Inflation Hedging Across Asset Classes: A Non-Linear Perspective from the South African Context

Master of Commerce (50% Research) in Finance

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Abstract

Navigating the intricacies of financial markets, investors grapple with the enduring challenge of preserving portfolio value amidst the complexities of inflation. This study delves into the dynamic interplay between inflation and returns across diverse asset classes, focusing on the distinctive nuances within South Africa. Against the backdrop of global disruptions such as the Covid-19 pandemic and geopolitical tensions, the research examines the inflation-hedging potential within traditional and alternative investments, including the emergent domain of cryptocurrencies. Situated within the framework of the "Inflation targeting" strategy embraced by the South African Reserve Bank, the study employs the NARDL model, which rigorously tests the short and long-run relationships between the asset returns and inflation. The research imparts nuanced insights into the complex environment of inflation hedging in the South African market.

CHAPTER 1

INTRODUCTION

1.1.1. BACKGROUND AND OVERVIEW

Investors and portfolio managers engage in a range of investment strategies with the goal of achieving returns surpassing a chosen benchmark over a specific time frame while managing risk. A perennial challenge faced by investors is the erosion in the value of financial assets due to rising inflation, leading to diminished purchasing power. This necessitates investors to generate returns that outpace the inflation rate as they seek to safeguard the value of their investments. Lintner (1975) emphasises that few matters hold as profound significance as the impact inflation has on financial institutions, markets, and investment strategies.

When investors strive to diversify their portfolios, it becomes essential that they consider the detrimental consequences of inflation on diverse asset classes and their returns. The concept of inflation hedging refers to safeguarding investments against the erosion of currency value due to inflation. In the aftermath of the global shock caused by the Covid-19 pandemic, inflation has surged to notable levels due to disruptions in supply chains. This prompted central banks to employ various monetary tools, including interest rate cuts and economic stimulus packages, to avert deeper economic downturns. For instance, in response to the pandemic the US government enacted a 2 trillion-dollar economic stimulus package aimed at stimulating economic activity (Snell, 2020). In South Africa, the government implemented a R500 billion economic stimulus package at the beginning of the pandemic. The South African Reserve Bank (SARB) and other financial institutions also introduced measures to complement the above fiscal stimulus where they reduced interest rates, relaxed regulatory requirements and introduced payment holidays to businesses and consumers (Department of National Treasury, 2020). Furthermore, the conflict between Russia and Ukraine has resulted in a shock to global trade and as a result an additional inflationary pressure on consumer prices. The impact of the war was evident in further increased prices for fuel and energy which reduced disposable income worldwide (The United Nations Development Programme South Africa, 2022). In an environment marked by elevated levels of inflation, it is imperative for investors to ensure that their portfolios incorporate assets capable of mitigating the effects of inflation.

1.1.2. PROBLEM STATEMENT

The inflation hedging potential of various assets has been the subject of considerable investigation. Rubens et al. (1989) describes inflation hedges as assets that can protect investors from the loss of portfolio value because of inflation. The Fisher hypothesis suggests that nominal interest rates adjust to changes in expected inflation and as a result, this theory has been a cornerstone of many of these studies examining the relationship between inflation and various types of assets (Fama & Schwert, 1977; Jaffe & Mandelker, 1976). The empirical evidence for the Fisher hypothesis's effectiveness as an inflation hedge has produced mixed results. Some studies have found that stocks and real estate for example may hedge against inflation, but it is dependent on factors such as the time period, economic cycle, or inflation regime (Anari & Kolari, 2001; Fama, 1981; National & Low, 2000).

Despite extensive research into the inflation hedging potential of various asset class returns, there are still several areas whereby further analysis and exploration can be done. The correlation between asset class returns and inflation is dynamic and is influenced by a multitude of factors such as shifts in market conditions and changes in monetary policy regimes that are pursued by different countries (Brière & Signori, 2012; Phochanachan et al., 2022). In addition, it's noteworthy that prevailing scholarly research primarily centers around developed economies. Thus, delving into this dynamic correlation becomes particularly imperative when considering it from the perspective of a developing economy (Davis & Ali, 2003; Hoesli et al., 2008; Bruno & Chincarini, 2010). Furthermore, within the realm of investor sentiment and behaviour, psychological biases which influence the decisions taken by investors should not be underestimated. These biases can distinctly impact what assets investors prefer during periods marked by elevated inflationary pressures (Adusei, 2014; Briere & Signori, 2011). Expanding on this, the landscape of available asset classes has significantly broadened, encompassing not only traditional options but a now wider range of innovative and alternative choices. As a result, these ever-changing possibilities require further exploration and examination from investors and researchers alike (McCown & Zimmerman, 2007; Smales, 2022). In addition, the factors that drive inflation are multifaceted and include monetary and fiscal policies, supply shocks, and more. Delving into the intricate interplay of these macroeconomic elements in shaping inflation is essential (Madsen, 2005). Moreover, while evaluating how efficient assets are in countering inflation, a balanced assessment of the risk and return trade-off is of utmost importance. This consideration is particularly significant due to the varying levels of responsiveness to inflation exhibited by different asset classes and their returns (Campbell & Viceira, 2005). Lastly, the impact of global events, such as the Global Financial Crisis (GFC) or the Covid-19 pandemic, extends not only to the inflationary environment but also influences how diverse asset classes and their returns perform. As a result, a thorough investigation of these occurrences contributes to enhancing the current body of knowledge regarding the inflation hedging characteristics of diverse asset types (Burdekin & Tao, 2021; D'Amico & King, 2023).

From the above, the realm of inflation hedging is marked by its dynamic and intricate nature, offering abundant room for continual research efforts. These endeavors are directed towards enhancing our understanding of how individual asset class returns serve as safeguards against the consequences of inflation. As the environment of market conditions, economic theories, and investment tools continue to evolve and transform, research pursuits will emerge. The outcome of these studies can shape the formulation of enhanced or newer investment strategies that effectively confront the complexities presented by inflation-related risks.

This study seeks to investigate the changing relationship between inflation and the returns of both traditional and alternative asset classes, which encompasses the novel category of cryptocurrency. The study will be conducted within the framework of South Africa, one of the prominent emerging economies in Africa. The study will also delve into the interplay between our variables over both short and extended timeframes, encompassing diverse economic scenarios under a unified monetary policy strategy known as "Inflation targeting". This monetary policy framework was officially adopted by the SARB in February 2000.

1.1.3. RESEARCH OBJECTIVES AND HYPOTHESES

This study aims to analyse the ever-changing relationship between the returns of significant asset class returns and inflation to see which of these assets hedge against the adverse effects of inflation. The objectives of the study are as follows:

- Initially, the investigation will determine whether a specific asset class return functions as a hedge against inflation.
- Subsequently, the research will explore the short-term and long-term associations between asset class returns and inflation.

The research will thus be testing the following hypotheses as per the objectives stated above:

Hypothesis 1: *The specific asset class return serves as a significant hedge against inflation.*
Hypothesis 2: *There exists a significant short-term association between the specific asset* class *return and inflation.*
Hypothesis 3: *There exists a significant long-term association between the specific asset class return and inflation.*

1.1.4. IMPORTANCE AND BENEFITS OF PROPOSED STUDY

Understanding the relationship between asset class returns and inflation is crucial because investors must comprehend how to structure their portfolios to attain optimal returns while also hedging against the impact of inflation. This knowledge enables them to build portfolios that are robust and well-positioned to simultaneously achieve high returns and mitigate the effects of inflation. Huang and Hudson-Wilson (2007) stated that an investors ability to effectively control and incorporate the inflation rate within their portfolio returns can mitigate the influence of inflation on the value of their investment.

Inflation hedging is important because over time the purchasing power of assets and investments diminishes if the rate of inflation is greater than the rate of return on these assets and thus the real value of the investment portfolio decreases. Excessive inflation can also disrupt the economic stability of a country, both in developed and developing markets. This is why central banks make use of various monetary policies such as inflation targeting to promote economic stability.

This study will add to existing literature by investigating the inflation hedging ability across various asset class returns particularly in South Africa by using newer methodology that will encompass the asymmetric impact of inflation. It can thus provide further insight to investors and portfolio managers on which South African assets provide the best hedge against inflation such that the value of their portfolio does not significantly depreciate. This paper stands out due to its inclusion of cryptocurrency in the analysis, marking a departure from conventional literature that often concentrates on specific and well-established asset categories. The inclusion of cryptocurrency introduces a distinctive dimension to this study, acknowledging the dynamic evolution of investment landscapes and bringing to light an element that has garnered increased attention in recent financial discussions. The outcome of this study can also attract increased foreign investment from global investors and portfolio managers seeking to take advantage of the inflation hedging abilities of domestic asset classes.

1.1.5. RESEARCH STRUCTURE

The upcoming sections of this study will be organised as follows: Chapter 2 will offer a comprehensive literature review, delving into prior research and key concepts. Chapter 3 will provide a detailed overview of the data and methodology utilised in the study. In Chapter 4, the focus will be on discussing the descriptive statistics and presenting the results obtained from the tests. Chapter 5 will be dedicated to conducting diagnostic tests. Finally, Chapter 6 will serve as the conclusion of the paper, summarising key findings and implications.

CHAPTER 2

LITERATURE REVIEW

This section examines the existing body of literature concerning the inflation hedging abilities of different asset classes. Initially, we will first discuss the concept of inflation and its history in South Africa. Subsequently, we will discuss the Fisher hypothesis, which has served as the foundation for numerous studies. Lastly, we delve into the existing literature exploring the capacity of diverse asset classes to serve as hedges against inflation, offering insights into their efficacy or lack thereof.

2.1.1. INFLATION

Inflation is commonly understood as the overall and constant rise in the prices of goods and services over time, contributing to an increase in the cost of living. Alternatively, it can be viewed as a decrease in the purchasing power of money as time progresses. This phenomenon is intrinsic to economies and markets, constituting an inevitable aspect. Recognised as a pivotal economic indicator in both developed and developing countries, central banks worldwide prioritise maintaining stability in prices within their economies. To achieve this objective, they implement various monetary and fiscal policy regimes, with the overarching aim of attaining low and stable inflation levels while achieving sustainable economic growth (Barro, 1996).

Diverse metrics, including the widely used Consumer Price Index (CPI) and the specific measure CPIX, are employed to assess inflation. However, on October 21, 2008, South Africa's Minister of Finance announced a noteworthy modification to the inflation-targeting framework. Effective from February 25, 2009, the year-on-year increase in the consumer price index, which previously excluded the impact of mortgage interest rates, underwent a change, replaced by the headline consumer price index for all urban areas (SARB, 2008). This index serves as a socio-economic indicator, examining fluctuations in the prices of goods and services over time within a fixed basket that households typically consume (STATSSA, 2017). Alternative measures encompass the Producer Price Index (PPI), which assesses the rate of change in the prices of goods and services sold by producers. Additionally, the GDP deflator, a ratio of nominal GDP to real GDP, monitors the price adjustments in a country's economic output (De Gaetano, 2017).

The intricate analysis of the factors contributing to inflation has not only sparked a profound macroeconomic debate in the field of economics but has also become a focal point for researchers and policymakers seeking a deeper understanding of economic dynamics. This ongoing discourse reflects the complex interplay of various factors influencing price levels, encompassing monetary policies, supply and demand dynamics, and external economic shocks. As scholars delve into this multifaceted subject, the quest for comprehensive insights continues to shape economic theories and guide strategies for mitigating the impact of inflation on economies worldwide. The growth in money supply has often been cited as the cause of inflation in developed economies whereas the cause in developing economies is a result of various factors extending past money supply linked to fiscal imbalances through exchange rate depreciation (Totonchi, 2011).

Two drivers of inflation have been identified by monetary economists namely: demand-pull and cost-push inflation. Demand-pull inflation is spurred by an excess of demand within the economy, closely tied to overall expenditure and the quantity of money in circulation. This is when consumers' demand for goods and services in the economy exceeds the overall quantity that can be supplied. This is often referred to as "too much money chasing too few goods". On the other hand, cost-push inflation is linked to escalating production costs or a drop in production output. When supplier costs increase, the market passes this increased cost on to the consumer meaning the price that goods and services are sold at is higher which also results in inflation. The origins of these inflationary forces can stem from either internal dynamics inherent to the economy or external influences exerted from outside sources (Ziramba, 2008). As mentioned earlier, the impact of inflation on investor wealth and portfolios, along with its effects on returns, manifests in diverse ways. Inflation discourages consumer savings, whether stored in banks or fixed deposits, as the diminishing purchasing power erodes the value of these holdings. The influence of inflation extends to salaries and wages, where an increase aligned with inflation, without corresponding adjustments to income tax brackets, leads to a financial setback for taxpayers who find themselves pushed into higher tax brackets. Moreover, the repercussions of inflation extend to the business landscape, where producers may hesitate to expand their operations due to confusion in price signals. The challenge lies in discerning whether a higher product price results from standard inflation adjustments or a surge in market demand. This ambiguity can act as a deterrent for producers, impeding their willingness to ramp up production (SARB, 2012).

2.1.2. INFLATION IN SOUTH AFRICA

During the elevated inflation periods witnessed by industrialised nations in the 1970s and 1980s, the pursuit of price stability emerged as the paramount objective in global monetary policies. This shift was motivated by the recognition that price stability plays a pivotal role in fostering long-term financial stability (Bordo, 2009). Pioneering this approach, New Zealand became the first nation to embrace a focus on price stability, setting a precedent for other countries to follow suit. Subsequently, countries including Canada, Sweden, Australia, the United Kingdom, and others adopted similar monetary policies, reflecting a widespread acknowledgment of the importance of maintaining stable prices in the broader economic landscape (van der Merwe, 2004).

Monetary policy in South Africa is primarily directed at achieving and sustaining price stability, underpinning a broader objective of cultivating balanced and sustainable economic growth. This strategic approach permeates the economy through various channels, exerting a significant influence on the overall economic landscape (SARB, 2024). In February 2000, the SARB formally embraced inflation targeting as a fundamental component of its monetary policy framework. Under this regime, the overarching objective is to secure price stability by keeping the inflation rate, as measured by the headline CPI, within a targeted range of 3-6%. This target is collaboratively established by the Minister of Finance and the Governor of the SARB, with the Monetary Policy Committee striving to maintain inflation around the midpoint of 4.5% within the specified range. Notably, preceding the adoption of inflation targeting, the central bank in South Africa based its monetary policy decisions on an intermediate target related to monetary supply growth. It wasn't until the 1990s that the enforcement of inflation targeting started becoming an informalised feature (van der Merwe, 2004).

The SARB primarily relies on the repo rate as its key tool for inflation targeting. However, before embracing this focused strategy, the SARB employed a variety of monetary policy approaches. These methods included managing bank credit extension, overseeing banking sector liquidity, considering the yield curve, adjusting foreign reserves, and targeting the Rand exchange rate.

The evolution of South Africa's monetary policy framework unfolded through distinct phases. From 1960 to 1981, the country operated under a liquid asset ratio-based system with quantitative controls over interest rates and credit. The period from 1981 to 1985 marked a transitional phase with a mixed system.

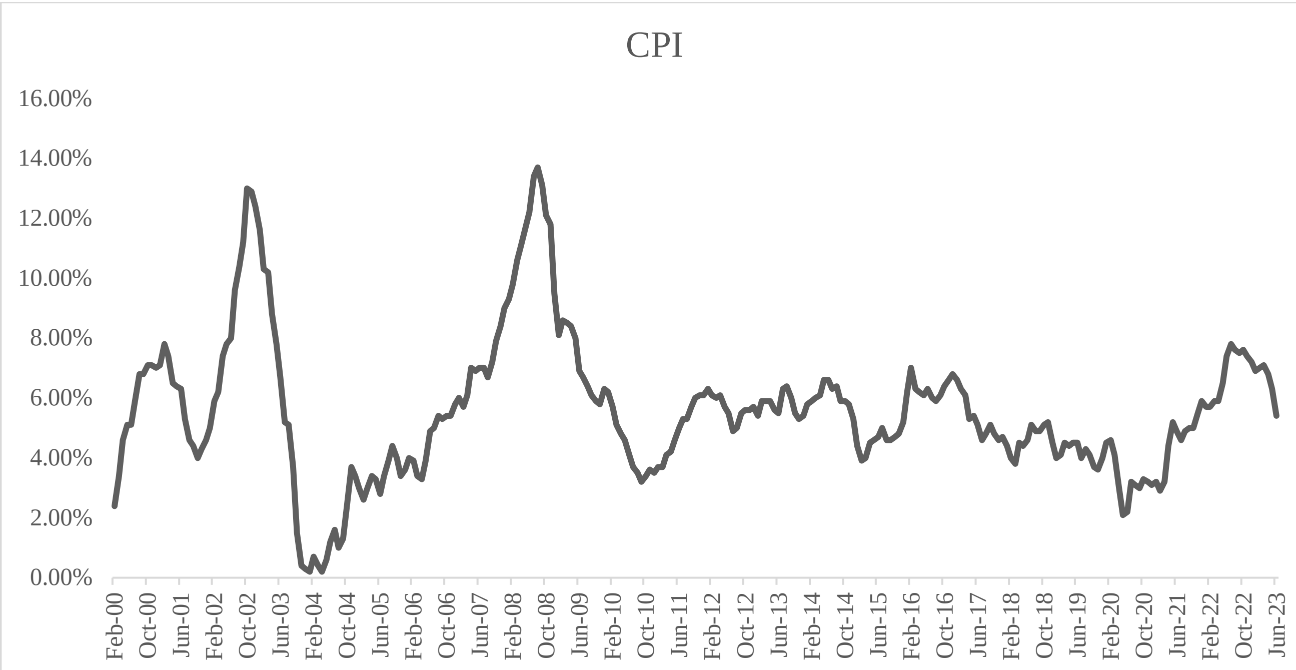
Between 1986 and 1998, the focus shifted to a cost of cash reserves-based system. The years 1998-1999 witnessed the introduction of daily tenders of liquidity through repurchase transactions. Finally, from 2000 to the present day, South Africa has formally adopted inflation targeting as its monetary policy framework (Mohr et al., 2007). Each of these strategies represented diverse tools employed by the SARB to influence and regulate various aspects of the monetary environment. With the transition to inflation targeting, the repo rate has taken center stage as the primary tool, indicating a more targeted and transparent approach to monetary policy (Ellyne & Veller, 2011; Ziramba, 2008).

Table 1: South Africa's monetary policy evolution

Years	Monetary Policy Framework
1960 – 1981	A system centered on a liquid asset ratio, incorporating quantitative measures for regulating interest rates and credit.
1981 – 1985	Transition period thus use of a mixed system
1986 – 1998	Cost of cash reserves-based system with pre-announced guidelines for growth in M3
1998 - 1999	Daily liquidity tenders via repurchase transactions (repo system), alongside explicit M3 targets and informal benchmarks for core inflation.
2000 - Present	Inflation targeting formally implemented.

Source: Mohr et al. (2007)

Figure 1: Monthly CPI since inflation targeting regime officially implemented



Source: SARB

In the 1970s and 1980s, South Africa encountered significant inflation, averaging 14% until the early 1990s. Subsequently, there was an improvement in the inflation rate during the period from 1994 to 2002, with an average of 7% (Nowak & Ricci, 2006). South Africa's inflation was primarily influenced by global inflation trends and its domestic monetary policy. Over the span of the last six decades, South Africa has witnessed a diverse range in the inflation rate for consumer prices, oscillating between -0.7% and 18.7%. Specifically, the inflation rate for the year 2022 was determined to be 7.0%. Across the comprehensive observation period from 1960 to 2022, the average annual inflation rate held steady at 7.9%. This cumulative average signifies an overall surge in prices totaling 10,396.73% (Worlddata.info, 2023). The data from Worlddata.info shows that this economic journey underscores the substantial impact of inflation on the purchasing power of the currency. For instance, an item priced at R100 in 1960 would now command an approximate value of R10,496.73 at the outset of 2023. Such fluctuations in inflation rates bear profound implications for consumer affordability, investment strategies, and overall economic planning within the country. Understanding and navigating these dynamics becomes pivotal for individuals, businesses, and policymakers alike in fostering financial resilience and stability.

Despite the implementation of diverse policies to stimulate economic growth, the South African economy demonstrates slow progress, characterised by a notably low employment coefficient. Growth has remained modest, with the mean growth rate between 2013 and 2019 being 1.0935%. On the inflation front, the SARB has been notably successful in maintaining price stability (Mandeya & Ho, 2021).

2.1.3. FISHER HYPOTHESIS

The use of Fisher's (1930) theory of interest rates to predict the inflation hedging nature of asset classes has been extensively studied. This theory describes the relationship between the nominal interest rate and inflation stating that an increase in the nominal interest rate results in a decrease in inflation. In other words, the real rate of interest is the difference between the nominal rate of interest and the expected rate of inflation (Gavriilidis & Kgari, 2016). When inflation increases, investors will require that nominal interest rates recoup the marginal utility of the present consumption that has eroded due to inflation. Fama and Schwert (1977) conducted a study examining the degree that assets could hedge against inflation. Applying Fisher's theory of interest rates, they studied the idea that expected nominal returns encompass market valuations of expected inflation rates which can be extended to all assets. Under the assumption that markets effectively incorporate all pertinent and accessible information at the time *t*-1, the pricing of asset *j* will be such that the nominal return expected on asset *j* from *t*-1 to *t* equals the combination of the suitable equilibrium expected real return and the most accurate possible estimation of the expected inflation rate from *t*-1 to *t*. This can be represented as:

$$\boldsymbol{E(r_{jt}|\theta_{t-1}) = E(i_{jt}|\theta_{t-1}) + E(\pi_t|\theta_{t-1})} \qquad 1$$

Where $E(r_{jt}|\theta_{t-1})$ is the expected nominal return of the asset j, $E(i_{jt}|\theta_{t-1})$ is the expected real return of asset j, and $E(\pi_t|\theta_{t-1})$ is the expected inflation rate.

To examine the hypothesis that expected real return and expected inflation are independent of each other, it is important to find a method that quantifies the anticipated inflation rate. Arnold and Auer (2015) noted that an empirical measure of the inflation rate can be extracted using various sources such as surveys, time-series models, information given by traded instruments, theoretical relations contained in the treasury bill market or using the realised inflation as a proxy for future inflation. Once an appropriate measure has been selected, the regression model can be estimated as follows:

$$\boldsymbol{r_{jt} = \alpha_j + \beta_j E(\pi_t|\theta_{t-1}) + \varepsilon_{jt}} \quad 1$$

Where r_{jt} is the nominal return, α_j is a constant, and β_j is an estimate not significantly different from one which is in alignment with the fisher hypothesis that the expected real return of an asset has a perfect correlation to the inflation rate.

Fama and Schwert (1977) extended the above model to include unexpected inflation unlike Fisher (1930) who only incorporated expected inflation. The inclusion of unexpected inflation leads to the regression equation below:

$$\boldsymbol{r_{jt} = \alpha_j + \beta_j E(\pi_t|\theta_{t-1}) + \gamma_j[\pi_t - E(\pi_t|\theta_{t-1})] + \omega_{jt}} \quad 2$$

Where $\pi_t - E(\pi_t|\theta_{t-1})$ is the unexpected inflation, and γ_j is an estimate not significantly different from one provided that the asset hedges perfectly against unexpected inflation. If the value of $\beta_j(\gamma_j)$ is not significantly different from one, asset j can be considered a perfect hedge against both expected inflation and unexpected inflation respectively, as indicated from the above. If the parameter values are between 0 and 1, a partial hedge can be given and if β_j and γ_j are negative, one can conclude that the asset acts as a "perverse hedge" against inflation.

2.2. ASSET CLASSES

The upcoming section aims to shed light on the selected asset class returns, which serve as the focal point of this research, and the rationale guiding their inclusion. Additionally, it will delve into the diverse conclusions derived from prior studies regarding their effectiveness as hedges against inflation. The subject of inflation hedging has been a focal point of extensive research, and for good reason. Inflation possesses the potential to erode the wealth of investors and devalue their returns, making it a crucial area of investigation.

The research focuses on evaluating returns and exploring the viability of different types of asset classes across two broad categories: traditional and alternative. The traditional asset categories under examination comprise of equities, real estate, and fixed-income instruments, encompassing cash. These assets form the bedrock of conventional investment portfolios and hold historical significance in wealth management strategies.

Conversely, the research also investigates alternative asset classes, including gold, cryptocurrency, platinum, and oil. These alternative assets are characterised by their distinct nature and have gained prominence for their potential to diversify investment portfolios beyond traditional avenues.

2.2.1. STOCK RETURNS

The question "Do stocks provide a hedge against inflation?" has long been investigated. Transposing Fisher's (1930) hypothesis in the stock market should result in a positive, one-to-one relationship between the two variables in the long-term (Anari & Kolari, 2001). If stock returns are considered a representation of a claim on real assets, then this relationship holds true, and stocks do then hedge against inflation (Geske & Roll, 1983).

According to Bodie (1976), there are two ways in which one can claim that stocks could hedge against inflation. The first being that stocks provide a hedge against inflation if the real return of the stock is independent of the inflation rate or if the likelihood that the real return of the stock will fall below a specified value is reduced.

Studies which have verified this notion include: Cagan (1972) who studied various global markets; Alagidede and Panagiotidis (2010) who studied various African markets; Boudoukh and Richardson (1993) who studied the US and UK; Rushdi, Kim and Silvapulle (2012) who studied the Australian market and Choudry (2001) who studied four Latin American countries. However, despite the above, multiple studies have found the relationship between stock returns and inflation to be negative using empirical evidence. This is supported by Bodie's (1976) and Fama and Schwertz (1977) studies of the US market and Zhao (1999) who studied the Chinese market. Fama (1981) explained that the reason behind this negative relationship stems from the idea that because inflation is often used as a proxy for economic conditions, there exists no relationship between inflation and stock returns. Stocks tend to perform better during periods of high economic activity while inflation tends to be on the rise during periods of low economic activity. This was referred to as the "Proxy Hypothesis" and has been extended further in other studies (Balduzzi, 1995; Gallagher & Taylor, 2002). Geske and Roll (1983) and Kaul (1987) suggest that a countercyclical monetary policy contributes to a negative output shock leading to lower stock prices, easier monetary policy, and increased inflation because of rational agent expectations. Pilotte (2003) further supported the proxy hypothesis when he found the relationship between expected output and inflation to be negatively correlated while inflation and excess returns had a positive relationship.

As a method of condensing the available findings from prior research, it's noticeable that the inverse correlation between stock returns and inflation is more commonly observed over shorter time spans. Conversely, investigations that delve into this correlation over extended periods have identified a tendency for a positive relationship between these two variables.

2.2.2. REAL ESTATE

Real estate is a favoured choice for investment among investors owing to its extensive range of investment options across multiple sectors such as residential, commercial, and agricultural. Investors often navigate this realm through two means. Firstly, via direct ownership which entails actively engaging in the acquisition and management of physical properties such as residential houses, office buildings, shopping centres etc. This form of investment involves procuring freehold or leasehold interests in real estate, granting investors a hands-on role in property management and value appreciation.

Alternatively, investors can opt for indirect investment routes, such as Real Estate Investment Trusts (REITs) or stocks linked to real estate performance. These avenues offer investors exposure to real estate returns without the direct responsibility of property management, providing a more accessible entry point into the market. Moreover, investors actively seek asset classes that safeguard against the erosive effects of inflation. Real estate has emerged as a preferred choice due to its historical ability to preserve the purchasing power of investments, as noted by Dabara (2016). The tangible nature of real estate, combined with its dual potential for generating steady rental income and capital appreciation, can solidify its status as a resilient asset class. This unique combination potentially allows real estate to position itself as a powerful hedge against the erosive effects of inflation, rendering it an attractive choice for investors seeking to fortify their wealth against economic fluctuations.

Despite its popularity as an asset class, inflation also impacts the return on real estate in several ways, particularly regarding the potential rental income, increasing expenses, and the capitalisation rate (Huang & Hudson-Wilson, 2007). The above characteristics of real estate suggest that it potentially possesses attributes capable of mitigating the impacts of inflation. The combination of stable income generation and a relatively independent performance from traditional financial assets underscores its viability as an inflation hedge.

Many studies affirm the Fisher hypothesis, revealing a positive correlation between inflation and real estate. Notably, these studies consistently highlight real estate's role as an effective hedge against inflation: Fama and Schwert (1977) who studied the private US residential market; Bond and Seiler (1998) studied the US residential and commercial market; Ganesan and Chiang (1998) who studied the Hong Kong market; Blake et al. (2010) who studied the UK market; Gunasekarage, Power and Ting Zhou (2008) studied the New Zealand market and Lee (2014) studied the Malaysian market.

As additional research endeavors unfolded, several studies, including those by Chatrath and Liang (1998), Chu and Sing (2004), Fang, Wang, and Nguyen (2008), as well as Obereiner and Kurzrock (2012), emerged to challenge the fisher hypothesis. These studies collectively demonstrated that real estate fails to serve as an effective hedge against inflation.

The varied outcomes observed in the aforementioned studies underline the nuanced nature of real estate's potential as an inflation hedge. The effectiveness of this asset class in countering inflation appears contingent upon multiple factors, including the property type, its geographical location, and the duration of ownership.

2.2.3. FIXED INCOME SECURITIES

Fixed-income securities and their inflation hedging potential have been researched but not as extensively when compared to stocks and real estate. Studies that have been conducted in this asset class type have primarily focused on Treasury bills and Treasury bonds.

Looking at the relationship between Treasury bills and inflation in the US market, Fama (1975) was able to confirm the Fisher hypothesis in the short-term. Lee, Clark, and Ahn (1998) also confirmed the Fisher hypothesis in both the short-term and long-term.

Outside of the US, Tsong and Lee (2013) found that the hypothesis was also true in the Australian, Belgian, Canadian, Swedish and UK markets. Bekaert and Wang (2010) studied 1- and 3-month treasury bills and concluded that an inflation hedge was present. Based on the information provided, research frequently employs short-term treasury bills as a representation of cash. Some of these studies include Bekaert & Wang, 2010, Roach & Attie, 2009 and, Spierdjik & Umar, 2015.

Studies examining the relationship between Treasury bonds and inflation have also found a positive relationship between the two variables. Fama and Schwert (1977) and Bruno and Chincarini (2010) presented evidence in favour of a hedging ability between bonds and stocks. Engsted and Tanngaard (2002) also found a positive long-term relationship between bonds and inflation. However, in his study of Pacific-Basin countries, Al-Khazali (1999) did not find evidence of cointegration between treasury bonds and inflation. Bekaert and Wang (2010) suggested that treasury bonds were not good inflation hedges both in the short and long-term. Briere and Signori (2012) presented that the inflation hedging abilities of nominal bonds differs according to the regime and hedging horizon examined. From their analysis of two different regimes, nominal bonds exhibited a negative relationship with inflation during 1973-1990 and a partial hedge against inflation between 1990-2010.

2.2.4. GOLD

Gold as an alternative asset class has long held a prominent place in financial markets. Historically, investors have perceived it as relatively risk-free over the long term, positioning it as a natural hedge against inflation. Its resilience lies in the unique attribute of retaining purchasing power, hence bolstering its appeal. The limited supply of gold further solidifies its value proposition, as its scarcity prevents depreciation through market oversupply. Its demand can be classified firstly as a “use demand” when extracted for items such as jewelry or coins and secondly as an “asset demand” when used by governments and portfolio managers as an investment (Ghosh et al., 2004). Gold is traditionally associated with the existence of providing a safe haven during periods of uncertainty, meaning that it is a store of value and thus should be an effective hedge against inflation, geopolitical risk as well as currency exchange risk. Gold investments offer diverse avenues, including purchasing gold coins, acquiring gold bullion, investing in mining companies specialising in gold, and engaging in futures and options contracts with gold as the underlying asset. Each of these methods comes with its own spectrum of transaction costs, varying in complexity and associated fees. Choosing one or a few amongst these options involves careful consideration of transaction expenses and individual investment preferences and objectives.

Harmston (1998) stated that because gold can relatively protect the rate of exchange with other goods, this makes it an ideal store of value and as a result can hedge against inflation. Using a multi-asset approach, Jaffe (1989) found that gold can be used to diversify a portfolio because its returns are independent of other asset returns.

Feldstein (1980) suggests that the demand for gold tends to rise proportionally with the anticipated rate of inflation. This highlights the common belief that gold, often seen as a hedge against inflation, sees greater demand when there are expectations or forecasts of rising inflationary pressures. Aggarwal (1992) found that in the long-term gold can hedge against inflation, but its price also showed significant short-term price volatility. Although Chua and Woodward (1982) found evidence of a positive relationship between gold and inflation in the US, the same could not be said about the relationship between these two variables in other developed countries such as Japan, UK, Canada, Germany, and Switzerland. Erb and Harvey (2013) were unable to find sufficient evidence to support the notion that gold provides an efficient hedge against inflation. It appears that earlier literature found evidence of a positive relationship between gold and inflation however when structural breaks and outliers in the data are accounted for in the methodology as well as in the sample data used, a negative relationship between gold and inflation is evident. In South Africa, Seetharam and Bodington (2015) found that if locals had invested in gold, it would have been able to hedge against inflation and when the economy was in a downturn, the asset would serve as a safe haven for investors. An analysis over the inflation hedging ability of gold in the short and long-run was conducted by Naidoo and Peerbhai (2015) and they concluded that while no significant evidence was found in the short-run the same could not be said in the long-run when using Johansen’s cointegration in the South African market.

2.2.5. CRYPTOCURRENCY

A continuous increase in inflation results in investors seeking newer and perhaps novel assets to invest in. The emergence of cryptocurrencies was evident after the GFC of 2008. Cryptocurrencies are a type of financial asset which is digital in nature in which their ownership and transactions are backed by cryptographic decentralised software (Giudici et al. 2020). Blockchain is the underlying technology that is used to manage the distributed ledger that allows the facilitation and recording of transactions across a network of computers (Kim, 2020).

Nakamoto (2008) outlined how Bitcoin, a type of cryptocurrency, and blockchain can be used as an alternative payment system that does not involve a central authority or a third party such as a bank. Bitcoin was introduced in 2009 and is the most widely recognized and advanced form of cryptocurrency underpinning the largest market capitalisation within the cryptocurrency space (Velde, 2013). Its groundbreaking blockchain technology enables direct transactions between peers, providing decentralisation, transparency, and security. This transformation is redefining financial transactions beyond centralised control.

