.961211	0.0783
UNEMR(-1)	-0.829188	0.402939	-2.057852	0.0666

ENEP	-6.41E-05	0.000142	-0.450433	0.6620
EX	-0.414363	0.555321	-0.746168	0.4727
INT	0.797529	0.289261	2.757124	0.0202
INT(-1)	-0.053351	0.301880	-0.176728	0.8633
INFEX	0.728289	1.034171	0.704225	0.4974
INFEX(-1)	-0.181991	0.863037	-0.210872	0.8372
LINF	-4.771030	79.55154	-0.059974	0.9534
LINF(-1)	149.0158	57.72934	2.581284	0.0274
LGDP	6.011644	56.76675	0.105901	0.9178
LGDP(-1)	-103.8956	50.00368	-2.077759	0.0644

R-squared	0.780468	Mean dependent var	-3.588046
Adjusted R-squared	0.538983	S.D. dependent var	2.584610
S.E. of regression	1.754904	Akaike info criterion	4.265157
Sum squared resid	30.79688	Schwarz criterion	4.860271
Log likelihood	-34.91673	Hannan-Quinn criter.	4.405348
F-statistic	3.231954	Durbin-Watson stat	2.020228
Prob(F-statistic)	0.037496		

Heteroskedasticity Test: Glejser

F-statistic	4.307524	Prob. F(11,10)	0.2144
Obs*R-squared	18.16610	Prob. Chi-Square(11)	0.0778
Scaled explained SS	11.89619	Prob. Chi-Square(11)	0.3715

Test Equation:
Dependent Variable: ARESID
Method: Least Squares
Date: 08/01/24 Time: 21:47
Sample: 2001 2022
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	39.53328	23.52679	1.680352	0.1238
UNEMR(-1)	-0.074733	0.046221	-1.616869	0.1370
ENEP	-1.68E-05	1.63E-05	-1.032326	0.3262
EX	-0.046088	0.063700	-0.723509	0.4859
INT	0.153635	0.033181	4.630235	0.0009
INT(-1)	0.043908	0.034628	1.267974	0.2335
INFEX	-0.005161	0.118629	-0.043509	0.9662
INFEX(-1)	-0.015980	0.098998	-0.161419	0.8750
LINF	2.555075	9.125263	0.280000	0.7852
LINF(-1)	13.08413	6.622064	1.975838	0.0764
LGDP	7.933101	6.511646	1.218294	0.2511
LGDP(-1)	-17.91366	5.735863	-3.123097	0.0108

R-squared	0.825732	Mean dependent var	0.310162
Adjusted R-squared	0.634036	S.D. dependent var	0.332760
S.E. of regression	0.201303	Akaike info criterion	-0.065560
Sum squared resid	0.405229	Schwarz criterion	0.529554
Log likelihood	12.72116	Hannan-Quinn criter.	0.074631
F-statistic	4.307524	Durbin-Watson stat	2.433808
Prob(F-statistic)	0.014409		

Heteroskedasticity Test: ARCH

F-statistic	2.100098	Prob. F(1,19)	0.1636
Obs*R-squared	2.090135	Prob. Chi-Square(1)	0.1483

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 08/01/24 Time: 21:49
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.142272	0.097778	1.455054	0.1620
RESID^2(-1)	0.316340	0.218291	1.449171	0.1636

R-squared	0.099530	Mean dependent var	0.209163
Adjusted R-squared	0.052137	S.D. dependent var	0.405721
S.E. of regression	0.395003	Akaike info criterion	1.070545
Sum squared resid	2.964517	Schwarz criterion	1.170023
Log likelihood	-9.240721	Hannan-Quinn criter.	1.092134
F-statistic	2.100098	Durbin-Watson stat	2.133375
Prob(F-statistic)	0.163595		

Appendix K: Omitted variable test results

Model A

Omitted Variables Test
Null hypothesis: ENEP LGDP UNEMR are jointly significant
Equation: UNTITLED
Specification: LINF LINF(-1) INT INFEX EX C
Omitted Variables: ENEP LGDP UNEMR

	Value	df	Probability
F-statistic	7.003313	(3, 15)	0.0036
Likelihood ratio	20.14213	3	0.0002

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.001312	3	0.000437
Restricted SSR	0.002249	18	0.000125
Unrestricted SSR	0.000937	15	6.24E-05

LR test summary:

	Value	df
Restricted LogL	73.54311	18
Unrestricted LogL	83.61418	15

Unrestricted Test Equation:
Dependent Variable: LINF
Method: Least Squares
Date: 03/05/25 Time: 19:37
Sample: 2001 2023
Included observations: 23

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF(-1)	0.735741	0.066966	10.98686	0.0000
INT	-0.000163	0.001335	-0.122368	0.9042
INFEX	0.008460	0.001893	4.469343	0.0004
EX	0.004665	0.001399	3.335294	0.0045
C	-0.656213	0.272437	-2.408682	0.0293
ENEP	7.32E-07	4.82E-07	1.517666	0.1499
LGDP	0.158326	0.055593	2.847928	0.0122
UNEMR	0.000256	0.001215	0.210356	0.8362

