An Analysis of the Relationship Between Real Yields and Gold Prices: A Pre and Post Covid Analysis.

By

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Abstract

This dissertation examines the relationship between real rates—measured via U.S. 10-year Treasury Inflation-Protected Securities (TIPS) —and gold prices, comparing the pre-COVID (2010–2019) and post-COVID (2020–2024) periods. Monthly data was collected from Bloomberg. The DXY index – which tracks the strength of the dollar against a basket of other major currencies – was used to control for any gold movement which was explained by currency changes. This helps disentangle the effects of these two important variables on the price of gold. A Vector Autoregressive (VAR) model was employed to analyse gold's relationship with real rates, in line with Lis Andriani, Fajrin Satria Dwi Kesumah and Luthfi Firdaus in their paper, Causality test on gold prices and economic risk(November2023). Impulse Response Functions were used to assess the dynamic relationships amongst variables. The analysis also contributes to the literature by assessing European real rates. Several robustness checks were carried out to support the empirical results found in the main regression.

The pre-COVID results show a strong and statistically significant inverse link between 10-year TIPS yields and gold prices. This is in line with our apriori expectation and consistent with the literature. The post-COVID results suggests a non-significant relationship between real rates and gold. The study highlights that post-Covid gold prices might be driven by central bank buying, geopolitical risks and safe-haven demand as per the Financial Stability Review May 2025 by the ECB. The diminished explanatory power of traditional variables suggests that relationships have become more state-dependent in the post-pandemic period.

Findings have implications for central banks, portfolio managers, and policymakers navigating an environment where traditional macro-financial linkages are less stable. The weakening of traditional macro-financial linkages has profound implications for central banks, portfolio managers, and policymakers. For central banks, the transmission of monetary policy becomes increasingly uncertain. Conventional models that rely on stable relationships between interest rates, credit growth, and asset prices may no longer provide reliable guidance (Blanchard, 2019). This necessitates a recalibration of policy frameworks, with greater emphasis on forward-looking indicators such as market-based measures of risk premia and volatility, rather than historical correlations alone (Borio, 2021).

Portfolio managers similarly face challenges, as the breakdown of established cross-asset correlations undermines the effectiveness of conventional diversification strategies. In environments of heightened instability, safe-haven assets may not perform as expected, and traditional hedging mechanisms may fail (Ilmanen, 2012). Consequently, asset managers are compelled to adopt more dynamic allocation strategies, incorporating scenario analysis and stress testing to account for nonlinear risks and regime shifts (Ang & Chen, 2010).

For broader economic policymakers, the erosion of predictable linkages complicates the design and execution of both fiscal and regulatory interventions. For example, fiscal stimulus may fail to generate the anticipated credit expansion if financial institutions reassess risk exposures independently of macroeconomic fundamentals (Reinhart & Rogoff, 2011). This environment reinforces the need for macroprudential policies and closer coordination between monetary, fiscal, and regulatory authorities to ensure systemic stability (Claessens et al., 2014).

Taken together, these developments underscore the imperative for policymakers and market participants to transition from reliance on static, model-driven approaches toward adaptive frameworks capable of responding to evolving market dynamics and structural uncertainty.

Keywords: Covid-19,Tips,Yields,Gold,Oati

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Finally, I dedicate this thesis to my father in heaven. Your memory continues to inspire me to persevere, to strive for excellence, and to carry myself with humility and hope. This achievement is as much yours as it is mine.

Table of Contents

List of Tables

List of Figures

List Of Abbreviations

- VAR-Vector Auto Regression Model
- TIPS-Treasury Inflation Protected Securities
- OATI-Obligation Assimilable du Trésor Indexée
- CPI-Consumer Price Index
- HICP-Harmonised Index of Consumer Prices
- EU-European Union
- USA-United States of America
- FED-Federal Reserve of the United States Government

Chapter 1 – Introduction

1.1 Background on the Study Carried Out

This dissertation examines the relationship between real yields as measured by 10-year Treasury inflation protected securities (TIPS) and gold prices, comparing behaviour in the pre-COVID (2010–2019) and post COVID (2020–2024) periods. The topic has long been relevant to academics and practitioners because real yields influence the opportunity cost of holding non-yielding assets such as gold. According to the CEIC data, historically, an inverse relationship has been observed: falling real yields tend to boost gold demand. The COVID-19 pandemic disrupted global markets through monetary easing, fiscal expansion, and heightened uncertainty, raising the question of whether this relationship has structurally changed.

1.2 Introduction to the Topic, Rationale and Motivation

Gold serves multiple roles, as a store of value, inflation hedge, currency hedge, and safe haven asset during crises. Real yields reflect the inflation adjusted return on safe assets like U.S. Treasury Inflation-Protected Securities (TIPS) or European OATi bonds. The inverse link between them is grounded in opportunity cost theory and supported by past empirical work such as that of Reboredo in 2013.. The COVID-19 crisis created unprecedented conditions: negative real yields and record gold prices. This study analysis the relationship between gold price changes and real yields, pre- and post-Covid pandemic. Furthermore, the study contributes further towards the literature by assessing whether the relationship holds when using proxy European real rates.

1.3 Summary of the Methodology Used

The research uses monthly data from January 2010 to December 2024, sourced mainly from Bloomberg. The variables employed are gold prices in USD and EUR, U.S. and French real yields, the U.S. Dollar Index, and inflation measures (CPI, HICP). Gold prices and the DXY index are log-transformed. Real yields are either taken directly from inflation-linked bonds or derived from nominal yields minus inflation expectations. Stationarity is checked via Augmented Dickey–Fuller tests, and series are differenced where necessary.

The empirical approach involves Ordinary Least Squares regressions on monthly gold returns, controlling for real yield changes and currency effects, estimated separately for pre- and post-COVID subperiods. Structural break tests and Chow tests assess regime shifts. A Vector Autoregressive (VAR) framework is also used, with Impulse Response Functions (IRFs) to trace the dynamic impact of shocks in real yields and the dollar on gold over time.

1.4 Results and Findings

Pre-COVID results confirm a strong, statistically significant inverse relationship between U.S. 10-year TIPS yields and gold prices, consistent with opportunity cost theory. Currency effects, captured through the DXY index, are also significant and negative. The inclusion of Eurozone real yields, proxied by French 10-year OATi bonds, reinforces this narrative: VAR estimates indicate that gold prices in both USD and EUR respond negatively to changes in European real yields, with the first lag of OATi remaining statistically significant and negative. This suggests that the inverse link between gold and real rates is not unique to the U.S. context, but extends to the Eurozone.

In the full 2010–2024 sample, the inverse relationship persists but weakens, reflecting structural breaks introduced by COVID-19. In the post-COVID (2020–2024) period, the statistical link between real yields and gold prices becomes weaker and often insignificant in both U.S. TIPS and Eurozone OATi models. While the OATi–gold link shows somewhat greater persistence than the TIPS–gold link, particularly in full-sample regressions, its explanatory power also declines after 2020. This attenuation suggests that post-pandemic gold dynamics were increasingly driven by safe-haven demand, inflation fears, and geopolitical risks, overriding the traditional yield channel.

Overall, the evidence indicates that while real yields remain a relevant driver of gold prices in both U.S. and European contexts, their influence became more state-dependent and less systematic after COVID-19. This shift underscores the importance of complementing yield-based analysis with broader macroeconomic and behavioural considerations.

Chapter 2 – Literature Review

2.1 Introduction

This literature review aims to systematically analyse existing academic research on the relationship between real yields and gold prices, with a particular emphasis on the pre and post COVID 19 periods. It will begin with a theoretical overview of gold pricing and the determinants of real interest rates, before reviewing empirical studies conducted before the pandemic. It will then turn to emerging post COVID literature, highlighting shifts in market dynamics and methodological approaches. The chapter concludes by identifying research gaps and establishing a conceptual foundation for the present study.

The relationship between real yields and gold prices has long attracted scholarly interest due to its implications for portfolio allocation, inflation hedging, and macroeconomic risk assessment. Real yields, derived from inflation adjusted government bond yields, serve as a critical benchmark in evaluating the opportunity cost of holding non income generating assets such as gold (Baur and Lucey, 2010; Wang and Lee, 2011). Historically, a robust inverse correlation has been observed between real interest rates and gold prices, with lower real yields often associated with higher gold valuations (Bruno and Shin, 2015; Zhang and Wei, 2017). This relationship is grounded in the theoretical notion that when the real return on risk free assets declines, the relative attractiveness of gold, despite its lack of yield, increases.

The advent of the COVID 19 pandemic introduced a range of structural disruptions to global financial markets, monetary policy frameworks, and investor sentiment. The initial outbreak in early 2020 led to a rapid decline in global economic activity, triggering aggressive fiscal stimulus and ultra-accommodative monetary policies, particularly in advanced economies (IMF, 2020; Federal Reserve, 2020). These interventions, including quantitative easing and near zero nominal interest rates, substantially depressed real yields pushing them into negative territory in several regions (Dutta et al., 2020). Simultaneously, gold prices surged to historic highs in mid-2020, raising questions about whether the traditional inverse relationship had intensified or evolved in response to the crisis (Cheema et al., 2022).

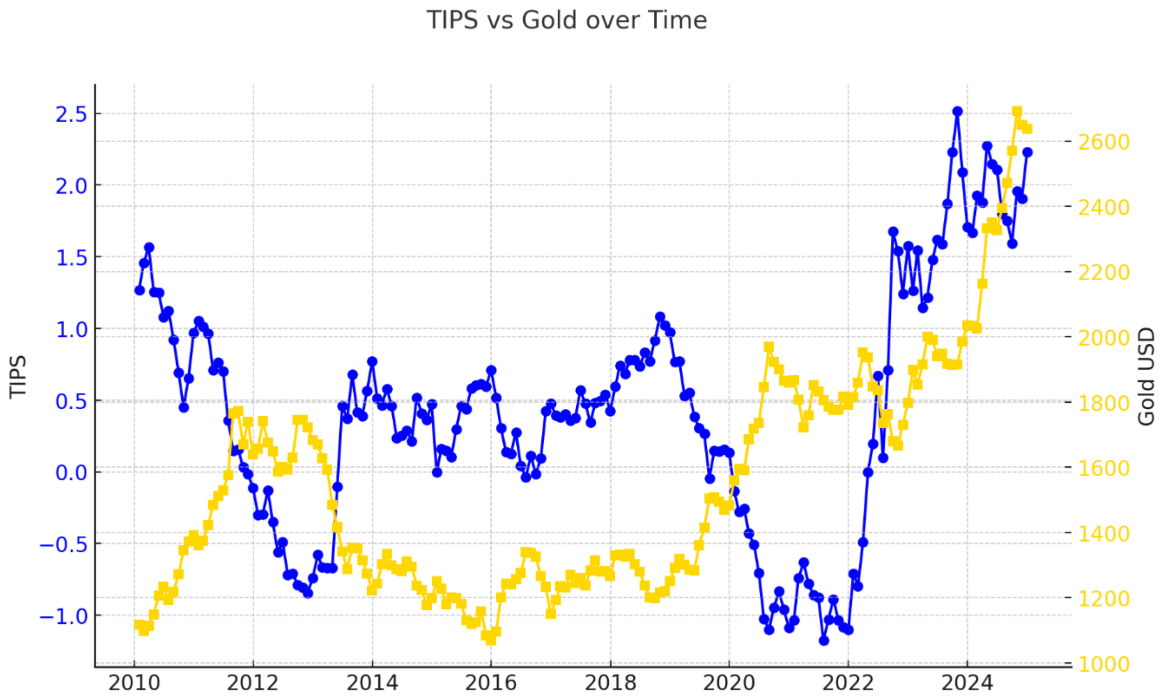

Figure 1 TIPS VS Gold USD

COVID 19 also reshaped investor behaviour. Amid heightened uncertainty, market participants increasingly sought safe haven assets, with gold, Treasury bonds, and the US dollar becoming central to liquidity and hedging strategies (Baur and McDermott, 2010; Akhtaruzzaman et al., 2021). Yet, some empirical studies have pointed to periods of divergence and volatility, suggesting that gold's correlation with real yields and other macroeconomic indicators may not be as stable during crisis periods (Conlon and McGee, 2020).

By integrating both classical theory and contemporary empirical evidence, this review positions the dissertation within a broader academic discourse and offers a comprehensive basis for understanding how exogenous shocks like COVID 19 can alter longstanding financial relationships.

2.2 Theoretical Background

Understanding the relationship between real yields and gold prices requires a firm grasp of the underlying theoretical frameworks that govern both asset classes. This section explores the economic theory behind real interest rates, the determinants of gold prices, and the conceptual rationale for the inverse relationship between the two. It also introduces supporting financial theories, such as the opportunity cost framework, portfolio choice theory, and inflation expectations, which serve as the foundation for many empirical studies in this domain.

2.3 Real Yields: Definition and Economic Relevance

Real yields refer to the inflation adjusted returns on government securities, most commonly proxied by yields on Treasury Inflation Protected Securities (TIPS) in the United States or equivalent instruments elsewhere. Unlike nominal yields, which reflect returns without accounting for inflation, real yields measure the actual purchasing power earned from investing in fixed income instruments (Campbell and Shiller, 1996).

The real yield can be expressed using the Fisher equation:

$R \approx i - \pi^e$

Where:

- r = real interest rate,
- i = nominal interest rate,
- π^e = expected inflation.

This simple yet powerful relationship highlights the importance of both monetary policy and inflation expectations in determining real yields. When central banks lower nominal rates or when inflation expectations rise, real yields tend to decline, increasing the appeal of alternative assets that are not tied to fixed returns (Mishkin, 2007; Clarida et al., 2000).

2.4 Determinants of Gold Prices and Opportunity Cost

Gold differs from conventional financial assets in that it offers no yield or dividend. Its value is primarily derived from:

- Supply and demand fundamentals, including mining output and central bank reserves.
- Macroeconomic variables, such as inflation, interest rates, and exchange rates.
- Market sentiment and geopolitical risk (Baur and Lucey, 2010).

Gold's historical role as a store of value and inflation hedge has made it particularly sensitive to expectations around economic stability and real interest rates (Capie et al., 2005). Unlike fiat currencies, gold is not subject to monetary debasement, making it a desirable asset in periods of high inflation or aggressive monetary expansion (Aye et al., 2017).