Even though there is a scarcity of in-depth research during different inflationary periods, particularly for this relatively newer asset type, investors may look to assets such as cryptocurrencies, to potentially hedge against inflation. Cryptocurrency stands out as an alternative investment avenue, potentially offering investors diversification benefits. Its dual functionality as both a payment method and a store of value in the realm of financial assets positions it as a speculative investment, as highlighted by Glaser et al. (2014). These digital assets, accessible through exchanges in forms like exchange-traded funds (ETFs), grant a broader exposure to diverse investors.

Studies by Bouri et al. (2017) and Baur et al. (2018) have uncovered an intriguing facet of cryptocurrencies, specifically that Bitcoin returns lack correlation with traditional assets. This uncorrelation presents an opportunity for portfolio diversification, offering a potential hedge against traditional market fluctuations. In fact, the study by Liu and Tsyvinski (2018) emphasises a striking divergence in risk factors impacting cryptocurrency prices compared to those influencing traditional stocks. Factors that conventionally sway traditional asset classes, like commodity prices or macroeconomic shifts, exert minimal influence on cryptocurrencies. The departure from traditional market norms highlights the distinctive stance of cryptocurrencies. This suggests they might have unique value drivers, making them attractive to investors looking for unconventional paths to diversify and expand their portfolios. An argument in favour of this notions stems from the fact that cryptocurrencies have a limited supply, like gold, and are thus robust against inflation. However, Wagenaar (2022) noted the following as reasons as to why cryptocurrencies may not efficiently hedge against inflation. Firstly, cryptocurrencies are extremely volatile. Secondly, they are still not considered a valid investment asset and lastly, they have also shown to be sensitive to government interventions. Using a vector autoregressive process, Blau et al. (2021) found that their study exhibited a positive relationship between Bitcoin returns and the inflation rate. Choi and Shin (2022) found that Bitcoin can be used to hedge against inflation. They noted that during periods of financial uncertainty, Bitcoin prices will fall but appreciate against positive inflation and inflation expectation shocks.

Despite recent price declines, cryptocurrencies maintain a remarkable allure among both investors and the wider public. This enduring interest signifies their resilience and sustained relevance. Cryptocurrencies are increasingly perceived not only as a credible investment asset class but also as a legitimate and evolving payment system, as highlighted by Corbet et al. (2019).

2.2.6. PLATINUM

Historically, platinum has primarily been considered a sought-after metal for industrial purposes rather than an investment instrument. The value of it originates from its scarcity and the challenges linked to its extraction. However, this perception has shifted with the emergence of Exchange Traded Funds (ETFs) which actively follow underlying assets on stock exchanges in real-time, providing a versatile alternative investment avenue. This form of alternative investment can serve both as an individual's personal investment avenue or as a strategy to hedge diversified portfolios. Particularly in times of market volatility, the inclusion of precious metals within portfolios stands as a valuable diversification tactic. They assume the crucial role of a safe haven, providing insulation against inflationary pressures or unforeseen geopolitical risks (Chong & Miffre, 2010). Moreover, Bilgin et al. (2018) underscored that the heightened financialisation within commodity markets has notably transformed precious metals like platinum into actively traded securities. Given that African nations stand prominently as producers of these precious metals, it becomes imperative to explore how investors within these economies can leverage these resources as a hedge against inflation. Understanding the potential of these resources as inflationary buffers holds significant relevance for investors within these regions.

In their paper, Bilgin et al (2018) find that platinum can be effective in hedging against inflation when examining the relationship between inflation and platinum ETFs. Hillier et al. (2006) discovered a positive correlation between inflation and platinum, showcasing its characteristic as a safe haven asset during volatile market periods. Their findings highlight platinum's unique tendency to positively respond to inflationary pressures, reinforcing its role as a reliable asset offering stability amidst market turmoil. This positive relationship between the two variables was also documented by Jain and Ghosh (2013) when examining the Indian market. An earlier study conducted by Taylor (1998) also confirmed the above when he examined the inflation hedging abilities of four precious metals: gold, silver, platinum, and palladium.

The selection of platinum as the focus of this study is rooted in South Africa's predominant position, contributing to the largest value-based share of global platinum exports in 2021 at $24.5 billion (Statista, 2022). Moreover, when evaluating the significance of precious metals, platinum emerges as the third most pivotal after gold and silver. Notably, in academic research, platinum frequently represents other metals such as palladium, emphasising its crucial role within the spectrum of precious metals (Hillier et al., 2006).

2.2.7. CRUDE OIL

Oil plays a crucial role as a key input in the manufacturing of various goods and services globally, exerting significant influence on a country's economic activity and the overarching macroeconomic policies in place. The repercussions of an increase in oil prices are felt universally, affecting countries to varying degrees. Notably, developing economies are particularly vulnerable to such external shocks, as highlighted by Sek, Teo, and Wong (2015). The surge in oil prices during the early 1970s was widely perceived as a significant factor contributing to both inflation and resulting recession, not only within the United States but globally, given the role of oil as a crucial input in the production function of economies (Darby, 1982). South Africa, despite its geographical distance, was not insulated from the impact of the 1973 oil price shock, experiencing a notable increase in inflation of 46% from 16%. Other noteworthy instances of oil shocks include the 1979 Iranian revolution and Iraq's invasion of Kuwait in 1990, as documented by Balcilar, Uwilingiye, and Gupta (2018). According to a study conducted by L'oeillet and Licheron (2001), the oil price shocks experienced during the 1970s had a more pronounced impact on inflation in Europe compared to more recent occurrences. This observation aligns with the findings of De Gregorio et al. (2007), who noted that the influence of oil shocks on economies has diminished over time. This diminished effect is attributed to factors such as lower oil intensity and improved economic environments.

Killan (2009) outlined three possible origins of oil shocks. The primary source is an oil supply shock, triggered by interruptions in oil production. Secondly, a surge in the demand for oil creates an oil demand shock. Lastly, political instability can generate precautionary shocks, with increased uncertainty causing a rise in oil prices. Given South Africa's status as a net oil-importing country, any of these shocks could impact its inflation rate.

Researchers, economists, and policymakers, including institutions like the SARB, endeavor to implement an optimal policy strategy. The overarching goal is to sustain low inflation and stable economic growth even in the presence of oil shocks. The far-reaching consequences of oil shocks on fuel prices extend to influencing transportation and production costs, thereby shaping the overall composition of the CPI basket of goods and services. The aim is to adeptly navigate these challenges, fostering resilience to external shocks and maintaining a stable economic environment.

Previous research examining the connection between oil and inflation includes the work of Chou and Tseng (2011), focusing on developing countries in Asia. Their findings revealed a long-run effect of oil on the inflation of these nations, although the short-term impact was less pronounced. Nkomo (2006) observed that South Africa, heavily dependent on oil imports, experiences an adverse economic impact with an increase in oil prices.

CHAPTER 3

DESCRIPTION OF DATA AND RESEARCH METHODOLGY

3.1. DESCRIPTION OF DATA & SAMPLING

This study will utilise monthly returns, calculated as the average of the daily prices of different asset class market indices in South Africa. The asset classes chosen for this study include equities, bonds, cash, property, gold, cryptocurrency, platinum, and oil. The period chosen for this study is from February 2000 to June 2023 where the data is available. The reason for this period is because the study intends to study the relationship between asset class returns and inflation during a singular monetary policy framework being inflation targeting which was employed by the SARB through the manipulation of short-term interest rates in February of 2000. The aim of this monetary policy tool is to maintain inflation within a specified target range and in the case of South Africa, the designated inflation target range is 3−6%. This period will also cover the GFC, the Covid-19 pandemic as well as the ongoing Russian/Ukraine war which have driven the rate of inflation to climb in multiple countries. Bitcoin will have a shorter sample period when compared to the others as it only emerged after the GFC. The period of study for Cryptocurrency will thus be from August 2010 to June 2023. This study utilises Bitcoin as a representation of cryptocurrencies primarily because it was the inaugural cryptocurrency to be developed and has gained the highest level of recognition. Within the fixed income securities segment of the literature review, it has been observed that prevailing research commonly employed short-term treasury bills as a stand-in for cash. Nonetheless, this study will deviate from this trend by employing the Short-Term Fixed Interest Index (STEFI) as the representative measure to gauge the returns achieved within the South African money market. The STEFI index holds a prominent status as a composite benchmark utilised for evaluating investment portfolios within the money market landscape as it integrates the South African Benchmark Overnight Rate (SABOR) alongside rates from various maturities of Negotiable Certificate of Deposits (NCD), effectively encapsulating the diverse landscape of money market investments (International Monetary Fund, 2022).

Other variables that will be used in this study include the Consumer Price Inflation (CPI) for South Africa, sourced from Statistics South Africa, as well as the USD/ZAR exchange rate, sourced from Bloomberg, to convert asset prices denoted in USD to the domestic currency where applicable.

The daily closing price of each asset will be converted into returns before an empirical analysis can be conducted. The prices will be converted using the following equation:

$$\boldsymbol{r_t = \ln\left(\frac{P_t}{P_{t-1}}\right)} \qquad 3$$

Where P_t is the current period index value and P_{t-1} is the previous period index value.

Subsequently, the daily returns can be aggregated to derive a monthly return, achieved by computing the mean of the daily returns for each month. The study will adopt this approach for collecting asset returns data to effectively capture the day-to-day variations in returns, as opposed to relying solely on a single monthly return, which may offer only a static view at a particular moment. It remains essential to present the data in a monthly format, primarily because the CPI rate is reported monthly, rather than daily.

$$\boldsymbol{Monthly\ return = Average\ r_t = \frac{sum\ of\ daily\ returns}{total\ number\ of\ observations\ for\ month}} \qquad 4$$

Table 2: Asset class and represented market data

ASSET CLASS	MARKET DATA	ABBREVIATION
Equities	JSE All Share Index	JALSH
Bonds	JSE ALBI total return	ALBI
	JSE GOVI total return	GOVI
Real Estate	JSE SA listed property index	JSAPY
Cash	STEFI composite index	STEFI
Gold	Gold Price	GOLD
Cryptocurrency	Bitcoin Price	BITCOIN
Platinum	Platinum Price	PLATINUM
Oil	Brent Crude Oil Price	OIL

The data represented in table 2 has been sourced from Bloomberg except for the JSE All share index and JSE SA listed property index which was sourced from IRESS.

3.2. RESEARCH DESIGN

3.2.1. CORRELATION TESTS

The study will make use of the Pearson coefficient to measure the correlation between the data. Bodie (1979) used the Pearson correlation coefficient to capture how strong the relationship between inflation and the nominal returns are. It can be calculated using the equation below:

$$\boldsymbol{\rho = Corr(t)[R_t^k, \pi_t^k]} \tag{5}$$

Where R_t^k is the nominal return of an asset and π_t^k is the inflation rate.

From the above the hedging ability of an asset will be denoted by the absolute value of ρ which will be between 0 and 1. If ρ is equal to 0 then the asset is not a hedge against inflation and if ρ is equal to 1 it is a perfect hedge. The higher the absolute value of ρ the greater the hedging ability of the asset against inflation.

3.2.2. TEST FOR STATIONARITY

This study will make use of the Augmented Dickey Fuller (ADF) test for stationarity. The ADF test is an extension of the Dickey Fuller test and is more applicable for advanced models (Thakar, 2022). Hamzah and Masih (2018) state that the ADF model can handle the issue of serial correlation by adding the lag of the dependent variable to the model via the error term.

The null hypothesis for the ADF test is that the series contains a unit root and is non-stationary whereas the alternative hypothesis states that the series does not contain a unit root present and is therefore stationary. To reject the null hypothesis, the p-value needs to be less than the significance level examined, and only then can we conclude that the series is stationary.

The ADF model is represented by the following equation when testing for a unit root:

$$\Delta y_t = \boldsymbol{\alpha} + \boldsymbol{\rho\delta_t y_{t-1}} + \sum_{\mathbf{i=1}}^{\mathbf{p}} \boldsymbol{\gamma_i \Delta y_{t-1}} + \boldsymbol{\varepsilon_i} \tag{6}$$

Where y_t is the return series, δ_t is deterministic time trend and α is a constant.

3.2.3. NARDL

Employing a similar methodology used by Magweva and Sibanda (2020), this study will use the Non-linear Autoregressive Distributive Lag method (NARDL) to explore the short-term and long-term connection between inflation and asset returns. This approach, proposed by Shin, Yu, and Greenwood-Nimmo (2014), is particularly useful due to its utilisation of positive and negative partial sum decompositions, enabling the identification of asymmetric effects in both short-term and long-term contexts. Shin et al. (2014) established this model because they believed that the standard Autoregressive Distributive Lag Model (ARDL) was not able to produce reliable forecasts and was restrictive when being examined under all market conditions.

Nonlinearity or asymmetry in this context does not refer to quadratic or log-linear parameters, which are typically conventional. Instead, it involves a disentangled linear association where the influence of the independent variable on the dependent variable within the ARDL framework is examined to determine whether positive or negative variations in the independent variable produce differing impacts on the dependent variable (Shin et al., 2014).

The framework of the NARDL model, signifies a type of relationship between two variables wherein alterations in one variable are not accompanied by uniform and symmetrical changes in the other variable (Bildrici & Turkmen, 2015). Extending the ARDL model by incorporating both positive and negative partial sums of inflation, the model transforms to a non-linear model (Meo et al., 2018). The NARDL methodology is thus able to address concerns related to endogeneity and serial correlation while remaining straightforward to estimate.

The general NARDL model in the short-term can be represented by the following equation:

$$\boldsymbol{\Delta R_t = \alpha + \sum_{i=1}^{p-1} \delta_i \, \Delta R_{t-i} + \sum_{i=0}^{q} \gamma_i \, \Delta INF^{+}_{t-i} + \sum_{i=0}^{q} \phi_i \, \Delta INF^{-}_{t-i} + \sum_{i=0}^{q} \varphi_i \, \Delta Z_{t-i} + \varepsilon_t} \qquad 7$$

Where R_t are the nominal returns of each asset class, α is a constant term, and Z represents the control variables,

INF^{+}_{t-i} and INF^{-}_{t-i} represent the partial sum of positive and negative change in inflation respectively, and γ_i and ϕ_i are parameters that characterise the capacity of the specific asset class to mitigate the impact of the positive and negative shifts in inflation.

The general long-term model is represented by the following equation:

$$\boldsymbol{R_t = \alpha + \beta R_{t-1} + \lambda INF^{+}_{t-1} + \omega INF^{-}_{t-1} + \theta Z_{t-1} + \varepsilon_t} \qquad 8$$

Where λ and ω are parameters that characterise the capacity of the specific asset class to mitigate the impact of the positive and negative shifts in inflation in the long-term.

The positive and negative components of inflation's partial sums are represented by the following equations:

$$\boldsymbol{INF^{+}_{t} = \sum_{i=1}^{t} \Delta INF^{+}_{t} = \sum_{i=1}^{t} \max(\Delta INF_i, 0)} \qquad 9$$

$$\boldsymbol{INF^{-}_{t} = \sum_{i=1}^{t} \Delta INF^{-}_{t} = \sum_{i=1}^{t} \min(\Delta INF_i, 0)} \qquad 10$$

The long-term NARDL model will apply the bounds testing method proposed by Pesaran et al. (2001). In this approach, the test will compute an F-statistic to ascertain the presence of a substantial coefficient between the returns of individual assets and inflation. As indicated by Davari and Kamalian (2018), the null hypothesis can be deemed acceptable when the computed F-statistic is below the critical values, implying the absence of a long-term effect. Conversely, if the F-statistic surpasses the critical values, the null hypothesis can be rejected implying that there is evidence of cointegration between the variables.

3.2.4. JOHANSEN INTEGRATION

The Johansen Cointegration test by Johansen (1991;1995) will be used as a diagnostic test in this paper to analyse the long-term integration of asset class returns and inflation. The Johansen method can be expressed as:

$$\boldsymbol{\Delta y_t = \delta + \Pi y_{t-1} + \sum \Delta y_{t-1} + \varepsilon_t} \tag{11}$$

Where $\boldsymbol{\Pi}$ is the number of lags specified in the dynamic VAR relationship and $\boldsymbol{y_t}$ is the column vector of the asset class returns. If $\boldsymbol{\Pi}$ has zero rank, the variables in $\boldsymbol{y_t}$ are not integrated and if the rank is r, then there are r possible stationary linear combinations.

The appropriate lag length can be determined using the Akaike (AIC) or Schwarz-Bayesian (SIC) information criterion. The rank will be determined using the Johansen trace statistics and along with the maximum eigenvalues (Luintel & Paudyal, 2006). If there is no evidence of cointegration between the asset class returns and inflation, then there exists no relationship in the long term between the variables and thus the Fisher hypothesis can be rejected implying that the asset may not be able to hedge against inflation.

The Johansen trace statistics is given by the following equation:

$$\boldsymbol{\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln(1 - \lambda_i)} \tag{12}$$

The Johansen maximum Eigen value is given by the following equation:

$$\boldsymbol{\lambda_{max}(r, r+1) = -T \ln(1 - \lambda_{r+1})} \tag{13}$$

3.2.5. GRANGER CAUSALITY TEST

The Granger causality test by Granger (1969) will be used as a diagnostic test to determine if there exists causality between the variables in our time-series data if cointegration has been confirmed. The test will determine whether one time series can be used to predict and forecast another time series. The null hypothesis for the Granger causality test states that there exists no causality links between the market returns. The null hypothesis is rejected if the p-value is less than 5%.

CHAPTER 4

DESCRIPTIVE STATISTICS AND RESULTS

4.1.1. DESCRIPTIVE STATISTICS

The table below represents the descriptive statistics results for the individual samples of the dependent variables and independent variable followed by the common sample of the entire dataset. Before we can get into the regression analysis of the various asset class returns it is important to understand the behaviour of these returns over time.

Table 3: Descriptive Statistics (Individual Sample)

	JALSH	ALBI	GOVI	JSAPY	STEFI	GOLD	BITCOIN	PLATINUM	OIL	CPI
Mean	0.000374	0.000308	0.000306	0.000166	0.000273	-0.000001	-0.000002	-0.000002	-0.000003	0.055858
Median	0.000409	0.000315	0.000306	0.000298	0.000271	0.000000	0.000000	0.000000	0.000000	0.054000
Maximum	0.006498	0.003550	0.003471	0.007621	0.000535	0.000017	0.000101	0.000023	0.000033	0.137000
Minimum	-0.007158	-0.003308	-0.003334	-0.021371	0.000139	-0.000058	-0.000142	-0.000064	-0.000215	0.002000
Std. Dev.	0.002296	0.000878	0.000869	0.002784	0.000077	0.000006	0.000025	0.000009	0.000017	0.023447
Skewness	-0.203783	-0.107856	-0.136014	-2.048844	0.934245	-3.788393	-1.103352	-3.351621	-8.008420	0.878001
Kurtosis	3.485209	5.464495	5.499103	17.66556	4.216140	34.93037	13.10247	23.64940	91.84565	4.935283
Jarque-Bera	4.701347	68.59797	70.83120	2260.729	49.70251	12609.36	690.5856	5518.504	95423.96	79.95465
Probability	0.095305	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

The asset return with the highest mean is equity represented by the JALSH index (0.0374%). This is then followed by ALBI, GOVI, then STEFI, JSAPY, GOLD, BITCOIN, PLATINUM and finally OIL. It is important to note that the average percentage change in CPI is higher than all of these as its mean over the period is 5.586%. The standard deviation shows that Property represented by the JSAPY index (0.02784%) is the most volatile with the highest standard deviation followed by JALSH, ALBI, GOVI, STEFI, BITCOIN, OIL, PLATINUM and lastly, GOLD in that order. It is interesting to note that on average alternative asset returns have a negative mean when compared to the traditional asset returns. However, they are also less volatile when compared to traditional asset class returns. This lower volatility could be interpreted from the perspective that alternative assets are a safer investment vehicle when compared to traditional asset classes over time.

CPI had the highest maximum return of 13.7% which was during the GFC where South Africa saw a significant increase in the prices of food and petrol (Monetary Policy Statement, 2008). Gold had the lowest maximum return of 0.0017%. CPI also had the highest minimum return across the asset types at 0.2% and STEFI was the only other asset that had a positive minimum return of 0.00139%. A positive minimum return for STEFI indicates that even during periods where it's performing poorly, there was still a small positive return observed. This characteristic could be of interest to investors as it suggests relative stability or a lack of significant downside risk during a particular period. The lowest minimum return came from Platinum at -0.0064% followed by Gold at -0.0058%.

Besides the STEFI and CPI indices, all other returns were negatively skewed which implies that the returns are not symmetric as the skewness measures below zero. The kurtosis measure is greater than 3 for the asset class returns with the highest being OIL (91.84). As this is a measure of the peakedness of the series' distribution, the results correspond to a leptokurtic positively peaked curve. The null hypothesis for the Jarque-Bera test posits that the returns of an index are normally distributed. The asset returns all had p-values statistically significant at a 95% and 99% significance level for the Jarque-Bera test except JALSH which had a p-value of 0.095305 and thus only significant at the 99% level. The null hypothesis that the series of the other variables except JALSH at the 95% level can therefore be normally distributed is rejected. None of these indices are normally distributed which is consistent with the above results of the kurtosis measure at the 99% level.

Table 4: Descriptive Statistics (Common Sample)

	JALSH	ALBI	GOVI	JSAPY	STEFI	GOLD	BITCOIN	PLATINUM	OIL	CPI
Mean	0.000317	0.000218	0.000214	-4.54E-05	0.000235	-1.32E-06	-1.53E-06	-2.52E-06	-3.59E-06	0.051735
Median	0.000356	0.000253	0.000256	0.000186	0.000236	-2.80E-07	-3.31E-07	-5.40E-07	-6.78E-07	0.052
Maximum	0.006498	0.002202	0.002227	0.007621	0.000333	9.56E-06	0.000101	9.16E-06	3.32E-05	0.078
Minimum	-0.006241	-0.003308	-0.003334	-0.021371	0.000139	-3.55E-05	-0.000142	-5.80E-05	-0.000215	0.021
Std. Dev.	0.001903	0.000782	0.00077	0.002901	4.76E-05	4.61E-06	2.48E-05	7.82E-06	1.91E-05	0.011773
Skewness	0.021267	-0.694779	-0.720893	-2.575398	-0.151858	-2.963983	-1.103352	-3.782093	-8.783231	-0.158593
Kurtosis	3.795683	5.750393	5.843888	20.91252	2.290503	21.78872	13.10247	25.13773	97.1196	2.605352
Jarque-Bera	4.100532	61.32532	65.65827	2243.554	3.846772	2506.846	690.5856	3534.621	59204.06	1.655617
Probability	0.128701	0.000000	0.000000	0.000000	0.146111	0.000000	0.000000	0.000000	0.000000	0.437006

When analysing the descriptive statistics over a common sample period, we can note that JALSH at 0.0317% still has the highest average return when looking at the asset returns but CPI is significantly higher at 5.174%. JSAPY, in contrast to the previous period, now registers a negative average return along with other assets. This shift may be attributed to the enduring repercussions of the GFC. During the GFC, property prices underwent a substantial decline, necessitating an extended recovery period. Factors such as the bursting of the housing bubble, financial institution struggles, economic downturn, loss of employment, credit tightening, and market speculation may have further contributed to the decline. These challenges resulted in reduced demand, greater foreclosures, and excess availability in the property market. JSAPY's negative average return could reflect the prolonged impact of the GFC on property values. We also see that alternative asset series returns consistently produce negative returns on average as per the individual sample findings.

JSAPY has the highest maximum return during this period at 0.762% followed by JALSH (0.065%) while CPI has a maximum return of 7.8%. The primary drivers behind the 7.8% CPI rate were costs associated with food and non-alcoholic drinks, accommodation and utilities, transportation, and other various goods and services (Monetary Policy Committee, 2022). Just like before, cash denoted by STEFI is the only asset series that has a positive minimum return at 0.0139%. CPI saw its lowest return, being 2.1% during this period. JSAPY is still the most volatile as it has the highest standard deviation at 0.2901 amongst the asset returns while inflation is at 0.01177. GOLD with a standard deviation of 0.00000461 is the least volatile followed by OIL at 0.00000782.

Under a common sample period, all variables have a negative skewness which implies that they are not symmetric. This is the exception with regards to JALSH which is positive at 0.0212. The kurtosis is above three for all the variables except STEFI and CPI. Implying that STEFI and CPI over a common period are platykurtic as their kurtosis measure is less than 3. JALSH, STEFI and CPI are the only variables that fail to reject the null hypothesis of the Jarque-Bera test as their p-values are greater than 0.05.

4.1.2. CORRELATION RESULTS

The Pearson correlation results show that BITCOIN has a negative relationship with the fixed income instruments being the ALBI, GOVI and the STEFI indices. GOLD shows a negative relationship with

STEFI, while the asset return series of JALSH, JSAPY, OIL, and PLATINUM also demonstrate a negative correlation with the STEFI index. Besides JSAPY, BITCOIN, STEFI and OIL all other return series had a negative relationship with the CPI index. ALBI and GOVI have a significant correlation with one another at (0.999325) other notable relationships include JSAPY: ALBI and JSAPY: GOVI at (0.565500) and (0.567377) respectively and OIL: PLATINUM has a correlation of (0.577755). The above results suggest that JSAPY, BITCOIN, STEFI and OIL may provide a hedge against inflation in the long-run, but this relationship would not be significant as the coefficients are closer to zero than they are to one.

Table 5: Pearson Correlation

	JALSH	ALBI	GOVI	JSAPY	STEFI	GOLD	BITCOIN	PLATINUM	OIL	CPI
JALSH	1	0.308581	0.316986	0.524783	-0.070231	0.018628	0.115739	0.166269	0.285404	-0.08863
ALBI	0.308581	1	0.999265	0.526325	0.022556	0.159588	-0.033701	0.270917	0.337083	-0.019391
GOVI	0.316986	0.999265	1	0.529701	0.023235	0.153898	-0.033201	0.273321	0.341048	-0.021299
JSAPY	0.524783	0.526325	0.529701	1	-0.110336	0.101346	0.060305	0.326303	0.531773	0.028959
STEFI	-0.070231	0.022556	0.023235	-0.110336	1	0.023924	-0.032182	-0.030901	-0.022437	0.062764
GOLD	0.018628	0.159588	0.153898	0.101346	0.023924	1	0.280447	0.654988	0.082538	-0.087301
BITCOIN	0.115739	-0.033701	-0.033201	0.060305	-0.032182	0.280447	1	0.422885	0.295983	0.014793
PLATINUM	0.166269	0.270917	0.273321	0.326303	-0.030901	0.654988	0.422885	1	0.568684	-0.010039
OIL	0.285404	0.337083	0.341048	0.531773	-0.022437	0.082538	0.295983	0.568684	1	0.119608
CPI	-0.08863	-0.019391	-0.021299	0.028959	0.062764	-0.087301	0.014793	-0.010039	0.119608	1

4.2. UNIT ROOT RESULTS

All asset return series included in this study underwent testing to assess their stationarity. The ADF unit root test was employed to investigate the null hypothesis of a unit root presence in each series. If the p-value is below 0.05, the null hypothesis is rejected. This test was conducted on both the level and the first difference of each series, assuming the presence of a trend and intercept.

Table 6: ADF test for the asset class returns in levels and first difference

Asset Type	ADF T-statistic (at Level)	P-value (at Level)	ADF T-statistic (at 1st difference)	P-value (at first difference)
JALSH	-17.52994	0.000***	-12.09617	0.000***
ALBI	-16.90840	0.000***	-15.10246	0.000***
GOVI	-16.87590	0.000***	-15.06954	0.000***
JSAPY	-13.88862	0.000***	-11.16617	0.000***
STEFI	-2.02057	0.5866	-5.77094	0.000***
GOLD	-18.98320	0.000***	-9.780741	0.000***
BITCOIN	-9.7819	0.000***	-8.947938	0.000***
PLATINUM	-13.84503	0.000***	-12.52609	0.000***
OIL	-15.78817	0.000***	-12.01798	0.000***
CPI	-2.75028	0.2174	-8.25746	0.000***

*, **, *** denotes 10, 5 and 1% level of significance, respectively.

Table 6 above has the results of the ADF test for all the asset return series and inflation at level and at first difference. Among all the asset return series, except CPI and the STEFI index, the p-values are virtually zero, leading to the rejection of the null hypothesis, indicating significance at all levels. In contrast, CPI and STEFI exhibits p-values of 0.2174 and 0.5866, respectively, exceeding 0.05, suggesting the failure to reject the null hypothesis. Consequently, apart from CPI and STEFI, all other asset series are deemed stationary and lack a unit root.

However, once we look at the p-values after first difference has been applied, we find that all the p-values are essentially zero including CPI and STEFI and thus we can reject the null hypothesis at the first level meaning that CPI and STEFI are also stationary.

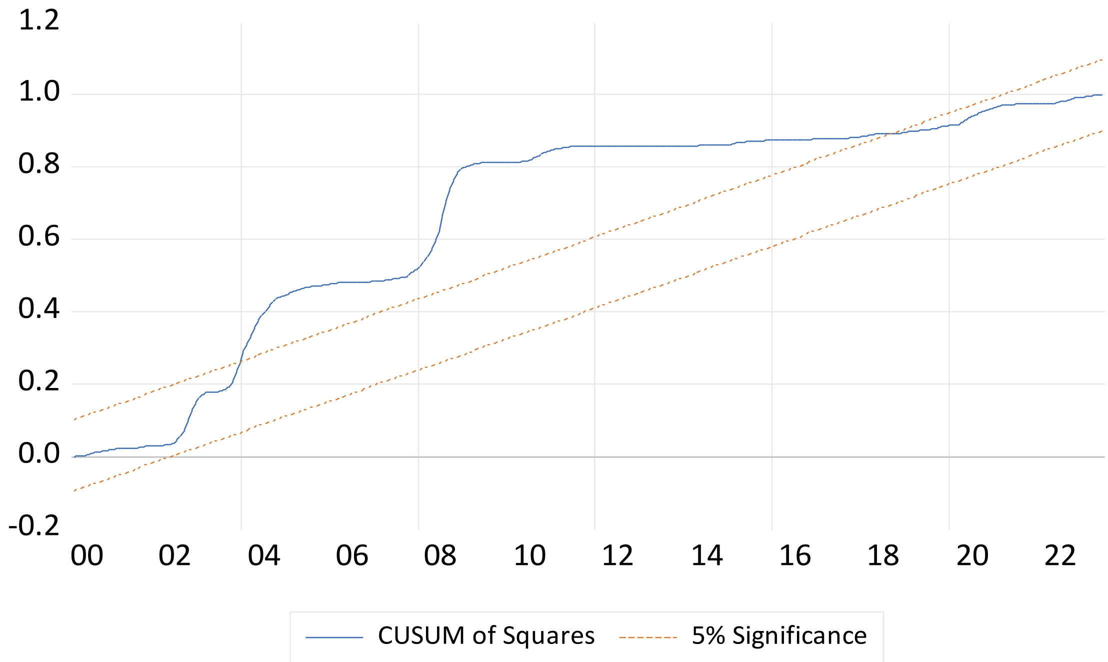
4.3. STRUCTURAL BREAKS

Neglecting structural breaks in financial data can distort statistical inferences and affect asset portfolio allocation made by investors. Ignoring such breaks in financial time series may lead to misinterpretations of volatility and the performance of a given asset. Economic events, such as financial liberalisation and global market integration and many more, can cause substantial structural changes in multiple financial series (Andreou & Ghysels, 2006). Structural breaks refer to the disruption or change in underlying parameters that influence the process of generating data. The cause of these breaks can be because of a difference in the intercept, parameter slope or volatility in the error term (Valentinyi-Endrész, 2004). These breaks are known to have a prolonged effect as compared to factors that simply cause a shock.

This study investigated the structural breaks in the independent variable, CPI. This was essential because when analysing the relationship between inflation and various assets over time, the effectiveness of an asset as a hedge against inflation could diminish. Consequently, overlooking structural breaks could lead to flawed interpretations regarding the correlation between inflation and asset performance. The primary test often utilised to identify structural breaks was introduced by Chow (1960) and thus the sub-samples identified below are structured around this Chow test. This test employs an F-statistic within a linear model framework to detect the presence of a structural break in a variable. The null hypothesis states that there are no breaks at specified breakpoints so if the F-statistic is significant, we fail to accept the null hypothesis.

The CUMSUMQ plot of CPI below revealed two significant deviation points from the 5% significance level boundary: 2003M12 and 2018M08. The Chow test confirmed structural breaks at these points with F-statistics p-values of 0.0002 and 0.0134 respectively, both below 0.05. Consequently, the study divided the CPI period into three sub-samples: Sub-sample 1 (Feb 2000 to Dec 2003), Sub-sample 2 (Jan 2004 to Aug 2018), and Sub-sample 3 (Sep 2018 to June 2023). The dependent variables were then analysed in these sub-samples where data was available for the asset return series. Thus, the NARDL models below will assess up to four periods, contingent on the availability of data from the asset return series: the full sample period, Sub-sample 1, Sub-sample 2, and Sub-sample 3.

Figure 2: CUMSUMQ plot of CPI overtime



Source: SARB

Table 7: Chow Test for Breakpoints

Chow Breakpoint Test	F-statistic	p-value
2003M12	14.537	0.0002
2018M08	6.189	0.0134

4.4. NARDL

This study investigated nine different asset return indices against inflation over varying periods. The models below were examined to evaluate the asymmetric and nonlinear abilities of these assets to effectively hedge against inflation. Before delving into each specific model, the study will first explore the explanation of the discussed variables. The notation X(L1) signifies the lagged value (L1) of the dependent variable. In this context, X represents the dependent variable under examination, such as JALSH(L1), GOVI(L1), and so forth. This variable represents the error correction term (ECT) which is also known as the short-run adjustment coefficient that indicates an adjustment of the variable towards the level equilibrium after some time when disequilibrium was experienced. CPI+(L1) and CPI-(L1) denote the lagged values (L1) of the positive and negative exogenous variables, respectively. CPI, serving as our independent variable, is considered an exogenous variable. The term DX(L1) indicates the first difference of the dependent variable. It reflects the impact of the past change in the dependent variable on the current value, with X being replaced by the specific asset model being analysed (e.g., DJALSH(L1), DALBI(L1), etc.). Similarly, DCPI+(L1) represents the first difference of the positive exogenous variable lagged by one period, capturing the change in the positive exogenous variable from the preceding period to the current one. Likewise, DCPI-(L1) represents the first difference of the negative exogenous variable lagged by one period, capturing the change in the negative exogenous variable from the previous period to the current one.