R-squared	0.998874	Mean dependent var	1.752878
Adjusted R-squared	0.998349	S.D. dependent var	0.194490
S.E. of regression	0.007902	Akaike info criterion	-6.575146
Sum squared resid	0.000937	Schwarz criterion	-6.180191
Log likelihood	83.61418	Hannan-Quinn criter.	-6.475816
F-statistic	1901.673	Durbin-Watson stat	2.092892
Prob(F-statistic)	0.000000		

Model B

Omitted Variables Test
Null hypothesis: ENEP LINF UNEMR are jointly significant
Equation: UNTITLED
Specification: LGDP LGDP(-1) INFEX INT EX_PER C
Omitted Variables: ENEP LINF UNEMR

	Value	df	Probability
F-statistic	2.025974	(3, 14)	0.0065
Likelihood ratio	7.932398	3	0.0474

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.000604	3	0.000201
Restricted SSR	0.001996	17	0.000117
Unrestricted SSR	0.001392	14	9.94E-05

LR test summary:

	Value	df
Restricted LogL	71.16814	17
Unrestricted LogL	75.13434	14

Unrestricted Test Equation:
Dependent Variable: LGDP
Method: Least Squares
Date: 03/05/25 Time: 19:42
Sample: 2001 2022
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGDP(-1)	0.649186	0.311678	2.082877	0.0561
INFEX	-0.001791	0.003915	-0.457452	0.6544
INT	-0.002989	0.001704	-1.754656	0.1012
EX_PER	-0.001349	0.001778	-0.758673	0.4606
C	1.694993	1.388621	1.220631	0.2424
ENEP	1.21E-06	4.96E-07	2.428704	0.0292

LINF	0.399347	0.420576	0.949524	0.3585
UNEMR	-0.002627	0.003356	-0.782778	0.4468

R-squared	0.998746	Mean dependent var	6.501578
Adjusted R-squared	0.998118	S.D. dependent var	0.229853
S.E. of regression	0.009970	Akaike info criterion	-6.103122
Sum squared resid	0.001392	Schwarz criterion	-5.706379

Model C

Omitted Variables Test
Null hypothesis: ENEP LINF LGDP are jointly significant
Equation: UNTITLED
Specification: UNEMR UNEMR(-1) EX INT INFEX C
Omitted Variables: ENEP LINF LGDP

	Value	df	Probability
F-statistic	0.248180	(3, 15)	0.0014
Likelihood ratio	1.114199	3	0.0036

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	1.250775	3	0.416925
Restricted SSR	26.44972	18	1.469429
Unrestricted SSR	25.19895	15	1.679930

LR test summary:

	Value	df
Restricted LogL	-34.24273	18
Unrestricted LogL	-33.68563	15

Unrestricted Test Equation:
Dependent Variable: UNEMR
Method: Least Squares
Date: 03/05/25 Time: 19:47
Sample: 2001 2023
Included observations: 23

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UNEMR(-1)	0.707760	0.219696	3.221550	0.0057
EX	0.352745	0.226193	1.559484	0.1397
INT	-0.411366	0.197844	-2.079250	0.0552
INFEX	0.047429	0.362815	0.130725	0.8977
C	26.40065	57.72221	0.457374	0.6540
ENEP	5.60E-05	7.76E-05	0.721759	0.4815
LINF	2.197384	15.69446	0.140010	0.8905
LGDP	-3.831498	12.10677	-0.316476	0.7560

R-squared	0.895897	Mean dependent var	26.45217
Adjusted R-squared	0.847315	S.D. dependent var	3.317018
S.E. of regression	1.296121	Akaike info criterion	3.624837
Sum squared resid	25.19895	Schwarz criterion	4.019792
Log likelihood	-33.68563	Hannan-Quinn criter.	3.724167
F-statistic	18.44112	Durbin-Watson stat	2.626029
Prob(F-statistic)	0.000003		

Appendix L: Granger causality test results

Pairwise Granger Causality Tests
Date: 08/01/24 Time: 20:52
Sample: 2000 2022
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
ENEP does not Granger Cause LINF	21	0.49353	0.6195
LINF does not Granger Cause ENEP		0.47883	0.6281
EX does not Granger Cause LINF	21	1.64669	0.2237
LINF does not Granger Cause EX		3.91309	0.0414
INT does not Granger Cause LINF	21	1.31909	0.2949
LINF does not Granger Cause INT		2.18167	0.1453
INFEX does not Granger Cause LINF	21	8.52452	0.0030
LINF does not Granger Cause INFEX		0.69350	0.5142
LGDP does not Granger Cause LINF	21	1.84505	0.1901
LINF does not Granger Cause LGDP		0.28475	0.7559
UNEMR does not Granger Cause LINF	21	1.14020	0.3444
LINF does not Granger Cause UNEMR		1.78329	0.1999
EX does not Granger Cause ENEP	21	2.44922	0.1180
ENEP does not Granger Cause EX		1.22189	0.3207
INT does not Granger Cause ENEP	21	1.85702	0.1883
ENEP does not Granger Cause INT		0.52202	0.6031
INFEX does not Granger Cause ENEP	21	1.88829	0.1835
ENEP does not Granger Cause INFEX		0.08733	0.9168
LGDP does not Granger Cause ENEP	21	0.55993	0.5820
ENEP does not Granger Cause LGDP		0.10899	0.8974
UNEMR does not Granger Cause ENEP	21	0.45646	0.6415
ENEP does not Granger Cause UNEMR		0.64757	0.5365
INT does not Granger Cause EX	21	1.00730	0.3872
EX does not Granger Cause INT		0.74570	0.4902
INFEX does not Granger Cause EX	21	1.53247	0.2461
EX does not Granger Cause INFEX		1.52241	0.2482
LGDP does not Granger Cause EX	21	2.54072	0.1101
EX does not Granger Cause LGDP		0.01263	0.9875
UNEMR does not Granger Cause EX	21	0.00116	0.9988
EX does not Granger Cause UNEMR		11.3340	0.0009
INFEX does not Granger Cause INT	21	0.15504	0.8577
INT does not Granger Cause INFEX		1.12557	0.3489
LGDP does not Granger Cause INT	21	6.96361	0.0067
INT does not Granger Cause LGDP		3.89135	0.0420