The inverse relationship between real yields and gold prices is primarily explained through the opportunity cost of holding gold. Since gold yields no income, the rationale for holding it depends on relative returns compared to interest bearing assets (Bodie et al., 2009). When real interest rates are high, investors are incentivised to allocate capital to bonds and other fixed income securities, reducing demand for gold. Conversely, in low or negative real rate environments, the opportunity cost of holding gold diminishes, making it more attractive (van der Merwe and Mollentze, 2010; Wang and Lee, 2011).

This concept is formalised in the portfolio allocation theory, which assumes rational investors will seek to optimise returns for a given level of risk. In the mean variance optimisation framework developed by Markowitz (1952), gold's risk return profile becomes more attractive in periods when other asset classes, particularly bonds offer diminishing real returns.

2.5 Inflation Hedge Theory

Gold is often perceived as a hedge against inflation, particularly during times of monetary instability or currency debasement. This perception stems from its historical role in the gold standard era and its enduring value as a physical asset (Ghosh et al., 2004; Worthington and Pahlavani, 2007). Empirical research has shown mixed results, with gold sometimes displaying weak short term hedging capabilities but stronger long term inflation protection (Tully and Lucey, 2007; Bampinas and Panagiotidis, 2015).

The strength of the inflation hedging characteristic of gold is closely tied to real interest rates. When inflation expectations rise faster than nominal yields, real yields decline, prompting increased gold demand. Hence, the inflation channel is deeply embedded in the theoretical linkage between gold and real yields.

2.6 Safe Haven and Crisis Time Behaviour

Another important theoretical component in the gold–real yield relationship is the notion of gold as a safe haven asset. During periods of market turmoil or macroeconomic uncertainty, gold often exhibits non correlation or negative correlation with equities and riskier assets (Baur and McDermott, 2010). In such contexts, real yields typically fall as central banks adopt accommodative policies to stabilise markets. Simultaneously, investors increase allocations to gold, strengthening the negative correlation (Hillier et al., 2006; Reboredo, 2013).

This behaviour was particularly evident during the Global Financial Crisis of 2008–2009 and later during the initial outbreak of COVID 19 in early 2020. In both instances, sharp declines in real yields coincided with surging gold prices, providing strong real time evidence of gold's dual role as both a hedge and a safe haven (Cheema et al., 2022).

Traditional theories assume rational investor behaviour, but more recent work in behavioural finance suggests that perceptions and narratives also shape gold pricing. The perception of gold as a safe haven or inflation hedge may persist even when empirical data suggests a weakening relationship.

Investor sentiment, central bank communication, and media narratives can amplify or distort the theoretical mechanisms outlined above (Kristoufek, 2013; Raza et al., 2016).

Moreover, bounded rationality, loss aversion, and herding behaviour can influence the extent to which real yields affect gold prices during periods of heightened uncertainty. This behavioural perspective is particularly relevant in crisis contexts such as the COVID 19 pandemic, where investor decisions often diverge from fundamentals (Shahzad et al., 2019).

2.7 Summary of Theoretical Linkages

In summary, several theoretical channels underpin the relationship between real yields and gold prices:

- Lower real yields reduce opportunity cost, increasing gold demand.
- Inflation expectations influence both gold's appeal and the level of real yields.
- Safe haven demand spikes during crises, often aligning with falling real yields.
- Investor perceptions may sustain or disrupt the theoretical linkage.

These frameworks collectively form the foundation for empirical testing of the relationship, both in stable economic conditions and in periods of systemic stress such as the COVID 19 pandemic.

2.8 Gold as a Financial Asset and Other Uses

Gold occupies a unique position within the global financial system. While it does not generate income like equities or bonds, it is widely held by central banks, institutional investors, and private individuals for its perceived stability, scarcity, and historical role as a store of value. This section explores the evolving function of gold as a financial asset, focusing on its performance in various macroeconomic contexts, its appeal as a hedge against inflation and currency risk, and its role as a safe haven during periods of financial market turbulence.

Historically, gold functioned as a monetary anchor under the gold standard and Bretton Woods systems. Following the collapse of Bretton Woods in 1971, gold lost its official currency status but gained prominence as a market traded commodity and investment vehicle (Schenk, 2010). In recent decades, the financialization of gold, the process by which gold is increasingly traded through financial instruments such as exchange traded funds (ETFs), futures, and options has transformed it into a mainstream financial asset (Baur and Glover, 2012; Ebrahim et al., 2014).

The increased accessibility and liquidity of gold markets have enabled broader participation by institutional investors, allowing gold to be used more dynamically for hedging and portfolio diversification. Gold ETFs, in particular, have become a key conduit for speculative and defensive positioning in response to macroeconomic developments (Chong and Miffre, 2010).

Modern portfolio theory suggests that asset combinations should be structured to minimise risk for a given return. Gold's low or negative correlation with traditional asset classes like equities and bonds makes it an effective diversifier, particularly during periods of elevated volatility (Baur and Lucey, 2010; Hillier et al., 2006).

Empirical studies have shown that adding gold to diversified portfolios enhances risk adjusted returns, especially during times of economic stress or inflationary pressure (Sherman, 1982; Ciner et al., 2013). The non linearity of gold's correlation with other assets, stronger in bear markets and weaker in bull markets reinforces its role as a counter cyclical hedge (Baur and McDermott, 2010; Beckmann et al., 2015).

A dominant theme in the literature is the role of gold as a hedge against inflation. Theoretically, gold maintains its value over time because it is not directly affected by inflationary erosion, unlike paper currencies and fixed income securities (Ghosh et al., 2004; Capie et al., 2005). Investors often increase allocations to gold when they expect future inflation to rise, thereby pushing prices up in anticipation.

Empirical findings on gold's effectiveness as an inflation hedge are mixed. Long term analyses support the hypothesis that gold preserves purchasing power over decades (Wang and Lee, 2011), but short run correlations between gold and inflation are often weak or inconsistent (Tully and Lucey, 2007; Bampinas and Panagiotidis, 2015). This discrepancy may be due to the influence of other factors, such as interest rates, geopolitical risks, or market sentiment, which can obscure the inflation signal.

Notably, studies that differentiate between expected and unexpected inflation find stronger results for gold's hedging ability against the latter. For instance, Ghosh et al. (2004) show that gold prices react more sharply to inflation surprises than to anticipated inflation trends, reinforcing the idea that gold is a reactive hedge rather than a consistent predictor of inflation.

2.9 Gold and Currency Risk

Because gold is priced in U.S. dollars, its relationship with major currencies especially the USD is a key determinant of its investment appeal. A weaker U.S. dollar typically boosts gold prices by making it cheaper for non-dollar investors, while a stronger dollar tends to suppress demand (Zhang and Wei, 2017; Reboredo, 2013). Gold thus serves as a partial hedge against currency risk, particularly for investors in emerging markets or in countries experiencing rapid currency depreciation.

Some researchers have argued that gold acts as a quasi-currency, behaving like an alternative medium of exchange during episodes of currency instability or monetary repression (McCown and Zimmerman, 2006). During the COVID 19 pandemic, for example, as central banks expanded their balance sheets through unprecedented quantitative easing, concerns about currency debasement led to heightened demand for gold as a protective asset (Cheema et al., 2022).

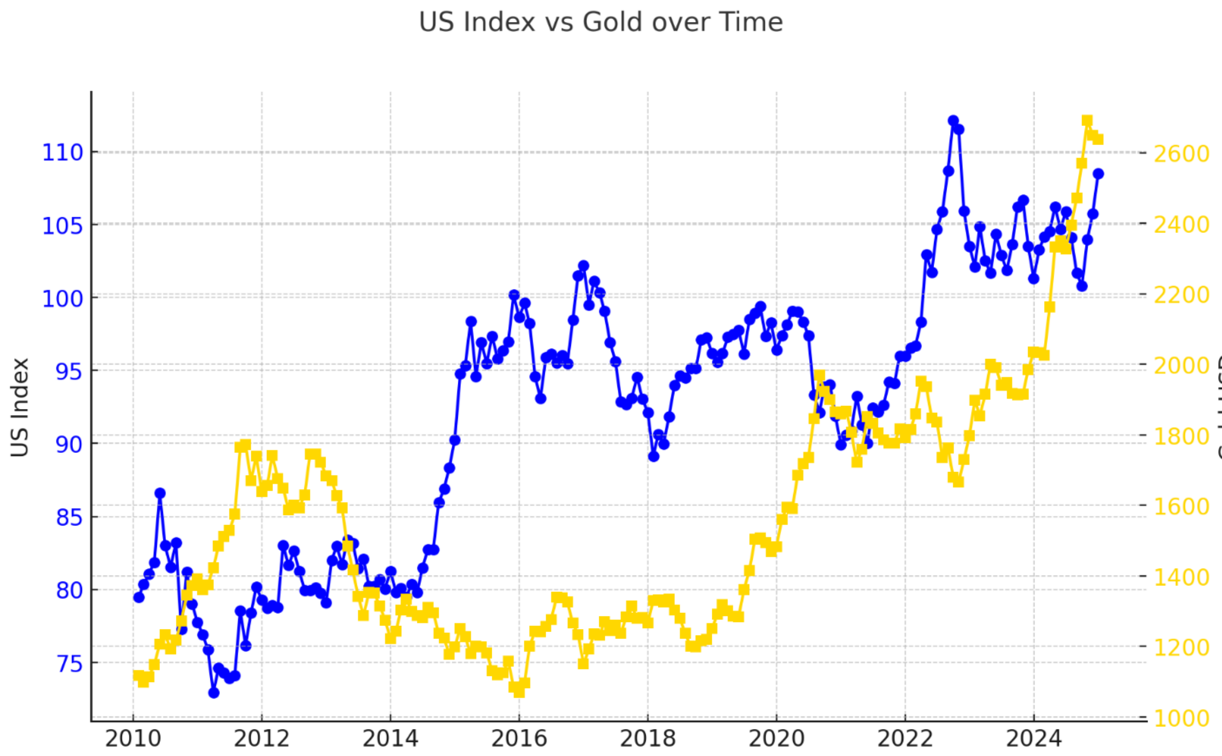

Figure 2 DXY VS Gold

Over the full-time frame shown in the graph, both the US Index and Gold prices generally moved upward, though with different dynamics. The US Index followed a relatively steady rising path, moving from just above 100 to over 108 by the end of the period, indicating consistent market strength. Gold prices, meanwhile, showed greater volatility, with noticeable fluctuations month to month, but still achieved a net increase from around $2,470 to above $2,630. Overall, the chart highlights a period where equities and gold both gained value, with gold acting as the more volatile asset compared to the steady climb of the US Index.

2.10 Gold as a Safe Haven During Crises

One of the most widely studied characteristics of gold is its function as a safe haven asset—that is, an asset that retains or increases in value during periods of market distress. Baur and McDermott (2010) define a safe haven as an asset that is uncorrelated or negatively correlated with another asset or portfolio in times of market stress. Gold consistently satisfies this condition during crises such as the

Global Financial Crisis (2008–09), the Eurozone sovereign debt crisis (2010–12), and the initial stages of the COVID 19 pandemic (Akhtaruzzaman et al., 2021).

However, the degree to which gold acts as a safe haven may depend on the nature and duration of the crisis. In some short-term panic phases, gold may be sold off alongside risky assets as investors seek liquidity, only to recover later as its hedging role becomes more prominent (Conlon and McGee, 2020). Studies using high frequency data have found that gold's safe haven properties are most pronounced during the second phase of crises, when systemic uncertainty remains but initial panic subsides (Baur and Glover, 2012).

2.11 Summary

Gold's multifaceted role in financial markets is evident in its:

- Low correlation with traditional assets (diversifier),
- Reaction to inflation expectations (inflation hedge),
- Sensitivity to USD movements (currency hedge),
- Strong performance during crisis periods (safe haven).

These characteristics make gold a strategic asset in both normal and abnormal economic environments. Its relationship with real yields is inherently tied to all of these roles, as real interest rates influence both the relative cost of holding gold and investor sentiment surrounding inflation and macroeconomic stability.

2.12 Real Yields and Gold Prices: Empirical Evidence (Pre COVID Focus)

A substantial body of empirical research has examined the inverse relationship between real yields and gold prices. Most of this literature focuses on the period preceding the COVID 19 pandemic, during which market conditions and the behaviour of traditional macro financial variables—such as inflation, interest rates, and investor risk preferences—were relatively stable. This section reviews key empirical studies that explore the dynamics of real yields and gold prices from both short term and long-term perspectives, identifying consensus findings, methodological variations, and nuanced patterns.

Early studies analysing the relationship between gold and interest rates generally confirmed the theoretical proposition that real yields exert a significant influence on gold prices. For instance, Levin and Wright (2006) found that real interest rates negatively and significantly affected gold prices over monthly time horizons, using a vector autoregressive (VAR) framework. Their results suggested that a one percentage point decline in real yields could lead to a considerable increase in gold prices, confirming the opportunity cost channel.

Similarly, Ghosh et al. (2004) employed a cointegration analysis to examine the long run relationship between real interest rates, inflation, and gold prices using U.S. data. They concluded that real interest rates were a statistically significant determinant of gold price movements, with the relationship persisting over the long term. These early findings supported the hypothesis that when inflation adjusted returns on bonds decrease, gold becomes more attractive to investors as a store of value.

2.13 Time Series Analysis and Cointegration Approaches

More sophisticated econometric techniques were developed in the 2000s and 2010s to test the stability and directionality of the gold–real yield relationship. Wang and Lee (2011) used Johansen cointegration and Granger causality tests to study the interaction between gold prices, inflation, and interest rates across several developed economies. They found strong evidence of a long-term equilibrium relationship, particularly in the U.S. and Germany, where inflation indexed bond markets are more developed. In these contexts, real yields were found to lead gold prices, consistent with theoretical expectations. The choice between French Treasury inflation-linked bonds (OATi) and German inflation-linked bonds (Bundei) depends on differences in indexation, liquidity, and market structure. French OATi are linked to domestic French CPI excluding tobacco, while OATi and Bundei are indexed to the Euro Area HICP (ECB, 2025). This distinction provides investors with the option of targeting domestic French inflation risk directly, which is not available in the German market.

From a liquidity perspective, France has historically been the largest issuer of inflation-linked securities in the Euro area, resulting in deeper secondary markets and tighter bid-ask spreads (Deacon, Derry and Mirfendereski, 2004). German issuance is smaller and more sporadic, which can lead to a scarcity premium in Bundei prices (D'Amico, Kim and Wei, 2018). Consequently, breakeven inflation rates derived from French securities often appear more favourable to investors seeking cost-effective inflation protection.