4.4.1. Asymmetric inflation hedging ability of JALSH and CPI

The estimates of this model are represented by the table below.

Table 8: NARDL model JALSH

	Feb 2000 - June 2023 (Full Sample)		Feb 2000 - Dec 2003 (Sub-sample 1)		Jan 2004 - Aug 2018 (Sub-sample 2)		Sep 2018 - June 2023 (Sub-sample 3)	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
JALSH(L1)	-1.007	0.000	-0.768	0.005	-1.213	0.000	-0.688	0.004
CPI+(L1)	-0.061	0.007	0.033	0.8	-0.078	0.002	-0.571	0.001
CPI-(L1)	-0.061	0.007	0.034	0.792	-0.078	0.002	-0.569	0.001
DJALSH(L1)	0.023	0.707	-0.133	0.496	0.133	0.099	-0.256	0.109
DCPI+(L1)	0.032	0.038	-0.048	0.546	0.047	0.012	0.368	0.001
DCPI+(L2)	0.024	0.031	-0.012	0.820	0.04	0.003	0.216	0.005
DCPI+(L3)	0.009	0.158	-0.015	0.524	0.006	0.612	0.075	0.082
DCPI-(L1)	0.032	0.051	-0.032	0.708	0.05	0.005	0.34	0.002
DCPI-(L2)	0.017	0.140	-0.031	0.548	0.029	0.04	0.238	0.001
DCPI-(L3)	0.003	0.654	-0.013	0.613	0.017	0.069	0.117	0.004
c	-0.000	0.920	0.001	0.396	0.000	0.291	-0.007	0.022

Feb 2000 - June 2023		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	2.685	0.103	Coint.	T-bdm	-11.597
	Long-run		3.846	0.051		F-pss	48.37
Long-run effect	Positive	-0.061	6.934	0.009			
	Negative	0.061	6.891	0.009			
Feb 2000 - Dec 2003		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.007	0.934	Coint.	T-bdm	-3.023
	Long-run		0.922	0.345		F-pss	3.063
Long-run effect	Positive	0.042	0.066	0.8			
	Negative	-0.044	0.071	0.792			
Jan 2004 – Aug 2018		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	1.018	0.315	Coint.	T-bdm	-10.282
	Long-run		0.597	0.441		F-pss	41.54
Long-run effect	Positive	-0.065	8.372	0.004			
	Negative	0.065	8.337	0.004			
Sep 2018 - June 2023		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.138	0.713	Coint.	T-bdm	-3.099
	Long-run		0.867	0.359		F-pss	10.434
Long-run effect	Positive	-0.83	4.185	0.047			
	Negative	0.827	4.173	0.048			

Over the full sample, the coefficient of JALSH(L1) also known as the ECT is -1.007 and is significant with a p-value of zero. The three sub-samples also have negative ECT coefficients with p-values that are significant and thus this confirms the presence of negative autocorrelation across all the periods. This also indicates that the variables exhibit a long-run relationship. Positive changes in inflation denoted by CPI+(L1) indicate that the impact on JALSH was negative and statistically significant and negative changes in CPI denoted by CPI-(L1) also have a negative statistically significant impact on JALSH during the full sample, sub-sample 2 and sub-sample 3 periods. This suggests that positive and negative changes in inflation have a dampening effect on the asset series. This means that JALSH was unable to effectively hedge against positive and negative changes in inflation in the short-run over these periods.

The coefficients of DJALSH(L1) across all the periods do not show evidence of any significance as the p-values are all greater than 0.05. This means that there is no effect of a short-run adjustment from the previous value of JALSH on the current value. The first and second difference of the positive and negative changes in inflation represented by DCPI+(L1), DCPI+(L2), DCPI-(L1) and DCPI-(L2) all have positive coefficients which are significant at 0.05. This is only true when analysing the data in the full sample period as well as sub-sample 2 and sub-sample 3, meaning that during these periods there is evidence of a short-run adjustment of both positive and negative lagged partial sums of these variables. In sub-sample 3, DCPI-(L3) has a positive coefficient and is significant.

The F-tests for long-run and short-run asymmetry across all the periods are insignificant meaning that there is no evidence of asymmetry between these variables and thus we cannot reject the null hypothesis of no long-run and short-run asymmetry. The results above show the long-run effects of inflation on equity to be significant during the full sample, sub-sample 2 and sub-sample 3 periods as the p-values are less than 0.05. Interpreting this during the full sample period means that an increase in inflation results in a decrease in JALSH by 0.061 and a decrease in inflation results in an increase in JALSH by 0.061. For sub-sample 2, an increase in inflation results in JALSH decreasing by 0.065 and a decrease in inflation results in a 0.065 increase in JALSH. Lastly, an increase in inflation during sub-sample 3 results in a decrease in JALSH by 0.083 and a decrease in inflation results in an 0.0827 increase in JALSH. The findings presented here are consistent with the seminal studies conducted by influential researchers such as Bodie (1976), Fama and Schwert (1977), and Kaul (1987). These works have consistently demonstrated a negative correlation between stock returns and inflation. Fama (1981) further expanded on this relationship through the Proxy hypothesis, suggesting that inflation serves as a proxy indicator for assessing the overall economic climate. According to this hypothesis, during periods of economic downturns characterised by high inflation, stocks tend to experience underperformance. Building upon this understanding, we observe that the periods during which inflation's dampening effect on stocks, as represented by JASLH, coincide with economic crises. Notably, the GFC occurred within the sub-sample 2 period, while events such as the COVID-19 pandemic and the oil crisis stemming from the Russia/Ukraine war fell within sub-sample 3.

The findings of the F-statistic over the full sample period, sub-sample 2 and sub-sample 3 infer the presence of a cointegration relationship between JALSH and inflation as each of these model's F-statistics are greater than the upper bound of the critical values at I(0) and I(1). Therefore, the null hypothesis that there exists no cointegration is rejected.

4.4.2. Asymmetric inflation hedging ability of ALBI and CPI

The estimates of this model are represented by the table below.

Table 9: NARDL model ALBI

	Feb 2001 - June 2023 (Full Sample)		Feb 2001 - Dec 2003 (Sub-sample 1)		Jan 2004 - Aug 2018 (Sub-sample 2)		Sep 2018 - June 2023 (Sub-sample 3)	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
ALBI(L1)	-0.892	0.000	-0.863	0.007	-0.901	0.000	-0.947	0.000
CPI+(L1)	0.019	0.032	-0.001	0.962	0.004	0.699	-0.071	0.275
CPI-(L1)	0.019	0.032	-0.003	0.947	0.004	0.689	-0.07	0.278
DALBI(L1)	0.002	0.971	0.140	0.585	-0.033	0.686	0.047	0.775
DALBI(L2)	N/A	N/A	0.366	0.042	N/A	N/A	N/A	N/A
DCPI+(L1)	-0.012	0.046	0.006	0.767	-0.003	0.747	0.041	0.331
DCPI+(L2)	-0.006	0.187	0.003	0.749	-0.001	0.872	0.023	0.441
DCPI+(L3)	-0.004	0.158	N/A	N/A	0.000	0.969	0.027	0.125
DCPI-(L1)	-0.014	0.024	0.018	0.441	-0.006	0.452	0.049	0.234
DCPI-(L2)	-0.01	0.037	0.008	0.474	-0.002	0.718	0.03	0.240
DCPI-(L3)	-0.005	0.102	N/A	N/A	-0.002	0.623	0.013	0.380
c	0.000	0.008	-0.000	0.665	0.000	0.117	-0.000	0.472

Feb 2001 - June 2023		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	3.153	0.077	Coint.	T-bdm	-10.531
	Long-run		0.765	0.383		F-pss	39.126
Long-run effect	Positive	0.021	4.396	0.037			
	Negative	-0.021	4.413	0.037			
Feb 2001 - Dec 2003		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.170	0.684	Coint.	T-bdm	-3.004

	Long-run		3.206	0.089		F-pss	3.065
Long-run effect	Positive	-0.002	0.002	0.962			
	Negative	0.003	0.005	0.947			
Jan 2004 – Aug 2018		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.421	0.518	Coint.	T-bdm	-8.178
	Long-run		2.402	0.123		F-pss	22.899
Long-run effect	Positive	0.005	0.148	0.701			
	Negative	-0.005	0.159	0.691			
Sep 2018 - June 2023		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.105	0.748	Coint.	T-bdm	-4.071
	Long-run		0.335	0.566		F-pss	6.855
Long-run effect	Positive	-0.074	1.064	0.309			
	Negative	0.074	1.053	0.311			

The negative autocorrelation is confirmed by the ECT values across all the periods being negative and significant implying that the model exhibits a long-run relationship between ALBI and inflation. The CPI+(L1) and CPI-(L1) both have positive coefficients and are significant as per their p-values being less than 0.05 only during the full sample period. This implies that ALBI may be considered as a potentially effective hedge against both positive and negative changes in inflation in the short-run, particularly during the specified full sample period.

In sub-sample 1, the second difference of ALBI, reflecting changes from two periods ago, is both positive and statistically significant. However, aside from this particular result, the coefficients of DALBI(L1) indicate a lack of evidence of a short-run adjustment based on the previous changes in ALBI from the preceding period. The absence of statistical significance suggests that the changes in ALBI from the preceding period do not exert a discernible impact on the current period's changes in ALBI.

DCPI+(L1), DCPI-(L1) and DCPI-(L2) during the full sample period had negative coefficients that were of significance. This means that there is evidence of a short-run adjustment up to the first difference in positive and negative partial sums of inflation and up to the second difference in the negative partial sum of inflation. All periods display no evidence of long-run or short-run asymmetry. The p-values of the long-run effect were only significant when analysed during the full sample period. During this period, The positive long-run effect had a positive coefficient of 0.021 and the negative long-run effect had a negative coefficient of -0.021. This means that when inflation increases, ALBI increases by 0.021 and when inflation decreases, ALBI decreases by 0.021.

The findings of the F-statistic over the full sample period, sub-sample 2 and sub-sample 3 infer the presence of a cointegration relationship between ALBI and inflation as each of these model's F-statistics are greater than the upper bound of the critical values at I(0) and I(1). Therefore, the null hypothesis that there exists no cointegration is rejected.

Overall, the findings above match up with the likes of Engsted and Tanngaard (2002) who presented evidence of hedging between bonds and inflation and Briere and Signori (2012) who stated that the hedging ability is dependent on the regime and horizon examined but noted a partial hedge in the late 90s and early 2000s.

4.4.3. Asymmetric inflation hedging ability of GOVI and CPI

The estimates of this model are represented by the table below.

Table 10: NARDL model for GOVI

	Feb 2001 - June 2023 (Full Sample)		Feb 2001 - Dec 2003 (Sub-sample 1)		Jan 2004 - Aug 2018 (Sub-sample 2)		Sep 2018 - June 2023 (Sub-sample 3)	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
GOVI(L1)	-0.896	0.000	-0.856	0.007	-0.9	0.000	-0.954	0.000
CPI+(L1)	0.019	0.031	-0.001	0.974	0.005	0.660	-0.071	0.274
CPI-(L1)	0.019	0.031	-0.002	0.958	0.005	0.649	-0.071	0.277
DGOVI(L1)	0.002	0.975	0.142	0.577	-0.038	0.642	0.0456	0.778
DGOVI(L2)	N/A	N/A	0.364	0.041	N/A	N/A	N/A	N/A
DCPI+(L1)	-0.012	0.044	0.006	0.774	-0.003	0.698	0.042	0.328
DCPI+(L2)	-0.006	0.178	0.003	0.746	-0.002	0.765	0.023	0.439

DCPI+(L3)	-0.004	0.180	N/A	N/A	-0.000	0.992	0.027	0.124
DCPI-(L1)	-0.014	0.024	0.019	0.439	-0.006	0.425	0.049	0.234
DCPI-(L2)	-0.01	0.037	0.008	0.472	-0.003	0.683	0.03	0.242
DCPI-(L3)	-0.005	0.092	N/A	N/A	-0.003	0.593	0.013	0.385
c	0.000	0.008	-0.000	0.667	0.000	0.102	-0.000	0.468S

Feb 2001 - June 2023		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	3.419	0.066	Coint.	T-bdm	-10.549
	Long-run		0.741	0.390		F-pss	39.215
Long-run effect	Positive	0.021	4.44	0.036			
	Negative	-0.021	4.46	0.036			
Feb 2001 - Dec 2003		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.18	0.0676	Coint.	T-bdm	-3.005
	Long-run		3.162	0.091		F-pss	3.078
Long-run effect	Positive	-0.002	0.001	0.974			
	Negative	0.003	0.003	0.958			
Jan 2004 – Aug 2018		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.321	0.572	Coint.	T-bdm	-8.158
	Long-run		2.347	0.127		F-pss	22.8
Long-run effect	Positive	0.005	0.192	0.662			
	Negative	-0.006	0.204	0.652			
Sep 2018 - June 2023		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.112	0.740	Coint.	T-bdm	-4.089
	Long-run		0.353	0.556		F-pss	6.914
Long-run effect	Positive	-0.075	1.069	0.307			
	Negative	0.074	1.058	0.310			

The negative and significant ECT coefficients across all the periods means that there is a long-run relationship between GOVI and CPI. The CPI+(L1) and CPI-(L1) both have positive coefficients and are significant as per their p-values being less than 0.05 only during the full sample period. This means that GOVI may efficiently hedge against positive and negative changes in inflation in the short-run.

The first difference coefficients are generally insignificant, except for the second difference, which is applicable only in sub-sample 1. This suggests a short-run adjustment in response to the previous changes in GOVI from two periods ago during that specific sub-sample. DCPI+(L1), DCPI-(L1) and DCPI-(L2) are negative and significant during the full sample period. This gives evidence of a short-run adjustment in these partial lagged sums of inflation.

The relationship between GOVI and inflation does not show signs of long-run or short-run asymmetry across all the periods. The statistical significance of the p-values for the long-run effect was observed exclusively when analysed across the entire sample period. Within this timeframe, the positive long-run effect exhibited a coefficient of 0.021, signifying that with an increase in inflation, the GOVI also increases by 0.021. Conversely, the negative long-run effect displayed a coefficient of -0.021, indicating that a decrease in inflation corresponds to a 0.021 decrease in GOVI.

The findings of the F-statistic over the full sample period, sub-sample 2 and sub-sample 3 infer the presence of a cointegration relationship between GOVI and inflation as each of these model's F-statistics are greater than the upper bound of the critical values at I(0) and I(1). Therefore, the null hypothesis that there exists no cointegration is rejected. The findings presented for the full sample period diverge from those of Spierdijk and Umar (2015), who observed that treasury bond indices failed to hedge against inflation during their analysis spanning from 1983 to 2012, attributing this to the price effect. They also highlighted a low correlation between bond indices and inflation post the GFC and the collapse of Lehman Brothers. Conversely, Bruno and Chincarini (2010), in their study on the optimal allocation of inflation-hedging portfolios, identified government bonds as an effective inclusion for mitigating inflation risk, corroborating the efficacy of the results obtained for the GOVI variable in hedging against inflation.

4.4.4. Asymmetric inflation hedging ability of JSAPY and CPI

The estimates of this model are represented by the table below.

Table 11: NARDL model for JSAPY

	June 2004 - June 2023 (Full Sample)	June 2004 - Aug 2018 (Sub-sample 2)	Sep 2018 - June 2023 (Sub-sample 3)

	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
JSAPY(L1)	-0.863	0.000	-0.806	0.000	-0.944	0.000
CPI+(L1)	-0.039	0.329	-0.047	0.150	-0.8	0.019
CPI-(L1)	-0.039	0.334	-0.047	0.155	-0.799	0.019
DJSAPY(L1)	-0.111	0.111	-0.152	0.057	0.026	0.876
DCPI+(L1)	0.01	0.747	0.014	0.553	0.53	0.017
DCPI+(L2)	0.004	0.830	-0.007	0.691	0.329	0.027
DCPI+(L3)	0.162	0.239	0.016	0.244	0.141	0.095
DCPI-(L1)	0.019	0.482	0.021	0.344	0.486	0.023
DCPI-(L2)	0.016	0.407	0.023	0.203	0.327	0.016
DCPI-(L3)	-0.003	0.787	-0.005	0.692	0.144	0.057
c	-0.001	0.514	-0.001	0.516	-0.012	0.036

June 2004 - June 2023		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	1.133	0.288	Coint.	T-bdm	-8.889
	Long-run		4.791	0.03		F-pss	26.990
Long-run effect	Positive	-0.045	0.938	0.334			
	Negative	0.045	0.916	0.340			
June 2004 – Aug 2018		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.007	0.933	Coint.	T-bdm	-7.258
	Long-run		4.135	0.044		F-pss	17.922
Long-run effect	Positive	-0.059	2.061	0.153			
	Negative	0.058	2.012	0.158			
Sep 2018 - June 2023		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.054	0.818	Coint.	T-bdm	-3.985
	Long-run		0.058	0.810		F-pss	11.012
Long-run effect	Positive	-0.846	3.322	0.076			
	Negative	0.846	3.32	0.076			

The coefficients of JSAPY(L1), representing the ECT, consistently exhibit negative values, accompanied by statistically significant p-values of zero indicating a negative autocorrelation. This suggests the existence of a long-run relationship between JSAPY and inflation. The significant negative coefficients of both CPI+(L1) and CPI-(L1), notably observed in recent years (sub-sample 3) with p-values below 0.05, suggest that JSAPY lacks effectiveness in hedging against both positive and negative fluctuations in inflation within the short-term during this specific timeframe.

The coefficients of DJSAPY(L1) are not significant. This means that there is no short-run adjustment from the previous changes in JSAPY across all periods. In sub-sample 3, the partial positive and negative first and second differences of inflation were positive and significant. This means that there exists a short-run adjustment from the previous changes of both positive and negative lagged partial sums of inflation on JSAPY so in the short-run, fluctuations or movements in inflation have an impact on JSAPY. The results above display the nuanced nature of real estate to act as a hedge against inflation as it is dependent on various factors from the type, location, and ownership duration. The variation in how real estate performs over different periods may be closely related to factors like overall economic climate and point in business cycle, market operations, and regional influences. Moreover, the type of real estate investment and how long one owns it are crucial details that cannot be dismissed. Different property types respond in their own unique manner to inflation, and being in possession of real estate for shorter periods can make investors experience greater vulnerabilities to market fluctuations. Despite indications of real estate's potential as an inflation hedge in some periods, its inconsistent performance aligns with previous research by Chu and Wang (2004) and Fang et al. (2008), emphasising the importance of understanding varying contextual factors for effective inflation risk management strategies involving real estate.

During the full sample and sub-sample 2 periods, the asymmetry in the long-run is significant. This implies that the behavior of JSAPY in response to changes in inflation is different in upward and downward directions over different time frames.

The cointegration statistics indicate that there is evidence of cointegration across all the different periods. Therefore, the null hypothesis that there exists no cointegration is rejected and can conclude that there is a long-run equilibrium relationship between JSAPY and inflation.

4.4.5. Asymmetric inflation hedging ability of STEFI and CPI

The estimates of this model are represented by the table below.

Table 12: NARDL model for STEFI

	July 2003 - June 2023 (Full Sample)		June 2004 - Aug 2018 (Sub-sample 2)		Sep 2018 - June 2023 (Sub-sample 3)	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
STEFI(L1)	-1.583	0.000	-1.038	0.000	-2.988	0.000
CPI+(L1)	0.356	0.000	0.197	0.001	1.077	0.001
CPI-(L1)	0.356	0.000	0.197	0.001	1.07	0.001
DSTEFI(L1)	0.498	0.000	-0.071	0.562	1.155	0.016
DSTEFI(L2)	0.266	0.000	0.02	0.811	0.54	0.06
DSTEFI(L3)	N/A	N/A	N/A	N/A	0.267	0.062
DCPI+(L1)	-0.144	0.008	-0.064	0.163	-0.604	0.007
DCPI+(L2)	-0.007	0.846	-0.013	0.683	-0.236	0.096
DCPI+(L3)	-0.013	0.636	0.026	0.348	-0.05	0.408
DCPI-(L1)	-0.112	0.043	0.038	0.412	-0.681	0.003
DCPI-(L2)	-0.085	0.041	0.02	0.587	-0.3	0.036
DCPI-(L3)	0.022	0.397	0.006	0.767	-0.054	0.425
C	-0.000	0.755	0.003	0.004	0.012	0.014

July 2003 - June 2023		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	N/A	N/A	Coint.	T-bdm	N/A
	Long-run		N/A	N/A		F-pss	N/A
Long-run effect	Positive	0.225	26.8	0.000			
	Negative	-0.225	26.8	0.000			
June 2004 – Aug 2018		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	16.97	0.000	Coint.	T-bdm	-7.036
	Long-run		0.21	0.648		F-pss	16.516
	Positive	0.190	13.91	0.000			

<table>
<tr><td>Long-run effect</td><td>Negative</td><td>-0.190</td><td>13.88</td><td>0.000</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Sep 2018 - June 2023</td><td>Coeff.</td><td>F-statistic</td><td>p-value</td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Asymmetry</td><td>Short-run</td><td rowspan="2">-</td><td>2.152</td><td>0.151</td><td rowspan="2">Coint.</td><td>T-bdm</td><td>-5.131</td></tr>
<tr><td>Long-run</td><td>1.629</td><td>0.210</td><td>F-pss</td><td>14.873</td></tr>
<tr><td rowspan="2">Long-run effect</td><td>Positive</td><td>0.361</td><td>8.578</td><td>0.006</td><td></td><td></td><td></td></tr>
<tr><td>Negative</td><td>-0.36</td><td>8.54</td><td>0.006</td><td></td><td></td><td></td></tr>
</table>

There is a long-run relationship between STEFI and inflation and this is confirmed by the negative ECT value which is denoted by the STEFI(L1) coefficient. In analysing the relationship between the STEFI index and inflation, the obtained results reveal compelling insights. The coefficients for both positive and negative changes in inflation, denoted by CPI+(L1) and CPI-(L1), consistently exhibit positive values and statistical significance across all periods, as indicated by p-values below 0.05. This intriguing finding suggests that STEFI may serve as an effective hedge against both positive and negative fluctuations in inflation in the short-run. The positive correlation could be attributed to investors perceiving cash or cash equivalents as a protective asset during periods of inflation. Additionally, the influence of interest rates and market expectations may contribute to the observed relationship, emphasising the multifaceted nature of the dynamics between cash equivalents and inflation. Looking at other studies the results above are consistent with their findings. Bekaert and Wang (2010) who used short-term treasury bills confirmed this positive hedging relationship as well as Tsong and Lee (2013) who confirmed this in various developed economies.

The coefficients of DSTEFI(L1) and DSTEFI(L2) are positive and statistically significant across the full sample. Moreover, in sub-sample 3, significance is observed only at the first lagged difference. This suggests a short-term adjustment influenced by the preceding changes in STEFI, with the nature of this adjustment varying based on the period under consideration. DCPI+(L1), DCPI-(L1) and DCPI-(L2) are negative and significant during the full sample and sub-sample 3 periods and thus there is a short-run adjustment from the previous positive first lagged difference and first and second negative lagged differences of inflation on STEFI. The only period that showed evidence of asymmetry was sub-sample 2 and this was in the short-run. The findings suggest a persistent impact of CPI on STEFI across all periods. A rise in inflation corresponds to an increase in STEFI, with sub-sample 3 demonstrating the most significant effect. Conversely, a decrease in inflation leads to a decline in STEFI, and once again, sub-sample 3 exhibits the most notable impact. In conclusion, the long-term relationship effect of inflation on STEFI is inferred to be direct.

The findings of the F-statistic over the full sample period were unable to converge as the maximum number of iterations had exceeded. However, in sub-sample 2 and sub-sample 3 we can infer the presence of a cointegration relationship between STEFI and inflation as each of these model’s F-statistics are greater than the upper bound of the critical values at I(0) and I(1). Therefore, the null hypothesis that there exists no cointegration is rejected.

4.4.6. Asymmetric inflation hedging ability of GOLD and CPI

The estimates of this model are represented by the table below.

Table 13: NARDL model for GOLD

	Feb 2000 - June 2023 (Full Sample)		Feb 2000 - Dec 2003 (Sub-sample 1)		Jan 2004 - Aug 2018 (Sub-sample 2)		Sep 2018 - June 2023 (Sub-sample 3)	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
GOLD(L1)	-1.083	0.000	-1.798	0.000	-1.114	0.000	-1.396	0.000
CPI+(L1)	-0.000	0.358	0.000	0.532	-0.000	0.609	-0.000	0.336
CPI-(L1)	-0.000	0.365	0.000	0.534	-0.000	0.632	-0.000	0.345
DGOLD(L1)	0.073	0.218	0.278	0.130	0.127	0.113	0.292	0.044
DCPI+(L1)	0.000	0.780	-0.000	0.328	0.000	0.734	0.000	0.940
DCPI+(L2)	0.000	0.405	-0.000	0.741	0.000	0.452	-0.000	0.843
DCPI+(L3)	0.000	0.022	0.000	0.792	0.000	0.278	0.000	0.787
DCPI-(L1)	0.000	0.625	-0.000	0.533	0.000	0.932	0.000	0.253
DCPI-(L2)	0.000	0.249	-0.000	0.429	0.000	0.578	0.000	0.175
DCPI-(L3)	0.000	0.927	-0.000	0.736	0.000	0.886	0.000	0.902
c	0.000	0.812	0.000	0.425	-0.000	0.686	0.000	0.746

Feb 2000 - June 2023	Coeff.	F-statistic	p-value

Asymmetry	Short-run	-	N/A	N/A	Coint.	T-bdm	N/A
	Long-run		N/A	N/A		F-pss	N/A
Long-run effect	Positive	-0.000	0.845	0.359			
	Negative	0.000	0.818	0.367			
Feb 2000 - Dec 2003		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	N/A	N/A	Coint.	T-bdm	N/A
	Long-run		N/A	N/A		F-pss	N/A
Long-run effect	Positive	0.000	0.412	0.526			
	Negative	-0.000	0.407	0.529			
Jan 2004 - Aug 2018		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.399	0.528	Coint.	T-bdm	-9.886
	Long-run		11.07	0.001		F-pss	33.521
Long-run effect	Positive	-0.000	0.259	0.611			
	Negative	0.000	0.227	0.634			
Sep 2018 - June 2023		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	4.653	0.037	Coint.	T-bdm	-6.433
	Long-run		2.307	0.137		F-pss	13.797
Long-run effect	Positive	-0.000	0.968	0.331			
	Negative	0.000	0.932	0.340			

The findings above affirm the existence of a prolonged association between GOLD and inflation. Nevertheless, GOLD demonstrates an inability to serve as a hedge against both positive and negative fluctuations in inflation over the short term. The coefficient of DGOLD(L1) is positive and significant in sub-sample 3 and thus, changes in GOLD from the previous period have an impact on the current period's outcome in this specific sub-sample.

The model does not yield any noteworthy results except in sub-sample 2, where long-run asymmetry is significant, and in sub-sample 3, where short-run asymmetry is also significant. This suggests that the relationship is not consistent when examined within these specific time frames. The null hypothesis that there exists no cointegration in sub-sample 2 and sub-sample 3 is rejected as the findings of the F-statistic are greater than the upper bound of the critical values at I(0) and I(1).

Gold's reputation as a safe haven asset during economic downturns appears to diverge from the findings of the models discussed, which largely yielded insignificant results. This discrepancy, consistent with the conclusions drawn by Erb and Harvey (2013), suggests a lack of evidence supporting gold's efficacy as an inflationary hedge in both the short and long term. Several factors contribute to this observed ineffectiveness. Firstly, while gold is often touted as a hedge against inflation, its ability to preserve value during inflationary periods may not be consistently supported by empirical data. Additionally, the volatile nature of gold prices, influenced by factors such as geopolitical events and market sentiment, may overshadow its role as a reliable hedge against inflation. Although short-run impacts of changes in gold prices are evident, particularly in sub-sample 3 which reflects prices from three periods ago, this does not necessarily translate into sustained effectiveness over longer periods. Moreover, contextual factors such as economic conditions and investor behavior play crucial roles in determining gold's performance as a safe haven asset and inflation hedge, further complicating its predictability. Overall, the models' results in this study challenge traditional expectations regarding gold's ability to maintain purchasing power and act as a robust hedge in inflationary environments, highlighting the nuanced nature of its behavior in different economic contexts.

4.4.7. Asymmetric inflation hedging ability of BITCOIN and CPI

The estimates of this model are represented by the table below.

Table 14: NARDL model for BITCOIN

	Aug 2010 - June 2023 (Full Sample)		Aug 2010 - Aug 2018 (Sub-sample 2)		Sep 2018 - June 2023 (Sub-sample 3)	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
JBITCOIN(L1)	-1.099	0.000	-1.094	0.000	-0.941	0.000
CPI+(L1)	-0.053	0.901	-1.52	0.088	-1.703	0.002

CPI-(L1)	-0.053	0.9	-1.524	0.087	-1.7	0.002
DBITCOIN(L1)	0.085	0.326	0.107	0.364	0.061	0.689
DCPI+(L1)	-0.025	0.94	1.26	0.030	1.096	0.003
DCPI+(L2)	0.079	0.704	0.017	0.965	0.621	0.011
DCPI+(L3)	-0.046	0.707	0.312	0.282	0.222	0.108
DCPI-(L1)	0.079	0.779	0.26	0.683	0.999	0.004
DCPI-(L2)	0.019	0.929	0.922	0.054	0.625	0.005
DCPI-(L3)	0.006	0.965	0.275	0.231	0.388	0.003
c	0.002	0.697	0.009	0.257	-0.021	0.029

Aug 2010 - June 2023		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.31	0.579	Coint.	T-bdm	-9.038
	Long-run		0.023	0.879		F-pss	27.49
Long-run effect	Positive	-0.048	0.016	0.901			
	Negative	0.048	0.016	0.9			
Aug 2010 – Aug 2018		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.131	0.719	Coint.	T-bdm	-6.901
	Long-run		0.427	0.515		F-pss	17.057
Long-run effect	Positive	-1.39	2.783	0.099			
	Negative	1.393	2.797	0.098			
Sep 2018 - June 2023		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.035	0.852	Coint.	T-bdm	-4.778
	Long-run		0.406	0.528		F-pss	11.931
Long-run effect	Positive	-1.810	6.993	0.012			
	Negative	1.806	6.975	0.012			

BITCOIN and inflation share a long-run relationship as the coefficients of BITCOIN(L1) are negative and significant. In sub-sample 3, both the positive (CPI+(L1)) and negative (CPI-(L1)) changes in inflation exhibit statistical significance, with p-values approaching zero. This finding indicates that in recent years, BITCOIN demonstrates an inability to effectively hedge against both positive and negative changes in inflation. Instead, changes in inflation appear to have a dampening effect on the asset's performance. This suggests that BITCOIN may not serve as an efficient hedge against inflationary pressures during this specific period.

DCPI+(L1) in sub-sample 2 and sub-sample 3 and DCPI+(L2) in sub-sample 3 are positive and significant. DCPI-(L1), DCPI-(L2) and DCPI-(L3) in sub-sample 3 are positive and significant. This means that during these periods these coefficients show evidence of a short-run adjustment from the previous changes of the positive and negative lagged partial sums of inflation on BITCOIN.

All the periods show no evidence of short-run or long-run asymmetry. In sub-sample 3 the model shows a significant relation in the long-run between inflation and BITCOIN. When inflation increases, BITCOIN decreases by 1.81 and when inflation decreases, BITCOIN increases by 1.806. The cointegration statistics indicate that there is evidence of cointegration across all the different periods. Therefore, the null hypothesis that there exists no cointegration is rejected and can conclude that there is a long-run equilibrium relationship between BITCOIN and inflation.

Cryptocurrencies, notably Bitcoin, have garnered considerable attention as investors explore their potential to serve as a hedge against inflation. Recent years, particularly within the highlighted sub-sample 3 period, have shown significant results, coinciding with a period marked by elevated global inflation levels. These outcomes align with Smales (2022), who also observed a positive relationship between cryptocurrency returns and inflation expectations. However, Smales (2022) still advocates for gold as a superior alternative between the two asset types. Contrary to Choi and Shin's (2022) findings, which affirm Bitcoin's role as an inflation hedge, the results of this paper present a different perspective. The discrepancy in findings underscores the complexity and varied interpretations within the emerging field of cryptocurrency research.

4.4.8. Asymmetric inflation hedging ability of PLATINUM and CPI

The estimates of this model are represented by the table below.