UNEMR does not Granger Cause INT	21	0.09503	0.9099
INT does not Granger Cause UNEMR		1.45679	0.2623
LGDP does not Granger Cause INFEX	21	1.49359	0.2543
INFEX does not Granger Cause LGDP		2.04317	0.1621
UNEMR does not Granger Cause INFEX	21	6.52243	0.0085
INFEX does not Granger Cause UNEMR		0.47365	0.6312
UNEMR does not Granger Cause LGDP	21	0.00795	0.9921
LGDP does not Granger Cause UNEMR		6.57902	0.0082

Appendix M: Variance Decomposition test results

Appendix M1: Model A

Variance Decomposition of LINF: Period	S.E.	LINF	ENEP	EX	INT	INFEX	LGDP	UNEMR
1	0.013246	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.015404	92.60128	0.157789	0.486191	1.241351	0.014240	5.261912	0.237233
3	0.016583	86.32714	0.372910	0.649523	2.220790	0.134050	10.04605	0.249540
4	0.017484	81.36583	0.874330	0.640591	2.777041	0.166186	13.93800	0.238027
5	0.018265	77.28753	1.451834	0.602886	3.154855	0.165362	17.11421	0.223322
6	0.018948	73.93517	1.996451	0.565745	3.436013	0.157516	19.69949	0.209611
7	0.019551	71.16723	2.478528	0.533706	3.654229	0.149305	21.81915	0.197853
8	0.020086	68.86972	2.894862	0.506802	3.828364	0.142016	23.57025	0.187988
9	0.020561	66.94917	3.251058	0.484255	3.970399	0.135781	25.02962	0.179718
10	0.020986	65.33128	3.555225	0.465261	4.088288	0.130484	26.25672	0.172749

Appendix M2: Model B

Variance Decomposition of LGDP: Period	S.E.	LGDP	ENEP	EX_PER	INT	INFEX	LINF	UNEMR
1	0.010576	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.012616	98.63779	0.068058	0.043557	0.214441	0.061869	0.932242	0.042040
3	0.014363	97.13470	0.130918	0.064847	0.330739	0.191142	2.109271	0.038387
4	0.015746	95.81435	0.190780	0.076782	0.429733	0.311214	3.145012	0.032131
5	0.016909	94.75886	0.240802	0.085506	0.508319	0.405466	3.973106	0.027942
6	0.017902	93.93755	0.280328	0.091777	0.569418	0.477795	4.617881	0.025250

7	0.018761	93.29680	0.311365	0.096413	0.616977	0.533845	5.121178	0.023420
8	0.019510	92.79120	0.335928	0.099968	0.654458	0.577959	5.518390	0.022097
9	0.020169	92.38652	0.355620	0.102771	0.684433	0.613224	5.836339	0.021091
10	0.020751	92.05792	0.371623	0.105030	0.708764	0.641842	6.094526	0.020297

Appendix M3: Model C

Variance Decomposition of UNEMR: Period	S.E.	UNEMR	ENEP	EX	INT	INFEX	LINF	LGDP
1	1.556718	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	1.693589	94.33815	2.867856	2.518917	0.045941	0.000596	0.036897	0.191638
3	1.739323	92.28616	3.757339	3.644624	0.050444	0.000824	0.070837	0.189772
4	1.753257	91.70701	3.938190	4.009835	0.049654	0.000867	0.096422	0.198025
5	1.758537	91.48342	3.958696	4.149924	0.051665	0.002073	0.118380	0.235839
6	1.761184	91.34621	3.949608	4.211333	0.056463	0.005539	0.137670	0.293180
7	1.762979	91.22794	3.942440	4.241782	0.062931	0.010513	0.154874	0.359522
8	1.764438	91.11578	3.941057	4.258690	0.070098	0.016123	0.170325	0.427924
9	1.765720	91.00900	3.943837	4.269171	0.077336	0.021830	0.184274	0.494556
10	1.766876	90.90863	3.948879	4.276371	0.084310	0.027351	0.196911	0.557544