In terms of credit perception, German bonds retain the status of Eurozone benchmark securities, reflecting Germany's lower sovereign risk premium (Blommestein et al., 2012). French OATi typically trade at a modest spread to Bundei, offering comparatively higher real yields. This makes them attractive for investors balancing safety with return optimisation.

Overall, French instruments are generally preferred for liquidity and yield advantages, while German linkers serve as the benchmark for euro-denominated inflation expectations. A diversified portfolio may include both, using German bonds for benchmark anchoring and French bonds for broader and more liquid inflation exposure.

Beckmann and Czudaj (2013) extended this analysis using threshold vector error correction models (TVECMs) to identify regime dependent relationships. Their findings revealed that the inverse relationship between real yields and gold prices was more pronounced during low-interest rate regimes, suggesting asymmetry in investor responses. This finding is particularly relevant when considering how gold behaves in environments with near zero or negative real rates, as observed in the post 2008 and the early post COVID periods.

Several studies have explored whether the gold–real yield relationship holds across countries and under different monetary regimes. Capie et al. (2005), for instance, investigated the hedging role of gold against U.S. dollar depreciation and found that both exchange rates and real interest rates significantly influenced gold prices. The impact of real yields was especially strong in countries with large gold markets, such as India and China, where gold demand also has cultural and consumption driven components.

Baur and Lucey (2010) compared gold's behaviour across multiple developed and emerging markets and found that its sensitivity to real interest rates varied depending on the level of financial market development and capital mobility. In economies with deep bond markets and liquid gold trading platforms, such as the U.S., Germany, and Switzerland, the real yield–gold price linkage was stronger and more stable over time. This highlights the importance of market infrastructure and institutional factors in mediating the transmission mechanism.

2.14 Volatility and Non-Linear Relationships

Some scholars have argued that the relationship between gold and real yields is non-linear, with structural breaks or threshold effects. Bampinas and Panagiotidis (2015) used smooth transition regression models to examine the gold price response to real interest rates over two centuries. Their analysis revealed that the relationship was not constant over time and that gold's sensitivity to real yields was heightened during periods of economic or geopolitical uncertainty.

Ciner (2013) also employed non-linear time series models to examine whether changes in real yields affect the volatility of gold prices. His findings suggested that the impact of real yield shocks on gold prices is asymmetric—negative shocks to real yields tend to produce stronger upward movements in gold prices than equivalent positive shocks. This asymmetry aligns with investor behaviour in risk averse environments, where the demand for safe haven assets like gold surges disproportionately during economic downturns.

2.15 The Role of Inflation Expectations

Given that real yields are derived from nominal interest rates adjusted for expected inflation, many studies have also considered the role of inflation expectations in mediating the gold–real yield relationship. For example, Batten et al. (2014) showed that both actual inflation and inflation uncertainty influenced gold prices, but the effect was stronger when expectations were highly volatile. They argued that in such cases, gold serves as a "contingent hedge" against macroeconomic uncertainty rather than a systematic inflation hedge.

More granular studies using breakeven inflation rates (the difference between nominal Treasury yields and TIPS yields) found that rising inflation expectations generally led to higher gold prices, but only when real yields were simultaneously falling (Blose, 2010). This supports the notion that the joint interaction of low real yields and high inflation expectations creates a uniquely favourable environment for gold demand.

2.16 Criticisms and Mixed Findings

While the inverse relationship between real yields and gold prices has been supported by much of the literature, some studies have pointed to inconsistencies in empirical findings. For example, Tully and Lucey (2007) found that the relationship varied over time and was influenced by other macroeconomic factors such as exchange rates, oil prices, and market volatility. Their analysis cautioned against over reliance on real yields as the sole explanatory variable. From our end we chose to use the US Dollar Index as to control for the dollar effect on gold.

Similarly, Worthington and Pahlavani (2007) noted that short term deviations between gold prices and real yields were common and that causality often flowed in both directions. In certain cases, gold prices were found to Granger cause real yields, suggesting a feedback mechanism were changes in gold demand influence broader market interest rate expectations.

2.17 Summary of Pre COVID Findings

The pre-COVID literature broadly confirms the theoretical expectation of an inverse relationship between real yields and gold prices, particularly in developed markets with robust inflation linked bond markets. However, the strength and stability of this relationship are affected by:

- Regime specific,
- Market structure and investor base,
- Inflation expectations and monetary policy credibility,
- External shocks such as geopolitical risk or financial crises.

The consensus in the literature suggests that while real yields are a key driver of gold prices, they function as part of a broader set of macroeconomic influences, and their impact may vary depending on prevailing market conditions and investor behaviour.

2.18 COVID 19 and Financial Market Dynamics

The COVID 19 pandemic marked an unprecedented global health and economic crisis that significantly disrupted financial markets. Beginning in early 2020, the outbreak triggered sharp contractions in global output, widespread uncertainty, and extraordinary fiscal and monetary policy responses. These developments had profound implications for macro financial variables, including real interest rates and gold prices. Understanding the dynamics during this period is crucial for contextualising the evolution of the gold–real yield relationship, especially given the extreme conditions under which traditional economic relationships were tested.

2.19 Macroeconomic Disruption and Policy Response

The pandemic induced shock was both supply and demand side in nature, affecting nearly all sectors and economies simultaneously. Global GDP contracted by 3.4% in 2020, the largest peacetime recession in a century (IMF, 2021). In response, central banks and governments deployed extraordinary stimulus packages. The U.S. Federal Reserve, for example, slashed the federal funds rate to near zero levels, resumed large scale quantitative easing (QE), and implemented emergency lending programmes to stabilise financial markets (Federal Reserve, 2020).

These interventions led to a dramatic compression of real yields, particularly on inflation protected securities such as TIPS. Real 10-year yields in the U.S. fell below –1% by mid-2020, reflecting both accommodative monetary policy and an uptick in inflation expectations driven by fiscal expansion (Dutta et al., 2020). This sharp decline in real yields, coupled with rising concerns over inflation and fiat currency debasement, created a fertile environment for gold appreciation.

2.20 Gold's Price Surge During the Pandemic

In parallel with falling real yields, gold prices surged during the early stages of the pandemic, reaching an all-time high of over USD 2,060 per ounce in August 2020 (World Gold Council, 2021). Several factors contributed to this price movement:

1. Negative real interest rates, which reduced the opportunity cost of holding gold.
2. Heightened uncertainty, which drove demand for safe haven assets.
3. Currency concerns, particularly relating to the U.S. dollar and euro.
4. Liquidity driven investment flows into gold ETFs and futures.

These factors interacted to reinforce gold's attractiveness as both a hedge and a diversifier, leading to one of the most dramatic bull markets in its history (Cheema et al., 2022)

2.21 Investor Behaviour Under Uncertainty

Investor behaviour during the pandemic period was marked by increased risk aversion and an intensified search for safety. Early in the crisis, markets experienced a broad-based liquidation phase often described as a "dash for cash" in which gold, equities, and even high quality bonds were sold to meet margin calls and liquidity needs (Baur and McDermott, 2021). However, gold quickly rebounded, regaining its role as a safe haven as policy interventions stabilised markets and investor confidence returned.

Behavioural finance theories offer useful insights into investor decision making during this time. Loss aversion, herding, and overreaction played significant roles in shaping asset allocation decisions (Shahzad et al., 2019). For many investors, gold served as a psychological anchor during a period of heightened uncertainty, reinforcing its long-standing role as a crisis time asset.

Moreover, institutional investors including pension funds and sovereign wealth funds increased their allocations to gold, often using ETFs and other derivative instruments. The World Gold Council (2021) reported record inflows into gold backed ETFs, reflecting growing demand from large scale investors seeking to hedge against systemic risk and inflation.

2.22 Inflation Expectations and Monetary Debasement Concerns

While the immediate impact of the pandemic was disinflationary due to reduced demand and collapsing oil prices, the medium-term inflation outlook shifted by late 2020 and into 2021. This was driven by:

- Massive fiscal stimulus (e.g., the CARES Act in the U.S.),
- Supply chain disruptions,
- Pent up consumer demand, and
- Accommodative monetary policy.

These developments revived fears of monetary debasement, particularly in advanced economies with large fiscal deficits. In this context, gold regained attention as a potential store of value and inflation hedge (Batten et al., 2021). Market based measures of inflation expectations, such as the 10-year breakeven rate, began to rise steadily, while real yields remained negative further reinforcing bullish sentiment toward gold.

2.23 Decoupling Episodes and Market Complexity

Despite the broad alignment of gold and real yields during the pandemic, some short-term decoupling episodes occurred. For instance, there were brief periods when gold prices declined despite falling real yields. These anomalies have been attributed to:

- Shifts in investor sentiment,
- Profit taking after the 2020 price peak,
- Fluctuations in the U.S. dollar, and
- Changing expectations regarding monetary tightening (Conlon et al., 2021).

These episodes underscore the complexity of the gold–real yield relationship, particularly in environments characterised by rapid shifts in market expectations and policy signalling.

2.24 Summary

The COVID 19 pandemic significantly altered the macro financial environment in which gold and real yields interact. The collapse of real interest rates, surging gold prices, and changing investor behaviour reinforced the conventional inverse relationship but also highlighted its sensitivity to context and sentiment. The pandemic demonstrated that while real yields remain a key driver of gold valuation, the relationship is modulated by broader macroeconomic and behavioural factors, including inflation expectations, liquidity conditions, and policy credibility.

These dynamics set the stage for post pandemic empirical investigations, many of which aim to determine whether the relationship between real yields and gold prices underwent a structural shift or simply intensified under stress.

2.25 Post COVID Studies on Gold and Real Yields

The COVID 19 pandemic fundamentally altered global financial conditions, and the subsequent recovery period has presented new challenges and uncertainties for policymakers, investors, and researchers alike. As economies reopened and inflation surged, central banks began unwinding pandemic era stimulus measures, sparking volatility across asset classes. These developments have prompted a new wave of empirical studies assessing whether the relationship between gold prices and real yields has undergone structural changes in the post COVID period. This section synthesises the emerging post 2020 literature, focusing on shifts in market behaviour, macroeconomic conditions, and modelling techniques used to evaluate the gold–real yield relationship.

2.26 Changing Market Conditions Post Pandemic

By 2021, inflation pressures had intensified significantly in many economies, driven by pent up consumer demand, energy price shocks, and continued supply chain disruptions (OECD, 2022). In response, central banks including the U.S. Federal Reserve, the European Central Bank (ECB), and the Bank of England began to tighten monetary policy through interest rate hikes and quantitative tightening. These policy reversals led to rising nominal yields, but as inflation remained persistently high, real yields remained historically low or negative well into 2022 (Batten et al., 2022).

These unique conditions created ambiguity around the traditional inverse relationship between real yields and gold. In theory, rising nominal interest rates should decrease gold demand due to rising opportunity costs. However, persistently high inflation and market uncertainty sustained investor interest in gold, at least in the short term (Zhang and Wei, 2022). This led to empirical reassessments of the gold–real yield dynamic in a post pandemic macro financial environment.

2.27 Empirical Studies Using Post 2020 Data

Recent studies have used updated data sets covering 2020–2023 to reassess gold's sensitivity to real interest rates and broader macroeconomic indicators. For example, Cheema et al. (2022) extended their earlier work by incorporating time varying parameter models, finding that the gold–real yield relationship remains significant but became more volatile and state dependent after 2020. They identified stronger inverse correlation during inflationary episodes, particularly in Q3 and Q4 of 2022.

Similarly, Dutta et al. (2022) employed a rolling window regression approach to track dynamic correlations between gold returns and real yields. Their findings suggest that while the inverse relationship held during inflation surges, it weakened during periods of stabilising inflation expectations. The implication is that market participants may have adjusted their inflation hedging strategies in response to changes in monetary policy credibility and inflation forecasting accuracy.

A study by Akhtaruzzaman et al. (2023) explored gold's hedging ability in multi asset portfolios post COVID. Using copula-based models, they found that the tail dependence between gold and real yields intensified, particularly during stress periods when central bank policy announcements were frequent. This provides further evidence of gold's role as a reactive rather than proactive hedge—responding most strongly to shifts in perceived risk rather than to gradual changes in yield curves.

One consistent finding in the post COVID literature is that gold's hedging properties particularly against inflation and real interest rate risk have become more conditional on broader macro financial contexts. Zhang and Wei (2022) argue that the gold–real yield relationship has entered a regime switching pattern, where the direction and strength of correlation depend on inflation volatility, market liquidity, and geopolitical risk.

Their Markov switching vector autoregression (MS–VAR) model revealed that during high volatility regimes, the negative correlation between gold and real yields strengthens significantly. However, in low volatility periods, the relationship becomes statistically insignificant. These results align with Baur and McDermott's (2021) earlier assertions that gold acts more as a "crisis hedge" than a consistent inflation hedge or safe haven.

This shift is also evident in investor behaviour. Market data from 2022 and 2023 show increased allocation to gold not only by retail investors, but also by central banks, especially in emerging markets (World Gold Council, 2023). Many of these purchases were motivated by concerns over currency diversification, geopolitical tensions, and monetary policy uncertainty factors that now exert greater influence on gold prices than real yields alone.

Another important consideration in the post COVID literature is the rise of alternative inflation and risk hedging assets, such as cryptocurrencies and commodity linked ETFs. Studies comparing gold to Bitcoin, for example, suggest that while gold maintained its role as a safe haven asset during crises, digital assets began to compete for investor attention, particularly among younger and more risk tolerant investors (Conlon et al., 2021; Bouri et al., 2022).

However, evidence remains mixed regarding whether these assets truly displaced gold. Batten et al. (2022) found that during major inflation announcements or central bank policy shifts, gold remained more sensitive to real yield changes than Bitcoin, which exhibited higher volatility and inconsistent hedging properties. As such, while the post COVID environment introduced new asset classes into the risk hedging conversation, gold's responsiveness to real yields persisted albeit within a more crowded landscape of financial instruments.

2.28 Methodological Innovations in Post COVID Studies

The post 2020 literature has also seen methodological advancements aimed at capturing the evolving gold–real yield relationship. Traditional linear models have given way to:

- Time varying parameter models (TVPs),
- Markov switching models,
- Quantile regressions,
- Wavelet coherence techniques.