Table 15: NARDL model for PLATINUM

	Feb 2000 - June 2023 (Full Sample)		Feb 2000 - Dec 2003 (Sub-sample 1)		Jan 2004 - Aug 2018 (Sub-sample 2)		Sep 2018 - June 2023 (Sub-sample 3)	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
PLATINUM(L1)	-0.861	0.000	-0.953	0.001	-0.842	0.000	-1.267	0.000
CPI+(L1)	-0.000	0.008	-0.000	0.887	-0.000	0.011	-0.000	0.654
CPI-(L1)	-0.000	0.009	-0.000	0.896	-0.000	0.012	-0.000	0.656
DPLATINUM(L1)	-0.097	0.243	-0.093	0.620	-0.085	0.455	0.246	0.119
DPLATINUM(L2)	-0.137	0.020	N/A	N/A	-0.137	0.094	N/A	N/A
DCPI+(L1)	0.000	0.024	-0.000	0.473	0.000	0.039	0.000	0.732
DCPI+(L2)	0.000	0.007	-0.000	0.743	0.000	0.056	0.000	0.910
DCPI+(L3)	0.000	0.002	0.000	0.987	0.000	0.286	0.000	0.547
DCPI-(L1)	0.000	0.020	-0.000	0.888	0.000	0.016	0.000	0.650
DCPI-(L2)	0.000	0.007	-0.000	0.407	0.000	0.029	0.000	0.473
DCPI-(L3)	0.000	0.068	-0.000	0.386	0.000	0.094	0.000	0.932
c	-0.000	0.373	0.000	0.503	0.000	0.211	-0.000	0.466

Feb 2000 - June 2023		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.509	0.476	Coint.	T-bdm	-8.466
	Long-run		9.328	0.002		F-pss	27.297
Long-run effect	Positive	-0.000	6.182	0.014			
	Negative	0.000	6.117	0.014			

Feb 2000 - Dec 2003		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.007	0.933	Coint.	T-bdm	-3.569
	Long-run		1.113	0.3		F-pss	4.251
Long-run effect	Positive	-0.000	0.021	0.887			
	Negative	0.000	0.017	0.896			

<table>
<tr><td colspan="2">Jan 2004 – Aug 2018</td><td>Coeff.</td><td>F-statistic</td><td>p-value</td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Asymmetry</td><td>Short-run</td><td rowspan="2">-</td><td>0.13</td><td>0.719</td><td rowspan="2">Coint.</td><td>T-bdm</td><td>-5.893</td></tr>
<tr><td>Long-run</td><td>9.191</td><td>0.003</td><td>F-pss</td><td>16.703</td></tr>
<tr><td rowspan="2">Long-run effect</td><td>Positive</td><td>-0.000</td><td>4.804</td><td>0.030</td><td></td><td></td><td></td></tr>
<tr><td>Negative</td><td>0.000</td><td>4.704</td><td>0.032</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Sep 2018 - June 2023</td><td>Coeff.</td><td>F-statistic</td><td>p-value</td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Asymmetry</td><td>Short-run</td><td rowspan="2">-</td><td>0.079</td><td>0.780</td><td rowspan="2">Coint.</td><td>T-bdm</td><td>-5.621</td></tr>
<tr><td>Long-run</td><td>0.0355</td><td>0.851</td><td>F-pss</td><td>11.632</td></tr>
<tr><td rowspan="2">Long-run effect</td><td>Positive</td><td>-0.000</td><td>0.195</td><td>0.661</td><td></td><td></td><td></td></tr>
<tr><td>Negative</td><td>0.000</td><td>0.193</td><td>0.663</td><td></td><td></td><td></td></tr>
</table>

The coefficients of PLATINUM(L1) which are the ECT variables have significant p-values of zero. This means that there is a long-run relationship between PLATINUM and inflation. The coefficients of CPI+(L1) and CPI-(L1) are negative and significant in the full sample and sub-sample 2 periods. This means that PLATINUM is ineffective in providing an efficient hedge against both positive and negative variations in inflation in the short-run.

The coefficient of DPLATINUM(L2) in the full sample period is negative and significant for the second difference. This means that there is short-run adjustment from the previous changes in PLATINUM when looking only at DPLATINUM(L2). The lagged differences in the positive and negative partial sums of inflation on the asset are significant throughout the full sample period (Feb 2000 – June 2023), except for DCPI-(L3). This indicates that there is a short-term adjustment over time in response to the preceding changes in the long-run. The only other period to exhibit evidence of significance are the DCPI+(L1), DCP-(L1) and DCPI-(L2) coefficients in sub-sample 2.

The full sample and sub-sample 2 periods show evidence of long-run asymmetry, the p-value is significant and thus we can conclude that there is evidence of long-run asymmetry. Even though the coefficients are essentially zero the long-run positive and negative effects of these two periods are significant. The cointegration statistics reveal evidence of cointegration across the various periods, with F-statistics surpassing critical values at I(0) and I(1). Consequently, the null hypothesis suggesting no cointegration is rejected, leading to the conclusion that a long-run equilibrium relationship exists between PLATINUM and inflation.

The effectiveness of platinum as an inflation hedge shows mixed results, with short-run efficacy questioned but long-run potential hinted at, despite coefficients nearing zero. Bilgin et al. (2018) found significant inflation hedging capabilities in platinum ETFs across eleven countries, mirroring our study's findings. Similarly, Hillier (2006) noted a positive correlation between platinum and inflation during volatile market periods, echoing our observations during the GFC. The complex nature of precious metals, serving as commodities and safe-haven assets, alongside economic factors like supply and demand dynamics, contributes to these nuanced results. Taylor's (1998) earlier study corroborated these findings across gold, silver, platinum, and palladium, emphasising the importance of considering both short-term and long-term perspectives in evaluating their inflation hedging abilities.

4.4.9. Asymmetric inflation hedging ability of OIL and CPI

The estimates of this model are represented by the table below.

Table 16: NARDL model for OIL

	Feb 2000 - June 2023 (Full Sample)		Feb 2000 - Dec 2003 (Sub-sample 1)		Jan 2004 - Aug 2018 (Sub-sample 2)		Sep 2018 - June 2023 (Sub-sample 3)	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
OIL(L1)	-1.037	0.000	-1.103	0.000	-0.979	0.000	-1.084	0.000
CPI+(L1)	-0.000	0.110	0.000	0.593	-0.000	0.003	-0.001	0.680
CPI-(L1)	-0.000	0.112	0.000	0.589	-0.000	0.004	-0.001	0.677
DOIL(L1)	0.028	0.643	0.183	0.292	0.033	0.674	0.006	0.969
DCPI+(L1)	0.000	0.109	-0.000	0.384	0.000	0.021	0.001	0.496
DCPI+(L2)	0.000	0.020	0.000	0.609	0.000	0.012	0.000	0.650
DCPI+(L3)	0.000	0.193	-0.000	0.445	0.000	0.274	0.000	0.369
DCPI-(L1)	0.000	0.095	-0.000	0.776	0.000	0.007	0.000	0.711
DCPI-(L2)	0.000	0.082	-0.000	0.452	0.000	0.020	0.000	0.504

DCPI-(L3)	0.000	0.062	0.000	0.436	0.000	0.074	0.000	0.917
c	-0.000	0.177	0.000	0.224	0.000	0.878	-0.000	0.299

Feb 2000 - June 2023		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.807	0.369	Coint.	T-bdm	-12.067
	Long-run		3.036	0.083		F-pss	49.663
Long-run effect	Positive	-0.000	2.51	0.114			
	Negative	0.000	2.486	0.116			
Feb 2000 - Dec 2003		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.42	0.533	Coint.	T-bdm	-4.363
	Long-run		0.304	0.586		F-pss	6.453
Long-run effect	Positive	0.000	0.290	0.594			
	Negative	-0.000	0.296	0.591			
Jan 2004 – Aug 2018		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	0.17	0.681	Coint.	T-bdm	-8.997
	Long-run		4.119	0.044		F-pss	29.573
Long-run effect	Positive	-0.000	8.053	0.005			
	Negative	0.000	7.95	0.005			
Sep 2018 - June 2023		Coeff.	F-statistic	p-value			
Asymmetry	Short-run	-	1.137	0.293	Coint.	T-bdm	-4.477
	Long-run		0.111	0.741		F-pss	7.908
Long-run effect	Positive	-0.001	0.162	0.689			
	Negative	0.001	0.165	0.687			

A long-run relationship between OIL and inflation can be confirmed by the OIL(L1) coefficients being negative and statistically significant. During sub-sample 2, both positive (CPI+(L1)) and negative (CPI-(L1)) changes in inflation had statistically significant p-values with negative coefficients. This implies that, during this specific period, OIL could not have been effectively used as a hedge against both positive and negative changes in inflation in the short-run. The negative coefficients suggest an inverse relationship, indicating a dampening effect rather than serving as a direct hedge. The coefficients of DOIL(L1) were not significant in any period. This means that there was no short-run adjustment from the previous changes in OIL. The lagged first and second differences of the positive and negative partial sums of inflation on OIL were significant in sub-sample 2 along with DCPI+(L2) in the full sample period.

Only in sub-sample 2 does the long-run asymmetry show that the p-value is significant and thus we can say that there is presence of long-run asymmetry between the dependent and independent variable. Despite the coefficients being zero, the positive and negative long-run effects of inflation on OIL are significant during sub-sample 2 which coincides with the period where the GFC occurred. Conclusively rejecting the null hypothesis, which suggests no cointegration, implies the existence of a long-term equilibrium relationship between OIL and inflation. The cointegration statistics reveal the presence of cointegration across the different time periods, with F-statistics exceeding critical values at both I(0) and I(1).

The attenuating character of the results observed in sub-sample 2 suggests that despite the pronounced volatility in oil prices during the GFC, they were insufficient in hedging against both positive and negative shifts in inflation. Furthermore, the long-term effects during this period displayed coefficients nearing zero, resembling those found in platinum. Although the short-term impacts of the study were less significant, the observations echoed those made by Chou and Tseng (2011) in their examination of Asian markets. The variance in significance could arise from a multitude of factors, including but not limited to time lags, the intricate dynamics of production costs, the influence of contractual agreements, and the nuanced responses implemented in economic policies. It is crucial to underscore the possibility of a fundamental shift in the correlation between oil and inflation. This perspective underscores that, frequently, oil shocks may not merely be a consequence but a catalyst for inflation, given their pivotal role as an input in the production costs of diverse industries.

CHAPTER 5

DIAGNOSTIC TESTS

The diagnostic procedures will incorporate both the Johansen Cointegration and Granger Causality tests. The results of these assessments will play a role in either substantiating or contesting the interpretations derived from the NARDL model results previously examined.

5.1. JOHANSEN COINTEGRATION

The Johansen Cointegration test is a valuable tool for analysing time series data to determine if there is a significant long-term relationship between various indices. In this test, the null hypothesis posits that the series under consideration lacks cointegration. Rejecting this null hypothesis, typically when the p-value is below 0.05, signifies the presence of a meaningful underlying relationship among a chosen asset return index and the independent variable, which can be mathematically represented by a linear equation. This implies that although short-term fluctuations may impact individual indices, over time, they tend to move together, converging towards a common trend.

The presence of cointegrating relationships implies that there exist diversification benefits among the variables chosen in the study and as a result could be used to hedge against the adverse effects of inflation. From the table we see that when looking at the Pairwise Johansen cointegration using the trace statistic and max-eigen statistic we reject the null hypothesis across all the asset class indices returns as their p-values are less than 0.05 meaning that each individual asset class has a significant underlying relationship with inflation represented by CPI. Each of these variables trace statistic and max-eigen statistics are greater than the critical values at 0.05 so in conclusion the trace statistic and max-eigenvalue statistic tests indicate the presence of at least two cointegrating equations at a 0.05 level of significance. Overall, these results confirm the cointegration found in the NARDL models in the previous section.

Table 17: Pairwise Johansen Cointegration – Trace Statistic

	P-VALUE TRACE STATISTIC		**NULL HYPOTHESIS**	
	NONE	**AT MOST 1**	**NONE**	**AT MOST 1**
JALSH	0.0000	0.0000	Fail to Reject	Fail to Reject

ALBI	0.0000	0.0000	Fail to Reject	Fail to Reject
GOVI	0.0000	0.0000	Fail to Reject	Fail to Reject
JSAPY	0.0000	0.0000	Fail to Reject	Fail to Reject
STEFI	0.0000	0.0000	Fail to Reject	Fail to Reject
GOLD	0.0000	0.0000	Fail to Reject	Fail to Reject
BITCOIN	0.0000	0.0000	Fail to Reject	Fail to Reject
PLATINUM	0.0000	0.0000	Fail to Reject	Fail to Reject
OIL	0.0000	0.0000	Fail to Reject	Fail to Reject

Table 18: Pairwise Johansen Cointegration – Max-Eigenvalue Statistic

	P-VALUE MAX-EIGEN STATISTIC		**NULL HYPOTHESIS**	
	NONE	**AT MOST 1**	**NONE**	**AT MOST 1**
JALSH	0.0000	0.0000	Fail to Reject	Fail to Reject
ALBI	0.0000	0.0000	Fail to Reject	Fail to Reject
GOVI	0.0000	0.0000	Fail to Reject	Fail to Reject
JSAPY	0.0000	0.0000	Fail to Reject	Fail to Reject
STEFI	0.0000	0.0000	Fail to Reject	Fail to Reject
GOLD	0.0000	0.0000	Fail to Reject	Fail to Reject
BITCOIN	0.0000	0.0000	Fail to Reject	Fail to Reject
PLATINUM	0.0000	0.0000	Fail to Reject	Fail to Reject
OIL	0.0000	0.0000	Fail to Reject	Fail to Reject

5.2.GRANGER CAUSALITY

To explore the potential causality between a specific asset return index and inflation, we conducted the Granger Causality test. This test enables us to investigate whether one variable's actions influence the behavior of another. According to the Granger Causality test, the null hypothesis posits that variable X does not Granger-cause variable Y. If the p-value is below 0.05, we can reject the null hypothesis, indicating that variable X does indeed impact the behavior of variable Y.

The results of the Granger Causality test are presented in the two tables below. Table 19 reveals that JALSH, ALBI, GOVI, PLATINUM, and OIL exert an influence on the behavior of inflation, as evidenced by the rejection of the null hypothesis at the 5% significance level. Conversely, when assessing whether inflation, represented by CPI in Table 20, influences any of the asset return indices, we observe that the null hypothesis was only rejected for STEFI, where the p-value was less than 5%. Notwithstanding these findings, it's important to note that the Granger Causality test doesn't ascertain the specific nature of the relationship between the two variables—whether it's positive or negative. Consequently, we cannot conclusively determine whether the returns of the asset series have a beneficial or adverse impact on inflation, or if inflation's influence on STEFI serves as an effective or ineffective hedge against inflation. The test solely indicates the presence of causality without providing insights into the directional aspect or the strength of the relationship between the variables. Further analysis and exploration are required to gain a comprehensive understanding of the dynamics and implications of the observed causal connections.

Table 19: Granger Causality results

	JALSH	**ALBI**	**GOVI**	**JSAPY**	**STEFI**	**GOLD**	**BITCOIN**	**PLATINUM**	**OIL**
CPI					*				

The * represents the existence of a granger causality relationship of asset return index on inflation.

Table 20: Granger Causality results

	CPI
JALSH	*
ALBI	*
GOVI	*
JSAPY	
STEFI	
GOLD	
BITCOIN	
PLATINUM	*
OIL	*

The * represents the existence of a granger causality relationship of inflation on asset return index.

CHAPTER 6

CONCLUSION

This study rigorously examined the empirical correlation between inflation and the performance of a diverse range of assets. By using the returns of these assets as proxies, it sought to pinpoint asset classes that could effectively act as a hedge against inflation. The importance of this investigation cannot be overstated, as inflation perpetually looms as a perennial concern for investors, impacting their portfolio construction and management decisions. Inflation steadily erodes the purchasing power of money and consequently diminishes the overall value of investment portfolios. While extensive research has been conducted on these relationships in developed economies elsewhere, it is imperative to ascertain whether the insights garnered from existing literature hold true for South Africa. As one of the largest developing economies in Africa, South Africa presents a unique context that warrants exploration to enrich our understanding of the dynamics between inflation and asset returns in emerging market environments. The NARDL method was employed in this study to explore the relationship between traditional and alternative asset class returns and inflation. This approach was chosen because it employs positive and negative partial sum decompositions, allowing for the identification of asymmetric effects in both short-term and long-term connections. Notably, fixed-income assets, exemplified by bonds (ALBI, and GOVI), and cash (STEFI), emerge as potent hedges against inflation, equipping investors with essential tools for strategic portfolio diversification during periods of inflationary pressure. The nuanced reactions displayed by asset classes like equity (JALSH), property (JSAPY), cryptocurrency (BITCOIN) and commodities (PLATINUM and OIL) to shifts in inflation emphasise the necessity for a customised approach to inflation risk management. It is important to emphasise that these findings stem from the average return of inflation significantly exceeding the average return of the various asset classes. Policymakers can capitalise on this understanding to refine monetary and fiscal policies, thereby enhancing their responsiveness to the ever-changing economic landscape. Additionally, the study highlights the crucial importance of investor education, promoting well-informed decision-making rooted in an enhanced understanding of how various assets respond to inflationary pressures. Gold, traditionally touted as a hedge and safe haven, did not yield noteworthy outcomes at any juncture over the study's duration. Despite its historical reputation as a reliable safeguard, gold's effectiveness as a hedge against inflationary fluctuations remained unsubstantiated throughout the examined time frame.

The confirmation of cointegration through both NARDL and Johansen Cointegration tests, examining the relationship between asset returns and inflation, provides actionable insights for policymakers and investors alike. This recognition unlocks avenues for deriving diversification benefits, contingent upon considerations of the economic climate and specific timeframes to optimise value addition. The research highlights the fluidity of inflation hedging, stressing the importance of regularly reviewing strategies to adapt to changing economic conditions. Investors are advised to take a long-term approach and implement strategies that acknowledge the complex interactions between inflation and various asset classes, promoting resilience and adaptability in the face of economic uncertainties.

These findings not only enrich the academic understanding of inflation and asset class dynamics but also furnish practical guidance capable of significantly shaping investment strategies and risk management frameworks when confronted with inflationary challenges. This study has potential limitations and as a result additional recommendations for further study can be investigated. Future research can explore behavioral finance, which recognises the impact of psychological factors on investors' asset selection and allocation strategies. Moreover, incorporating a multivariate analysis that includes various macroeconomic factors, such as gross domestic product, could offer a more comprehensive perspective. Expanding the scope of this research to include diverse economies and different monetary policy regimes could provide deeper insights into the universal applicability of the observed relationships, thereby enhancing the study's relevance across different economic contexts and policy frameworks.

REFERENCES

Adusei, M. (2014). The inflation-stock market returns nexus: Evidence from Ghana stock exchange. *Journal of Economics and International Finance, 6*(2), 38–17.

Aggarwal, R. (1992). Gold markets. In P. Newman, M. Milgate, & J. Eatwell (Eds.), *The new Palgrave dictionary of money and finance, 2*, 257–258.

Al-Khazali, O. (1999). Nominal interest rates and inflation in the Pacific-Basin countries. *Management Decision, 37*(6), 491–498.

Alagidede, P., & Panagiotidis, T. (2010). Can common stocks provide a hedge against inflation? Evidence from African countries. *Review of Financial Economics, 19*(3), 91–100.

Anari, A., & Kolari, J. (2001). Stock prices and inflation. *Journal of Financial Research*, *24*(4), 587-602.

Andreou, E., & Ghysels, E. (2009). Structural breaks in financial time series. *Handbook of financial time series*, 839-870.

Arnold, S., & Auer, B. (2015). What do scientists know about inflation hedging? *The North American Journal of Economics and Finance, 34*, 187–214.

Balcilar, M., Uwilingiye, J., & Gupta, R(2018). Dynamic relationship between oil price and inflation in South Africa. *The Journal of Developing Areas, 52*(2), 73-93.

Balduzzi, P. (1995). Stock returns, inflation, and the 'proxy hypothesis': A new look at the data. *Economics Letters*, *48*(1), 47-53.

Barro, R. J. (1996). Inflation and growth. *Review-Federal Reserve Bank of Saint Louis*, *78*, 153-169.

Baur, D. G., Hong, K., & Lee, A. D. (2018). Bitcoin: Medium of exchange or speculative assets? *Journal of International Financial Markets, Institutions and Money*, *54*, 177-189.

Bekaert, G., & Wang, X. (2010). Inflation risk and the inflation risk premium. *Economic Policy, 25*(64), 755–806.

Bildirici, M. E., & Turkmen, C. (2015). Nonlinear causality between oil and precious metals. *Resources Policy*, *46*, 202-211.

Bilgin, M. H., Gogolin, F., Lau, M. C. K., & Vigne, S. A. (2018). Time-variation in the relationship between white precious metals and inflation: A cross-country analysis. *Journal of International Financial Markets, Institutions and Money*, *56*, 55-70.

Blake, N., Goodwin, A., McIntosh, A., & Simmons, C. (2010). Property and inflation: Research report (IPF Research Programme, 2006-2009). *London: Investment Property Forum*.

Blau, B. M., Griffith, T. G., & Whitby, R. J. (2021). Inflation and Bitcoin: A descriptive time-series analysis. *Economics Letters*, *203*, 109848.

Bodie, Z. (1976). Common stocks as a hedge against inflation. *The journal of finance, 31*(2), 459-470.

Bodie, Z. (1979). Inflation risk and capital market equilibrium (No. w0373). *National Bureau of Economic Research*.

Bond, M., & Seiler, M. (1998). Real Estate Returns and Inflation: An Added Variable Approach. *Journal of Real Estate Research, 15*(3), 327–338.

Bordo, M. D. (2009). The crisis of 2007: the same old story, only the players have changed. In *Globalization and systemic risk*, 39-50.

Boudoukh, J., & Richardson, M. (1993). Stock Returns and Inflation: A Long-Horizon Perspective. *American Economic Review, 83*(5).

Bouri, E., Molnár, P., Azzi, G., Roubaud, D., & Hagfors, L. I. (2017). On the hedge and safe haven properties of Bitcoin: Is it really more than a diversifier? *Finance Research Letters, 20*, 192-198.

Brière, M., & Signori, O. (2011). Hedging Inflation Risk in a Developing Economy. Working Paper. *Amundi Asset Management, 7.*

Brière, M., & Signori, O. (2012). Inflation-Hedging Portfolios: Economic Regimes Matter. *Journal of Portfolio Management, 38*(4).

Bruno, S., & Chincarini, L. (2010). Hedging inflation internationally. *SSRN Working Paper.* https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1536959

Burdekin, R. C., & Tao, R. (2021). The golden hedge: From global financial crisis to global pandemic. *Economic Modelling*, *95*, 170-180.

Cagan, P. (1972). Common Stock Values and Inflation—The Historical Record of Many Countries. *Supplement to NBER Report Thirteen*, 1-10. NBER.

Campbell, J. Y., & Viceira, L. M. (2005). The term structure of the risk–return trade-off. *Financial Analysts Journal*, *61*(1), 34-44.

Chatrath, A., & Liang, Y. (1998). REITs and inflation: a long-run perspective. *Journal of Real Estate Research*, *16*(3), 311-326.

Choi, S., & Shin, J. (2022). Bitcoin: An inflation hedge but not a safe haven. *Finance Research Letters*, *46*, 102379.

Chong, J., & Miffre, J. (2009). Conditional correlation and volatility in commodity futures and traditional asset markets. *The Journal of Alternative Investments*, *12*(3), 061-075.

Chou, K, & Tseng, Y. (2011). Oil Price Pass-through into CPI Inflation in Asian Emerging Countries: The Discussion of Dramatic Oil Price Shocks and High Oil Price Periods. *British Journal of Economics, Finance and Management Sciences*, *2*(1), 1-13.

Choudhry, T. (2001). Inflation and rates of return on stocks: evidence from high inflation countries. *Journal of International Financial Markets, Institutions and Money*, *11*(1), 75– 96.

Chow, G. C. (1960). Tests of equality between sets of coefficients in two linear regressions. *Econometrica: Journal of the Econometric Society*, 591-605.

Chu, Y., & Sing, T. (2004). Inflation Hedging Characteristics of Chinese Real Estate Market. *Journal of Real Estate Portfolio Management, 10.*

Chua, J., & Woodward, R. S. (1982). Gold as an inflation hedge: a comparative study of six major industrial countries. *Journal of Business Finance & Accounting*, *9*(2), 191-197.

Corbet, S., Lucey, B., Urquhart, A., & Yarovaya, L. (2019). Cryptocurrencies as a financial asset: A systematic analysis. *International Review of Financial Analysis*, *62,* 182-199.

D'Amico, S., & King, T. B. (2023). Inflation hedging products. *Chapters*, 470-489.

Dabara, D. I., Olusegun, O., Adewuyi, O., Anthony, A., & Olatunde, A. (2016). Real estate investments and the inflation-hedging question: A review. *International Journal of Business and Management Studies*, *5*(01), 187-196.

Darby, M. R. (1982). The price of oil and world inflation and recession. *The American Economic Review*, *72*(4), 738-751.

Davari, H., & Kamalian, A. (2018). Oil price and inflation in Iran: Non-linear ARDL approach. *International Journal of Energy Economics and Policy*, *8*(3), 295.

Davis, N., & Ali, K. (2003). Inflation and output as predictors of stock returns and volatility: International evidence. Applied Financial Economics, 13, 693–700.

De Gaetano (2017). Inflation - What Does the Academic Research Say. https://www.man.com/maninstitute/inflation-what-the-academic-research-says

De Gregorio, J., Landerretche, O., Neilson, C., Broda, C., & Rigobon, R. (2007). Another pass-through bites the dust? Oil prices and inflation [with comments]. *Economia*, *7*(2), 155-208.

Department of National Treasury. (2020). Economic measures for covid-19. https://www.treasury.gov.za/comm_media/press/2020/20200428_COVID_Economic_Response_final.pdf

Ellyne, M., & Veller, C. (2011). What is the SARB's inflation targeting policy, and is it appropriate? *MPRA Paper No. 42134*. University Library of Munich, Germany.

Engsted, T., & Tanggaard, C. (2002). The relation between asset returns and inflation at short and long horizons. *Journal of International Financial Markets, Institutions and Money*, *12*(2), 101-118.

Erb, C. B., & Harvey, C. R. (2013). The Golden Dilemma. *Financial Analysts Journal*, *69*(4), 10–42.

Fama, E. (1975). Short-term interest rates as predictors of inflation. *The American Economic Review*, *65*(3), 269-282.

Fama, E. (1981). Stock returns, real activity, and money. *American Economic Review*, *71*, 545–565.

Fama, E., & Schwert, G. (1977). Asset Returns and Inflation. *Journal of Financial Economics*, *5*, 115–146.

Fang, W. S., Wang, K. M., & Nguyen, T. B. T. (2008). Is real estate really an inflation hedge? Evidence from Taiwan. *Asian Economic Journal, 22*(2), 209–224.

Feldstein, M. (1980). Inflation, tax rules, and the prices of land and gold. *Journal of Public Economics*, *14*(3), 309-317.

Fisher, I. (1930). The Theory of Interest. Macmillan: New York.

Gallagher, L. A., & Taylor, M. P. (2002). The stock return–inflation puzzle revisited. *Economics Letters*, *75*(2), 147-156.

Ganesan, S., & Chiang, Y. H. (1998). The Inflation-Hedging Characteristics of Real and Financial Assets in Hong Kong. *The Journal of Real Estate Portfolio Management, 4*, 55–67.

Gavriilidis, K., & Kgari, L. M. (2016). Stock returns and inflation: The case of Botswana. In KA. Kim & R. M. Ebrahim (Eds.), Handbook of Frontier Markets (pp. 27–38). Academic Press.

Geske, R., & Roll, R. (1983). The fiscal and monetary linkage between stock returns and inflation. *The journal of Finance*, *38*(1), 1-33.

Ghosh, D., Levin, E. J., Macmillan, P., & Wright, R. E. (2004). Gold as an inflation hedge? *Studies in Economics and Finance*, *22*(1), 1–25.

Giudici, G., Milne, A. & Vinogradov, D. (2020). Cryptocurrencies: market analysis and perspectives. *J. Ind. Bus. Econ, 47*, 1–18.

Glaser, F., Zimmermann, K., Haferkorn, M., Weber, M. C., & Siering, M. (2014). Bitcoin-asset or currency? revealing users' hidden intentions. *Revealing Users' Hidden Intentions (April 15, 2014). ECIS.*

Granger, C. W. J. (1969). Investigating Causal Relations by Econometric Models and Cross-spectral Methods. *Econometrica*, *37*(3), 424–438.

Gunasekarage, A., Power, D., & Zhou, T. (2008). The long-term inflation hedging effectiveness of real estate and financial assets: A New Zealand investigation. *Studies in Economics and Finance, 25,* 267–278.

Hamzah, N. H., & Masih, M. (2018). Revisiting effectiveness of interest rate as a tool to control inflation: evidence from Malaysia based on ARDL and NARDL.

Harmston, S. (1998). Gold as a store of value (Centre for Public Policy Studies, The World Gold Council).

Hillier, D., Draper, P., & Faff, R. (2006). Do precious metals shine? An investment perspective. *Financial Analysts Journal, 62*(2), 98–106.

Hoesli, M., Lizieri, C., & MacGregor, B. (2008). The inflation hedging characteristics of US and UK investments: a multi-factor error correction approach. *The Journal of Real Estate Finance and Economics, 36*, 183-206.

Huang, H., & Hudson-Wilson, S. (2007). Private Commercial Real Estate Equity Returns and Inflation. *The Journal of Portfolio Management, 33.*

International Monetary Fund. (2022). South Africa: Financial Sector Assessment Program-Technical Note on Financial Safety Net and Crisis Management. IMF Staff Country Reports 2022/182. https://www.imf.org/en/Publications/CR/Issues/2022/06/16/South-Africa-Financial-Sector-Assessment-Program-Technical-Note-on-Financial-Safety-Net-and-519719

Jaffe, J. F. (1989). Gold and Gold Stocks as Investments for Institutional Portfolios. *Financial Analysts Journal, 45*(2), 53–59.

Jaffe, J. F., & Mandelker, G. (1976). The" Fisher effect" for risky assets: An empirical investigation. *The Journal of finance*, *31*(2), 447-458.

Jain, A., & Ghosh, S. (2013). Dynamics of global oil prices, exchange rate and precious metal prices in India. *Resources Policy*, *38*(1), 88-93.

Johansen, S. (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica: Journal of the Econometric Society*, 59(6), 1551- 1580

Johansen, S. (1995). Identifying restrictions of linear equations with applications to simultaneous equations and cointegration. *Journal of Econometrics*, *69*(1), 111-132.

Kaul, G. (1987). Stock returns and inflation: The role of the monetary sector. *Journal of financial economics*, *18*(2), 253-276.

Kilian, L. (2009). Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market. *American Economic Review*, *99*(3), 1053-1069.

Kim, J. W. (2020). Blockchain technology and its applications: Case studies. *Journal of System and Management Sciences*, *10*(1), 83-93.

L'Oeillet, G., & Licheron, J. (2008). *Oil prices and inflation in the euro area: A nonlinear and unstable relationship* (No. halshs-00323614).

Lee, J. L., Clark, C., & Ahn, S. K. (1998). Long- and short-run Fisher effects: new tests and new results. *Applied Economics, 30*(1), 113–124.

Lee, C. (2014). The inflation-hedging characteristics of Malaysian residential property. *International Journal of Housing Markets and Analysis*, *7*(1), 61–75.

Lintner, J. (1975). Inflation and Security Returns. *Journal of Finance, 30*(2), 259-280.

Liu, Y., & Tsyvinski, A. (2021). Risks and returns of cryptocurrency. *The Review of Financial Studies*, *34*(6), 2689-2727.

Luintel, K. B., & Paudyal, K. (2006). Are common stocks a hedge against inflation? *Journal of Financial Research*, *29*(1), 1-19.

Madsen, J. (2005). The Fisher Hypothesis and the Interaction Between Share Returns, Inflation, and Supply Shocks. *Journal of International Money and Finance, 24*, 103–120.

Magweva, R., & Sibanda, M. (2020). Managing inflation risk in emerging markets using infrastructure investments-a fact or a myth? A non-linear perspective. *Journal of Contemporary Management, 17*, 108–128.

Mandeya, S., & Ho, S. (2021). Inflation, inflation uncertainty and the economic growth nexus: An impact study of South Africa. *MethodsX*, *8*, 101501.

McCown, J. R., & Zimmerman, J. R. (2007). Analysis of the investment potential and inflation-hedging ability of precious metals. *Available at SSRN 1002966*.

Meo, M. S., Chowdhury, M. A. F., Shaikh, G. M., Ali, M., & Masood Sheikh, S. (2018). Asymmetric impact of oil prices, exchange rate, and inflation on tourism demand in Pakistan: new evidence from nonlinear ARDL. *Asia Pacific Journal of Tourism Research*, *23*(4), 408-422.

Mohr, P. J. (1986). The de Kock Commission and inflation. *South African Journal of Economics*, *54*(1), 22-40.

Monetary Policy Committee. (2008, October 9). Statement of the Monetary Policy Committee. Reserve Bank of South Africa. https://www.resbank.co.za/en/home/publications/publication-detail-

______pages/statements/monetary-policy statements/2008/3348#:~:text=CPIX%20inflation%20increased%20from%2013,contribu tors%20to%20this%20rising%20trend.

Monetary Policy Committee. (2022, July 21). Statement of the Monetary Policy Committee July 2022. Reserve Bank of South Africa. https://www.resbank.co.za/en/home/publications/publication-detail-pages/statements/monetary-policy-statements/2022/Statement-of-the-Monetary-Policy-Committee-July-2022

Naidoo, K., & Peerbhai, F. (2015). An evaluation of gold as an inflation hedge: Empirical evidence from South Africa. The Journal of Developing Areas, 49 (6), 205–217.

Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system. *Decentralized business review.*

National, T., & Low, S. (2000). The Inflation-Hedging Characteristics of Real Estate and Financial Assets in Singapore. *Journal of Real Estate Portfolio Management*, *6*, 373–385.

Nkomo, J. C. (2006). The impact of higher oil prices on Southern African countries. *Journal of Energy in Southern Africa*, *17*(1), 10-17.

Nowak, M., & Ricci, L. A. (2006). Post-Apartheid South Africa: The First Ten Years. International Monetary Fund. https://doi.org/10.5089/9781589064706.071

Obereiner, D., & Kurzrock, B. M. (2012). Inflation-hedging properties of indirect real estate investments in Germany. *Journal of Property Investment & Finance*, *30*(3), 218-240.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches the analysis of level relationships. *Journal of applied econometrics*, *16*(3), 289-326.

Phochanachan, P., Pirabun, N., Leurcharusmee, S., & Yamaka, W. (2022). Do Bitcoin and Traditional Financial Assets Act as an Inflation Hedge during Stable and Turbulent Markets? Evidence from High Cryptocurrency Adoption Countries. *Axioms*, *11*(7), 339.

Pilotte, E. (2003). Capital Gains, Dividend Yields, and Expected Inflation. *Journal of Finance*, *58*(1), 447–466.

Roache, S., & Attié, A. (2009). Inflation hedging for long-term investors. International Monetary Fund, Finance Department.

Rubens, J. H., Bond, M. T., & Webb, J. R. (1989). The Inflation-Hedging Effectiveness of Real Estate. *The Journal of Real Estate Research*, *4*(2), 45–55.

Rushdi, M., Kim, J., & Silvapulle, P. (2012). ARDL bound tests and robust inference for the long run relationship between real stock returns and inflation in Australia. *Economic Modelling, 29*, 535–543.