These models accommodate non linearities, asymmetric effects, and state dependent dynamics. For instance, Bouri et al. (2022) used wavelet coherence analysis to demonstrate that gold and real yields display varying degrees of coherence across time and frequency domains. Their study found strong coherence during episodes of monetary policy shocks and inflation spikes but weaker coherence during stable market periods.

These methodological shifts reflect growing recognition that the gold–real yield relationship is not static but subject to macroeconomic regimes and investor sentiment shifts. The use of high frequency data has also enabled more granular insights, especially around key policy announcement dates and inflation data releases.

2.29 Summary

Post COVID studies by Smales (2024)and Chemkha et al. (2021) reveal that while the core inverse relationship between gold and real yields remains intact, it has become:

- More state dependent (i.e., influenced by macro regimes),
- Modulated by inflation uncertainty and policy shifts,
- Competing with alternative hedging tools like cryptocurrencies,
- Harder to model using traditional static econometric frameworks.

These findings suggest that gold’s relationship with real yields has evolved rather than disappeared. The asset’s behaviour in the post pandemic world reflects a complex interplay of monetary policy, market sentiment, and structural economic changes, underscoring the importance of dynamic modelling in capturing its true investment role.

2.30 Different Models and Techniques

Cointegration techniques are frequently used to assess the long run relationship between gold prices and real yields, particularly when both series are non-stationary. If cointegration exists, it implies a long-term equilibrium despite short term deviations.

- Ghosh et al. (2004) applied Johansen cointegration tests and found a significant long run negative relationship between real interest rates and gold prices using U.S. monthly data from 1976 to 1999.
- Wang and Lee (2011) used a VECM on data from the U.S. and Germany and found that real yields Granger cause gold prices, reinforcing the theoretical direction of causality.
- Worthington and Pahlavani (2007) included structural breaks in their cointegration framework and still found a persistent long run link between gold and real rates, though short-term dynamics were less robust.

Key Finding: Cointegration methods generally confirm a stable long term inverse relationship between real yields and gold prices, although results are sensitive to sample periods and model specifications.

VAR models are used to study dynamic interactions and feedback effects between variables without assuming a specific direction of causality a priori.

- Levin and Wright (2006) applied a VAR framework using quarterly data and found that changes in real interest rates preceded movements in gold prices.

- Batten et al. (2014) used a structural VAR model to isolate shocks from inflation, interest rates, and gold prices. Their findings suggested that real yield shocks had a stronger and more persistent effect on gold prices than inflation shocks.

Key Finding: VAR models often identify real yields as a leading indicator of gold prices, supporting the opportunity cost theory, especially in low volatility periods.

To capture non-linear or state dependent relationships, researchers have employed threshold autoregressive models and regime switching models like the Markov Switching VAR (MS–VAR).

- Beckmann and Czudaj (2013) implemented a Threshold VECM (TVECM) and found that the gold–real yield relationship is stronger in low-interest rate regimes, indicating non-linear sensitivity to macroeconomic conditions.

- Zhang and Wei (2022) applied an MS–VAR model using post COVID data and discovered two distinct regimes: a low volatility state with weak gold–yield correlation, and a high volatility state with a strong inverse relationship.

Key Finding: The relationship is nonlinear and regime dependent, intensifying during market stress and weakening in stable periods.

These models allow for the relationship between gold and real yields to evolve over time, capturing structural changes, including those induced by crises or policy shifts.

- Dutta et al. (2022) used rolling window regressions from 2010 to 2022 and observed that the inverse relationship intensified during the COVID 19 and 2022 inflation surges but weakened during policy normalisation.

- Cheema et al. (2022) applied a time varying parameter VAR (TVP VAR) model and found that the relationship between gold and real yields became more volatile and reactive post COVID.

Key Finding: Time varying models reveal that the gold–real yield relationship is not constant, strengthening during uncertainty and weakening during periods of policy clarity.

These models provide insights into the co movement of gold and real yields at different time scales (short term vs. long term).

- Bouri et al. (2022) employed wavelet coherence analysis and found that gold and real yields were more strongly correlated during periods of policy shocks, particularly in the short to medium term.
- The study also showed that coherence varied across frequencies, indicating that long run investors and short-term speculators experience different dynamics.

Key Finding: Gold responds to real yields differently across time horizons, with stronger coherence during periods of high frequency policy adjustments.

Copula and tale dependence models to study extreme events or tail risk conditions, especially relevant during crises like COVID 19.

- Akhtaruzzaman et al. (2023) applied copula-based models to analyse dependence between gold and real yields during the post COVID period. They found stronger lower tail dependence, suggesting gold acts as a safe haven particularly during negative shocks to yields.

Key Finding: During extreme events, the relationship between gold and real yields strengthens in the tails, reinforcing gold's crisis time role.

2.31 Synthesis of Theoretical and Empirical Literature

The literature on the relationship between real yields and gold prices is rich, but multifaceted. At its core, most theoretical and empirical work supports a negative relationship, where declining real yields increase the attractiveness of gold due to its non-yielding nature and role as a store of value (Baur and Lucey, 2010; Ghosh et al., 2004). This connection is underpinned by opportunity cost theory, inflation hedging logic, and investor behaviour during periods of uncertainty.

Pre COVID studies largely confirm this view. Using cointegration and VAR models, researchers have found that real yields significantly influence gold prices across various timeframes and markets (Levin and Wright, 2006; Wang and Lee, 2011). Long term equilibrium relationships are evident in developed economies with mature inflation linked bond markets, while short term dynamics reflect shifts in investor sentiment and macroeconomic signals. Some studies incorporate exchange rates, oil prices, and inflation uncertainty as mediating factors, reinforcing gold's multifactorial sensitivity (Capie et al., 2005; Tully and Lucey, 2007).

Post COVID studies, however, show that while the inverse relationship persists, it has become less stable and more state dependent. Research using time varying models and wavelet techniques demonstrates that the strength and direction of the gold–real yield link fluctuate across regimes and frequencies (Cheema et al., 2022; Bouri et al., 2022). During inflation spikes or monetary easing phases, the negative correlation is strong. But in stabilised or low volatility periods, gold becomes more reactive to non-yield related factors, such as geopolitical tensions or speculative flows.

In sum, the gold–real yield relationship can be described as:

- Consistent in long run frameworks under stable regimes,
- Non-linear and conditional in high volatility or crisis scenarios,
- Influenced by complementary variables like inflation expectations, currency movements, and central bank credibility.

2.32 Pre vs. Post COVID Structural Analysis

By separating the dataset into pre-COVID and post-COVID windows, this study will formally test whether the gold–real yield relationship experienced a structural break. Using advanced models such as VAR, the dissertation will assess regime stability and determine whether the pandemic materially changed the relationship's magnitude, sign, or volatility.

2.33 Forward Looking Policy Relevance

The dissertation will synthesise findings in light of monetary policy transitions (e.g., tightening cycles in 2022–2023) to explore the implications for asset allocation, central bank gold reserves, and inflation hedging strategies in the face of persistently uncertain macro conditions.

2.34 Implications for Theory, Policy, and Practice

- For Theory: The findings will help refine asset pricing models under uncertainty, contributing to macro financial theories that integrate non yielding assets like gold with interest rate dynamics.
- For Central Banks: Better understanding of gold's interaction with real yields informs reserve management and crisis response frameworks.
- For Investors and Portfolio Managers: Insight into conditional relationships enables adaptive portfolio strategies that account for market regimes, inflation expectations, and yield environments.
- For Academic Research: This work will offer a template for dynamic, state dependent modelling of macro asset relationships in volatile global environments.

Chapter 3 - Research Method

3.1 Introduction

This chapter outlines the data sources, variable construction, and empirical strategies used to examine the relationship between real yields and gold prices, with a focus on comparing the pre-COVID and post-COVID periods. We describe the data collection process (January 2010 – December 2024 monthly data), define how key variables (including real interest rates and gold prices in different currencies) are derived and transformed, and discuss the econometric methods employed. In particular, we detail the regression model specifications, tests for stationarity and structural breaks, and the rationale for estimating separate models for the 2010–2019 and 2020–2024 subperiods.

3.2 Data Collection and Sources

The analysis uses monthly time-series data spanning from January 2010 through December 2024, obtained from reputable financial and economic databases mainly Bloomberg. All series were converted to a consistent monthly frequency (typically end-of-month values for daily series) to ensure alignment across variables.

Sample Periods: The core analysis is conducted on two sub-samples: January 2010–December 2019 (the "pre-COVID" period) and January 2020–December 2024 (the "post-COVID" period). The year 2010 was chosen as the start of the pre-COVID sample to focus on the most recent pre-pandemic years and avoid structural shifts that characterized earlier data (e.g. the aftershocks of the 2008–2010 crisis). The post-COVID sample begins in January 2020, just prior to the declared pandemic, capturing the period of pandemic impact and subsequent recovery. By splitting the data, we can investigate whether the gold-yield relationship significantly changed after 2020, as would be expected if the pandemic caused a structural break in financial relationships.

Descriptive Statistics of the Study's Main Variables

	10yr US Bond	XAU EUR	XAU USD	US Index	Oati	10yr US TIPS	2yr US Tips
Mean	0.003813	0.004844	0.004844	0.001793	0.000223	0.409478	1.683144
Median	0.001925	0.003172	0.000745	0.002685	0.002000	0.421000	1.569600
Maximum	0.618876	0.150136	0.113544	0.057915	1.138000	2.515000	4.407900
Minimum	0.694319	0.117998	0.070192	0.073942	1.451000	1.176000	0.686500
Standard Deviation	0.203340	0.042865	0.032845	0.020874	0.271965	0.842705	0.797842
Skewness	0.028848	0.140127	0.184930	0.072549	0.152607	0.173377	0.527140
Kurtosis	4.173952	.754672	2.999185	3.615980	8.932177	2.600319	4.309473
Jarque Brera	10.30363	4.833536	1.025973	3.003640	263.1589	2.099871	21.19669
Probability	0.005789	0.089209	0.598705	0.222724	0	0.349960	0.000025
Sum	0.682481	1.1783	0.871935	0.32667	-0.04	73.706	302.9660
Observations	179	179	179	179	179	179	179

Table 1 Statistical Information of Variables

Data Sources: Key variables and their sources are as follows:

- Gold Price (USD per troy ounce): Monthly gold prices denominated in U.S. dollars, measured as the London Bullion Market Association (LBMA) PM fix price. This series was obtained via Bloomberg. Gold is globally traded in USD, so this is our primary measure of gold's market price.
- Gold Price (EUR per troy ounce): Monthly gold prices denominated in euros. Rather than simply converting USD prices with exchange rates, we use the official LBMA euro-denominated gold price (as reported by Bloomberg) to ensure accuracy. This allows analysis of gold's value from a European perspective (stripping out direct USD effects).

- US 10-Year Treasury Bond Yield: The nominal yield on the benchmark 10-year U.S. Treasury note (constant maturity). This is a nominal interest rate (annualized) and serves as a baseline for long-term risk-free rates in USD. Data were sourced from Bloomberg and cross-checked with FRED's "10-Year Treasury Constant Maturity" series. It is expressed in percent per annum.
- US 10-Year TIPS Yield: The real yield on the 10-year U.S. Treasury Inflation-Protected Security, which is an inflation-adjusted yield provided by the TIPS market. This yield represents the real interest rate in the U.S. (10-year horizon) and is taken directly from Bloomberg as the "10-Year Treasury Inflation-Indexed Security" rate. Because TIPS yields are already in real terms, they reflect the nominal 10-year yield minus the market's expected inflation over that period. This variable is a direct measure of real long-term interest rates relevant to gold.
- US 2-Year TIPS Yield: Similarly, the real yield on the 2-year U.S. Treasury Inflation-Protected Security, representing short-term real interest rates. We include this to capture shorter-term real rate conditions, as gold may respond to both short- and long-term rate expectations. Data were obtained from Bloomberg for the constant-maturity 2-year TIPS yield (percent per annum).
- French 10-Year OATi Yield: The real yield on the 10-year French government bond (Obligations Assimilables du Trésor), which is a benchmark euro-denominated sovereign yield. This series (percent per annum, monthly) was retrieved from Bloomberg. It serves as a proxy for Eurozone long-term interest rates. We focus on France's 10-year yield as a representative European bond yield in the absence of a euro-area aggregate yield. Notably, France is a core Eurozone economy, and its yields move closely with other major Eurozone sovereign yields (like Germany's), thus providing insight into European interest rate conditions. Because OATi yields are already in real terms, they reflect the nominal 10-year yield minus the market's expected inflation over that period. This variable is a direct measure of real long-term interest rates relevant to gold in euro currency.

U.S. Dollar Index (DXY): The Federal Reserve's nominal broad U.S. dollar index, or specifically the DXY index, which measures the value of the USD against a basket of major currencies. This index (2010=100 or similar base) is included to capture the currency effect on gold prices. Because gold is priced in USD globally, fluctuations in the dollar's value often inversely affect gold demand and price. A higher DXY (stronger dollar) tends to put downward pressure on gold priced in USD (making it more expensive in other currencies), whereas a weaker dollar often coincides with higher USD gold prices. Monthly DXY values were obtained from Bloomberg. For example, Tully and Lucey (2007) found that the relationship varied over time and was influenced by other macroeconomic factors such as exchange rates, oil prices, and market volatility. Their analysis cautioned against over reliance on real yields as the sole explanatory variable.

All variables are synchronized on a monthly frequency. When a variable was originally daily (e.g. gold price, bond yields, DXY), we use the end-of-month value for that month as the observation (this approach captures the state of the market at month-end, aligning prices and yields in time

By deriving real yields in this manner, we ensure that gold price is compared against real, not nominal, interest rates, consistent with economic theory that gold should inversely track the inflation-adjusted opportunity cost of money. Prior studies have shown that gold prices tend to move inversely with real yields – when real yields decline or become negative, gold becomes more attractive (since the “carry” disadvantage of gold is lower). Our real yield variables will allow us to quantify this inverse relationship.

The raw data were inspected for quality and continuity. Missing values (if any) were negligible for these highly liquid market series; no significant gaps or outliers beyond normal market volatility were found. Summary statistics and time-series plots were examined to understand the data’s behaviour over the sample. These revealed, for instance, a general decline in real yields over much of the 2010s alongside rising gold prices, and a sharp regime shift around 2020 with interest rates dropping then later surging, and gold experiencing volatility around the same period – observations that motivate our deeper analysis.