Seetharam, Y. & Bodington, L. (2015). Gold in the South African Market: A Safe Haven or Hedge? Applied Economics Quarterly. 61. 331-352.

South African Reserve Bank. (2008). Monetary Policy Review. https://www.resbank.co.za/content/dam/sarb/publications/reviews/monetary-policy-review/2008/3355/mprnov08.pdf

South African Reserve Bank. (2012). No. 2 - Why is inflation bad? Fact Sheet. Retrieved from https://www.resbank.co.za/en/home/publications/publication-detail-pages/fact-sheet/fact-sheet/2012/4996

South African Reserve Bank. (2024). What we do: Monetary policy. https://www.resbank.co.za/en/home/what-we-do/monetary-policy

Sek, S. K., Teo, X. Q., & Wong, Y. N. (2015). A comparative study on the effects of oil price changes on inflation. *Procedia Economics and Finance*, *26*, 630-636.

Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. *Festschrift in honor of Peter Schmidt: Econometric methods and applications*, 281-314.

Smales, L. (2022). Cryptocurrency as an Alternative Inflation Hedge? https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3883123

Snell, K. (2020, March 26). What's Inside The Senate's $2 Trillion Coronavirus Aid Package. NPR. https://www.npr.org/2020/03/26/821457551/whats-inside-the-senate-s-2-trillion- coronavirus-aid-package.

Spierdijk, L., & Umar, Z. (2015). Stocks, bonds, T-bills, and inflation hedging: From great moderation to great recession. *Journal of Economics and Business, 79*, 1–37.

Statista. (2022). Distribution platinum exports by country. https://www.statista.com/statistics/1175510/distribution-platinum-exports-by-country-globally/?cv=1.

STATSSA. Consumer Price Index The South African CPI Sources and Methods Manual. https://www.statssa.gov.za/cpi/documents/The_South_African_CPI_sources_and_methods_May2017.pdf

Taylor, N. J. (1998). Precious metals and inflation. *Applied Financial Economics, 8*(2), 201–210.

Thakar, C. (2022). Augmented Dickey Fuller (ADF) Test for a Pairs Trading Strategy: Mean Reversion & Statistical Arbitrage. https://blog.quantinsti.com/augmented- dickey-fuller-adf-test-for-a-pairs-trading-strategy/#:~:text=The%20primary%20difference%20between%20the,missing%20values%20in%20the%20data.

The United Nations Development Programme South Africa. (2022). The Impact of the Ukraine War on the South African Economy. https://www.undp.org/sites/g/files/zskgke326/files/migration/za/Policy-Brief---UNDP-SA---The-Impact-of-the-Ukraine-War-on-the-South-African-Economy.pdf

Totonchi, J. (2011). Macroeconomic theories of inflation. In *International conference on economics and finance research, 4*(1), 459-462.

Tsong, C., & Lee, F. (2013). Quantile cointegration analysis of the Fisher hypothesis. *Journal of Macroeconomics, 35*, 186–198.

Valentinyi-Endrész, M. (2004). *Structural breaks and financial risk management* (No. 2004/11). Magyar Nemzeti Bank (Central Bank of Hungary).

Van der Merwe, E. J. (2004). *Inflation targeting in South Africa*. Pretoria: South African Reserve Bank.

Velde, F. (2013). Bitcoin: A primer. *Chicago Fed Letter*, Federal Reserve Bank of Chicago.

Wagenaar, L. P. (2022). Are cryptocurrencies good hedges against inflation? (Bachelor's thesis, University of Twente).

Worlddata.info.(2023).Inflation rates in South Africa. https://www.worlddata.info/africa/south-africa/inflation-rates.php

Zhao, X. (1999). Stock prices, inflation, and output: Evidence from China. *Applied Economics Letters*, *6*(8), 509–511.

Ziramba, E. (2008). Bank lending, expenditure components and inflation in South Africa: assessment from bounds testing approach. *South African Journal of Economic and Management Sciences*, *11*(2), 217-228.

APPENDIX

8.1. A: ADF UNIT ROOT TESTS

A1: Table of ADF test JALSH at level

Null Hypothesis: JALSH has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-17.52994	0.0000
Test critical values:	1% level	-3.991172	
	5% level	-3.425956	
	10% level	-3.136162	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(JALSH)
Method: Least Squares
Date: 12/23/23 Time: 18:29
Sample (adjusted): 2000M03 2023M06
Included observations: 280 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
JALSH(-1)	-1.041748	0.059427	-17.52994	0.0000
C	0.000588	0.000275	2.138874	0.0333
@TREND("2000M02")	-1.28E-06	1.69E-06	-0.756497	0.4500

R-squared	0.525971	Mean dependent var	1.97E-05
Adjusted R-squared	0.522548	S.D. dependent var	0.003302
S.E. of regression	0.002282	Akaike info criterion	-9.317154
Sum squared resid	0.001442	Schwarz criterion	-9.278210
Log likelihood	1307.402	Hannan-Quinn criter.	-9.301533
F-statistic	153.6759	Durbin-Watson stat	2.000852
Prob(F-statistic)	0.000000		

A2: Table of ADF test JALSH at first difference

Null Hypothesis: D(JALSH) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 5 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.09617	0.0000
Test critical values:	1% level	-3.991904	
	5% level	-3.426311	
	10% level	-3.136371	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(JALSH,2)
Method: Least Squares
Date: 12/23/23 Time: 18:30
Sample (adjusted): 2000M09 2023M06
Included observations: 274 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(JALSH(-1))	-4.088046	0.337962	-12.09617	0.0000
D(JALSH(-1),2)	2.188830	0.304719	7.183114	0.0000
D(JALSH(-2),2)	1.476145	0.253772	5.816824	0.0000
D(JALSH(-3),2)	0.937424	0.191745	4.888913	0.0000
D(JALSH(-4),2)	0.531022	0.124907	4.251330	0.0000
D(JALSH(-5),2)	0.158161	0.059690	2.649704	0.0085
C	-2.12E-05	0.000304	-0.069564	0.9446
@TREND("2000M02")	6.31E-08	1.86E-06	0.034007	0.9729

R-squared	0.827626	Mean dependent var	-5.17E-06
Adjusted R-squared	0.823090	S.D. dependent var	0.005774
S.E. of regression	0.002428	Akaike info criterion	-9.174397
Sum squared resid	0.001569	Schwarz criterion	-9.068904
Log likelihood	1264.892	Hannan-Quinn criter.	-9.132055
F-statistic	182.4506	Durbin-Watson stat	2.023071
Prob(F-statistic)	0.000000		

A3: Table of ADF test ALBI at level

Null Hypothesis: ALBITR has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-16.90840	0.0000
Test critical values:	1% level	-3.992670	
	5% level	-3.426682	
	10% level	-3.136590	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ALBITR)
Method: Least Squares
Date: 02/27/24 Time: 11:14
Sample (adjusted): 2001M03 2023M06
Included observations: 268 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ALBITR(-1)	-1.035777	0.061258	-16.90840	0.0000
C	0.000523	0.000118	4.416140	0.0000
@TREND("2000M02")	-1.44E-06	6.93E-07	-2.074676	0.0390

R-squared	0.519086	Mean dependent var	-2.56E-06
Adjusted R-squared	0.515456	S.D. dependent var	0.001247
S.E. of regression	0.000868	Akaike info criterion	-11.24947
Sum squared resid	0.000200	Schwarz criterion	-11.20928
Log likelihood	1510.429	Hannan-Quinn criter.	-11.23333
F-statistic	143.0168	Durbin-Watson stat	1.967037
Prob(F-statistic)	0.000000		

A4: Table of ADF test ALBI at first difference

Null Hypothesis: D(ALBITR) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-15.10246	0.0000
Test critical values:	1% level	-3.993200	
	5% level	-3.426939	
	10% level	-3.136742	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ALBITR,2)
Method: Least Squares
Date: 12/19/23 Time: 18:45
Sample (adjusted): 2001M07 2023M06
Included observations: 264 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ALBITR(-1))	-3.113917	0.206186	-15.10246	0.0000
D(ALBITR(-1),2)	1.335167	0.170670	7.823075	0.0000
D(ALBITR(-2),2)	0.696086	0.117198	5.939398	0.0000
D(ALBITR(-3),2)	0.295050	0.059090	4.993207	0.0000
C	-4.53E-05	0.000129	-0.351845	0.7252
@TREND("2000M02")	2.02E-07	7.72E-07	0.262225	0.7934

R-squared	0.798645	Mean dependent var	5.64E-06
Adjusted R-squared	0.794743	S.D. dependent var	0.002109
S.E. of regression	0.000955	Akaike info criterion	-11.04660
Sum squared resid	0.000235	Schwarz criterion	-10.96533
Log likelihood	1464.151	Hannan-Quinn criter.	-11.01394
F-statistic	204.6638	Durbin-Watson stat	2.038060
Prob(F-statistic)	0.000000		

A5: Table of ADF test GOVI at level

Null Hypothesis: GOVITR has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-16.87590	0.0000
Test critical values:	1% level	-3.992670	
	5% level	-3.426682	
	10% level	-3.136590	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOVITR)
Method: Least Squares
Date: 12/23/23 Time: 18:18
Sample (adjusted): 2001M03 2023M06
Included observations: 268 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GOVITR(-1)	-1.034031	0.061273	-16.87590	0.0000
C	0.000523	0.000117	4.466890	0.0000
@TREND("2000M02")	-1.46E-06	6.86E-07	-2.135129	0.0337

R-squared	0.518129	Mean dependent var	-2.48E-06
Adjusted R-squared	0.514492	S.D. dependent var	0.001232
S.E. of regression	0.000859	Akaike info criterion	-11.27105
Sum squared resid	0.000195	Schwarz criterion	-11.23085
Log likelihood	1513.320	Hannan-Quinn criter.	-11.25490
F-statistic	142.4696	Durbin-Watson stat	1.964982
Prob(F-statistic)	0.000000		

A6: Table of ADF test GOVI at first difference

Null Hypothesis: D(GOVITR) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-15.06954	0.0000
Test critical values:	1% level	-3.993200	
	5% level	-3.426939	
	10% level	-3.136742	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOVITR,2)
Method: Least Squares
Date: 12/23/23 Time: 18:19
Sample (adjusted): 2001M07 2023M06
Included observations: 264 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GOVITR(-1))	-3.101512	0.205813	-15.06954	0.0000
D(GOVITR(-1),2)	1.326091	0.170339	7.784995	0.0000
D(GOVITR(-2),2)	0.693016	0.117085	5.918935	0.0000
D(GOVITR(-3),2)	0.293912	0.059114	4.971936	0.0000
C	-4.50E-05	0.000127	-0.353088	0.7243
@TREND("2000M02")	2.01E-07	7.64E-07	0.263236	0.7926

R-squared	0.797542	Mean dependent var	5.74E-06
Adjusted R-squared	0.793618	S.D. dependent var	0.002082
S.E. of regression	0.000946	Akaike info criterion	-11.06668
Sum squared resid	0.000231	Schwarz criterion	-10.98541
Log likelihood	1466.801	Hannan-Quinn criter.	-11.03402
F-statistic	203.2678	Durbin-Watson stat	2.041531
Prob(F-statistic)	0.000000		

A7: Table of ADF test JSAPY at level

Null Hypothesis: JSAPY has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-14.01536	0.0000
Test critical values:	1% level	-3.997930	
	5% level	-3.429229	
	10% level	-3.138092	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(JSAPY)
Method: Least Squares
Date: 12/23/23 Time: 18:31
Sample (adjusted): 2004M02 2023M06
Included observations: 233 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
JSAPY(-1)	-0.921210	0.065729	-14.01536	0.0000
C	0.001098	0.000483	2.271665	0.0240
@TREND("2000M02")	-5.76E-06	2.72E-06	-2.115780	0.0354

R-squared	0.460639	Mean dependent var	8.00E-07
Adjusted R-squared	0.455949	S.D. dependent var	0.003744
S.E. of regression	0.002762	Akaike info criterion	-8.933077
Sum squared resid	0.001754	Schwarz criterion	-8.888643
Log likelihood	1043.703	Hannan-Quinn criter.	-8.915159
F-statistic	98.21517	Durbin-Watson stat	1.990194
Prob(F-statistic)	0.000000		

A8: Table of ADF test JSAPY at first difference

Null Hypothesis: D(JSAPY) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 5 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.19064	0.0000
Test critical values:	1% level	-3.998997	
	5% level	-3.429745	
	10% level	-3.138397	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(JSAPY,2)
Method: Least Squares
Date: 12/23/23 Time: 18:32
Sample (adjusted): 2004M08 2023M06
Included observations: 227 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(JSAPY(-1))	-4.152208	0.371043	-11.19064	0.0000
D(JSAPY(-1),2)	2.371470	0.334292	7.094017	0.0000
D(JSAPY(-2),2)	1.642585	0.274414	5.985789	0.0000
D(JSAPY(-3),2)	0.998744	0.205401	4.862408	0.0000
D(JSAPY(-4),2)	0.464918	0.133938	3.471140	0.0006
D(JSAPY(-5),2)	0.201040	0.066553	3.020733	0.0028
C	2.72E-05	0.000536	0.050756	0.9596
@TREND("2000M02")	-2.42E-07	2.99E-06	-0.081044	0.9355

R-squared	0.794240	Mean dependent var	1.08E-05
Adjusted R-squared	0.787663	S.D. dependent var	0.006405
S.E. of regression	0.002951	Akaike info criterion	-8.778465
Sum squared resid	0.001908	Schwarz criterion	-8.657762
Log likelihood	1004.356	Hannan-Quinn criter.	-8.729759
F-statistic	120.7639	Durbin-Watson stat	2.049812
Prob(F-statistic)	0.000000		

A9: Table of ADF test GOLD at level

Null Hypothesis: GOLDZAR has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-18.98320	0.0000
Test critical values:	1% level	-3.991172	
	5% level	-3.425956	
	10% level	-3.136162	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOLDZAR)
Method: Least Squares
Date: 12/23/23 Time: 18:16
Sample (adjusted): 2000M03 2023M06
Included observations: 280 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GOLDZAR(-1)	-1.131214	0.059590	-18.98320	0.0000
C	-1.60E-06	7.18E-07	-2.225157	0.0269
@TREND("2000M02")	7.05E-10	4.40E-09	0.160239	0.8728

R-squared	0.565401	Mean dependent var	6.42E-09
Adjusted R-squared	0.562263	S.D. dependent var	8.99E-06
S.E. of regression	5.95E-06	Akaike info criterion	-21.21548
Sum squared resid	9.81E-09	Schwarz criterion	-21.17654
Log likelihood	2973.167	Hannan-Quinn criter.	-21.19986
F-statistic	180.1848	Durbin-Watson stat	1.976558
Prob(F-statistic)	0.000000		

A10: Table of ADF test GOLD at first difference

Null Hypothesis: D(GOLDZAR) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 11 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.780741	0.0000
Test critical values:	1% level	-3.992670	
	5% level	-3.426682	
	10% level	-3.136590	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOLDZAR,2)
Method: Least Squares
Date: 12/23/23 Time: 18:17
Sample (adjusted): 2001M03 2023M06
Included observations: 268 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GOLDZAR(-1))	-8.327898	0.851459	-9.780741	0.0000
D(GOLDZAR(-1),2)	6.287262	0.824781	7.622949	0.0000
D(GOLDZAR(-2),2)	5.443128	0.777486	7.000937	0.0000
D(GOLDZAR(-3),2)	4.658770	0.718195	6.486779	0.0000
D(GOLDZAR(-4),2)	3.933995	0.649170	6.060033	0.0000
D(GOLDZAR(-5),2)	3.231259	0.568778	5.681051	0.0000
D(GOLDZAR(-6),2)	2.491727	0.479241	5.199317	0.0000
D(GOLDZAR(-7),2)	1.990365	0.388818	5.119011	0.0000
D(GOLDZAR(-8),2)	1.582187	0.300421	5.266566	0.0000
D(GOLDZAR(-9),2)	1.116684	0.216117	5.167033	0.0000
D(GOLDZAR(-10),2)	0.668169	0.136300	4.902204	0.0000
D(GOLDZAR(-11),2)	0.265778	0.061026	4.355172	0.0000
C	-1.19E-08	8.03E-07	-0.014871	0.9881
@TREND("2000M02")	-1.10E-10	4.85E-09	-0.022652	0.9819

R-squared	0.867270	Mean dependent var	1.21E-08
Adjusted R-squared	0.860476	S.D. dependent var	1.64E-05
S.E. of regression	6.14E-06	Akaike info criterion	-21.11286
Sum squared resid	9.57E-09	Schwarz criterion	-20.92527
Log likelihood	2843.123	Hannan-Quinn criter.	-21.03751
F-statistic	127.6657	Durbin-Watson stat	2.014560
Prob(F-statistic)	0.000000		

A11: Table of ADF test BITCOIN at level

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-15.13386	0.0000
Test critical values:	1% level	-4.018748	
	5% level	-3.439267	
	10% level	-3.143999	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(BITCOINZAR)
Method: Least Squares
Date: 12/23/23 Time: 18:11
Sample (adjusted): 2010M09 2023M06
Included observations: 154 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BITCOINZAR(-1)	-1.205522	0.079657	-15.13386	0.0000
C	-9.81E-07	9.26E-06	-0.106002	0.9157
@TREND("2000M02")	-4.25E-09	4.44E-08	-0.095581	0.9240

R-squared	0.602668	Mean dependent var	-5.10E-08
Adjusted R-squared	0.597405	S.D. dependent var	3.86E-05
S.E. of regression	2.45E-05	Akaike info criterion	-18.37478
Sum squared resid	9.08E-08	Schwarz criterion	-18.31562
Log likelihood	1417.858	Hannan-Quinn criter.	-18.35075
F-statistic	114.5173	Durbin-Watson stat	1.995271
Prob(F-statistic)	0.000000		

A12: Table of ADF test BITCOIN at first difference

Null Hypothesis: D(BITCOINZAR) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.48624	0.0000
Test critical values:	1% level	-4.020822	
	5% level	-3.440263	
	10% level	-3.144585	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(BITCOINZAR,2)
Method: Least Squares
Date: 12/23/23 Time: 18:13
Sample (adjusted): 2011M02 2023M06
Included observations: 149 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(BITCOINZAR(-1))	-4.124798	0.393353	-10.48624	0.0000
D(BITCOINZAR(-1),2)	2.131202	0.342794	6.217156	0.0000
D(BITCOINZAR(-2),2)	1.347870	0.261194	5.160422	0.0000
D(BITCOINZAR(-3),2)	0.664244	0.170194	3.902866	0.0001
D(BITCOINZAR(-4),2)	0.192931	0.077331	2.494876	0.0137
C	-3.90E-06	1.02E-05	-0.384048	0.7015
@TREND("2000M02")	1.62E-08	4.83E-08	0.335319	0.7379

R-squared	0.868245	Mean dependent var	-9.84E-07
Adjusted R-squared	0.862678	S.D. dependent var	6.84E-05
S.E. of regression	2.54E-05	Akaike info criterion	-18.28080
Sum squared resid	9.13E-08	Schwarz criterion	-18.13968
Log likelihood	1368.920	Hannan-Quinn criter.	-18.22347
F-statistic	155.9593	Durbin-Watson stat	1.991815
Prob(F-statistic)	0.000000		

A13: Table of ADF test STEFI at level

Null Hypothesis: STEFI has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 7 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.020571	0.5866
Test critical values:	1% level	-3.998104	
	5% level	-3.429313	
	10% level	-3.138142	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(STEFI)
Method: Least Squares
Date: 12/23/23 Time: 18:52
Sample (adjusted): 2004M03 2023M06
Included observations: 232 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
STEFI(-1)	-0.047370	0.023444	-2.020571	0.0445
D(STEFI(-1))	-0.608438	0.064682	-9.406679	0.0000
D(STEFI(-2))	-0.286447	0.075875	-3.775236	0.0002
D(STEFI(-3))	0.273185	0.075555	3.615718	0.0004
D(STEFI(-4))	0.504619	0.066988	7.532944	0.0000
D(STEFI(-5))	0.309967	0.069697	4.447368	0.0000
D(STEFI(-6))	0.067058	0.070603	0.949790	0.3433
D(STEFI(-7))	-0.243948	0.060202	-4.052125	0.0001
C	1.67E-05	9.41E-06	1.773015	0.0776
@TREND("2000M02")	-2.15E-08	2.49E-08	-0.864073	0.3885

R-squared	0.458038	Mean dependent var	1.47E-08
Adjusted R-squared	0.436066	S.D. dependent var	2.74E-05
S.E. of regression	2.06E-05	Akaike info criterion	-18.70015
Sum squared resid	9.42E-08	Schwarz criterion	-18.55158
Log likelihood	2179.218	Hannan-Quinn criter.	-18.64024
F-statistic	20.84694	Durbin-Watson stat	1.945629
Prob(F-statistic)	0.000000		

A14: Table of ADF test STEFI at first difference

Null Hypothesis: D(STEFI) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 6 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.770944	0.0000
Test critical values:	1% level	-3.998104	
	5% level	-3.429313	
	10% level	-3.138142	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(STEFI,2)
Method: Least Squares
Date: 12/23/23 Time: 18:54
Sample (adjusted): 2004M03 2023M06
Included observations: 232 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(STEFI(-1))	-1.135339	0.196734	-5.770944	0.0000
D(STEFI(-1),2)	-0.496433	0.187147	-2.652631	0.0086
D(STEFI(-2),2)	-0.793730	0.182235	-4.355518	0.0000
D(STEFI(-3),2)	-0.528769	0.179116	-2.952110	0.0035
D(STEFI(-4),2)	-0.044068	0.158845	-0.277425	0.7817
D(STEFI(-5),2)	0.233305	0.112772	2.068825	0.0397
D(STEFI(-6),2)	0.267396	0.059480	4.495547	0.0000
C	-8.21E-07	3.70E-06	-0.222156	0.8244
@TREND("2000M02")	6.89E-09	2.07E-08	0.332807	0.7396

R-squared	0.805267	Mean dependent var	1.09E-07
Adjusted R-squared	0.798281	S.D. dependent var	4.62E-05
S.E. of regression	2.07E-05	Akaike info criterion	-18.69055
Sum squared resid	9.60E-08	Schwarz criterion	-18.55684
Log likelihood	2177.104	Hannan-Quinn criter.	-18.63662
F-statistic	115.2698	Durbin-Watson stat	1.955616
Prob(F-statistic)	0.000000		

A15: Table of ADF test PLATINUM at level

Null Hypothesis: PLATINUMZAR has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-13.84503	0.0000
Test critical values:	1% level	-3.991172	
	5% level	-3.425956	
	10% level	-3.136162	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(PLATINUMZAR)
Method: Least Squares
Date: 12/23/23 Time: 18:51
Sample (adjusted): 2000M03 2023M06
Included observations: 280 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PLATINUMZAR(-1)	-0.821523	0.059337	-13.84503	0.0000
C	-3.91E-07	1.06E-06	-0.370273	0.7115
@TREND("2000M02")	-8.38E-09	6.55E-09	-1.278324	0.2022

R-squared	0.409013	Mean dependent var	3.33E-08
Adjusted R-squared	0.404746	S.D. dependent var	1.14E-05
S.E. of regression	8.82E-06	Akaike info criterion	-20.42931
Sum squared resid	2.15E-08	Schwarz criterion	-20.39037
Log likelihood	2863.104	Hannan-Quinn criter.	-20.41369
F-statistic	95.85355	Durbin-Watson stat	1.992739
Prob(F-statistic)	0.000000		

A16: Table of ADF test PLATINUM at first difference

Null Hypothesis: D(PLATINUMZAR) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.52609	0.0000
Test critical values:	1% level	-3.991780	
	5% level	-3.426251	
	10% level	-3.136336	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(PLATINUMZAR,2)
Method: Least Squares
Date: 12/23/23 Time: 18:52
Sample (adjusted): 2000M08 2023M06
Included observations: 275 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(PLATINUMZAR(-1))	-3.037264	0.242475	-12.52609	0.0000
D(PLATINUMZAR(-1),2)	1.392128	0.207831	6.698367	0.0000
D(PLATINUMZAR(-2),2)	0.929792	0.162156	5.733941	0.0000
D(PLATINUMZAR(-3),2)	0.499621	0.113597	4.398199	0.0000
D(PLATINUMZAR(-4),2)	0.155679	0.060821	2.559611	0.0110
C	-2.06E-07	1.20E-06	-0.171892	0.8637
@TREND("2000M02")	1.34E-09	7.34E-09	0.182547	0.8553

R-squared	0.754953	Mean dependent var	6.16E-08
Adjusted R-squared	0.749467	S.D. dependent var	1.93E-05
S.E. of regression	9.67E-06	Akaike info criterion	-20.23092
Sum squared resid	2.50E-08	Schwarz criterion	-20.13885
Log likelihood	2788.751	Hannan-Quinn criter.	-20.19397
F-statistic	137.6113	Durbin-Watson stat	2.021981
Prob(F-statistic)	0.000000		

A17: Table of ADF test OIL at level

Null Hypothesis: OILZAR has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-15.78817	0.0000
Test critical values:	1% level	-3.991172	
	5% level	-3.425956	
	10% level	-3.136162	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OILZAR)
Method: Least Squares
Date: 12/23/23 Time: 18:50
Sample (adjusted): 2000M03 2023M06
Included observations: 280 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OILZAR(-1)	-0.947339	0.060003	-15.78817	0.0000
C	-2.23E-07	2.07E-06	-0.107732	0.9143
@TREND("2000M02")	-1.78E-08	1.28E-08	-1.393180	0.1647

R-squared	0.473651	Mean dependent var	-1.30E-08
Adjusted R-squared	0.469851	S.D. dependent var	2.37E-05
S.E. of regression	1.72E-05	Akaike info criterion	-19.08734
Sum squared resid	8.24E-08	Schwarz criterion	-19.04839
Log likelihood	2675.227	Hannan-Quinn criter.	-19.07172
F-statistic	124.6334	Durbin-Watson stat	2.008812
Prob(F-statistic)	0.000000		

A18: Table of ADF test OIL at first difference

Null Hypothesis: D(OILZAR) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 5 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.01798	0.0000
Test critical values:	1% level	-3.991904	
	5% level	-3.426311	
	10% level	-3.136371	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OILZAR,2)
Method: Least Squares
Date: 12/23/23 Time: 18:50
Sample (adjusted): 2000M09 2023M06
Included observations: 274 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(OILZAR(-1))	-3.896019	0.324182	-12.01798	0.0000
D(OILZAR(-1),2)	2.073178	0.291237	7.118518	0.0000
D(OILZAR(-2),2)	1.473887	0.241208	6.110438	0.0000
D(OILZAR(-3),2)	0.953389	0.183740	5.188804	0.0000
D(OILZAR(-4),2)	0.522660	0.122859	4.254142	0.0000
D(OILZAR(-5),2)	0.183712	0.060244	3.049475	0.0025
C	-6.83E-08	2.31E-06	-0.029528	0.9765
@TREND("2000M02")	3.01E-10	1.41E-08	0.021360	0.9830

R-squared	0.808970	Mean dependent var	8.32E-09
Adjusted R-squared	0.803943	S.D. dependent var	4.17E-05
S.E. of regression	1.85E-05	Akaike info criterion	-18.93194
Sum squared resid	9.08E-08	Schwarz criterion	-18.82644
Log likelihood	2601.675	Hannan-Quinn criter.	-18.88959
F-statistic	160.9221	Durbin-Watson stat	2.049327
Prob(F-statistic)	0.000000		

A19: Table of ADF test CPI at level

Null Hypothesis: CPI has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 13 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.750277	0.2174
Test critical values:	1% level	-3.992801	
	5% level	-3.426745	
	10% level	-3.136628	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CPI)
Method: Least Squares
Date: 12/23/23 Time: 18:14
Sample (adjusted): 2001M04 2023M06
Included observations: 267 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPI(-1)	-0.041283	0.015011	-2.750277	0.0064
D(CPI(-1))	0.499078	0.061884	8.064743	0.0000
D(CPI(-2))	-0.077260	0.062228	-1.241550	0.2156
D(CPI(-3))	0.180737	0.062200	2.905718	0.0040
D(CPI(-4))	-0.063993	0.062943	-1.016689	0.3103
D(CPI(-5))	0.137489	0.063052	2.180561	0.0301
D(CPI(-6))	0.022832	0.063503	0.359544	0.7195
D(CPI(-7))	-0.025210	0.063234	-0.398683	0.6905
D(CPI(-8))	0.036148	0.063115	0.572734	0.5673
D(CPI(-9))	0.026416	0.062874	0.420146	0.6747
D(CPI(-10))	0.124444	0.062633	1.986878	0.0480
D(CPI(-11))	-0.033269	0.062399	-0.533158	0.5944
D(CPI(-12))	-0.423447	0.061905	-6.840229	0.0000
D(CPI(-13))	0.161624	0.061255	2.638536	0.0088
C	0.002550	0.001078	2.365635	0.0188
@TREND("2000M02")	-1.84E-06	3.32E-06	-0.554739	0.5796

R-squared	0.472084	Mean dependent var	-7.49E-05
Adjusted R-squared	0.440535	S.D. dependent var	0.005451
S.E. of regression	0.004077	Akaike info criterion	-8.108914
Sum squared resid	0.004172	Schwarz criterion	-7.893948
Log likelihood	1098.540	Hannan-Quinn criter.	-8.022564
F-statistic	14.96360	Durbin-Watson stat	2.001199
Prob(F-statistic)	0.000000		

A20: Table of ADF test CPI at first difference

Null Hypothesis: D(CPI) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 11 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.257457	0.0000
Test critical values:	1% level	-3.992670	
	5% level	-3.426682	
	10% level	-3.136590	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CPI,2)
Method: Least Squares
Date: 12/23/23 Time: 18:15
Sample (adjusted): 2001M03 2023M06
Included observations: 268 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CPI(-1))	-0.824696	0.099873	-8.257457	0.0000
D(CPI(-1),2)	0.247538	0.097032	2.551099	0.0113
D(CPI(-2),2)	0.146094	0.095484	1.530042	0.1273
D(CPI(-3),2)	0.332525	0.090803	3.662060	0.0003
D(CPI(-4),2)	0.247832	0.087766	2.823767	0.0051
D(CPI(-5),2)	0.365880	0.083618	4.375623	0.0000
D(CPI(-6),2)	0.364491	0.081294	4.483589	0.0000
D(CPI(-7),2)	0.315766	0.079386	3.977617	0.0001
D(CPI(-8),2)	0.345329	0.074140	4.657796	0.0000
D(CPI(-9),2)	0.341477	0.070696	4.830203	0.0000
D(CPI(-10),2)	0.471679	0.060133	7.843978	0.0000
D(CPI(-11),2)	0.392560	0.056626	6.932520	0.0000
C	-3.08E-05	0.000545	-0.056615	0.9549
@TREND("2000M02")	1.66E-07	3.29E-06	0.050619	0.9597

R-squared	0.477475	Mean dependent var	-5.97E-05
Adjusted R-squared	0.450732	S.D. dependent var	0.005610
S.E. of regression	0.004158	Akaike info criterion	-8.076876
Sum squared resid	0.004391	Schwarz criterion	-7.889287
Log likelihood	1096.301	Hannan-Quinn criter.	-8.001531
F-statistic	17.85394	Durbin-Watson stat	1.876446
Prob(F-statistic)	0.000000		

8.2.C: STRUCTURAL BREAKS

C1: BREAKPOINT 1

Chow Breakpoint Test: 2003M12
Null Hypothesis: No breaks at specified breakpoints
Varying regressors: All equation variables
Equation Sample: 2000M02 2023M06

F-statistic	14.53706	Prob. F(1,279)	0.0002
Log likelihood ratio	14.27258	Prob. Chi-Square(1)	0.0002
Wald Statistic	14.53706	Prob. Chi-Square(1)	0.0001

C2:BREAKPOINT 2

Chow Breakpoint Test: 2018M08
Null Hypothesis: No breaks at specified breakpoints
Varying regressors: All equation variables
Equation Sample: 2000M02 2023M06

F-statistic	6.188852	Prob. F(1,279)	0.0134
Log likelihood ratio	6.165089	Prob. Chi-Square(1)	0.0130
Wald Statistic	6.188852	Prob. Chi-Square(1)	0.0129

8.3.D: NARDL RESULTS

D1: JALSH (Full sample, Sub-sample 1, sub-sample 2 & sub-sample 3)

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. nardl jalsh Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =       276
-------------+----------------------------------   F(12, 263)      =     25.88
       Model |  .001531119        12  .000127593   Prob > F        =    0.0000
    Residual |  .001296671       263  4.9303e-06   R-squared       =    0.5415
-------------+----------------------------------   Adj R-squared   =    0.5205
       Total |   .00282779       275  .000010283   Root MSE        =    .00222

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -1.007494   .0868729   -11.60   0.000    -1.178549   -.8364387
             |
        _x1p |
         L1. |  -.0614419   .0224956    -2.73   0.007    -.1057363   -.0171476
             |
        _x1n |
         L1. |  -.0612518   .0224957    -2.72   0.007    -.1055464   -.0169573
             |
         _dy |
         L1. |   .0233993   .0620808     0.38   0.707    -.0988394     .145638
             |
       _dx1p |
         --. |   -.016344   .0071558    -2.28   0.023    -.0304339   -.0022541
         L1. |   .0318965   .0152639     2.09   0.038     .0018415    .0619515
         L2. |   .0241833   .0111719     2.16   0.031     .0021855     .046181
         L3. |   .0092488   .0065346     1.42   0.158    -.0036179    .0221155
             |
       _dx1n |
         --. |  -.0227523   .0070396    -3.23   0.001    -.0366135    -.008891
         L1. |   .0319616   .0163264     1.96   0.051    -.0001855    .0641087
         L2. |   .0171019   .0115467     1.48   0.140    -.0056339    .0398377
         L3. |    .003315   .0073769     0.45   0.654    -.0112103    .0178402
             |
       _cons |  -.0000378   .0003738    -0.10   0.920    -.0007738    .0006983
------------------------------------------------------------------------------

Asymmetry statistics:

------------------------------------------------------------------------------
             |            Long-run effect [+] |            Long-run effect [-]
   Exog. var.|       coef.      F-stat    P>F |       coef.      F-stat    P>F
-------------+--------------------------------+--------------------------------
        Dcpi |      -0.061       6.934  0.009 |       0.061       6.891  0.009
-------------+--------------------------------+--------------------------------
             |             Long-run asymmetry |            Short-run asymmetry
             |                  F-stat    P>F |                  F-stat    P>F
-------------+--------------------------------+--------------------------------
        Dcpi |                   3.846  0.051 |                   2.685  0.103
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =     -11.5973
                                    F_PSS =      48.3702

  Model diagnostics                                 stat.    p-value
  ------------------------------------------------------------------
  Portmanteau test up to lag  40 (chi2)             33.85     0.7422
  Breusch/Pagan heteroskedasticity test (chi2)      2.005     0.1567
  Ramsey RESET test (F)                             .7724     0.5104
  Jarque-Bera test on normality (chi2)              2.795     0.2473

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. nardl jalsh Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =        42
-------------+----------------------------------   F(12, 29)       =      4.28
       Model |  .000485561        12  .000040463   Prob > F        =    0.0007
    Residual |  .000274245        29  9.4567e-06   R-squared       =    0.6391
-------------+----------------------------------   Adj R-squared   =    0.4897
       Total |  .000759805        41  .000018532   Root MSE        =    .00308

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -.7683319   .2537746    -3.03   0.005    -1.287359   -.2493045
             |
        _x1p |
         L1. |   .0325785   .1271914     0.26   0.800    -.2275572    .2927142
             |
        _x1n |
         L1. |   .0338157   .1272857     0.27   0.792    -.2265128    .2941442
             |
         _dy |
         L1. |  -.1331433   .1931683    -0.69   0.496    -.5282168    .2619302
             |
       _dx1p |
         --. |  -.0240738   .0240047    -1.00   0.324    -.0731689    .0250213
         L1. |  -.0483786   .0791838    -0.61   0.546    -.2103276    .1135704
         L2. |  -.0116783   .0509008    -0.23   0.820    -.1157822    .0924255
         L3. |  -.0149938   .0232347    -0.65   0.524    -.0625141    .0325265
             |
       _dx1n |
         --. |  -.0205537   .0281549    -0.73   0.471     -.078137    .0370295
         L1. |  -.0317751   .0839269    -0.38   0.708    -.2034249    .1398748
         L2. |  -.0313813   .0516681    -0.61   0.548    -.1370545    .0742919
         L3. |  -.0131499   .0257479    -0.51   0.613    -.0658102    .0395104
             |
       _cons |   .0013707   .0015904     0.86   0.396     -.001882    .0046235
------------------------------------------------------------------------------

Asymmetry statistics:

------------------------------------------------------------------------------
             |          Long-run effect [+] |          Long-run effect [-]
  Exog. var. |     coef.      F-stat    P>F |     coef.      F-stat    P>F
-------------+------------------------------+---------------------------------
        Dcpi |     0.042      .06554   0.800|    -0.044      .07052   0.792
------------------------------------------------------------------------------
             |            Long-run asymmetry|            Short-run asymmetry
             |                F-stat    P>F |                F-stat    P>F
-------------+------------------------------+---------------------------------
        Dcpi |                 .9219   0.345|               .007036   0.934
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -3.0276
                                    F_PSS =       3.0627

  Model diagnostics                                 stat.    p-value
  ------------------------------------------------------------------
  Portmanteau test up to lag  19 (chi2)            17.43     0.5605
  Breusch/Pagan heteroskedasticity test (chi2)     .5371     0.4636
  Ramsey RESET test (F)                            .2863     0.8348
  Jarque-Bera test on normality (chi2)               1.4     0.4965
```

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. nardl jalsh Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =       171
-------------+----------------------------------   F(12, 158)      =     19.63
       Model |  .000892086        12  .000074341   Prob > F        =    0.0000
    Residual |  .000598455       158  3.7877e-06   R-squared       =    0.5985
-------------+----------------------------------   Adj R-squared   =    0.5680
       Total |  .001490542       170  8.7679e-06   Root MSE        =    .00195

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -1.211574   .1178377   -10.28   0.000    -1.444314   -.9788338
             |
        _x1p |
         L1. |  -.0784028   .0251288    -3.12   0.002    -.1280346    -.028771
             |
        _x1n |
         L1. |  -.0782287   .0251267    -3.11   0.002    -.1278563   -.0286011
             |
         _dy |
         L1. |   .1332641   .0802159     1.66   0.099    -.0251697    .2916978
             |
       _dx1p |
         --. |  -.0002163   .0105082    -0.02   0.984    -.0209709    .0205383
         L1. |   .0469498   .0183838     2.55   0.012     .0106402    .0832595
         L2. |   .0397438   .0133223     2.98   0.003     .0134311    .0660566
         L3. |   .0057399   .0112886     0.51   0.612    -.0165561     .028036
             |
       _dx1n |
         --. |  -.0312747   .0106355    -2.94   0.004    -.0522807   -.0102686
         L1. |   .0497931   .0174061     2.86   0.005     .0154145    .0841718
         L2. |   .0294237    .014182     2.07   0.040      .001413    .0574345
         L3. |   .0170079   .0092895     1.83   0.069    -.0013397    .0353555
             |
       _cons |   .0004916   .0004645     1.06   0.291    -.0004258     .001409
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |           Long-run effect [+] |           Long-run effect [-]
  Exog. var. |        coef.     F-stat    P>F |        coef.     F-stat    P>F
-------------+-------------------------------+--------------------------------
        Dcpi |       -0.065      8.372  0.004 |        0.065      8.337  0.004
-------------+-------------------------------+--------------------------------
             |            Long-run asymmetry |           Short-run asymmetry
             |                  F-stat    P>F |                  F-stat    P>F
-------------+-------------------------------+--------------------------------
        Dcpi |                   .5969  0.441 |                   1.018  0.315
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =     -10.2817
                                    F_PSS =      41.5395

  Model diagnostics                                 stat.    p-value
  ------------------------------------------------------------------
  Portmanteau test up to lag  40 (chi2)             34.38     0.7206
  Breusch/Pagan heteroskedasticity test (chi2)      5.998     0.0143
  Ramsey RESET test (F)                             2.942     0.0349
  Jarque-Bera test on normality (chi2)              1.608     0.4476

.
```

```
. nardl jalsh Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =        53
-------------+----------------------------------   F(12, 40)       =      6.16
       Model |  .000364341        12  .000030362   Prob > F        =    0.0000
    Residual |  .000197272        40  4.9318e-06   R-squared       =    0.6487
-------------+----------------------------------   Adj R-squared   =    0.5434
       Total |  .000561613        52    .0000108   Root MSE        =    .00222

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -.6881418   .2220252    -3.10   0.004    -1.136871   -.2394121
             |
        _x1p |
         L1. |  -.5710008   .1640586    -3.48   0.001    -.9025755   -.2394261
             |
        _x1n |
         L1. |  -.5692444   .1640793    -3.47   0.001     -.900861   -.2376277
             |
         _dy |
         L1. |  -.2563248     .15623    -1.64   0.109    -.5720774    .0594278
             |
       _dx1p |
         --. |  -.0925312   .0447408    -2.07   0.045    -.1829557   -.0021066
         L1. |   .3677608   .1072555     3.43   0.001     .1509893    .5845323
         L2. |   .2156017   .0720155     2.99   0.005     .0700529    .3611505
         L3. |   .0746246   .0417964     1.79   0.082    -.0098491    .1590984
             |
       _dx1n |
         --. |  -.0900461   .0412175    -2.18   0.035    -.1733497   -.0067425
         L1. |    .339635   .1028537     3.30   0.002       .13176      .54751
         L2. |   .2383513   .0656937     3.63   0.001     .1055794    .3711233
         L3. |   .1166536   .0378265     3.08   0.004     .0402034    .1931037
             |
       _cons |  -.0068654   .0028732    -2.39   0.022    -.0126724   -.0010584
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |           Long-run effect [+] |           Long-run effect [-]
  Exog. var. |      coef.     F-stat      P>F |      coef.     F-stat      P>F
-------------+--------------------------------+-------------------------------
        Dcpi |     -0.830      4.185    0.047 |      0.827      4.173    0.048
-------------+--------------------------------+-------------------------------
             |            Long-run asymmetry |           Short-run asymmetry
             |                F-stat      P>F |                F-stat      P>F
-------------+--------------------------------+-------------------------------
        Dcpi |                 .8616    0.359 |                 .1376    0.713
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -3.0994
                                    F_PSS =      10.4339

  Model diagnostics                                 stat.    p-value
  ------------------------------------------------------------------
  Portmanteau test up to lag  24 (chi2)             24.88     0.4124
  Breusch/Pagan heteroskedasticity test (chi2)      1.412     0.2347
  Ramsey RESET test (F)                             .9973     0.4049
  Jarque-Bera test on normality (chi2)              .3922     0.8219

.
```

D2: ALBI (Full sample, Sub-sample 1, sub-sample 2 & sub-sample 3)

```
. nardl albi Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =       264
-------------+----------------------------------   F(12, 251)      =     19.08
       Model |  .000169512        12  .000014126   Prob > F        =    0.0000
    Residual |  .000185849       251  7.4043e-07   R-squared       =    0.4770
-------------+----------------------------------   Adj R-squared   =    0.4520
       Total |  .000355361       263  1.3512e-06   Root MSE        =    .00086

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -.8928183   .0847779   -10.53   0.000    -1.059785   -.7258515
             |
        _x1p |
         L1. |   .0188744   .0087573     2.16   0.032     .0016273    .0361215
             |
        _x1n |
         L1. |   .0189093   .0087566     2.16   0.032     .0016635    .0361552
             |
         _dy |
         L1. |    .002293   .0637963     0.04   0.971    -.1233512    .1279372
             |
       _dx1p |
         --. |    .004763   .0029171     1.63   0.104    -.0009822    .0105082
         L1. |  -.0121232   .0060516    -2.00   0.046    -.0240416   -.0002048
         L2. |  -.0058399   .0044119    -1.32   0.187     -.014529    .0028493
         L3. |  -.0037973   .0026832    -1.42   0.158    -.0090817    .0014871
             |
       _dx1n |
         --. |   .0033426   .0028737     1.16   0.246    -.0023172    .0090023
         L1. |  -.0142687   .0062979    -2.27   0.024    -.0266721   -.0018653
         L2. |  -.0095759   .0045761    -2.09   0.037    -.0185884   -.0005633
         L3. |   -.004836   .0029451    -1.64   0.102    -.0106362    .0009643
             |
       _cons |   .0004625   .0001724     2.68   0.008      .000123     .000802
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |         Long-run effect [+]     |         Long-run effect [-]
  Exog. var. |       coef.     F-stat     P>F  |       coef.     F-stat     P>F
-------------+---------------------------------+------------------------------
        Dcpi |       0.021      4.396   0.037  |      -0.021      4.413   0.037
-------------+---------------------------------+------------------------------
             |          Long-run asymmetry     |         Short-run asymmetry
             |                 F-stat     P>F  |                 F-stat     P>F
-------------+---------------------------------+------------------------------
        Dcpi |                  .7651   0.383  |                  3.153   0.077
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =     -10.5313
                                    F_PSS =      39.1263

  Model diagnostics                                  stat.    p-value
  -------------------------------------------------------------------
  Portmanteau test up to lag  40 (chi2)              37.01     0.6056
  Breusch/Pagan heteroskedasticity test (chi2)       2.452     0.1173
  Ramsey RESET test (F)                              .3808     0.7670
  Jarque-Bera test on normality (chi2)               74.57     0.0000

.
```

```
. nardl albi Dcpi, p(3) q(3)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =        31
-------------+----------------------------------   F(11, 19)       =      5.89
       Model |  .000053517        11  4.8652e-06   Prob > F        =    0.0004
    Residual |  .000015703        19  8.2647e-07   R-squared       =    0.7731
-------------+----------------------------------   Adj R-squared   =    0.6418
       Total |   .00006922        30  2.3073e-06   Root MSE        =    .00091

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |   -.863377   .2874554    -3.00   0.007    -1.465028   -.2617259
             |
        _x1p |
         L1. |  -.0019462   .0408374    -0.05   0.962    -.0874199    .0835274
             |
        _x1n |
         L1. |  -.0027613   .0408541    -0.07   0.947      -.08827    .0827473
             |
         _dy |
         L1. |    .140453   .2524912     0.56   0.585    -.3880171    .6689231
         L2. |   .3659379   .1677971     2.18   0.042     .0147345    .7171413
             |
       _dx1p |
         --. |   .0213736    .008668     2.47   0.023     .0032313    .0395159
         L1. |   .0062864    .020954     0.30   0.767    -.0375708    .0501436
         L2. |   .0026989   .0083016     0.33   0.749    -.0146765    .0200743
             |
       _dx1n |
         --. |    .000101   .0105006     0.01   0.992     -.021877    .0220791
         L1. |    .018485   .0234856     0.79   0.441     -.030671     .067641
         L2. |   .0082407   .0112873     0.73   0.474    -.0153839    .0318654
             |
       _cons |  -.0003286   .0007479    -0.44   0.665    -.0018939    .0012367
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |          Long-run effect [+] |          Long-run effect [-]
  Exog. var. |      coef.      F-stat   P>F |      coef.      F-stat   P>F
-------------+------------------------------+---------------------------------
        Dcpi |     -0.002     .002281  0.962 |      0.003     .004596  0.947
-------------+------------------------------+---------------------------------
             |           Long-run asymmetry |          Short-run asymmetry
             |                 F-stat   P>F |                 F-stat   P>F
-------------+------------------------------+---------------------------------
        Dcpi |                  3.206  0.089 |                  .1704  0.684
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -3.0035
                                    F_PSS =       3.0648

  Model diagnostics                                 stat.    p-value
  -----------------------------------------------------------------
  Portmanteau test up to lag  13 (chi2)            7.745     0.8598
  Breusch/Pagan heteroskedasticity test (chi2)     .4078     0.5231
  Ramsey RESET test (F)                            .1513     0.9273
  Jarque-Bera test on normality (chi2)             8.349     0.0154
```

```
. nardl albi Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =       171
-------------+----------------------------------   F(12, 158)      =     11.99
       Model |  .000107925        12  8.9937e-06   Prob > F        =    0.0000
    Residual |   .00011856       158  7.5038e-07   R-squared       =    0.4765
-------------+----------------------------------   Adj R-squared   =    0.4368
       Total |  .000226485       170  1.3323e-06   Root MSE        =    .00087

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -.9014535   .1102266    -8.18   0.000    -1.119161   -.6837459
             |
        _x1p |
         L1. |   .0043344   .0111838     0.39   0.699    -.0177545    .0264234
             |
        _x1n |
         L1. |   .0044899   .0111798     0.40   0.689    -.0175911    .0265709
             |
         _dy |
         L1. |  -.0326658    .080647    -0.41   0.686     -.191951    .1266194
             |
       _dx1p |
         --. |   .0019283   .0046552     0.41   0.679    -.0072662    .0111227
         L1. |  -.0026481   .0081787    -0.32   0.747    -.0188018    .0135055
         L2. |  -.0009649   .0059593    -0.16   0.872    -.0127351    .0108053
         L3. |   .0001982    .005043     0.04   0.969    -.0097622    .0101585
             |
       _dx1n |
         --. |   .0008274   .0046964     0.18   0.860    -.0084484    .0101032
         L1. |   -.005887   .0078055    -0.75   0.452    -.0213035    .0095296
         L2. |  -.0022657   .0062696    -0.36   0.718    -.0146487    .0101173
         L3. |  -.0020396   .0041376    -0.49   0.623    -.0102117    .0061325
             |
       _cons |   .0003261   .0002071     1.57   0.117     -.000083    .0007352
------------------------------------------------------------------------------

Asymmetry statistics:

------------------------------------------------------------------------------
             |          Long-run effect [+] |          Long-run effect [-]
  Exog. var. |       coef.     F-stat   P>F |       coef.     F-stat   P>F
-------------+------------------------------+---------------------------------
        Dcpi |       0.005      .1482  0.701 |     -0.005      .1591  0.691
-------------+------------------------------+---------------------------------
             |          Long-run asymmetry  |          Short-run asymmetry
             |                 F-stat   P>F |                 F-stat   P>F
-------------+------------------------------+---------------------------------
        Dcpi |                  2.402  0.123 |                  .4207  0.518
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -8.1782
                                     F_PSS =      22.8985

  Model diagnostics                              stat.    p-value
  -----------------------------------------------------------------
  Portmanteau test up to lag  40 (chi2)          32.67     0.7880
  Breusch/Pagan heteroskedasticity test (chi2)   3.774     0.0521
  Ramsey RESET test (F)                          .3413     0.7955
  Jarque-Bera test on normality (chi2)           30.23     0.0000

.
```

```
. nardl albi Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =        53
-------------+----------------------------------   F(12, 40)       =      4.02
       Model |  .000035672        12  2.9727e-06   Prob > F        =    0.0004
    Residual |  .000029548        40  7.3870e-07   R-squared       =    0.5469
-------------+----------------------------------   Adj R-squared   =    0.4110
       Total |   .00006522        52  1.2542e-06   Root MSE        =    .00086

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -.9467829   .2325927    -4.07   0.000     -1.41687   -.4766954
             |
        _x1p |
         L1. |  -.0705341   .0637813    -1.11   0.275    -.1994408    .0583727
             |
        _x1n |
         L1. |  -.0701189   .0637816    -1.10   0.278    -.1990264    .0587886
             |
         _dy |
         L1. |   .0467064   .1622437     0.29   0.775    -.2812003    .3746131
             |
       _dx1p |
         --. |  -.0040532   .0170931    -0.24   0.814    -.0385996    .0304932
         L1. |   .0414003   .0421087     0.98   0.331    -.0437046    .1265052
         L2. |   .0227304   .0292102     0.78   0.441    -.0363057    .0817665
         L3. |   .0268698   .0171587     1.57   0.125    -.0078092    .0615489
             |
       _dx1n |
         --. |  -.0184638   .0158792    -1.16   0.252    -.0505569    .0136293
         L1. |   .0488497   .0403906     1.21   0.234    -.0327829    .1304822
         L2. |   .0302863    .025406     1.19   0.240    -.0210612    .0816337
         L3. |   .0128349   .0144522     0.89   0.380    -.0163741    .0420439
             |
       _cons |  -.0008219   .0011314    -0.73   0.472    -.0031085    .0014647
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |          Long-run effect [+] |          Long-run effect [-]
  Exog. var. |      coef.     F-stat     P>F |      coef.     F-stat     P>F
-------------+------------------------------+---------------------------------
        Dcpi |     -0.074      1.064   0.309 |      0.074      1.053   0.311
-------------+------------------------------+---------------------------------
             |            Long-run asymmetry |           Short-run asymmetry
             |                F-stat     P>F |               F-stat     P>F
-------------+------------------------------+---------------------------------
        Dcpi |                 .3345   0.566 |                .1048   0.748
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -4.0706
                                    F_PSS =       6.8551

  Model diagnostics                                stat.    p-value
  -----------------------------------------------------------------
  Portmanteau test up to lag  24 (chi2)            10.94     0.9895
  Breusch/Pagan heteroskedasticity test (chi2)     .8516     0.3561
  Ramsey RESET test (F)                            .8955     0.4526
  Jarque-Bera test on normality (chi2)             29.14     0.0000

.
```

D3: GOVI (Full sample, Sub-sample 1, sub-sample 2 & sub-sample 3)

```
. nardl govi Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =       264
-------------+----------------------------------   F(12, 251)      =     19.18
       Model |  .000166417        12  .000013868   Prob > F        =    0.0000
    Residual |   .00018152       251  7.2319e-07   R-squared       =    0.4783
-------------+----------------------------------   Adj R-squared   =    0.4534
       Total |  .000347937       263  1.3230e-06   Root MSE        =    .00085

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -.8955225   .0848906   -10.55   0.000    -1.062711   -.7283339
             |
        _x1p |
         L1. |   .0187361   .0086543     2.16   0.031     .0016919    .0357803
             |
        _x1n |
         L1. |   .0187701   .0086536     2.17   0.031     .0017271    .0358131
             |
         _dy |
         L1. |   .0019748   .0638272     0.03   0.975    -.1237303    .1276799
             |
       _dx1p |
         --. |   .0047801   .0028827     1.66   0.099    -.0008972    .0104575
         L1. |  -.0120844   .0059806    -2.02   0.044     -.023863   -.0003059
         L2. |  -.0058854   .0043603    -1.35   0.178    -.0144728     .002702
         L3. |  -.0035612   .0026517    -1.34   0.180    -.0087836    .0016612
             |
       _dx1n |
         --. |   .0032681   .0028411     1.15   0.251    -.0023274    .0088635
         L1. |  -.0141744   .0062253    -2.28   0.024    -.0264349   -.0019139
         L2. |  -.0095028   .0045226    -2.10   0.037    -.0184099   -.0005956
         L3. |  -.0049293   .0029108    -1.69   0.092     -.010662    .0008035
             |
       _cons |   .0004524   .0001704     2.65   0.008     .0001168     .000788
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |            Long-run effect [+] |            Long-run effect [-]
  Exog. var. |         coef.    F-stat    P>F |         coef.    F-stat    P>F
-------------+--------------------------------+-------------------------------
        Dcpi |         0.021      4.44  0.036 |        -0.021     4.456  0.036
-------------+--------------------------------+-------------------------------
             |          Long-run asymmetry    |          Short-run asymmetry
             |                  F-stat    P>F |                  F-stat    P>F
-------------+--------------------------------+-------------------------------
        Dcpi |                   .7408  0.390 |                   3.419  0.066
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =     -10.5491
                                    F_PSS =      39.2145

  Model diagnostics                                 stat.    p-value
  -------------------------------------------------------------------
  Portmanteau test up to lag  40 (chi2)             37.17     0.5984
  Breusch/Pagan heteroskedasticity test (chi2)      1.856     0.1731
  Ramsey RESET test (F)                             .3831     0.7653
  Jarque-Bera test on normality (chi2)              77.36     0.0000

.
```

```
. nardl govi Dcpi, p(3) q(3)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =        31
-------------+----------------------------------   F(11, 19)       =      5.93
       Model |  .000054597        11  4.9634e-06   Prob > F        =    0.0004
    Residual |  .000015912        19  8.3745e-07   R-squared       =    0.7743
-------------+----------------------------------   Adj R-squared   =    0.6437
       Total |  .000070509        30  2.3503e-06   Root MSE        =    .00092

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -.8558537   .2847842    -3.01   0.007    -1.451914   -.2597936
             |
        _x1p |
         L1. |  -.0013799   .0411926    -0.03   0.974    -.0875971    .0848373
             |
        _x1n |
         L1. |   -.002195   .0412104    -0.05   0.958    -.0884493    .0840592
             |
         _dy |
         L1. |   .1421925    .250661     0.57   0.577    -.3824469     .666832
         L2. |   .3635169   .1661503     2.19   0.041     .0157604    .7112734
             |
       _dx1p |
         --. |   .0220965   .0087238     2.53   0.020     .0038374    .0403556
         L1. |   .0061363   .0211007     0.29   0.774     -.038028    .0503007
         L2. |   .0027603   .0083939     0.33   0.746    -.0148084    .0203289
             |
       _dx1n |
         --. |   .0002813   .0105788     0.03   0.979    -.0218603    .0224229
         L1. |     .01873   .0236949     0.79   0.439    -.0308641     .068324
         L2. |    .008328   .0113607     0.73   0.472    -.0154503    .0321063
             |
       _cons |  -.0003302   .0007547    -0.44   0.667    -.0019097    .0012494
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |          Long-run effect [+] |          Long-run effect [-]
   Exog. var.|       coef.    F-stat    P>F |       coef.    F-stat    P>F
-------------+------------------------------+---------------------------------
        Dcpi |      -0.002   .001126  0.974 |       0.003   .002851  0.958
-------------+------------------------------+---------------------------------
             |           Long-run asymmetry |          Short-run asymmetry
             |                F-stat    P>F |                F-stat    P>F
-------------+------------------------------+---------------------------------
        Dcpi |                 3.162  0.091 |                   .18  0.676
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =       -3.0053
                                    F_PSS =        3.0766

  Model diagnostics                                      stat.    p-value

  ------------------------------------------------------------------------
  Portmanteau test up to lag  13 (chi2)                   7.69     0.8632
  Breusch/Pagan heteroskedasticity test (chi2)           .5349     0.4645
  Ramsey RESET test (F)                                  .1565     0.9239
  Jarque-Bera test on normality (chi2)                   8.006     0.0183
```

```
. nardl govi Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =       171
-------------+----------------------------------   F(12, 158)      =     12.09
       Model |  .000103456        12  8.6213e-06   Prob > F        =    0.0000
    Residual |  .000112675       158  7.1313e-07   R-squared       =    0.4787
-------------+----------------------------------   Adj R-squared   =    0.4391
       Total |  .000216131       170  1.2714e-06   Root MSE        =    .00084

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -.9001947   .1103517    -8.16   0.000    -1.118149   -.6822399
             |
        _x1p |
         L1. |   .0048087   .0108934     0.44   0.660    -.0167068    .0263242
             |
        _x1n |
         L1. |   .0049585   .0108896     0.46   0.649    -.0165494    .0264665
             |
         _dy |
         L1. |  -.0375475   .0805702    -0.47   0.642     -.196681    .1215859
             |
       _dx1p |
         --. |   .0016965    .004537     0.37   0.709    -.0072644    .0106574
         L1. |   -.003097   .0079684    -0.39   0.698    -.0188353    .0126413
         L2. |  -.0015096   .0058067    -0.26   0.795    -.0129783    .0099592
         L3. |  -.0000475   .0049116    -0.01   0.992    -.0097483    .0096533
             |
       _dx1n |
         --. |   .0010801   .0045731     0.24   0.814    -.0079523    .0101124
         L1. |  -.0060801   .0076064    -0.80   0.425    -.0211034    .0089432
         L2. |   -.002503   .0061107    -0.41   0.683    -.0145721    .0095661
         L3. |  -.0021595    .004033    -0.54   0.593    -.0101251    .0058061
             |
       _cons |   .0003322   .0002021     1.64   0.102     -.000067    .0007315
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |          Long-run effect [+] |          Long-run effect [-]
  Exog. var. |        coef.     F-stat   P>F |        coef.     F-stat   P>F
-------------+-------------------------------+--------------------------------
        Dcpi |        0.005       .192  0.662 |       -0.006      .2042  0.652
-------------+-------------------------------+--------------------------------
             |           Long-run asymmetry |          Short-run asymmetry
             |                  F-stat   P>F |                  F-stat   P>F
-------------+-------------------------------+--------------------------------
        Dcpi |                   2.347  0.127 |                   .3212  0.572
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -8.1575
                                    F_PSS =      22.7989

  Model diagnostics                                stat.    p-value
  ------------------------------------------------------------------
  Portmanteau test up to lag  40 (chi2)            31.13     0.8414
  Breusch/Pagan heteroskedasticity test (chi2)     3.285     0.0699
  Ramsey RESET test (F)                            .2585     0.8552
  Jarque-Bera test on normality (chi2)             27.26     0.0000

.
```

```
. nardl govi Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =        53
-------------+----------------------------------   F(12, 40)       =      4.06
       Model |  .000036777        12  3.0648e-06   Prob > F        =    0.0004
    Residual |  .000030185        40  7.5462e-07   R-squared       =    0.5492
-------------+----------------------------------   Adj R-squared   =    0.4140
       Total |  .000066962        52  1.2877e-06   Root MSE        =    .00087

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -.9540494   .2333332    -4.09   0.000    -1.425633   -.4824655
             |
        _x1p |
         L1. |  -.0714209    .064447    -1.11   0.274     -.201673    .0588313
             |
        _x1n |
         L1. |  -.0709897    .064448    -1.10   0.277    -.2012439    .0592645
             |
         _dy |
         L1. |   .0459275   .1620573     0.28   0.778    -.2816026    .3734576
             |
       _dx1p |
         --. |  -.0043486   .0172541    -0.25   0.802    -.0392204    .0305233
         L1. |   .0421166   .0425627     0.99   0.328    -.0439059    .1281391
         L2. |   .0230632   .0294793     0.78   0.439    -.0365168    .0826431
         L3. |   .0271892   .0173252     1.57   0.124    -.0078264    .0622047
             |
       _dx1n |
         --. |  -.0186056    .016052    -1.16   0.253    -.0510479    .0138366
         L1. |    .049244   .0407907     1.21   0.234    -.0331971    .1316851
         L2. |   .0304997   .0256771     1.19   0.242    -.0213957    .0823952
         L3. |   .0128329   .0146059     0.88   0.385    -.0166867    .0423525
             |
       _cons |  -.0008384   .0011436    -0.73   0.468    -.0031497    .0014728
------------------------------------------------------------------------------

Asymmetry statistics:

------------------------------------------------------------------------------
             |       Long-run effect [+]      |       Long-run effect [-]
  Exog. var. |     coef.      F-stat     P>F  |     coef.      F-stat     P>F
-------------+--------------------------------+-------------------------------
        Dcpi |    -0.075       1.069   0.307  |     0.074       1.058   0.310
------------------------------------------------------------------------------
             |        Long-run asymmetry      |       Short-run asymmetry
             |                F-stat     P>F  |                F-stat     P>F
-------------+--------------------------------+-------------------------------
        Dcpi |                 .3533   0.556  |                 .1121   0.740
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -4.0888
                                    F_PSS =       6.9135

  Model diagnostics                                stat.    p-value
  -----------------------------------------------------------------
  Portmanteau test up to lag  24 (chi2)            10.89     0.9898
  Breusch/Pagan heteroskedasticity test (chi2)     .8633     0.3528
  Ramsey RESET test (F)                            .8834     0.4586
  Jarque-Bera test on normality (chi2)             27.75     0.0000

.
```

D4: JSAPY (Full sample, sub-sample 2 & sub-sample 3)

```
. nardl jsapy Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =       224
-------------+----------------------------------   F(12, 211)      =     18.11
       Model |  .001687249        12  .000140604   Prob > F        =    0.0000
    Residual |  .001638288       211  7.7644e-06   R-squared       =    0.5074
-------------+----------------------------------   Adj R-squared   =    0.4793
       Total |  .003325537       223  .000014913   Root MSE        =    .00279

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -.8625476   .0970344    -8.89   0.000    -1.053829   -.6712665
             |
        _x1p |
         L1. |  -.0390049   .0398263    -0.98   0.329    -.1175133    .0395035
             |
        _x1n |
         L1. |  -.0385438   .0398277    -0.97   0.334     -.117055    .0399675
             |
         _dy |
         L1. |  -.1105147   .0689972    -1.60   0.111    -.2465268    .0254973
             |
       _dx1p |
         --. |   .0110708   .0142863     0.77   0.439    -.0170913    .0392329
         L1. |   .0095673   .0295679     0.32   0.747     -.048719    .0678536
         L2. |   .0042058   .0196084     0.21   0.830    -.0344477    .0428594
         L3. |    .016262     .01377     1.18   0.239    -.0108824    .0434065
             |
       _dx1n |
         --. |  -.0241152   .0124779    -1.93   0.055    -.0487124     .000482
         L1. |   .0185617   .0263721     0.70   0.482    -.0334249    .0705483
         L2. |   .0162828   .0195865     0.83   0.407    -.0223276    .0548931
         L3. |  -.0034432   .0127148    -0.27   0.787    -.0285075    .0216211
             |
       _cons |  -.0010618   .0016229    -0.65   0.514    -.0042611    .0021375
------------------------------------------------------------------------------

Asymmetry statistics:

------------------------------------------------------------------------------
             |        Long-run effect [+]      |        Long-run effect [-]
  Exog. var. |      coef.     F-stat     P>F   |      coef.     F-stat     P>F
-------------+---------------------------------+------------------------------
        Dcpi |     -0.045      .9382   0.334   |      0.045      .9162   0.340
-------------+---------------------------------+------------------------------
             |         Long-run asymmetry      |        Short-run asymmetry
             |                F-stat     P>F   |                F-stat     P>F
-------------+---------------------------------+------------------------------
        Dcpi |                 4.791   0.030   |                 1.133   0.288
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -8.8891
                                    F_PSS =      26.9903

  Model diagnostics                                      stat.    p-value
  ---------------------------------------------------------------------
  Portmanteau test up to lag  40 (chi2)                  36.55     0.6265
  Breusch/Pagan heteroskedasticity test (chi2)           .6802     0.4095
  Ramsey RESET test (F)                                  .2667     0.8493
  Jarque-Bera test on normality (chi2)                    2096     0.0000

.
```

```
. nardl jsapy Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =       166
-------------+----------------------------------   F(12, 153)      =     13.29
       Model |  .000757438        12  .00006312   Prob > F        =    0.0000
    Residual |  .000726867       153  4.7508e-06   R-squared       =    0.5103
-------------+----------------------------------   Adj R-squared   =    0.4719
       Total |  .001484306       165  8.9958e-06   Root MSE        =    .00218

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -.8056899   .1110097    -7.26   0.000       -1.025   -.5863803
             |
        _x1p |
         L1. |  -.0471876   .0325876    -1.45   0.150    -.1115674    .0171921
             |
        _x1n |
         L1. |  -.0466228   .0325844    -1.43   0.155    -.1109962    .0177505
             |
         _dy |
         L1. |  -.1523221    .079422    -1.92   0.057    -.3092274    .0045832
             |
       _dx1p |
         --. |    .000811   .0128321     0.06   0.950      -.02454    .0261621
         L1. |   .0144843   .0243844     0.59   0.553    -.0336894    .0626579
         L2. |  -.0065021   .0163494    -0.40   0.691    -.0388019    .0257977
         L3. |   .0157777   .0134955     1.17   0.244    -.0108838    .0424393
             |
       _dx1n |
         --. |  -.0171924   .0122159    -1.41   0.161     -.041326    .0069412
         L1. |   .0209009   .0220216     0.95   0.344    -.0226048    .0644066
         L2. |    .022796     .01784     1.28   0.203    -.0124485    .0580405
         L3. |  -.0045057   .0113514    -0.40   0.692    -.0269315      .01792
             |
       _cons |  -.0008615   .0013229    -0.65   0.516    -.0034749     .001752
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |          Long-run effect [+] |          Long-run effect [-]
  Exog. var. |       coef.     F-stat   P>F |       coef.     F-stat   P>F
-------------+------------------------------+---------------------------------
        Dcpi |      -0.059      2.061  0.153 |       0.058      2.012  0.158
-------------+------------------------------+---------------------------------
             |           Long-run asymmetry |          Short-run asymmetry
             |                F-stat   P>F |                 F-stat   P>F
-------------+------------------------------+---------------------------------
        Dcpi |                 4.135  0.044 |                .007142  0.933
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -7.2578
                                    F_PSS =      17.9216

  Model diagnostics                              stat.    p-value
  -----------------------------------------------------------------
  Portmanteau test up to lag  40 (chi2)          42.11     0.3798
  Breusch/Pagan heteroskedasticity test (chi2)   1.677     0.1954
  Ramsey RESET test (F)                          .7226     0.5400
  Jarque-Bera test on normality (chi2)           13.09     0.0014

.
```

```
. nardl jsapy Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =        53
-------------+----------------------------------   F(12, 40)       =      4.66
       Model |  .001035235        12  .00008627   Prob > F        =    0.0001
    Residual |  .000740265        40  .000018507   R-squared       =    0.5831
-------------+----------------------------------   Adj R-squared   =    0.4580
       Total |   .0017755         52  .000034144   Root MSE        =     .0043

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -.9444976   .2370051    -3.99   0.000    -1.423503   -.4654924
             |
        _x1p |
         L1. |   -.799515   .3263198    -2.45   0.019    -1.459032   -.1399981
             |
        _x1n |
         L1. |  -.7986654   .3262626    -2.45   0.019    -1.458067    -.139264
             |
         _dy |
         L1. |   .0261452   .1661995     0.16   0.876    -.3097565    .3620468
             |
       _dx1p |
         --. |  -.1337003   .0884971    -1.51   0.139    -.3125596     .045159
         L1. |   .5297525   .2118351     2.50   0.017     .1016178    .9578873
         L2. |    .329436   .1433771     2.30   0.027       .03966     .619212
         L3. |   .1410294   .0825039     1.71   0.095    -.0257173     .307776
             |
       _dx1n |
         --. |  -.1374165    .080009    -1.72   0.094    -.2991208    .0242878
         L1. |     .48595   .2052308     2.37   0.023     .0711631    .9007369
         L2. |   .3269597   .1298145     2.52   0.016     .0645948    .5893247
         L3. |   .1439938   .0733584     1.96   0.057    -.0042691    .2922567
             |
       _cons |   -.012104   .0055858    -2.17   0.036    -.0233934   -.0008146
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |        Long-run effect [+]   |         Long-run effect [-]
  Exog. var. |       coef.     F-stat   P>F |        coef.     F-stat   P>F
-------------+------------------------------+---------------------------------
        Dcpi |      -0.846      3.322 0.076 |        0.846       3.32 0.076
-------------+------------------------------+---------------------------------
             |         Long-run asymmetry   |         Short-run asymmetry
             |                 F-stat   P>F |                 F-stat   P>F
-------------+------------------------------+---------------------------------
        Dcpi |                 .05845 0.810 |                 .05394 0.818
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -3.9851
                                    F_PSS =      11.0119

  Model diagnostics                                stat.    p-value
  ----------------------------------------------------------------
  Portmanteau test up to lag  24 (chi2)            22.85     0.5288
  Breusch/Pagan heteroskedasticity test (chi2)      1.35     0.2453
  Ramsey RESET test (F)                            .4291     0.7334
  Jarque-Bera test on normality (chi2)             119.2     0.0000

.
```