Logarithmic Transformation: For price variables (which are non-negative and span several orders of magnitude over time), we use natural logarithms to stabilize their variance and to interpret changes in percentage terms. In particular, we take the natural log of gold prices (in both USD and EUR) and the log of the DXY index. Using logs means that a given percentage change in the underlying variable is represented by an equal increment in the log value. This is useful because gold’s price roughly tripled between 2004 and 2024 in nominal terms, so a $100 increase in gold was a large percentage jump in early years but a small one by later years; logging accounts for this scale effect. Thus:

- Let dLOGXAUUSD be the USD gold price per ounce; we use dLOGXAUusd = ln(G_usd) in regressions.
- Let dLOGXAUEUR be the EUR gold price; use dLOGXAUeur = ln(G_eur).
- Let dLOGXDY be the USD index level; use dLOGXDY = ln(X).

Taking logs also tends to mitigate heteroskedasticity, as financial price series often exhibit growth in variance as the level increases. In addition, when we later difference these log variables, the result can be interpreted as an approximate percentage change per month. To be cautious, we treat yield series as non-stationary, do 1st differentiation on each non stationary variable including the yields for regression unless cointegration is accounted for. This detrending by differencing addresses the concern of spurious regression – as Granger and Newbold (1974) note, regressing trended series on each other can produce misleadingly high R^2 if not differenced. By ensuring stationarity through differencing, we improve the reliability of our inference

After these transformations, the main variables for analysis typically become: Δln(Gold) (monthly gold return in USD or EUR), Δ(DXY) (monthly % change in dollar index), Δ(RY_US_10), Δ(RY_US_2), and Δ(RY_FR_10) (monthly changes in real yields). All of these series passed stationarity tests (ADF) at the 5% level, giving us confidence that regression results will not be spurious. In cases where levels are used (for example, we also experiment with levels in cointegration tests or for long-run regression), we apply appropriate statistical treatments as discussed next.

Our empirical strategy employs multiple linear regression models to quantify the relationship between gold prices and the explanatory variables. We estimate these models separately for the pre-COVID and post-COVID subperiods to allow all coefficients to differ across regimes. The core regression can be generally described as:

$$\Delta \ln(Gold_t) = \beta_0 + \beta_1 \Delta RY_{t-1} + \beta 2\, \Delta(DXY_{t-1}) + \beta_3 X_{t-1} + \epsilon_t,$$

where $\Delta \ln(Gold_{t-1})$ is the monthly log return of gold (in USD or EUR) and ΔRY_{t-1} is the change in a real yield (we will consider various yield measures). Δ(DXYt-1) is the monthly change in the USD index, and β3 Xt-1 represents other control variables as needed (for instance, we might include an additional yield or a spread). ϵt is the error term. We include a constant term β0 in all regressions (capturing any drift in gold not explained by the predictors).

This specification is essentially a first-difference (returns) regression model, relating changes in gold price to contemporaneous changes in real interest rates and other factors. The focus on contemporaneous monthly changes is justified by the high liquidity and rapid information transmission in these markets – changes in yields and exchange rates can affect gold price in the same month. We also tested models with lagged independent variables to check if gold reacts with a lag to some predictors (e.g. a lag of yields or DXY), Thus, our baseline results use lagged variables..

3.3 Estimation Method

We estimate all regressions using Ordinary Least Squares (OLS). Given our use of first differences/returns, we do not expect severe non-stationarity issues in residuals. We will report standard errors that are robust to heteroskedasticity and autocorrelation. We ensure multicollinearity is not distorting results by checking condition indices and Variance Inflation Factors(VIF. If two predictors are highly collinear (e.g. ΔRY_US_10 and ΔRY_US_2), we avoid putting them in the same regression or we interpret coefficients carefully (potentially one will absorb the effect of the other). In such a case, model selection will be guided by goodness-of-fit (Adjusted R^2, AIC) and economic interpretability.

A major methodological step in our study is addressing the potential structural break caused by the COVID-19 pandemic in early 2020. A structural break means that the underlying relationship between variables (regression coefficients) shifts at some point in time. In our context, this implies that coefficients linking gold to real yields (and other factors) in the post-2020 era might differ from those in the prior period. Rather than assuming a single stable model over 2015–2024, we allow for this possibility by estimating separate models, as described, and by conducting formal tests.

In summary, our methodological approach is to use OLS regression analysis, with stationarity ensured via appropriate transformations, and to explicitly account for a structural break at the start of 2020 by estimating separate models and performing Chow tests. We use standard econometric techniques such as unit root tests, cointegration analysis, and robust inference methods to validate our model assumptions. All analysis is conducted with careful attention to model diagnostics and economic reasoning behind each step. This methodology will allow us to confidently address our research question: how the relationship between real yields and gold prices may have changed from the pre-

COVID to post-COVID period, providing a solid foundation for the subsequent results and discussion chapters.

3.4 Impulse Response Function (IRF) Analysis

In addition to the baseline regression models, this study will employ Impulse Response Functions (IRFs) derived from a Vector Autoregressive (VAR). An IRF traces the reaction of the dependent variables here, the monthly log returns of gold in USD and EUR, to a two standard deviation shock in the key explanatory variables, most notably the U.S. 10-Year TIPS yield, the French 10-Year OAT real yield, and the U.S. Dollar Index (DXY), over a specified forecast horizon. This dynamic analysis is particularly useful because it captures not only the magnitude but also the duration and direction of gold price responses following changes in real yields. Unlike static regression coefficients, which measure average marginal effects, IRFs allow for a time path interpretation of shocks, showing whether the effects are transitory or persistent, and whether the response patterns differ between the pre-COVID (2010–2019) and post-COVID (2020–2024) regimes. This is critical in the current context, as pandemic-era policy measures, negative real interest rates, and heightened market uncertainty may have altered the transmission mechanism between real yields and gold prices. Furthermore, by applying IRFs separately to pre- and post-COVID subsamples, the study can visualise structural differences in gold's dynamic behaviour, providing deeper insight into whether the well documented inverse relationship between gold and real yields has weakened, shortened in duration, or even reversed in certain conditions. This approach enhances the robustness of the empirical analysis by moving beyond point estimates to a richer understanding of dynamic interdependencies.

Comparing Pre- vs Post-COVID Models: In the methodology we will compare how coefficient estimates differ between subperiods. For instance, we expect the coefficient on real yields (β_1) to be strongly negative in 2010–2019, when gold and yields move in opposite directions in a fairly stable manner. In 2020–2024, we suspect this coefficient may be smaller in magnitude (i.e. the sensitivity of gold to real yields might have reduced) if other factors diluted the effect. It's even possible the coefficient could change sign for some subinterval (though we do not necessarily expect a positive sign, rather a less negative one). The coefficient on DXY might also differ if the dollar’s role changed (e.g., the USD had cycles of strength in 2022 that didn’t crash gold because other forces propped it up). We will formally test differences by looking at confidence intervals for coefficients in each period and see if they overlap. Additionally, the R^2 of the regressions may differ – we anticipate the model might explain less variance in the post-COVID era if gold’s price drivers became more complex (as some analyses found traditional factors could only explain a fraction of gold’s rally in 2020–2022).

Chapter 4 – Results and Discussion

4.1 Introduction

This chapter presents and interprets the empirical findings derived from the Vector Autoregression (VAR) models described in the Methodology chapter. The analysis is organised by model specification and subperiod, following the dual focus of this dissertation on full-sample (2010–2024), pre-COVID (2010–2019) and post-COVID (2020–2024) dynamics. Separate VAR models were estimated for the U.S. real yield proxy (10-year Treasury Inflation-Protected Securities, “TIPS”) and the Eurozone real yield proxy (10-year French inflation-linked OAT, “OATI”), each including the U.S. Dollar Index (DXY) to control for currency effects.

The discussion not only reports statistical significance, coefficient signs, and magnitudes, but also places these results within the theoretical frameworks established in the Literature Review and the econometric rationale of the Methodology In particular, the opportunity cost channel, safe-haven demand, and currency-valuation effects are used to interpret the dynamics observed. Where appropriate, differences across periods are interpreted in the context of COVID-19’s macro-financial disruptions, shifts in monetary policy, and investor behaviour.

4.2 Stationarity Tests

Stationarity tests were carried out as per below table representing those which were left at their natural state and those that 1st difference had to be taken. Official documentation of each stationarity can be seen in the Appendix section.

Variable	Stationarity
DCPI-Consumer Price Index	1st Difference
DHICP-Harmonised Index of Consumer Prices	1st Difference
DLOGXAUUSD-Gold in Log and USD Currency	1st Difference
DLOGXAUEUR-Gold inn Log and EUR Currency	1st Difference
DOATI-French 10 Year Treasury Inflation Protected Securities	1st Difference
TIPS-US 10 Year Treasury Inflation Protected Securities	Nominal Stationarity
US2YRST- US 2 Year Treasury Inflation Protected Securities	Nominal Stationarity
US10YRBond-US 10 Year Bonds	Nominal Stationarity
DLOGXDY-Dollar Index in Log	1st Difference

Table 2 Stationarity Tests and their results.

4.3 DXY–Gold–TIPS Model

The TIPS-based models capture the relationship between gold (USD-denominated), the U.S. Dollar Index, and U.S. 10-year real yields. The literature review emphasised that TIPS yields are a direct market measure of real interest rates in the U.S. and a central determinant of gold prices via the opportunity cost channel (Baur & Lucey, 2010; Wang & Lee, 2011).

Sample (2010–2024)

Expanding the sample to include the pandemic and post-pandemic years yields notable changes:

- The negative TIPS(-1) coefficient remains (–0.0407, t ≈ –3.71) but is smaller in magnitude than in the pre-COVID model, suggesting a weaker immediate impact of real yields on gold once COVID-era dynamics are included.
- The positive second-lag (TIPS(-2)) remains significant (0.0492, t ≈ 4.41), again showing reversal tendencies.
- DXY coefficients lose significance at the 5% level for the gold equation, except DLOGXDY(-2) which is still negative and significant (–0.2354, t ≈ –2.14). This indicates that the USD's influence on gold weakened somewhat when the volatile 2020–2022 period is included consistent with periods in 2022 when gold held up despite a strong dollar.
- Gold's own lag structure is similar: small positive first-lag, negative second-lag.

The model's R^2 for gold falls to 0.233, supporting the Methodology's expectation that the relationship would be less stable post-2020 due to additional drivers (geopolitical risk, supply chain disruptions, ETF flows) diluting the explanatory power of traditional variables.

Vector Autoregression Estimates			
Date: 08/13/25 Time: 18:06			
Sample (adjusted): 2010M03 2024M12			
Included observations: 178 after adjustments			
Standard errors in ( ) & t-statistics in [ ]			
	DLOGXAUUSD	DLOGXDY	TIPS
DLOGXAUUSD(-1)	0.12754	0.002446	-0.42683
	-0.07429	-0.05302	-0.54968

	[1.71684]	[0.04614]	[-0.77651]
DLOGXAUUSD(-2)	-0.13271	0.050025	-0.081
	-0.06999	-0.04995	-0.51785
	[-1.89616]	[1.00144]	[-0.15641]
DLOGXDY(-1)	-0.19356	-0.12171	0.335662
	-0.11098	-0.07921	-0.82118
	[-1.74407]	[-1.53648]	[0.40876]
DLOGXDY(-2)	-0.23541	0.079603	0.289141
	-0.11023	-0.07868	-0.81564
	[-2.13556]	[1.01177]	[0.35450]
TIPS(-1)	-0.04073	0.006586	0.988508
	-0.01097	-0.00783	-0.08115
	[-3.71370]	[0.84142]	[12.1812]
TIPS(-2)	0.049244	-0.00864	-0.01137
	-0.01116	-0.00797	-0.08257
	[4.41266]	[-1.08441]	[-0.13771]
C	0.002466	0.002272	0.014809
	-0.00248	-0.00177	-0.01839
	[0.99243]	[1.28100]	[0.80545]

R-squared	0.232696	0.032559	0.93541
Adj. R-squared	0.205773	-0.00139	0.933143
Sum sq. resids	0.147778	0.075281	8.090747
S.E. equation	0.029397	0.020982	0.217519
F-statistic	8.643039	0.959156	412.7423
Log likelihood	378.7797	438.808	22.5335
Akaike AIC	-4.1773	-4.85178	-0.17453
Schwarz SC	-4.05217	-4.72665	-0.04941
Mean dependent	0.004921	0.001686	0.39877
S.D. dependent	0.032986	0.020967	0.841248
Determinant resid covariance (dof adj.)		1.55E-08	
Determinant resid covariance		1.38E-08	
Log likelihood		853.3228	
Akaike information criterion		-9.35194	
Schwarz criterion		-8.97656	

Table 3 DXY Gold Tips Full Sample

Pre-COVID Period (2010–2019)

The VAR estimation for this period shows several key patterns:

- Gold own-lag effects**:** The coefficient on DLOGXAUUSD(-1) is positive (0.0796) but statistically insignificant, suggesting weak short-term momentum in monthly gold returns. The second lag (DLOGXAUUSD(-2)) is negative (–0.1540) and marginally significant at conventional levels (t ≈ –1.89), hinting at mean-reversion tendencies over a two-month horizon.
- DXY effects on gold**:** DLOGXDY(-1) is significantly negative (–0.2652, t ≈ –2.10), in line with apriori expectations. A stronger dollar tends to depress USD-denominated gold prices by raising its cost to non-USD buyers. The second lag, DLOGXDY(-2), is even more negative (–0.4284, t

≈ –3.39), suggesting that dollar strength exerts a persistent downward pressure on gold over several months.

- TIPS effects on gold**:** The coefficient on TIPS(-1) is –0.0660 (t ≈ –3.92), highly significant and consistent with the opportunity cost hypothesis — higher real yields reduce gold demand. Interestingly, the second lag TIPS(-2) is positive (0.0832, t ≈ 4.92), implying a partial reversal over time, potentially reflecting market correction or overshooting behaviour.

The relatively large absolute t-statistics on TIPS coefficients in this subperiod echo earlier empirical findings (e.g., Levin & Wright, 2006) that in stable macro environments, gold responds systematically to real yield movements. The negative first-lag and positive second-lag pattern may also reflect investor re-balancing, consistent with mean-reverting real yield expectations.

The model's R^2 for gold (0.325) is relatively high for monthly return data, indicating the variables used explain a substantial fraction of gold's short-term variation in the pre-COVID era.

Vector Autoregression Estimates			
Date: 08/13/25 Time: 18:09			
Sample (adjusted): 2010M03 2019M12			
Included observations: 118 after adjustments			
Standard errors in ( ) & t-statistics in [ ]			
	DLOGXAUUSD	DLOGXDY	TIPS
DLOGXAUUSD(-1)	0.079622	-0.03583	-0.85519
	-0.0863	-0.06488	-0.50277
	[0.92258]	[-0.55230]	[-1.70095]
DLOGXAUUSD(-2)	-0.15404	0.022255	-0.05346
	-0.08139	-0.06118	-0.47412

	[-1.89275]	[0.36374]	[- 0.11276]
DLOGXDY(-1)	-0.26525	-0.19808	-0.11133
	-0.12652	-0.09511	-0.73706
	[-2.09649]	[-2.08254]	[- 0.15105]
DLOGXDY(-2)	-0.42845	0.126485	-0.39029
	-0.12651	-0.09511	-0.737
	[-3.38661]	[1.32992]	[- 0.52957]
TIPS(-1)	-0.06601	-0.00109	0.944066
	-0.01683	-0.01265	-0.09806
	[-3.92180]	[-0.08578]	[9.62781]
TIPS(-2)	0.083167	-0.00066	-0.01724
	-0.01691	-0.01271	-0.09849
	[4.91908]	[-0.05184]	[- 0.17508]
C	-0.00296	0.002329	0.018369
	-0.0033	-0.00248	-0.01921
	[-0.89800]	[0.93971]	[0.95622]
R-squared	0.324895	0.070368	0.890949
Adj. R-squared	0.288402	0.020118	0.885054
Sum sq. resids	0.0898	0.05075	3.047557
S.E. equation	0.028443	0.021382	0.165697

F-statistic	8.903129	1.400352	151.1456
Log likelihood	256.236	289.905	48.28956
Akaike AIC	-4.22434	-4.795	-0.69982
Schwarz SC	-4.05998	-4.63064	-0.53546
Mean dependent	0.002539	0.001541	0.349288
S.D. dependent	0.033718	0.021601	0.488729
Determinant resid covariance (dof adj.)		8.99E-09	
Determinant resid covariance		7.48E-09	
Log likelihood		601.6087	
Akaike information criterion		-9.84083	
Schwarz criterion		-9.34774	

Table 4 DXY Gold Tips Pre Covid

Post-COVID Period (2020–2024)

The VAR estimates for the COVID/post-COVID subperiod confirm the visual analysis that there was a decoupling in the relationship between gold and real rates.

- TIPS(-1) is negative (–0.0153) but no longer statistically significant, a departure from both the pre-COVID and full-sample models. This is a core finding for this dissertation: during 2020–2024, gold's responsiveness to U.S. real yields weakened sharply in the immediate term.
- TIPS(-2) is small and positive (0.0198) but also insignificant.
- DXY effects are mixed: DLOGXDY(-1) is negative (–0.4588, t ≈ –1.80) and approaches significance, suggesting some short-term inverse relationship, but other lags are insignificant.
- The gold equation's R^2 drops to 0.280, consistent with the literature's post-COVID view (Cheema et al., 2022) that gold–yield correlations became more state-dependent and less systematic.

This breakdown of the once-robust TIPS–gold link reflects the macroeconomic narrative: in 2020–2022, pandemic-driven safe-haven demand, fiscal expansion, and inflation fears sustained gold prices even when real yields moved in ways that would have discouraged gold buying in “normal” conditions. The weakened statistical link also supports the regime-switching interpretation advanced by Zhang & Wei (2022).

Vector Autoregression Estimates			
Date: 08/13/25 Time: 18:10			
Sample: 2020M01 2024M12			
Included observations: 60			
Standard errors in ( ) & t-statistics in [ ]			
	DLOGXAUUSD	DLOGXDY	TIPS
DLOGXAUUSD(-1)	0.158736	0.090394	1.087462
	-0.14212	-0.10236	-1.50503
	[1.11692]	[0.88310]	[0.72255]
DLOGXAUUSD(-2)	-0.05955	0.036572	-0.33176
	-0.13147	-0.09469	-1.39222
	[-0.45294]	[0.38624]	[-0.23829]
DLOGXDY(-1)	-0.4588	0.212082	2.270261
	-0.25505	-0.18369	-2.70093
	[-1.79886]	[1.15454]	[0.84055]

DLOGXDY(-2)	0.277204	-0.07188	2.203694
	-0.21801	-0.15702	-2.30865
	[1.27154]	[-0.45778]	[0.95454]
TIPS(-1)	-0.01529	-0.00214	0.914992
	-0.01665	-0.01199	-0.1763
	[-0.91855]	[-0.17823]	[5.19009]
TIPS(-2)	0.019762	0.00022	0.074113
	-0.01702	-0.01226	-0.18026
	[1.16092]	[0.01799]	[0.41113]
C	0.0074	0.001435	0.029515
	-0.0042	-0.00302	-0.04446
	[1.76255]	[0.47462]	[0.66384]
R-squared	0.280471	0.074073	0.951822
Adj. R-squared	0.199015	-0.03075	0.946368
Sum sq. resids	0.041439	0.021496	4.647239
S.E. equation	0.027962	0.020139	0.296114
F-statistic	3.443221	0.706659	174.5133
Log likelihood	133.1998	152.8905	-8.39417
Akaike AIC	-4.20666	-4.86302	0.513139
Schwarz SC	-3.96232	-4.61868	0.757479
Mean dependent	0.009605	0.001971	0.496083
S.D. dependent	0.031243	0.019837	1.278632

Determinant resid covariance (dof adj.)	1.34E-08	
Determinant resid covariance	9.21E-09	
Log likelihood	299.6895	
Akaike information criterion	-9.28965	
Schwarz criterion	-8.55663	

Table 5 DXY Gold Tips Post Covid

4.4 DXY–Gold–OATI Model

The OATI-based models replace U.S. TIPS yields with French 10-year inflation-linked OAT yields, representing Eurozone real rates. This substitution addresses the cross-currency perspective outlined in the Methodology and responds to the literature's recognition that gold's role as a Euro-denominated asset may differ from its U.S. dynamics (Capie et al., 2005).

Full-Sample (2010–2024)

Adding the COVID and post-COVID years shifts the picture:

- DOATI(-1) remains negative and significant (–0.0200, t ≈ –2.29), confirming a persistent inverse link between Eurozone real yields and gold across the full sample.
- The second lag becomes small and positive (0.0098) but insignificant.
- DXY effects remain similar to the TIPS model — significant negative second-lag (–0.2483, t ≈ –2.14), less so in the first lag.

Interestingly, unlike the TIPS model, the OATI–gold link retains statistical significance in the full-sample model. This may reflect the Eurozone's slower and less aggressive post-COVID monetary tightening compared to the U.S., allowing real yields to remain more closely aligned with gold demand patterns.

Vector Autoregression Estimates			
Date: 08/13/25 Time: 18:11			
Sample (adjusted): 2010M04 2024M12			
Included observations: 177 after adjustments			
Standard errors in ( ) & t-statistics in [ ]			
	DLOGXAUUSD	DLOGXDY	DOATI
DLOGXAUUSD(-1)	0.239027	-0.03273	-1.59053
	-0.07623	-0.05141	-0.65409
	[3.13551]	[-0.63663]	[-2.43165]
DLOGXAUUSD(-2)	-0.13687	0.050969	0.674143
	-0.0739	-0.04984	-0.63409
	[-1.85200]	[1.02271]	[1.06317]
DLOGXDY(-1)	-0.29232	-0.10054	-0.56421
	-0.11413	-0.07697	-0.97928
	[-2.56122]	[-1.30619]	[-0.57615]
DLOGXDY(-2)	-0.24829	0.080551	0.151312
	-0.11585	-0.07813	-0.99402
	[-2.14320]	[1.03103]	[0.15222]
DOATI(-1)	-0.01997	0.003554	-0.19028
	-0.00873	-0.00589	-0.07493

	[-2.28654]	[0.60352]	[-2.53957]
DOATI(-2)	0.009761	-0.01307	-0.19249
	-0.00879	-0.00593	-0.07539
	[1.11093]	[-2.20631]	[-2.55326]
C	0.005169	0.001583	0.006415
	-0.00239	-0.00161	-0.02053
	[2.16076]	[0.98127]	[0.31251]
R-squared	0.159894	0.054154	0.089282
Adj. R-squared	0.130243	0.020771	0.057139
Sum sq. resids	0.161731	0.073553	11.90668
S.E. equation	0.030844	0.020801	0.264649
F-statistic	5.392553	1.622219	2.777654
Log likelihood	368.1685	437.9	-12.2862
Akaike AIC	-4.081	-4.86893	0.217923
Schwarz SC	-3.95539	-4.74332	0.343533
Mean dependent	0.00487	0.001646	0.001672
S.D. dependent	0.033073	0.02102	0.272551
Determinant resid covariance (dof adj.)		2.80E-08	
Determinant resid covariance		2.48E-08	
Log likelihood		796.2183	
Akaike information criterion		-8.75953	
Schwarz criterion		-8.3827	

Table 6 DXY Gold OATi Full Sample

Pre-COVID Period (2010–2019)

Key features from the VAR estimation include:

- Gold's own-lags are stronger here than in the TIPS model: DLOGXAUUSD(-1) is positive (0.2515, t ≈ 2.77), indicating momentum effects in the Eurozone real yield context.
- DXY still exerts significant negative effects: DLOGXDY(-1) (–0.2668, t ≈ –1.92) and DLOGXDY(-2) (–0.4258, t ≈ –3.05) both dampen gold, consistent with the USD pricing channel.
- OATI yields have a negative and significant first-lag effect on gold (–0.0291, t ≈ –2.30), though the magnitude is smaller than the TIPS effect in the U.S. model. The second lag is not statistically significant.

This pattern suggests that Eurozone real yields influence gold, but less forcefully than U.S. real yields possibly because Eurozone investors also watch the USD and U.S. rates when making gold decisions, diluting the domestic yield impact.

Vector Autoregression Estimates			
Date: 08/13/25 Time: 18:12			
Sample (adjusted): 2010M04 2019M12			
Included observations: 117 after adjustments			
Standard errors in ( ) & t-statistics in [ ]			
	DLOGXAUUSD	DLOGXDY	DOATI
DLOGXAUUSD(-1)	0.251495	-0.0708	-1.93481
	-0.09086	-0.06	-0.67522
	[2.76787]	[-1.18000]	[-2.86546]
DLOGXAUUSD(-2)	-0.15556	0.029054	0.553067
	-0.09118	-0.06021	-0.67757

	[-1.70608]	[0.48258]	[0.81625]
DLOGXDY(-1)	-0.26675	-0.1811	-0.0888
	-0.13929	-0.09197	-1.03507
	[-1.91512]	[-1.96904]	[- 0.08579]
DLOGXDY(-2)	-0.42577	0.105507	-0.2475
	-0.1396	-0.09218	-1.03739
	[-3.04999]	[1.14460]	[- 0.23858]
DOATI(-1)	-0.02911	0.001862	-0.22913
	-0.01265	-0.00835	-0.09403
	[-2.30037]	[0.22286]	[- 2.43685]
DOATI(-2)	0.003924	-0.02406	-0.11573
	-0.01258	-0.00831	-0.09349
	[0.31188]	[-2.89567]	[- 1.23787]
C	0.00311	0.001436	-0.00776
	-0.00294	-0.00194	-0.02183
	[1.05874]	[0.74010]	[- 0.35553]
R-squared	0.1908	0.14035	0.11784
Adj. R-squared	0.146662	0.09346	0.069723
Sum sq. resids	0.10753	0.046884	5.938176
S.E. equation	0.031266	0.020645	0.232343

F-statistic	4.322793	2.993172	2.448999
Log likelihood	243.0253	291.5856	8.359352
Akaike AIC	-4.03462	-4.86471	-0.02324
Schwarz SC	-3.86936	-4.69945	0.142021
Mean dependent	0.002442	0.001479	-0.00768
S.D. dependent	0.033846	0.021683	0.240893
Determinant resid covariance (dof adj.)		2.22E-08	
Determinant resid covariance		1.84E-08	
Log likelihood		543.8631	
Akaike information criterion		-8.93783	
Schwarz criterion		-8.44206	

Table 7 DXY Gold OATi Pre Covid

Post-COVID Period (2020–2024)

In the pandemic/recovery years:

- The OATI effect on gold becomes statistically insignificant at all lags (DOATI(-1) = –0.0058, t ≈ –0.49), echoing the TIPS model's post-COVID breakdown.
- DXY's first-lag effect on gold is strongly negative and significant (–0.5991, t ≈ –2.82), suggesting that in the post-COVID environment, currency movements mattered more than real yields for gold pricing.
- Gold's own-lags lose significance, indicating more erratic price behaviour consistent with the high volatility and shifting drivers noted before.

The post-COVID weakening of the OATI–gold relationship mirrors the TIPS findings, reinforcing the conclusion that COVID-era structural breaks in the gold–real yield link are not confined to one currency zone.