D5: GOLD (Full sample, sub-sample 1, sub-sample 2 & sub-sample 3)

```
. nardl gold Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =       276
-------------+----------------------------------   F(12, 263)      =     25.61
       Model |  1.0231e-08        12  8.5254e-10   Prob > F        =    0.0000
    Residual |  8.7556e-09       263  3.3291e-11   R-squared       =    0.5388
-------------+----------------------------------   Adj R-squared   =    0.5178
       Total |  1.8986e-08       275  6.9041e-11   Root MSE        =    5.8e-06

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -1.083202   .0839575   -12.90   0.000    -1.248516   -.9178878
             |
        _x1p |
         L1. |  -.0000537   .0000583    -0.92   0.358    -.0001686    .0000611
             |
        _x1n |
         L1. |  -.0000529   .0000583    -0.91   0.365    -.0001677     .000062
             |
         _dy |
         L1. |   .0733103   .0593935     1.23   0.218    -.0436371    .1902576
             |
       _dx1p |
         --. |  -.0000335   .0000185    -1.81   0.072      -.00007    2.99e-06
         L1. |   .0000111   .0000397     0.28   0.780     -.000067    .0000892
         L2. |   .0000243   .0000291     0.83   0.405    -.0000331    .0000816
         L3. |    .000039   .0000169     2.30   0.022     5.66e-06    .0000724
             |
       _dx1n |
         --. |  -.0000183   .0000181    -1.01   0.313    -.0000539    .0000174
         L1. |   .0000207   .0000424     0.49   0.625    -.0000628    .0001043
         L2. |   .0000346   .0000299     1.16   0.249    -.0000243    .0000936
         L3. |   1.75e-06   .0000192     0.09   0.927    -.0000361    .0000396
             |
       _cons |   2.29e-07   9.62e-07     0.24   0.812    -1.67e-06    2.12e-06
------------------------------------------------------------------------------

Asymmetry statistics:

------------------------------------------------------------------------------
             |         Long-run effect [+]      |         Long-run effect [-]
  Exog. var. |       coef.      F-stat      P>F |       coef.      F-stat      P>F
-------------+----------------------------------+-----------------------------
        Dcpi |      -0.000        .845    0.359 |       0.000       .8181    0.367
-------------+----------------------------------+-----------------------------
             |          Long-run asymmetry      |          Short-run asymmetry
             |              F-stat      P>F     |              F-stat      P>F
-------------+----------------------------------+-----------------------------
        Dcpi |             Maximum number of iterations exceeded.
r(498);

.
```

```
. nardl gold Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =        42
-------------+----------------------------------   F(12, 29)       =      6.71
       Model |  1.9464e-09        12  1.6220e-10   Prob > F        =    0.0000
    Residual |  7.0055e-10        29  2.4157e-11   R-squared       =    0.7353
-------------+----------------------------------   Adj R-squared   =    0.6258
       Total |  2.6470e-09        41  6.4560e-11   Root MSE        =   4.9e-06

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -1.798068   .3034621    -5.93   0.000    -2.418718   -1.177419
             |
        _x1p |
         L1. |   .0001315   .0002077     0.63   0.532    -.0002934    .0005563
             |
        _x1n |
         L1. |   .0001307   .0002078     0.63   0.534    -.0002943    .0005557
             |
         _dy |
         L1. |   .2776427    .178282     1.56   0.130     -.086985    .6422704
             |
       _dx1p |
         --. |  -.0000322   .0000374    -0.86   0.397    -.0001087    .0000444
         L1. |  -.0001309   .0001315    -1.00   0.328       -.0004    .0001381
         L2. |  -.0000286   .0000859    -0.33   0.741    -.0002043     .000147
         L3. |   9.64e-06   .0000363     0.27   0.792    -.0000646    .0000839
             |
       _dx1n |
         --. |   .0000227   .0000452     0.50   0.620    -.0000698    .0001152
         L1. |  -.0000874   .0001386    -0.63   0.533    -.0003708    .0001961
         L2. |   -.000067   .0000836    -0.80   0.429     -.000238     .000104
         L3. |  -.0000148   .0000435    -0.34   0.736    -.0001038    .0000742
             |
       _cons |   2.06e-06   2.55e-06     0.81   0.425    -3.15e-06    7.27e-06
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |            Long-run effect [+] |            Long-run effect [-]
  Exog. var. |       coef.       F-stat   P>F |       coef.       F-stat   P>F
-------------+--------------------------------+-------------------------------
        Dcpi |       0.000        .4119 0.526 |      -0.000        .4067 0.529
-------------+--------------------------------+-------------------------------
             |             Long-run asymmetry |            Short-run asymmetry
             |                   F-stat   P>F |                   F-stat   P>F
-------------+--------------------------------+-------------------------------
        Dcpi |              Maximum number of iterations exceeded.
r(498);

.
```

```
. nardl gold Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =       171
-------------+----------------------------------   F(12, 158)      =     14.33
       Model |  7.4672e-09        12  6.2227e-10   Prob > F        =    0.0000
    Residual |  6.8620e-09       158  4.3431e-11   R-squared       =    0.5211
-------------+----------------------------------   Adj R-squared   =    0.4847
       Total |  1.4329e-08       170  8.4290e-11   Root MSE        =   6.6e-06

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -1.114021   .1126878    -9.89   0.000     -1.33659   -.8914521
             |
        _x1p |
         L1. |  -.0000435   .0000847    -0.51   0.609    -.0002108    .0001238
             |
        _x1n |
         L1. |  -.0000407   .0000847    -0.48   0.632     -.000208    .0001267
             |
         _dy |
         L1. |   .1270182   .0797644     1.59   0.113    -.0305238    .2845602
             |
       _dx1p |
         --. |  -.0000351   .0000357    -0.98   0.327    -.0001055    .0000354
         L1. |   .0000213   .0000626     0.34   0.734    -.0001023    .0001449
         L2. |   .0000344   .0000457     0.75   0.452    -.0000558    .0001246
         L3. |   .0000417   .0000382     1.09   0.278    -.0000339    .0001172
             |
       _dx1n |
         --. |  -.0000233   .0000353    -0.66   0.511     -.000093    .0000465
         L1. |   5.04e-06   .0000593     0.09   0.932     -.000112    .0001221
         L2. |   .0000268   .0000482     0.56   0.578    -.0000683     .000122
         L3. |  -4.54e-06   .0000317    -0.14   0.886    -.0000673    .0000582
             |
       _cons |   6.41e-07   1.58e-06     0.40   0.686    -2.49e-06    3.77e-06
------------------------------------------------------------------------------

Asymmetry statistics:

------------------------------------------------------------------------------
             |            Long-run effect [+] |            Long-run effect [-]
  Exog. var. |      coef.      F-stat     P>F |      coef.      F-stat     P>F
-------------+--------------------------------+-------------------------------
        Dcpi |     -0.000       .2594   0.611 |      0.000        .227   0.634
-------------+--------------------------------+-------------------------------
             |              Long-run asymmetry|             Short-run asymmetry
             |                 F-stat     P>F |                 F-stat     P>F
-------------+--------------------------------+-------------------------------
        Dcpi |                  11.07   0.001 |                  .3994   0.528
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -9.8859
                                    F_PSS =      33.5213

  Model diagnostics                                stat.    p-value
  -----------------------------------------------------------------
  Portmanteau test up to lag  40 (chi2)            53.9     0.0700
  Breusch/Pagan heteroskedasticity test (chi2)    .8748     0.3496
  Ramsey RESET test (F)                           1.433     0.2354
  Jarque-Bera test on normality (chi2)             6706     0.0000
```

```
. nardl gold Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =        53
-------------+----------------------------------   F(12, 40)       =      6.27
       Model |  8.1703e-10        12  6.8086e-11   Prob > F        =    0.0000
    Residual |  4.3437e-10        40  1.0859e-11   R-squared       =    0.6529
-------------+----------------------------------   Adj R-squared   =    0.5488
       Total |  1.2514e-09        52  2.4065e-11   Root MSE        =    3.3e-06

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -1.396154   .2170405    -6.43   0.000    -1.834809   -.9574983
             |
        _x1p |
         L1. |  -.0002312   .0002376    -0.97   0.336    -.0007114     .000249
             |
        _x1n |
         L1. |  -.0002268   .0002375    -0.96   0.345    -.0007068    .0002532
             |
         _dy |
         L1. |   .2922192   .1405362     2.08   0.044     .0081848    .5762535
             |
       _dx1p |
         --. |  -.0001077   .0000603    -1.79   0.082    -.0002295    .0000141
         L1. |    .000012   .0001578     0.08   0.940    -.0003069     .000331
         L2. |   -.000021   .0001054    -0.20   0.843    -.0002339    .0001919
         L3. |   .0000168   .0000617     0.27   0.787    -.0001079    .0001415
             |
       _dx1n |
         --. |  -.0000532   .0000608    -0.88   0.386     -.000176    .0000696
         L1. |   .0001717   .0001481     1.16   0.253    -.0001277     .000471
         L2. |   .0001335   .0000968     1.38   0.175    -.0000621    .0003291
         L3. |   7.25e-06   .0000583     0.12   0.902    -.0001105     .000125
             |
       _cons |   1.38e-06   4.23e-06     0.33   0.746    -7.17e-06    9.93e-06
------------------------------------------------------------------------------

Asymmetry statistics:

------------------------------------------------------------------------------
             |           Long-run effect [+] |           Long-run effect [-]
  Exog. var. |      coef.     F-stat      P>F |      coef.     F-stat      P>F
-------------+--------------------------------+--------------------------------
        Dcpi |     -0.000       .968    0.331 |      0.000      .9317    0.340
-------------+--------------------------------+--------------------------------
             |            Long-run asymmetry |           Short-run asymmetry
             |                F-stat      P>F |                F-stat      P>F
-------------+--------------------------------+--------------------------------
        Dcpi |                 2.307    0.137 |                 4.653    0.037
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -6.4327
                                    F_PSS =      13.7972

  Model diagnostics                                 stat.    p-value
  ------------------------------------------------------------------
  Portmanteau test up to lag  24 (chi2)             16.68     0.8622
  Breusch/Pagan heteroskedasticity test (chi2)     .09369     0.7595
  Ramsey RESET test (F)                            .02677     0.9940
  Jarque-Bera test on normality (chi2)              1.108     0.5747

.
```

D6: BITCOIN (Full sample, sub-sample 2 & sub-sample 3)

```
. nardl bitcoin Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =       150
-------------+----------------------------------   F(12, 137)      =     17.40
       Model |  .037120268        12  .003093356   Prob > F        =    0.0000
    Residual |  .024354878       137  .000177773   R-squared       =    0.6038
-------------+----------------------------------   Adj R-squared   =    0.5691
       Total |  .061475145       149  .000412585   Root MSE        =    .01333

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -1.099318     .12164    -9.04   0.000    -1.339853   -.8587835
             |
        _x1p |
         L1. |    -.05289   .4235135    -0.12   0.901    -.8903587    .7845787
             |
        _x1n |
         L1. |  -.0532207   .4234662    -0.13   0.900     -.890596    .7841547
             |
         _dy |
         L1. |   .0845167    .085722     0.99   0.326    -.0849926     .254026
             |
       _dx1p |
         --. |  -.0240505   .1240805    -0.19   0.847    -.2694112    .2213102
         L1. |  -.0248505   .3301992    -0.08   0.940    -.6777966    .6280956
         L2. |   .0792078   .2079532     0.38   0.704    -.3320053    .4904209
         L3. |  -.0458982   .1220214    -0.38   0.707    -.2871871    .1953908
             |
       _dx1n |
         --. |  -.2981884   .1211983    -2.46   0.015    -.5378498   -.0585271
         L1. |   .0788527   .2809041     0.28   0.779    -.4766157    .6343212
         L2. |   .0190549   .2132771     0.09   0.929    -.4026859    .4407956
         L3. |   .0056263   .1266518     0.04   0.965    -.2448191    .2560716
             |
       _cons |   .0015771   .0040362     0.39   0.697    -.0064043    .0095584
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |          Long-run effect [+] |          Long-run effect [-]
  Exog. var. |        coef.     F-stat   P>F |        coef.     F-stat   P>F
-------------+------------------------------+---------------------------------
        Dcpi |       -0.048     .01556  0.901 |        0.048     .01576  0.900
-------------+------------------------------+---------------------------------
             |           Long-run asymmetry |          Short-run asymmetry
             |                F-stat   P>F |                F-stat   P>F
-------------+------------------------------+---------------------------------
        Dcpi |                .02337  0.879 |                 .3099  0.579
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -9.0375
                                    F_PSS =      27.4897

  Model diagnostics                                   stat.    p-value
  ------------------------------------------------------------------
  Portmanteau test up to lag  40 (chi2)               60.06     0.0216
  Breusch/Pagan heteroskedasticity test (chi2)        .5804     0.4462
  Ramsey RESET test (F)                               .4092     0.7466
  Jarque-Bera test on normality (chi2)                800.9     0.0000
```

```
. nardl bitcoin Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =        92
-------------+----------------------------------   F(12, 79)       =     10.94
       Model |  .032772893        12  .002731074   Prob > F        =    0.0000
    Residual |  .019727946        79  .000249721   R-squared       =    0.6242
-------------+----------------------------------   Adj R-squared   =    0.5672
       Total |   .05250084        91  .000576932   Root MSE        =     .0158

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |   -1.09388    .158502    -6.90   0.000    -1.409371    -.77839
             |
        _x1p |
         L1. |  -1.520039   .8795238    -1.73   0.088    -3.270687   .2306097
             |
        _x1n |
         L1. |  -1.524167    .879697    -1.73   0.087     -3.27516    .226826
             |
         _dy |
         L1. |   .1069656   .1171521     0.91   0.364    -.1262199    .340151
             |
       _dx1p |
         --. |  -.5092255   .2266002    -2.25   0.027    -.9602619  -.0581892
         L1. |    1.25986   .5702948     2.21   0.030     .1247171   2.395004
         L2. |   .0168886   .3833464     0.04   0.965    -.7461433   .7799205
         L3. |   .3122504    .288422     1.08   0.282    -.2618392   .8863401
             |
       _dx1n |
         --. |  -.1356747   .2929426    -0.46   0.645    -.7187624    .447413
         L1. |   .2600665    .633768     0.41   0.683    -1.001417    1.52155
         L2. |   .9218823   .4710475     1.96   0.054    -.0157143   1.859479
         L3. |   .2749067   .2276507     1.21   0.231    -.1782206    .728034
             |
       _cons |   .0089289   .0078245     1.14   0.257    -.0066454   .0245032
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |            Long-run effect [+] |            Long-run effect [-]
   Exog. var.|       coef.      F-stat    P>F |       coef.      F-stat    P>F
-------------+--------------------------------+-------------------------------
        Dcpi |     -1.390       2.783   0.099 |       1.393       2.797   0.098
-------------+--------------------------------+-------------------------------
             |              Long-run asymmetry|             Short-run asymmetry
             |                  F-stat    P>F |                  F-stat    P>F
-------------+--------------------------------+-------------------------------
        Dcpi |                   .4269   0.515|                   .1306   0.719
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -6.9014
                                    F_PSS =      17.0567

  Model diagnostics                                 stat.    p-value
  --------------------------------------------------------------------
  Portmanteau test up to lag  40 (chi2)            41.25     0.4156
  Breusch/Pagan heteroskedasticity test (chi2)     1.833     0.1758
  Ramsey RESET test (F)                            .3363     0.7991
  Jarque-Bera test on normality (chi2)             220.9     0.0000

.
```

```
. nardl bitcoin Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =        53
-------------+----------------------------------   F(12, 40)       =      5.23
       Model |  .003334721        12  .000277893   Prob > F        =    0.0000
    Residual |  .002125809        40  .000053145   R-squared       =    0.6107
-------------+----------------------------------   Adj R-squared   =    0.4939
       Total |   .00546053        52   .00010501   Root MSE        =    .00729

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -.9411871   .1969975    -4.78   0.000    -1.339334   -.5430404
             |
        _x1p |
         L1. |  -1.703643   .5194455    -3.28   0.002    -2.753482   -.6538044
             |
        _x1n |
         L1. |   -1.69981   .5194371    -3.27   0.002    -2.749632   -.6499889
             |
         _dy |
         L1. |   .0605599   .1500462     0.40   0.689    -.2426947    .3638145
             |
       _dx1p |
         --. |  -.3394033   .1384535    -2.45   0.019    -.6192283   -.0595784
         L1. |   1.095545   .3467131     3.16   0.003     .3948117    1.796278
         L2. |   .6209878   .2333385     2.66   0.011     .1493931    1.092582
         L3. |   .2220246    .134861     1.65   0.108    -.0505397    .4945889
             |
       _dx1n |
         --. |  -.3474834   .1349747    -2.57   0.014    -.6202774   -.0746895
         L1. |   .9985029   .3230387     3.09   0.004     .3456173    1.651389
         L2. |   .6251008   .2089817     2.99   0.005     .2027329    1.047469
         L3. |   .3882853   .1212762     3.20   0.003     .1431771    .6333936
             |
       _cons |  -.0211051   .0093375    -2.26   0.029    -.0399769   -.0022334
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |          Long-run effect [+] |           Long-run effect [-]
  Exog. var. |       coef.    F-stat    P>F |        coef.    F-stat      P>F
-------------+------------------------------+---------------------------------
        Dcpi |      -1.810     6.993  0.012 |        1.806     6.975    0.012
-------------+------------------------------+---------------------------------
             |           Long-run asymmetry |          Short-run asymmetry
             |                F-stat    P>F |                  F-stat     P>F
-------------+------------------------------+---------------------------------
        Dcpi |                 .4063  0.528 |                  .03503   0.852
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -4.7777
                                    F_PSS =      11.9309

  Model diagnostics                                 stat.    p-value
  -------------------------------------------------------------------
  Portmanteau test up to lag  24 (chi2)             28.73     0.2303
  Breusch/Pagan heteroskedasticity test (chi2)      2.967     0.0850
  Ramsey RESET test (F)                            .04403     0.9875
  Jarque-Bera test on normality (chi2)              4.921     0.0854

.
```

D7: PLATINUM (Full sample, Sub-sample 1, sub-sample 2 & sub-sample 3)

```
. nardl platinum Dcpi, p(3) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =       276
-------------+----------------------------------   F(13, 262)      =     23.52
       Model |  2.2078e-08        13  1.6983e-09   Prob > F        =    0.0000
    Residual |  1.8920e-08       262  7.2215e-11   R-squared       =    0.5385
-------------+----------------------------------   Adj R-squared   =    0.5156
       Total |  4.0998e-08       275  1.4908e-10   Root MSE        =    8.5e-06

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -.8617402   .1017947    -8.47   0.000     -1.06218   -.6613004
             |
        _x1p |
         L1. |  -.0002285   .0000862    -2.65   0.008    -.0003981   -.0000588
             |
        _x1n |
         L1. |  -.0002273   .0000862    -2.64   0.009    -.0003969   -.0000576
             |
         _dy |
         L1. |  -.0965332   .0824409    -1.17   0.243    -.2588642    .0657978
         L2. |  -.1373528   .0588575    -2.33   0.020    -.2532468   -.0214587
             |
       _dx1p |
         --. |  -.0000408   .0000274    -1.49   0.137    -.0000947    .0000131
         L1. |    .000133   .0000585     2.27   0.024     .0000179    .0002481
         L2. |   .0001166   .0000427     2.73   0.007     .0000324    .0002007
         L3. |   .0000777   .0000249     3.12   0.002     .0000286    .0001268
             |
       _dx1n |
         --. |   -.000064   .0000268    -2.39   0.018    -.0001167   -.0000112
         L1. |   .0001469   .0000626     2.35   0.020     .0000237    .0002702
         L2. |   .0001193   .0000443     2.70   0.007     .0000322    .0002065
         L3. |    .000052   .0000283     1.84   0.068    -3.79e-06    .0001077
             |
       _cons |  -1.27e-06   1.42e-06    -0.89   0.373    -4.06e-06    1.53e-06
------------------------------------------------------------------------------

Asymmetry statistics:

------------------------------------------------------------------------------
             |           Long-run effect [+] |           Long-run effect [-]
  Exog. var. |       coef.      F-stat     P>F |       coef.      F-stat     P>F
-------------+---------------------------------+------------------------------
        Dcpi |      -0.000       6.182   0.014 |       0.000       6.117   0.014
-------------+---------------------------------+------------------------------
             |            Long-run asymmetry   |           Short-run asymmetry
             |                  F-stat     P>F |                  F-stat     P>F
-------------+---------------------------------+------------------------------
        Dcpi |                   9.328   0.002 |                   .5087   0.476
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -8.4655
                                    F_PSS =      27.2970

  Model diagnostics                                 stat.    p-value
  ------------------------------------------------------------------
  Portmanteau test up to lag  40 (chi2)             44.39     0.2918
  Breusch/Pagan heteroskedasticity test (chi2)      6.768     0.0093
  Ramsey RESET test (F)                             2.006     0.1135
  Jarque-Bera test on normality (chi2)               3242     0.0000

.
```

```
. nardl platinum Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =        42
-------------+----------------------------------   F(12, 29)       =      3.85
       Model |  1.4768e-09        12  1.2307e-10   Prob > F        =    0.0015
    Residual |  9.2684e-10        29  3.1960e-11   R-squared       =    0.6144
-------------+----------------------------------   Adj R-squared   =    0.4548
       Total |  2.4036e-09        41  5.8626e-11   Root MSE        =    5.7e-06

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -.9531338   .2670721    -3.57   0.001    -1.499357   -.4069101
             |
        _x1p |
         L1. |  -.0000337   .0002351    -0.14   0.887    -.0005145     .000447
             |
        _x1n |
         L1. |   -.000031   .0002351    -0.13   0.896    -.0005119    .0004499
             |
         _dy |
         L1. |  -.0925676   .1844315    -0.50   0.620    -.4697723    .2846371
             |
       _dx1p |
         --. |  -.0000542   .0000439    -1.23   0.227     -.000144    .0000357
         L1. |  -.0001053   .0001449    -0.73   0.473    -.0004016    .0001911
         L2. |  -.0000313   .0000943    -0.33   0.743    -.0002241    .0001616
         L3. |   7.12e-07   .0000418     0.02   0.987    -.0000847    .0000861
             |
       _dx1n |
         --. |  -.0000513   .0000528    -0.97   0.339    -.0001592    .0000566
         L1. |  -.0000219    .000155    -0.14   0.888    -.0003389     .000295
         L2. |  -.0000786   .0000934    -0.84   0.407    -.0002697    .0001124
         L3. |  -.0000423   .0000481    -0.88   0.386    -.0001406     .000056
             |
       _cons |   1.97e-06   2.91e-06     0.68   0.503    -3.98e-06    7.93e-06
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |            Long-run effect [+] |            Long-run effect [-]
  Exog. var. |       coef.     F-stat      P>F |       coef.     F-stat      P>F
-------------+--------------------------------+--------------------------------
        Dcpi |      -0.000     .02069    0.887 |       0.000     .01743    0.896
-------------+--------------------------------+--------------------------------
             |             Long-run asymmetry |            Short-run asymmetry
             |                 F-stat      P>F |                 F-stat      P>F
-------------+--------------------------------+--------------------------------
        Dcpi |                  1.113    0.300 |                 .00724    0.933
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -3.5688
                                    F_PSS =       4.2509

  Model diagnostics                                stat.    p-value
  -----------------------------------------------------------------
  Portmanteau test up to lag  19 (chi2)            12.55     0.8608
  Breusch/Pagan heteroskedasticity test (chi2)     2.725     0.0988
  Ramsey RESET test (F)                            .1761     0.9116
  Jarque-Bera test on normality (chi2)              41.3     0.0000

.
```

```
. nardl platinum Dcpi, p(3) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =       171
-------------+----------------------------------   F(13, 157)      =     13.69
       Model |  1.5714e-08        13  1.2088e-09   Prob > F        =    0.0000
    Residual |  1.3865e-08       157  8.8313e-11   R-squared       =    0.5313
-------------+----------------------------------   Adj R-squared   =    0.4924
       Total |  2.9579e-08       170  1.7400e-10   Root MSE        =    9.4e-06

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -.8422799   .1429195    -5.89   0.000    -1.124573   -.5599868
             |
        _x1p |
         L1. |  -.0003161   .0001229    -2.57   0.011    -.0005588   -.0000734
             |
        _x1n |
         L1. |  -.0003127    .000123    -2.54   0.012    -.0005557   -.0000698
             |
         _dy |
         L1. |  -.0850041   .1134509    -0.75   0.455    -.3090911    .1390829
         L2. |  -.1368478   .0811746    -1.69   0.094     -.297183    .0234874
             |
       _dx1p |
         --. |   -.000089   .0000505    -1.76   0.080    -.0001889    .0000108
         L1. |   .0001879   .0000904     2.08   0.039     9.42e-06    .0003663
         L2. |    .000127    .000066     1.93   0.056    -3.27e-06    .0002574
         L3. |   .0000595   .0000555     1.07   0.286    -.0000502    .0001691
             |
       _dx1n |
         --. |  -.0000997   .0000524    -1.90   0.059    -.0002032    3.88e-06
         L1. |   .0002071   .0000849     2.44   0.016     .0000394    .0003748
         L2. |   .0001511   .0000687     2.20   0.029     .0000155    .0002868
         L3. |    .000076    .000045     1.69   0.094     -.000013     .000165
             |
       _cons |    2.99e-06   2.38e-06    1.26   0.211    -1.71e-06    7.69e-06
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |          Long-run effect [+] |          Long-run effect [-]
   Exog. var.|      coef.     F-stat     P>F |      coef.     F-stat     P>F
-------------+------------------------------+---------------------------------
        Dcpi |     -0.000      4.804   0.030 |      0.000      4.704   0.032
-------------+------------------------------+---------------------------------
             |           Long-run asymmetry |          Short-run asymmetry
             |                F-stat     P>F |                F-stat     P>F
-------------+------------------------------+---------------------------------
        Dcpi |                 9.191   0.003 |                 .1297   0.719
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -5.8934
                                    F_PSS =      16.7030

  Model diagnostics                                 stat.    p-value
  ------------------------------------------------------------------
  Portmanteau test up to lag  40 (chi2)             38.84     0.5225
  Breusch/Pagan heteroskedasticity test (chi2)      13.94     0.0002
  Ramsey RESET test (F)                             2.521     0.0600
  Jarque-Bera test on normality (chi2)               1344     0.0000

.
```

```
. nardl platinum Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =        53
-------------+----------------------------------   F(12, 40)       =      5.28
       Model |  4.6240e-09        12  3.8533e-10   Prob > F        =    0.0000
    Residual |  2.9172e-09        40  7.2930e-11   R-squared       =    0.6132
-------------+----------------------------------   Adj R-squared   =    0.4971
       Total |  7.5412e-09        52  1.4502e-10   Root MSE        =    8.5e-06

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -1.266748   .2253499    -5.62   0.000    -1.722197   -.8112988
             |
        _x1p |
         L1. |  -.0002835   .0006285    -0.45   0.654    -.0015537    .0009867
             |
        _x1n |
         L1. |  -.0002822   .0006287    -0.45   0.656    -.0015528    .0009885
             |
         _dy |
         L1. |   .2458257   .1541175     1.60   0.119    -.0656574    .5573087
             |
       _dx1p |
         --. |  -9.71e-06   .0001635    -0.06   0.953    -.0003401    .0003207
         L1. |   .0001431   .0004153     0.34   0.732    -.0006962    .0009824
         L2. |   .0000321   .0002824     0.11   0.910    -.0005387    .0006029
         L3. |   .0001005   .0001656     0.61   0.547    -.0002341    .0004352
             |
       _dx1n |
         --. |  -.0001959    .000159    -1.23   0.225    -.0005173    .0001255
         L1. |   .0001811    .000396     0.46   0.650    -.0006193    .0009816
         L2. |   .0001823   .0002517     0.72   0.473    -.0003263     .000691
         L3. |  -.0000122   .0001428    -0.09   0.932    -.0003009    .0002765
             |
       _cons |  -8.19e-06   .0000111    -0.74   0.466    -.0000307    .0000143
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |             Long-run effect [+] |             Long-run effect [-]
  Exog. var. |       coef.     F-stat      P>F |       coef.     F-stat      P>F
-------------+---------------------------------+--------------------------------
        Dcpi |      -0.000      .1949    0.661 |       0.000       .193    0.663
-------------+---------------------------------+--------------------------------
             |               Long-run asymmetry |             Short-run asymmetry
             |                 F-stat      P>F |                 F-stat      P>F
-------------+---------------------------------+--------------------------------
        Dcpi |                  .0355    0.851 |                  .0792    0.780
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -5.6212
                                    F_PSS =      11.6317

  Model diagnostics                               stat.    p-value
  -----------------------------------------------------------------
  Portmanteau test up to lag  24 (chi2)           16.92     0.8521
  Breusch/Pagan heteroskedasticity test (chi2)    8.777     0.0030
  Ramsey RESET test (F)                           .0511     0.9845
  Jarque-Bera test on normality (chi2)            269.3     0.0000

.
```

D8: OIL

```
. nardl oil Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =       276
-------------+----------------------------------   F(12, 263)      =     23.98
       Model |  8.5750e-08        12  7.1458e-09   Prob > F        =    0.0000
    Residual |  7.8386e-08       263  2.9805e-10   R-squared       =    0.5224
-------------+----------------------------------   Adj R-squared   =    0.5006
       Total |  1.6414e-07       275  5.9686e-10   Root MSE        =    1.7e-05

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |   -1.03733   .0859636   -12.07   0.000    -1.206594    -.868065
             |
        _x1p |
         L1. |  -.0002796   .0001745    -1.60   0.110    -.0006232    .0000641
             |
        _x1n |
         L1. |  -.0002782   .0001745    -1.59   0.112    -.0006219    .0000654
             |
         _dy |
         L1. |   .0281656   .0606956     0.46   0.643    -.0913456    .1476767
             |
       _dx1p |
         --. |   .0000247   .0000554     0.45   0.656    -.0000844    .0001338
         L1. |   .0001906   .0001184     1.61   0.109    -.0000425    .0004237
         L2. |   .0002034   .0000867     2.35   0.020     .0000326    .0003741
         L3. |   .0000662   .0000507     1.31   0.193    -.0000336     .000166
             |
       _dx1n |
         --. |  -.0000739   .0000541    -1.36   0.173    -.0001805    .0000327
         L1. |   .0002127    .000127     1.68   0.095    -.0000373    .0004627
         L2. |   .0001563   .0000896     1.74   0.082    -.0000201    .0003327
         L3. |   .0001073   .0000574     1.87   0.062    -5.62e-06    .0002203
             |
       _cons |  -3.89e-06   2.87e-06    -1.35   0.177    -9.55e-06    1.77e-06
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |          Long-run effect [+]   |          Long-run effect [-]
  Exog. var. |        coef.     F-stat     P>F |        coef.     F-stat     P>F
-------------+--------------------------------+-------------------------------
        Dcpi |       -0.000       2.51   0.114 |        0.000      2.486   0.116
-------------+--------------------------------+-------------------------------
             |           Long-run asymmetry   |          Short-run asymmetry
             |                  F-stat     P>F |                 F-stat     P>F
-------------+--------------------------------+-------------------------------
        Dcpi |                   3.036   0.083 |                  .8086   0.369
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -12.0671
                                    F_PSS =       49.6627

  Model diagnostics                                 stat.    p-value
  ------------------------------------------------------------------

  Portmanteau test up to lag  40 (chi2)            20.99     0.9942
  Breusch/Pagan heteroskedasticity test (chi2)     10.59     0.0011
  Ramsey RESET test (F)                            .3434     0.7940
  Jarque-Bera test on normality (chi2)             94652     0.0000

.
```

```
. nardl oil Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =        42
-------------+----------------------------------   F(12, 29)       =      3.20
       Model |  3.7701e-09        12  3.1418e-10   Prob > F        =    0.0051
    Residual |  2.8501e-09        29  9.8281e-11   R-squared       =    0.5695
-------------+----------------------------------   Adj R-squared   =    0.3913
       Total |  6.6203e-09        41  1.6147e-10   Root MSE        =    9.9e-06

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |   -1.10302   .2528359    -4.36   0.000    -1.620128   -.5859127
             |
        _x1p |
         L1. |    .000223   .0004124     0.54   0.593    -.0006205    .0010664
             |
        _x1n |
         L1. |   .0002253   .0004127     0.55   0.589    -.0006187    .0010694
             |
         _dy |
         L1. |   .1831522   .1707161     1.07   0.292    -.1660015    .5323059
             |
       _dx1p |
         --. |  -1.77e-06   .0000766    -0.02   0.982    -.0001584    .0001549
         L1. |  -.0002259   .0002556    -0.88   0.384    -.0007487    .0002969
         L2. |   .0000862   .0001666     0.52   0.609    -.0002545    .0004269
         L3. |  -.0000579   .0000747    -0.78   0.445    -.0002108    .0000949
             |
       _dx1n |
         --. |  -5.23e-06   .0000901    -0.06   0.954    -.0001895     .000179
         L1. |  -.0000781   .0002725    -0.29   0.776    -.0006353    .0004792
         L2. |  -.0001257   .0001647    -0.76   0.452    -.0004625    .0002112
         L3. |   .0000668   .0000846     0.79   0.436    -.0001062    .0002398
             |
       _cons |   6.64e-06   5.34e-06     1.24   0.224    -4.29e-06    .0000176
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |          Long-run effect [+] |          Long-run effect [-]
  Exog. var. |      coef.     F-stat    P>F |      coef.     F-stat    P>F
-------------+------------------------------+---------------------------------
        Dcpi |      0.000      .2901  0.594 |     -0.000      .2959  0.591
-------------+------------------------------+---------------------------------
             |            Long-run asymmetry |          Short-run asymmetry
             |                F-stat    P>F |                F-stat    P>F
-------------+------------------------------+---------------------------------
        Dcpi |                 .3036  0.586 |                 .4199  0.522
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -4.3626
                                    F_PSS =       6.4527

  Model diagnostics                                stat.    p-value
  -----------------------------------------------------------------
  Portmanteau test up to lag  19 (chi2)            16.48     0.6251
  Breusch/Pagan heteroskedasticity test (chi2)     2.338     0.1263
  Ramsey RESET test (F)                           .09693     0.9610
  Jarque-Bera test on normality (chi2)             1.195     0.5503

.
```

```
. nardl oil Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =       171
-------------+----------------------------------   F(12, 158)      =     13.43
       Model |  2.5040e-08        12  2.0867e-09   Prob > F        =    0.0000
    Residual |  2.4554e-08       158  1.5541e-10   R-squared       =    0.5049
-------------+----------------------------------   Adj R-squared   =    0.4673
       Total |  4.9594e-08       170  2.9173e-10   Root MSE        =    1.2e-05

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -.9785404   .1087597    -9.00   0.000    -1.193351   -.7637301
             |
        _x1p |
         L1. |  -.0004735   .0001594    -2.97   0.003    -.0007884   -.0001586
             |
        _x1n |
         L1. |  -.0004704   .0001594    -2.95   0.004    -.0007852   -.0001556
             |
         _dy |
         L1. |   .0334256   .0792959     0.42   0.674    -.1231911    .1900422
             |
       _dx1p |
         --. |  -.0000245    .000067    -0.37   0.715    -.0001569    .0001078
         L1. |    .000274   .0001175     2.33   0.021     .0000418    .0005061
         L2. |   .0002156   .0000853     2.53   0.012     .0000471     .000384
         L3. |   .0000794   .0000723     1.10   0.274    -.0000635    .0002223
             |
       _dx1n |
         --. |  -.0001541   .0000667    -2.31   0.022    -.0002858   -.0000224
         L1. |   .0003068   .0001118     2.74   0.007      .000086    .0005277
         L2. |   .0002127   .0000902     2.36   0.020     .0000345     .000391
         L3. |   .0001072   .0000595     1.80   0.074    -.0000103    .0002248
             |
       _cons |   4.56e-07   2.96e-06     0.15   0.878    -5.40e-06    6.31e-06
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |          Long-run effect [+] |          Long-run effect [-]
  Exog. var. |     coef.      F-stat    P>F |     coef.      F-stat    P>F
-------------+------------------------------+---------------------------------
        Dcpi |    -0.000       8.053  0.005 |     0.000        7.95  0.005
-------------+------------------------------+---------------------------------
             |           Long-run asymmetry |          Short-run asymmetry
             |                F-stat    P>F |                F-stat    P>F
-------------+------------------------------+---------------------------------
        Dcpi |                 4.119  0.044 |                   .17  0.681
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -8.9973
                                    F_PSS =      29.5728

  Model diagnostics                                stat.    p-value
  -----------------------------------------------------------------
  Portmanteau test up to lag  40 (chi2)            25.96     0.9579
  Breusch/Pagan heteroskedasticity test (chi2)     .6697     0.4131
  Ramsey RESET test (F)                            1.929     0.1272
  Jarque-Bera test on normality (chi2)             15775     0.0000

.
```

```
. nardl oil Dcpi, p(2) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =        53
-------------+----------------------------------   F(12, 40)       =      4.70
       Model |  6.1952e-08        12  5.1627e-09   Prob > F        =    0.0001
    Residual |  4.3960e-08        40  1.0990e-09   R-squared       =    0.5849
-------------+----------------------------------   Adj R-squared   =    0.4604
       Total |  1.0591e-07        52  2.0368e-09   Root MSE        =    3.3e-05

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -1.084827   .2422968    -4.48   0.000    -1.574527   -.5951271
             |
        _x1p |
         L1. |  -.0010388   .0024962    -0.42   0.680    -.0060837    .0040062
             |
        _x1n |
         L1. |  -.0010477    .002496    -0.42   0.677    -.0060924     .003997
             |
         _dy |
         L1. |   .0063671   .1623798     0.04   0.969    -.3218146    .3345488
             |
       _dx1p |
         --. |   .0002759   .0006354     0.43   0.666    -.0010083    .0015601
         L1. |   .0011259   .0016402     0.69   0.496    -.0021891    .0044409
         L2. |   .0004973   .0010868     0.46   0.650    -.0016993    .0026939
         L3. |   .0005735   .0006312     0.91   0.369    -.0007022    .0018493
             |
       _dx1n |
         --. |  -.0004981   .0006233    -0.80   0.429    -.0017578    .0007615
         L1. |   .0005845    .001567     0.37   0.711    -.0025826    .0037516
         L2. |    .000682   .0010111     0.67   0.504    -.0013614    .0027255
         L3. |   .0000596     .00057     0.10   0.917    -.0010925    .0012117
             |
       _cons |  -.0000453    .000043    -1.05   0.299    -.0001322    .0000417
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |         Long-run effect [+]   |         Long-run effect [-]
  Exog. var. |       coef.     F-stat    P>F |       coef.     F-stat    P>F
-------------+-------------------------------+--------------------------------
        Dcpi |      -0.001      .1623  0.689 |       0.001      .1651  0.687
-------------+-------------------------------+--------------------------------
             |          Long-run asymmetry   |         Short-run asymmetry
             |                 F-stat    P>F |                 F-stat    P>F
-------------+-------------------------------+--------------------------------
        Dcpi |                  .1106  0.741 |                  1.137  0.293
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =       -4.4773
                                    F_PSS =        7.9082

  Model diagnostics                                 stat.    p-value
  ------------------------------------------------------------------
  Portmanteau test up to lag  24 (chi2)             16.8     0.8569
  Breusch/Pagan heteroskedasticity test (chi2)     19.88     0.0000
  Ramsey RESET test (F)                            2.795     0.0537
  Jarque-Bera test on normality (chi2)              1662     0.0000

.
```

D9: STEFI

```
. nardl Dstefi Dcpi, p(3) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =       235
-------------+----------------------------------   F(13, 221)      =     35.98
       Model |  .016627356        13  .001279027   Prob > F        =    0.0000
    Residual |  .007855425       221  .000035545   R-squared       =    0.6791
-------------+----------------------------------   Adj R-squared   =    0.6603
       Total |  .024482781       234  .000104627   Root MSE        =    .00596

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -1.583589   .1248395   -12.69   0.000    -1.829617   -1.337561
             |
        _x1p |
         L1. |   .3561321   .0734407     4.85   0.000     .2113984    .5008657
             |
        _x1n |
         L1. |   .3561404   .0734348     4.85   0.000     .2114182    .5008625
             |
         _dy |
         L1. |     .49751   .0957724     5.19   0.000      .308766     .686254
         L2. |    .266457    .066619     4.00   0.000     .1351671    .3977468
             |
       _dx1p |
         --. |   .1131512   .0271482     4.17   0.000     .0596488    .1666537
         L1. |  -.1440369   .0542342    -2.66   0.008    -.2509193   -.0371545
         L2. |  -.0073608   .0379407    -0.19   0.846    -.0821325     .067411
         L3. |  -.0129812   .0274285    -0.47   0.636     -.067036    .0410736
             |
       _dx1n |
         --. |   .1286098   .0252597     5.09   0.000     .0788292    .1783904
         L1. |  -.1117249     .05479    -2.04   0.043    -.2197026   -.0037473
         L2. |   -.085235   .0414582    -2.06   0.041    -.1669391    -.003531
         L3. |   .0217171   .0255858     0.85   0.397    -.0287063    .0721404
             |
       _cons |  -.0003564   .0011401    -0.31   0.755    -.0026034    .0018905
------------------------------------------------------------------------------

Asymmetry statistics:

------------------------------------------------------------------------------
             |          Long-run effect [+] |          Long-run effect [-]
   Exog. var.|      coef.     F-stat    P>F |      coef.     F-stat    P>F
-------------+------------------------------+---------------------------------
        Dcpi |      0.225       26.8  0.000 |     -0.225       26.8  0.000
------------------------------------------------------------------------------
             |           Long-run asymmetry |         Short-run asymmetry
             |                F-stat    P>F |               F-stat    P>F
-------------+------------------------------+---------------------------------
        Dcpi |            Maximum number of iterations exceeded.
r(498);

.
```

```
. nardl Dstefi Dcpi, p(3) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =       171
-------------+----------------------------------   F(13, 157)      =     39.63
       Model |   .00884073        13  .000680056   Prob > F        =    0.0000
    Residual |  .002694165       157   .00001716   R-squared       =    0.7664
-------------+----------------------------------   Adj R-squared   =    0.7471
       Total |  .011534895       170  .000067852   Root MSE        =    .00414

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -1.038318   .1475645    -7.04   0.000    -1.329786   -.7468501
             |
        _x1p |
         L1. |   .1974502   .0594903     3.32   0.001     .0799457    .3149547
             |
        _x1n |
         L1. |   .1972305   .0594725     3.32   0.001     .0797609       .3147
             |
         _dy |
         L1. |  -.0706494   .1214519    -0.58   0.562    -.3105399     .169241
         L2. |   .0202851   .0847417     0.24   0.811    -.1470959     .187666
             |
       _dx1p |
         --. |   .0695678   .0246772     2.82   0.005     .0208256    .1183099
         L1. |  -.0639163   .0456091    -1.40   0.163     -.154003    .0261703
         L2. |  -.0133206   .0326095    -0.41   0.683    -.0777305    .0510893
         L3. |   .0255652   .0271691     0.94   0.348    -.0280988    .0792292
             |
       _dx1n |
         --. |   .2039503   .0222322     9.17   0.000     .1600375    .2478632
         L1. |   .0376079   .0457635     0.82   0.412    -.0527837    .1279994
         L2. |   .0196584   .0361639     0.54   0.587     -.051772    .0910889
         L3. |   .0059521   .0200115     0.30   0.767    -.0335744    .0454787
             |
       _cons |   .0029237   .0009981     2.93   0.004     .0009522    .0048952
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |           Long-run effect [+] |           Long-run effect [-]
  Exog. var. |     coef.      F-stat     P>F |     coef.      F-stat     P>F
-------------+-------------------------------+--------------------------------
        Dcpi |     0.190       13.91   0.000 |    -0.190       13.88   0.000
-------------+-------------------------------+--------------------------------
             |            Long-run asymmetry |           Short-run asymmetry
             |                F-stat     P>F |                F-stat     P>F
-------------+-------------------------------+--------------------------------
        Dcpi |                 .2097   0.648 |                 16.97   0.000
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -7.0364
                                    F_PSS =      16.5158

  Model diagnostics                                stat.    p-value
  -------------------------------------------------------------------
  Portmanteau test up to lag  40 (chi2)            97.77     0.0000
  Breusch/Pagan heteroskedasticity test (chi2)     9.564     0.0020
  Ramsey RESET test (F)                            8.651     0.0000
  Jarque-Bera test on normality (chi2)             79.69     0.0000

.
```

```
. nardl Dstefi Dcpi, p(4) q(4)

Regression results (variables renamed):

      Source |       SS           df       MS      Number of obs   =        53
-------------+----------------------------------   F(14, 38)       =     50.85
       Model |  .005300904        14  .000378636   Prob > F        =    0.0000
    Residual |  .000282979        38  7.4468e-06   R-squared       =    0.9493
-------------+----------------------------------   Adj R-squared   =    0.9307
       Total |  .005583883        52  .000107382   Root MSE        =    .00273

------------------------------------------------------------------------------
         _dy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
          _y |
         L1. |  -2.987831   .5822935    -5.13   0.000    -4.166622   -1.809039
             |
        _x1p |
         L1. |   1.077321   .2839621     3.79   0.001     .5024693    1.652172
             |
        _x1n |
         L1. |    1.07449   .2839482     3.78   0.001     .4996669    1.649313
             |
         _dy |
         L1. |   1.154648    .455742     2.53   0.016     .2320465    2.077249
         L2. |    .540434   .2792548     1.94   0.060    -.0248877    1.105756
         L3. |   .2670892   .1391648     1.92   0.062    -.0146351    .5488136
             |
       _dx1p |
         --. |   .1507594   .0627212     2.40   0.021      .023787    .2777318
         L1. |  -.6044804    .213523    -2.83   0.007    -1.036735   -.1722257
         L2. |  -.2355813   .1381184    -1.71   0.096    -.5151875    .0440248
         L3. |  -.0496549   .0593952    -0.84   0.408    -.1698941    .0705843
             |
       _dx1n |
         --. |   .1058956   .0584524     1.81   0.078     -.012435    .2242262
         L1. |  -.6807172   .2122329    -3.21   0.003     -1.11036   -.2510742
         L2. |  -.2986304   .1370379    -2.18   0.036    -.5760491   -.0212116
         L3. |  -.0543004   .0673066    -0.81   0.425    -.1905554    .0819546
             |
       _cons |   .0116041   .0045266     2.56   0.014     .0024405    .0207677
------------------------------------------------------------------------------

Asymmetry statistics:
------------------------------------------------------------------------------
             |         Long-run effect [+] |          Long-run effect [-]
  Exog. var. |      coef.      F-stat   P>F |      coef.      F-stat     P>F
-------------+------------------------------+---------------------------------
        Dcpi |      0.361       8.578 0.006 |     -0.360        8.54   0.006
-------------+------------------------------+---------------------------------
             |          Long-run asymmetry |          Short-run asymmetry
             |                 F-stat   P>F |                 F-stat     P>F
-------------+------------------------------+---------------------------------
        Dcpi |                  1.629 0.210 |                  2.152   0.151
------------------------------------------------------------------------------
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

  Cointegration test statistics:    t_BDM =      -5.1311
                                    F_PSS =      14.8726

  Model diagnostics                                 stat.    p-value
  -------------------------------------------------------------------
  Portmanteau test up to lag  24 (chi2)             30.66     0.1639
  Breusch/Pagan heteroskedasticity test (chi2)      1.968     0.1606
  Ramsey RESET test (F)                             4.159     0.0127
  Jarque-Bera test on normality (chi2)              3.513     0.1726

.
```

8.4.E: PAIRWISE JOHANSEN COINTEGRATION

E1: JALSH

Date: 01/26/24 Time: 00:28
Sample (adjusted): 2000M06 2023M06
Included observations: 277 after adjustments
Trend assumption: No deterministic trend (restricted constant)
Series: JALSH CPI1
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.263187	128.1130	20.26184	0.0000
At most 1 *	0.145364	43.51122	9.164546	0.0000

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.263187	84.60174	15.89210	0.0000
At most 1 *	0.145364	43.51122	9.164546	0.0000

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

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

JALSH	CPI1	C
785.0705	-11.21300	-0.335145
-47.10783	-245.5828	0.008407

Unrestricted Adjustment Coefficients (alpha):

D(JALSH)	-0.001258	0.000320
D(CPI1)	0.000975	0.001769

1 Cointegrating Equation(s): Log likelihood 2373.218

Normalized cointegrating coefficients (standard error in parentheses)

JALSH	CPI1	C
1.000000	-0.014283	-0.000427
	(0.03179)	(0.00013)

Adjustment coefficients (standard error in parentheses)

D(JALSH)	-0.987414
	(0.10784)
D(CPI1)	0.765768
	(0.23416)

E2: ALBI

Date: 01/26/24 Time: 00:32
Sample (adjusted): 2001M06 2023M06
Included observations: 265 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: ALBI CPI1
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.292934	129.3003	25.87211	0.0000
At most 1 *	0.131766	37.44282	12.51798	0.0000

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.292934	91.85747	19.38704	0.0000
At most 1 *	0.131766	37.44282	12.51798	0.0000

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

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

ALBI	CPI1	@TREND(01M03)
-2188.755	-25.46497	-0.003215
-408.0872	-255.3223	-0.000935

Unrestricted Adjustment Coefficients (alpha):

D(ALBI)	0.000541	-6.42E-05
D(CPI1)	0.000114	0.001768

1 Cointegrating Equation(s): Log likelihood 2533.731

Normalized cointegrating coefficients (standard error in parentheses)

ALBI	CPI1	@TREND(01M03)
1.000000	0.011634	1.47E-06
	(0.01089)	(5.8E-07)

Adjustment coefficients (standard error in parentheses)

D(ALBI)	-1.183199
	(0.11673)
D(CPI1)	-0.249873
	(0.66288)

E3: GOVI

Date: 01/26/24 Time: 00:36
Sample (adjusted): 2001M06 2023M06
Included observations: 265 after adjustments
Trend assumption: Linear deterministic trend
Series: GOVI CPI1
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.276581	122.9035	15.49471	0.0000
At most 1 *	0.130659	37.10523	3.841465	0.0000

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.276581	85.79826	14.26460	0.0000
At most 1 *	0.130659	37.10523	3.841465	0.0000

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

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

GOVI	CPI1
-2127.983	-16.95480
-463.5453	-256.1620

Unrestricted Adjustment Coefficients (alpha):

D(GOVI)	0.000523	-5.02E-05
D(CPI1)	2.11E-05	0.001763

1 Cointegrating Equation(s): Log likelihood 2533.253

Normalized cointegrating coefficients (standard error in parentheses)

GOVI	CPI1
1.000000	0.007968
	(0.01165)

Adjustment coefficients (standard error in parentheses)

D(GOVI)	-1.112807
	(0.11333)
D(CPI1)	-0.044920
	(0.64492)

E4: JSAPY

Date: 01/26/24 Time: 00:40
Sample (adjusted): 2004M10 2023M06
Included observations: 225 after adjustments
Trend assumption: Quadratic deterministic trend
Series: JSAPY CPI1
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.286621	126.2397	18.39771	0.0000
At most 1 *	0.200144	50.24774	3.841465	0.0000

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.286621	75.99195	17.14769	0.0000
At most 1 *	0.200144	50.24774	3.841465	0.0000

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

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

JSAPY	CPI1
-605.6782	-33.25258
5.455870	-317.9321

Unrestricted Adjustment Coefficients (alpha):

D(JSAPY)	0.001743	0.000113
D(CPI1)	-0.000117	0.002050

1 Cointegrating Equation(s): Log likelihood 1899.025

Normalized cointegrating coefficients (standard error in parentheses)

JSAPY	CPI1
1.000000	0.054901
	(0.05614)

Adjustment coefficients (standard error in parentheses)

D(JSAPY)	-1.055930
	(0.11330)
D(CPI1)	0.070689
	(0.18811)

E5: GOLD

Date: 01/26/24 Time: 00:43
Sample (adjusted): 2000M06 2023M06
Included observations: 277 after adjustments
Trend assumption: Linear deterministic trend
Series: GOLD CPI1
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.272126	128.5061	15.49471	0.0000
At most 1 *	0.136096	40.52342	3.841465	0.0000

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.272126	87.98273	14.26460	0.0000
At most 1 *	0.136096	40.52342	3.841465	0.0000

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

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

GOLD	CPI1
-303463.0	-53.20862
54686.30	-239.4973

Unrestricted Adjustment Coefficients (alpha):

D(GOLD)	3.58E-06	-4.89E-08
D(CPI1)	0.000169	0.001846

1 Cointegrating Equation(s): Log likelihood 4018.359

Normalized cointegrating coefficients (standard error in parentheses)

GOLD	CPI1
1.000000	0.000175
	(8.0E-05)

Adjustment coefficients (standard error in parentheses)

D(GOLD)	-1.086045
	(0.10792)
D(CPI1)	-51.35191
	(92.4052)

E6:BITCOIN

Date: 01/26/24 Time: 00:47
Sample (adjusted): 2010M12 2023M06
Included observations: 151 after adjustments
Trend assumption: Linear deterministic trend
Series: BITCOIN CPI1
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.255806	78.59740	15.49471	0.0000
At most 1 *	0.201531	33.98401	3.841465	0.0000

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.255806	44.61339	14.26460	0.0000
At most 1 *	0.201531	33.98401	3.841465	0.0000

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

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

BITCOIN	CPI1
-59.82193	328.7321
80.93228	258.1077

Unrestricted Adjustment Coefficients (alpha):

D(BITCOIN)	0.004106	-0.005565
D(CPI1)	-0.001718	-0.000985

1 Cointegrating Equation(s): Log likelihood 1061.879

Normalized cointegrating coefficients (standard error in parentheses)

BITCOIN	CPI1
1.000000	-5.495178
	(0.98921)

Adjustment coefficients (standard error in parentheses)

D(BITCOIN)	-0.245656
	(0.07074)
D(CPI1)	0.102769
	(0.01819)

E7:PLATINUM

Date: 01/26/24 Time: 00:53
Sample (adjusted): 2000M06 2023M06
Included observations: 277 after adjustments
Trend assumption: No deterministic trend (restricted constant)
Series: PLATINUM CPI1
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.291625	140.5659	20.26184	0.0000
At most 1 *	0.150134	45.06153	9.164546	0.0000

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.291625	95.50433	15.89210	0.0000
At most 1 *	0.150134	45.06153	9.164546	0.0000

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

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

PLATINUM	CPI1	C
-176116.5	52.18846	-0.336511
-4521.500	-245.2350	-0.021551

Unrestricted Adjustment Coefficients (alpha):

D(PLATINUM)	4.95E-06	1.72E-06
D(CPI1)	-0.000940	0.001835

1 Cointegrating Equation(s): Log likelihood 3911.820

Normalized cointegrating coefficients (standard error in parentheses)

PLATINUM	CPI1	C
1.000000	-0.000296	1.91E-06
	(0.00013)	(5.4E-07)

Adjustment coefficients (standard error in parentheses)

D(PLATINUM)	-0.872564
	(0.09515)
D(CPI1)	165.5918
	(52.9444)

E8: OIL

Date: 01/26/24 Time: 00:56
Sample (adjusted): 2000M06 2023M06
Included observations: 277 after adjustments
Trend assumption: No deterministic trend (restricted constant)
Series: OIL CPI1
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.247330	122.2278	20.26184	0.0000
At most 1 *	0.145405	43.52441	9.164546	0.0000

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.247330	78.70344	15.89210	0.0000
At most 1 *	0.145405	43.52441	9.164546	0.0000

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

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

OIL	CPI1	C
-94694.45	13.46397	-0.265667
-11100.99	249.0712	-0.014778

Unrestricted Adjustment Coefficients (alpha):

D(OIL)	9.48E-06	-1.63E-06
D(CPI1)	-0.000395	-0.001880

1 Cointegrating Equation(s): Log likelihood 3725.393

Normalized cointegrating coefficients (standard error in parentheses)

OIL	CPI1	C
1.000000	-0.000142	2.81E-06
	(0.00027)	(1.1E-06)

Adjustment coefficients (standard error in parentheses)

D(OIL)	-0.897649
	(0.09806)
D(CPI1)	37.41998
	(28.5796)

E9: STEFI

Date: 01/26/24 Time: 00:50
Sample (adjusted): 2003M11 2023M06
Included observations: 236 after adjustments
Trend assumption: No deterministic trend
Series: STEFI1 CPI1
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.407194	179.1317	12.32090	0.0000
At most 1 *	0.210333	55.72993	4.129906	0.0000

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.407194	123.4017	11.22480	0.0000
At most 1 *	0.210333	55.72993	4.129906	0.0000

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

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

STEFI1	CPI1
-967.2681	183.9886
-267.3555	-251.9643

Unrestricted Adjustment Coefficients (alpha):

D(STEFI1)	0.001847	0.000328
D(CPI1)	-0.001001	0.002025

1 Cointegrating Equation(s): Log likelihood 2031.190

Normalized cointegrating coefficients (standard error in parentheses)

STEFI1	CPI1
1.000000	-0.190215
	(0.02396)

Adjustment coefficients (standard error in parentheses)

D(STEFI1)	-1.786456
	(0.14897)
D(CPI1)	0.968409
	(0.29139)

8.5.F: GRANGER CAUSALITY

F1: JALSH

Date: 01/26/24 Time: 00:26
Series: JALSH CPI1
Sample (adjusted): 2000M03 2023M06
Included observations: 280 after adjustments
Null hypothesis: Series are not cointegrated
Cointegrating equation deterministics: C
Automatic lags specification based on Akaike criterion (maxlag=15)

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
JALSH	-17.36734	0.0000	-290.3713	0.0000
CPI1	-6.312426	0.0000	115.6081	0.9999

*MacKinnon (1996) p-values.

Intermediate Results:

	JALSH	CPI1
Rho - 1	-1.040757	-0.704158
Rho S.E.	0.059926	0.111551
Residual variance	5.18E-06	1.73E-05
Long-run residual variance	5.18E-06	6.54E-06
Number of lags	0	12
Number of observations	279	267
Number of stochastic trends**	2	2

**Number of stochastic trends in asymptotic distribution

F2: ALBI

Date: 01/26/24 Time: 00:31
Series: ALBI CPI1
Sample (adjusted): 2001M03 2023M06
Included observations: 268 after adjustments
Null hypothesis: Series are not cointegrated
Cointegrating equation deterministics: C
Automatic lags specification based on Akaike criterion (maxlag=15)

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
ALBI	-16.91907	0.0000	-276.4851	0.0000
CPI1	-5.039947	0.0002	151.5564	0.9999

*MacKinnon (1996) p-values.

Intermediate Results:

	ALBI	CPI1
Rho - 1	-1.035525	-0.671321
Rho S.E.	0.061205	0.133200
Residual variance	7.45E-07	1.71E-05
Long-run residual variance	7.45E-07	1.36E-05
Number of lags	0	14
Number of observations	267	253
Number of stochastic trends**	2	2

**Number of stochastic trends in asymptotic distribution

F3: GOVI

Date: 01/26/24 Time: 00:36
Series: GOVI CPI1
Sample (adjusted): 2001M03 2023M06
Included observations: 268 after adjustments
Null hypothesis: Series are not cointegrated
Cointegrating equation deterministics: C
Automatic lags specification based on Akaike criterion (maxlag=15)

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
GOVI	-16.84929	0.0000	-275.3743	0.0000
CPI1	-5.033164	0.0002	152.6798	0.9999

*MacKinnon (1996) p-values.

Intermediate Results:

	GOVI	CPI1
Rho - 1	-1.031365	-0.669084
Rho S.E.	0.061211	0.132935
Residual variance	7.30E-07	1.70E-05
Long-run residual variance	7.30E-07	1.39E-05
Number of lags	0	14
Number of observations	267	253
Number of stochastic trends**	2	2

**Number of stochastic trends in asymptotic distribution

F4: JSAPY

Date: 01/26/24 Time: 00:39
Series: JSAPY CPI1
Sample (adjusted): 2004M07 2023M06
Included observations: 228 after adjustments
Null hypothesis: Series are not cointegrated
Cointegrating equation deterministics: C
Automatic lags specification based on Akaike criterion (maxlag=14)

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
JSAPY	-13.61088	0.0000	-204.4720	0.0000
CPI1	-4.261391	0.0037	2026.198	1.0000

*MacKinnon (1996) p-values.

Intermediate Results:

	JSAPY	CPI1
Rho - 1	-0.900758	-0.630693
Rho S.E.	0.066179	0.148002
Residual variance	7.91E-06	1.46E-05
Long-run residual variance	7.91E-06	0.003260
Number of lags	0	12
Number of observations	227	215
Number of stochastic trends**	2	2

**Number of stochastic trends in asymptotic distribution

F5: GOLD

Date: 01/26/24 Time: 00:42
Series: GOLD CPI1
Sample (adjusted): 2000M03 2023M06
Included observations: 280 after adjustments
Null hypothesis: Series are not cointegrated
Cointegrating equation deterministics: C
Automatic lags specification based on Akaike criterion (maxlag=15)

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
GOLD	-4.255137	0.0036	-180.6759	0.0000
CPI1	-6.325416	0.0000	115.1911	0.9999

*MacKinnon (1996) p-values.

Intermediate Results:

	GOLD	CPI1
Rho - 1	-1.109212	-0.703396
Rho S.E.	0.260676	0.111202
Residual variance	3.52E-11	1.69E-05
Long-run residual variance	1.31E-11	6.37E-06
Number of lags	12	12
Number of observations	267	267
Number of stochastic trends**	2	2

**Number of stochastic trends in asymptotic distribution

F6: BITCOIN

Date: 01/26/24 Time: 00:46
Series: BITCOIN CPI1
Sample (adjusted): 2010M09 2023M06
Included observations: 154 after adjustments
Null hypothesis: Series are not cointegrated
Cointegrating equation deterministics: C
Automatic lags specification based on Akaike criterion (maxlag=13)

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
BITCOIN	-5.426488	0.0001	-180.7816	0.0000
CPI1	-3.631097	0.0264	185.7168	0.9999

*MacKinnon (1996) p-values.

Intermediate Results:

	BITCOIN	CPI1
Rho - 1	-0.869536	-0.884320
Rho S.E.	0.160239	0.243541
Residual variance	0.000134	1.03E-05
Long-run residual variance	0.000275	2.30E-05
Number of lags	8	12
Number of observations	145	141
Number of stochastic trends**	2	2

**Number of stochastic trends in asymptotic distribution

F7: PLATINUM

Date: 01/26/24 Time: 00:52
Series: PLATINUM CPI1
Sample (adjusted): 2000M03 2023M06
Included observations: 280 after adjustments
Null hypothesis: Series are not cointegrated
Cointegrating equation deterministics: C
Automatic lags specification based on Akaike criterion (maxlag=15)

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
PLATINUM	-13.86467	0.0000	-229.2014	0.0000
CPI1	-6.326506	0.0000	114.4244	0.9999

*MacKinnon (1996) p-values.

Intermediate Results:

	PLATINUM	CPI1
Rho - 1	-0.821511	-0.715816
Rho S.E.	0.059252	0.113146
Residual variance	7.66E-11	1.71E-05
Long-run residual variance	7.66E-11	6.13E-06
Number of lags	0	12
Number of observations	279	267
Number of stochastic trends**	2	2

**Number of stochastic trends in asymptotic distribution

F8: OIL

Date: 01/26/24 Time: 00:55
Series: OIL CPI1
Sample (adjusted): 2000M03 2023M06
Included observations: 280 after adjustments
Null hypothesis: Series are not cointegrated
Cointegrating equation deterministics: C
Automatic lags specification based on Akaike criterion (maxlag=15)

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
OIL	-10.46989	0.0000	-220.6557	0.0000
CPI1	-6.310333	0.0000	115.6926	0.9999

*MacKinnon (1996) p-values.

Intermediate Results:

	OIL	CPI1
Rho - 1	-0.864223	-0.705297
Rho S.E.	0.082544	0.111769
Residual variance	2.96E-10	1.71E-05
Long-run residual variance	2.49E-10	6.44E-06
Number of lags	1	12
Number of observations	278	267
Number of stochastic trends**	2	2

**Number of stochastic trends in asymptotic distribution

F9: STEFI

Date: 01/26/24 Time: 00:50
Series: STEFI1 CPI1
Sample (adjusted): 2003M08 2023M06
Included observations: 239 after adjustments
Null hypothesis: Series are not cointegrated
Cointegrating equation deterministics: C
Automatic lags specification based on Akaike criterion (maxlag=14)

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
STEFI1	-2.788860	0.1733	-30.30325	0.0049
CPI1	-5.323925	0.0001	215.7003	0.9999

*MacKinnon (1996) p-values.

Intermediate Results:

	STEFI1	CPI1
Rho - 1	-0.791579	-0.770048
Rho S.E.	0.283836	0.144639
Residual variance	3.99E-06	1.58E-05
Long-run residual variance	1.14E-07	2.41E-05
Number of lags	12	11
Number of observations	226	227
Number of stochastic trends**	2	2

**Number of stochastic trends in asymptotic distribution