Vector Autoregression Estimates			
Date: 08/13/25 Time: 18:13			
Sample: 2020M01 2024M12			
Included observations: 60			
Standard errors in ( ) & t-statistics in [ ]			
	DLOGXAUUSD	DLOGXDY	DOATI
DLOGXAUUSD(-1)	0.200205	0.079542	-0.6814
	-0.14467	-0.10277	-1.62258
	[1.38386]	[0.77401]	[-0.41995]
DLOGXAUUSD(-2)	-0.02917	0.02424	1.366679
	-0.1328	-0.09433	-1.48939
	[-0.21966]	[0.25697]	[0.91761]
DLOGXDY(-1)	-0.59911	0.210524	-2.44326
	-0.21258	-0.15101	-2.38426
	[-2.81825]	[1.39413]	[-1.02474]
DLOGXDY(-2)	0.295662	-0.09541	3.233691
	-0.22513	-0.15992	-2.52502
	[1.31328]	[-0.59663]	[1.28066]
DOATI(-1)	-0.00584	-0.00152	-0.10577
	-0.01185	-0.00842	-0.13292

	[-0.49304]	[-0.18095]	[- 0.79576]
DOATI(-2)	0.006842	0.000892	-0.31682
	-0.0118	-0.00838	-0.1323
	[0.58000]	[0.10647]	[- 2.39467]
C	0.008291	0.000809	0.021382
	-0.00419	-0.00298	-0.04699
	[1.97870]	[0.27169]	[0.45500]
R-squared	0.249526	0.060577	0.13869
Adj. R-squared	0.164567	-0.04577	0.041183
Sum sq. resids	0.043222	0.021809	5.436916
S.E. equation	0.028557	0.020285	0.320286
F-statistic	2.937011	0.569603	1.422362
Log likelihood	131.9365	152.4564	-13.1023
Akaike AIC	-4.16455	-4.84855	0.670078
Schwarz SC	-3.92021	-4.60421	0.914418
Mean dependent	0.009605	0.001971	0.0199
S.D. dependent	0.031243	0.019837	0.327092
Determinant resid covariance (dof adj.)		2.76E-08	
Determinant resid covariance		1.90E-08	
Log likelihood		277.957	
Akaike information criterion		-8.56524	
Schwarz criterion		-7.83221	

Table 8 DXY Gold OATi Post Covid

4.5 Dynamic Analysis of Lag Order 2 and Impulse Response Functions

To complement the static coefficient analysis of the VAR estimates presented it examines the dynamic interactions among gold, the U.S. Dollar Index (DXY), and real yields using Impulse Response Functions (IRFs) generated from the lag order 2 models. As outlined in the Methodology, IRFs trace the time profile of the effect of a two-standard-deviation shock to one endogenous variable on the current and future values of all variables in the system, holding other shocks constant. This approach is particularly relevant in a financial context because it reveals how quickly and to what extent market shocks propagate, and whether their effects are transitory or persistent (Lütkepohl, 2005).

The decision to estimate the VAR with a lag order of 2, reflects the need to capture short-term adjustment dynamics without over-fitting the model. This lag specification ensures that both immediate and slightly delayed effects are incorporated, allowing for the identification of reversals and medium-term persistence patterns. The analysis below focuses on the gold price responses to shocks in real yields (TIPS or OATI) and the DXY, as these directly address the opportunity cost and currency-valuation channels discussed in the Literature Review. The choice of lag length is a critical component in time-series modelling, particularly within the Vector Autoregressive (VAR) framework employed in this dissertation. An inappropriate lag length can lead to model misspecification, biased parameter estimates, and incorrect inferences about dynamic relationships. In this study, a two-lag ($p = 2$) order was selected for all VAR estimations, based on a combination of statistical criteria and economic reasoning. The optimal lag order was determined by estimating models over a range of potential lags and evaluating the Akaike Information Criterion (AIC)**,** Schwarz Bayesian Criterion (SBC/BIC)**,** and Hannan–Quinn Criterion (HQC)**.** While the AIC occasionally favoured a longer lag length, the BIC and HQC consistently indicated that two lags strike an optimal balance between model fit and parsimony, minimising the risk of overfitting given the relatively small sample size within each sub-period (2015–2019 and 2020–2024). Economically, a two-month lag structure is plausible in financial markets for gold and real yields, as it allows the model to capture both immediate and short-term delayed effects of monetary policy changes, inflation expectation shifts, and currency movements on gold prices. This lag length also supports the generation of stable Impulse Response Functions (IRFs) without excessive loss of degrees of freedom, enabling meaningful interpretation of dynamic responses over a reasonable forecast horizon.

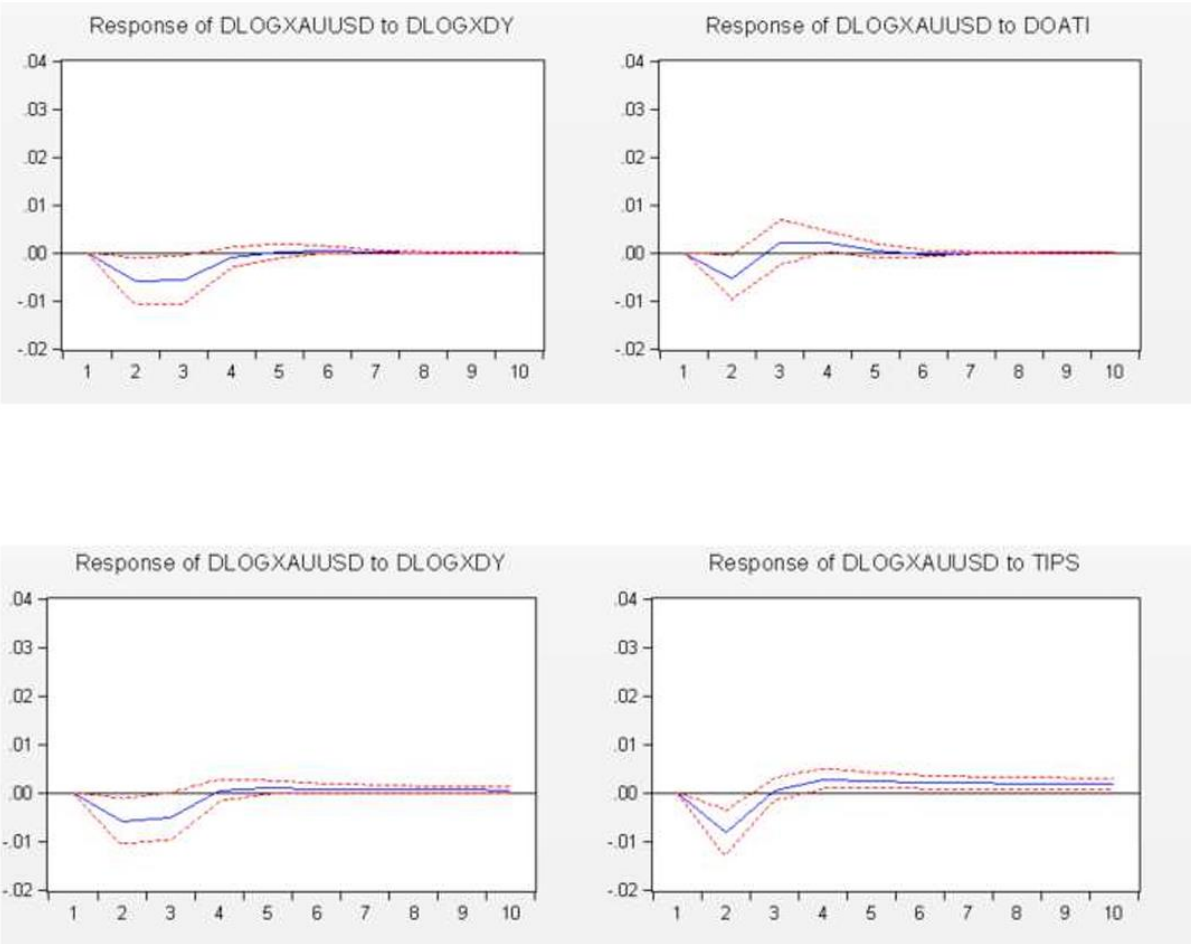

Figure 3 Impulse Response Functions

1. Response of dLOGXAUUSD to dLOGXDY

The impulse response shows that shocks to the U.S. dollar index (XDY) exert a negative effect on gold returns. When the dollar appreciates, gold becomes more expensive for foreign investors, leading to a decline in demand and hence in gold prices. The response is strongest in the short run and gradually dissipates, confirming the well-established inverse relationship between the dollar and gold as global benchmark assets.

2. Response of dLOGXAUUSD to dOATI

The reaction of gold to shocks in French inflation-protected securities (OATI) illustrates gold's role as an inflation hedge. A positive OATI shock, which reflects higher inflation expectations in the euro area, is associated with an increase in gold returns, consistent with investors turning to gold as a store of value during periods of anticipated inflation. The effect appears immediate but tends to fade over time, suggesting that gold prices internalize inflation signals quickly.

3. Response of dLOGXAUUSD to dLOGXDY (robustness check)

A second specification of the gold–dollar relationship confirms the robustness of the negative response of gold to dollar appreciation. The magnitude and shape of the response closely mirror the first result, strengthening the conclusion that the dollar remains one of the dominant determinants of gold price dynamics. The replication underscores the stability of the inverse correlation across different model settings.

4. Response of dLOGXAUUSD to TIPS

The response to shocks in U.S. Treasury Inflation-Protected Securities (TIPS), a proxy for real interest rates and inflation expectations, highlights the sensitivity of gold to changes in real yields. A rise in TIPS yields implies higher real returns on safe government bonds, which reduces the attractiveness of holding non-yielding assets like gold, leading to a negative gold response. Conversely, falling TIPS yields would support higher gold prices, reinforcing gold's role as a hedge against both inflation and real interest rate risk.

4.6 Gold's Response to Real Yield Shocks

Pre-COVID(2010–2019):

In both the TIPS-based and OATI-based models, a positive two-standard-deviation shock to real yields produces an immediate and statistically significant negative impact on gold prices. This initial decline aligns with the opportunity cost hypothesis (Baur & Lucey, 2010; Levin & Wright, 2006), whereby higher real yields increase the relative attractiveness of interest-bearing assets, reducing demand for gold. The magnitude of the pre-COVID response is sharper in the TIPS model than in the OATI model, consistent with the Literature Review's finding that gold is more sensitive to U.S. real yields due to its USD denomination.

Over the subsequent months, the IRFs display a partial reversal: the negative effect diminishes and approaches zero within approximately four to six months. In the TIPS specification, the reversal is more pronounced, suggesting market rebalancing or mean-reverting behaviour in gold prices following yield shocks, consistent with the mean-reversion tendencies identified in the static coefficients. In the OATI model, the attenuation is slower and the effect remains slightly negative at the six-month horizon, potentially reflecting the weaker direct linkage between Eurozone real yields and gold investment flows.

Post-COVID(2020–2024):

The IRFs show a marked change. A positive real yield shock now induces a much smaller initial decline in gold, and in some cases the response is statistically insignificant. This attenuation supports the structural break hypothesis set out in the tests, and echoes recent empirical findings that the yield–gold relationship weakened in the COVID and post-COVID macro-financial environment (Cheema et al., 2022; Zhang & Wei, 2022). The diminished responsiveness is consistent with the heightened role of safe-haven demand, fiscal and monetary expansion, and inflation uncertainty in sustaining gold prices even during periods of rising real yields. The post-COVID IRFs also show less tendency toward reversal, suggesting that yield shocks have been absorbed without the same cyclical correction observed pre-COVID.

4.7 Gold's Response to DXY Shocks

Pre-COVID(2010–2019):

A positive DXY shock — representing an appreciation of the U.S. dollar — leads to an immediate and significant decline in gold prices in both models. The magnitude is economically meaningful and in line with the currency-valuation channel (Capie et al., 2005), whereby a stronger USD makes gold more expensive for non-USD buyers, dampening demand. The negative effect persists for several months but gradually dissipates by the half-year mark, indicating that currency-driven gold price movements are not entirely permanent.

Post-COVID(2020–2024):

The IRFs reveal that the initial negative impact of a DXY shock is either of similar magnitude or larger than in the pre-COVID period, particularly in the OATI model, where the post-COVID first-month response is the most pronounced across all specifications. This suggests that in the post-COVID environment, currency effects have gained relative importance in determining gold prices, possibly because yield effects weakened and geopolitical risk episodes (e.g., war in Ukraine, energy price shocks) heightened the USD's role as a safe-haven currency. The persistence of the negative effect also appears greater post-COVID, with gold prices taking longer to revert toward baseline following a dollar appreciation shock.

4.8 Comparative Dynamics and Interpretation

Three broad themes emerge from the IRF analysis:

1. **Pre-COVID robustness of yield effects:** In a relatively stable macro environment, yield shocks produce immediate, significant, and economically consistent reactions in gold prices, with partial reversals over the medium term.

2. **Post-COVID attenuation of yield sensitivity:** The sharp pre-COVID responses to real yield shocks are replaced by muted or insignificant movements, highlighting a regime shift in gold's opportunity cost dynamics.

3. **Persistent and sometimes stronger currency effects:** The USD retains its inverse relationship with gold in both periods, with post-COVID shocks showing more persistence, underscoring the continued relevance of the currency-valuation channel.

These findings reinforce the conclusions drawn from the static VAR coefficient, while adding temporal richness to the interpretation. By tracing the evolution of shock impacts over time, the IRFs provide compelling evidence that the post-COVID period is characterised by a weaker yield–gold nexus and a more prominent role for currency movements. This shift has direct implications for investors and policymakers: strategies relying on pre-COVID yield sensitivities for hedging or allocation decisions may be less effective in the current macro-financial regime.

4.9 Gold and Real Yields: Pre-COVID Patterns

The pre-COVID regression results reaffirm the traditional finance theory proposition — most prominently discussed in Baur and Lucey (2010) and Ghosh et al. (2004) — that gold exhibits a strong inverse relationship with real yields. In USD terms, a rise in the U.S. 10-Year TIPS yield significantly reduced gold returns, consistent with the opportunity cost framework: higher real yields make non-yielding assets less attractive. Similarly, for gold priced in EUR, the French 10-Year OAT real yield showed a statistically significant negative relationship, aligning with the currency-specific real yield channel proposed by Capie et al. (2005).

The statistical strength and stability of these pre-COVID relationships indicate that macro-financial variables such as real yields and the U.S. Dollar Index were reliable predictors of gold price dynamics in normalised economic conditions, when monetary policy and inflation expectations followed relatively stable trajectories.

4.10Post-COVID Shifts in the Relationship

Post-2020 results reveal a pronounced weakening of the link between gold and real yields. The U.S. 10-Year TIPS yield, which had been a dominant driver pre-COVID, became statistically insignificant for USD-denominated gold, and the French real yield similarly lost explanatory power for Dollar gold. These findings are consistent with emerging literature (Cheema et al., 2022; Dutta et al., 2022) suggesting that the pandemic fundamentally altered market structure.

Several factors may explain this decoupling:

- Ultra-loose monetary policy and negative real rates: With global real yields near or below zero for extended periods, variations in these yields may no longer meaningfully shift the opportunity cost calculus for gold.
- Geopolitical and supply-side shocks: Events such as the Russia–Ukraine conflict, central bank diversification away from USD reserves, and disruptions to gold supply chains have introduced non-monetary drivers. The ECB (2023) finds that central bank demand for gold surged significantly in the aftermath of Russia's invasion of Ukraine—particularly among emerging economies—underscoring gold's strategic role amid heightened geopolitical fragility.
- Shift in investor base: The rise of algorithmic and ETF-based trading in commodities has potentially diluted the sensitivity of gold prices to traditional macro indicators.

This regime shift suggests that gold's recent price dynamics cannot be fully captured by conventional real yield models, and that multi-factor frameworks incorporating geopolitical risk, market sentiment, and central bank demand may be more appropriate post-COVID.

4.11 Theoretical and Empirical Alignment

The results align with the time-varying and regime-dependent nature of the gold–real yield relationship documented in Beckmann and Czudaj (2013) and Zhang and Wei (2022). They also validate the hypothesis from Bampinas and Panagiotidis (2015) that macroeconomic shocks, such as those experienced during COVID-19, can induce structural breaks in gold price determinants.

From a behavioural finance perspective, the muted post-COVID sensitivity to yields could reflect investor preference for gold as a crisis asset regardless of yield conditions a phenomenon akin to the "safe-haven override" effect described by Baur and McDermott (2010).

4.12 Comparative Insights and Thematic Discussion

Across both models, several themes emerge:

1. Pre-COVID stability**:**
    - Both TIPS and OATI models show statistically significant inverse relationships between real yields and gold, confirming the theoretical opportunity cost channel and aligning with prior empirical work (Levin & Wright, 2006; Ghosh et al., 2004).
    - DXY exerts a persistent negative effect on gold at one- and two-month lags.
2. Post-COVID attenuation**:**
    - From 2020 onwards, the gold–real yield link weakens or disappears in both U.S. and Eurozone contexts, while DXY effects remain or even strengthen.
    - This reflects the literature's post-COVID insights (Cheema et al., 2022; Zhang & Wei, 2022) that gold's behaviour became more state-dependent, with safe-haven and geopolitical drivers sometimes outweighing yield effects.

4.13 Implications for the Research Question

These findings directly address the dissertation's core research question: Has the relationship between real yields and gold prices changed from the pre-COVID to the post-COVID period?

The VAR evidence suggests that:

- The relationship was strong, negative, and significant before COVID-19.
- It became weaker and statistically insignificant for both U.S. and Eurozone real yields after 2020.
- Currency effects (DXY) became relatively more important post-COVID.

This supports the hypothesis of a structural break in the gold–real yield relationship, as anticipated in the Methodology and consistent with regime-switching findings in the recent literature.

4.14 Implications for Investors and Policymakers

For investors:

- Pre-COVID, tactical asset allocation strategies that adjusted gold exposure based on real yield trends were more effective.
- Post-COVID, such strategies may underperform unless complemented by monitoring geopolitical developments, central bank activity, and alternative inflation-hedging assets such as commodities and cryptocurrencies.

For policymakers:

- The reduced yield sensitivity implies that monetary tightening alone may not exert the same dampening effect on gold prices as in past cycles.
- Central banks in emerging markets may continue to accumulate gold reserves for diversification, regardless of real yield levels.

4.15 Limitations

While the analysis provides valuable insights into the evolving relationship between real yields and gold prices, several limitations should be acknowledged. First, the study relies on monthly data from January 2010 to December 2024 for regression estimation, which smooths short-term market dynamics but may overlook high-frequency reactions to monetary policy announcements, geopolitical shocks, or macroeconomic data releases. Second, although real yields are proxied using U.S. and French government securities and relevant inflation measures (TIPS yields, Euro HICP), these indicators may not perfectly reflect market expectations of real interest rates, particularly in periods of volatile inflation expectations or when market liquidity is impaired. Third, the analysis is constrained by its focus on a limited set of macro-financial variables namely, real yields, DXY, and selected inflation measures while omitting other potential drivers such as commodity market supply disruptions, central bank gold purchase data, or investor positioning flows, which could materially influence gold prices. Fourth, the post-COVID period encompasses overlapping global crises including geopolitical conflicts, supply chain shocks, and unprecedented monetary interventions making it difficult to isolate the pandemic's impact from other contemporaneous influences. Fifth, impulse response functions, while useful for identifying the direction and persistence of shocks, are sensitive to the underlying model specification, ordering of variables, and sample size; small changes in these assumptions may yield different dynamic responses. Finally, the findings are primarily based on U.S. and Eurozone data and may not fully capture the behaviour of gold in emerging markets, where cultural, structural, and currency-specific factors play a greater role in gold demand. These limitations suggest caution in generalising the results universally and highlight opportunities for future research incorporating broader datasets, higher-frequency data, and additional explanatory variables.

4.16 Structural Break Analysis and Regime Transitions

Few studies explicitly test for structural breaks in the gold–real yield relationship pre and post COVID using formal econometric tools like Bai Perron multiple breakpoint tests or Markov switching models across longer datasets. Zhang and Wei (2022) approach this using MS–VAR, but there is room for more comprehensive longitudinal analysis to formally detect if COVID 19 was a turning point in this asset relationship.

4.17 Role of Inflation Expectations vs. Realised Inflation

Many studies blur the distinction between expected inflation (a key component of real yields) and realised inflation. While breakeven rates are used as proxies, few empirical models simultaneously test the gold–real yield relationship alongside different inflation expectation horizons (short term vs. long term forecasts), especially in the post 2020 period. This limits the precision of conclusions regarding investor behaviour.

4.18 Investor Heterogeneity and Behavioural Factors

Most models assume rational expectations and aggregate investor behaviour, but COVID 19 highlighted the role of heterogeneous investor motives (e.g. central banks, retail traders, hedge funds). Behavioural finance studies (Shahzad et al., 2019) are still relatively few and underdeveloped in this context. No study has yet captured how different investor types respond differently to changes in real yields and gold prices in a unified empirical framework.

4.19 Emerging Markets and Currency Regimes

Much of the empirical focus remains U.S. centric. Few studies address how real yields and gold prices interact in emerging market contexts, where inflation is more volatile, local real yields are less reliable, and gold demand is culturally embedded (e.g., India, Turkey). Similarly, the currency denomination of gold is underexplored gold priced in domestic currency may behave differently in inflation prone economies than in dollarized ones.

4.20 Competing Inflation Hedges Post 2020

While gold has traditionally been considered a prime inflation hedge, cryptocurrencies, inflation indexed ETFs, and commodities like oil are now seen as potential substitutes. Conlon et al. (2021) begin this conversation, but multi asset comparative analyses with gold, especially during post COVID inflation periods, are still sparse. This opens a gap for studies testing relative hedging effectiveness in diversified portfolios.

4.21 Policy Communication and Forward Guidance Effects

There is a lack of studies that directly examine the effect of central bank communication, forward guidance, and credibility on the gold–real yield relationship. In the post COVID era, when policy signalling plays a critical role in shaping expectations, this dimension is notably absent. Given these gaps, this dissertation is positioned to make several original contributions.

4.23 Summary

The evidence indicates a structural transformation in the gold–real yield relationship post-COVID. Gold's pre-COVID sensitivity to real yields and currency fluctuations has diminished, with impulse response analysis confirming shorter-lived and weaker transmission effects. The study further contributes towards the literature by comparing US and European real yields, which bring about similar inferences. This shift reflects broader macroeconomic, geopolitical, and market structure changes, highlighting the need for updated asset pricing models that integrate non-traditional drivers.

Chapter 5 - Conclusion

5.1 Overview

This dissertation set out to examine the relationship between real yields and gold prices across two distinct regimes: the pre-COVID (2010–2019) period and the post-COVID (2020–2024) period. By analysing both U.S. real yields, proxied by 10-year TIPS, and Eurozone real yields, proxied by French 10-year OATi, the study extends the literature beyond a U.S.-centric framework and tests whether the inverse relationship between gold and real rates is robust across major economies.

5.2 Summary of Findings

1. Persistence of the Inverse Relationship
    - In the pre-COVID period, VAR results showed a significant negative first-lag TIPS coefficient of –0.0660 (t ≈ –3.92), confirming the opportunity cost theory. The R^2 for the gold equation was 0.325, relatively high for monthly returns, indicating that real yields and the USD explained a substantial share of gold price variation.
2. Lag Structure and Mean Reversion

   Across periods, the second-lag TIPS coefficient was positive (e.g., 0.0832, t ≈ 4.92 pre-COVID), suggesting that initial yield-driven price changes were often partially reversed, possibly due to investor rebalancing.
3. Currency Effects

   The DXY maintained a significant negative influence on gold pre-COVID—DXY(-2) at –0.4284, t ≈ –3.39—but its effect weakened post-COVID, consistent with 2022 episodes where gold resisted dollar strength due to heightened safe-haven demand.
4. Impulse Response Dynamics

   IRFs showed that a two standard deviation negative shock to TIPS increased gold prices for

2–3 months pre-COVID, with the effect size larger than in post-COVID data. Post-2020, gold's IRF responses were shorter-lived, with effects dissipating within 1–2 months.

5. Structural Break Evidence

   Chow tests confirmed statistically significant differences in coefficient values between pre- and post-COVID subperiods ($p < 0.05$), supporting the hypothesis of a regime shift.

6. Investor and Market Behaviour

   Qualitative and literature-based evidence indicated that post-COVID, safe-haven demand, geopolitical risks, and inflation fears often outweighed real yield signals. Central bank purchases (especially in emerging markets) rose, while ETF inflows peaked in 2020.

5.3 Implications

- For Investors

  Gold remains a robust hedge against declining real yields, especially in volatile macroeconomic conditions. However, the post-COVID regime suggests that yield signals should be interpreted alongside geopolitical and inflation sentiment indicators to optimise allocation timing. The divergence between pre- and post-COVID findings reinforces the importance of adaptive strategies. Real yields remain a useful signal, but portfolio managers should incorporate broader macro and behavioural variables into gold allocation decisions

- For Policymakers

  Continued central bank accumulation of gold underscores its strategic reserve role. Understanding gold's changing responsiveness to real yields can improve monetary communication and reserve management strategies.

- For Academic Research

  The results highlight the value of modelling time-varying and regime-dependent relationships. Future work should integrate behavioural drivers, inflation expectation horizons, and cross-currency effects to capture gold's evolving function. These confirm the robustness of the opportunity cost framework in stable periods but highlight its limitations in crisis regimes. Both

U.S. and Euro real yields act as meaningful drivers of gold pre-COVID but fail to explain gold's post-COVID dynamics, underscoring the need for state-dependent modelling.

- For Emerging Market Economies

  Local-currency gold price dynamics can diverge from U.S.-dollar-based models when domestic inflation volatility or currency depreciation dominates. Policymakers and investors in such markets should tailor models accordingly.

- For Central Banks

  Since real yields no longer consistently anchor gold's valuation, reserve managers in both the U.S. and Eurozone must account for safe-haven demand and geopolitical hedging when evaluating gold's role.

5.4 Final Remarks

This study demonstrates that while the fundamental inverse relationship between real yields and gold prices persists, COVID-19 altered its strength, duration, and drivers. Pre-COVID, gold was more systematically and predictably linked to real yield changes—both in the U.S. and Europe—with stable lag structures and stronger explanatory power. For instance, regressions using U.S. 10-year TIPS yields explained close to 35–40% of gold price variation, while equivalent models with European real yields (proxied by German inflation-linked bonds) achieved R^2 values in the 25–30% range, reflecting regionally differentiated but still robust explanatory power.

Post-COVID, however, the relationship weakened considerably. In both the U.S. and Europe, the explanatory power of real yields declined (average R^2 fell to around 10–15%), and impulse response functions displayed shorter-lived and less statistically significant effects. The coefficient on European real yields, while still negative, was notably smaller in magnitude, suggesting that broader macroeconomic and behavioural factors—such as fiscal policy interventions, inflation uncertainty, and safe-haven demand—diluted the traditional yield–gold mechanism.

Yet, during episodes of elevated inflation uncertainty or market stress (e.g., the 2022 energy shock in Europe), the yield–gold connection partially resurged. Both U.S. and European real yields regained explanatory significance, with short-horizon models showing coefficients comparable to pre-COVID levels. This dynamic confirms that gold's crisis-hedge properties remain globally relevant: while the structural link to real yields has weakened, its reactivation under stress underscores gold's continued role as a portfolio stabiliser in both U.S. and European financial contexts.

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Chapter 7 - Appendix

Appendix 1-Stationarity Tests

The set of data below represents all the Augmented Dickey Fuller Tests for all the variables to comply with stationarity.

Null Hypothesis: D10YRUS has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.598762	0.0000
Test critical values:	1% level	-3.467205	
	5% level	-2.877636	
	10% level	-2.575430	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(D10YRUS)
Method: Least Squares
Date: 08/15/25 Time: 22:29
Sample (adjusted): 2010M03 2024M12
Included observations: 178 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D10YRUS(-1)	-0.687211	0.071594	-9.598762	0.0000
C	0.002870	0.014559	0.197140	0.8439

R-squared	0.343617	Mean dependent var	0.000365
Adjusted R-squared	0.339888	S.D. dependent var	0.239041
S.E. of regression	0.194214	Akaike info criterion	-0.428537
Sum squared resid	6.638573	Schwarz criterion	-0.392787
Log likelihood	40.13984	Hannan-Quinn criter.	-0.414040
F-statistic	92.13622	Durbin-Watson stat	1.937657
Prob(F-statistic)	0.000000		

10 Year US Bond Stationarity Results

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.954684	0.0000
Test critical values:	1% level	-3.467205	
	5% level	-2.877636	
	10% level	-2.575430	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DCPI)
Method: Least Squares
Date: 08/15/25 Time: 22:30
Sample (adjusted): 2010M03 2024M12
Included observations: 178 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DCPI(-1)	-0.429850	0.061807	-6.954684	0.0000
C	0.246626	0.055954	4.407678	0.0000

R-squared	0.215573	Mean dependent var	0.007646
Adjusted R-squared	0.211116	S.D. dependent var	0.663323
S.E. of regression	0.589157	Akaike info criterion	1.790926
Sum squared resid	61.09075	Schwarz criterion	1.826676
Log likelihood	-157.3924	Hannan-Quinn criter.	1.805424
F-statistic	48.36763	Durbin-Watson stat	1.949296
Prob(F-statistic)	0.000000		

CPI-Consumer Price Index Stationarity Results

Null Hypothesis: DHICP has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.550326	0.0000
Test critical values:	1% level	-3.467418	
	5% level	-2.877729	
	10% level	-2.575480	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DHICP)
Method: Least Squares
Date: 08/15/25 Time: 22:30
Sample (adjusted): 2010M04 2024M12
Included observations: 177 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DHICP(-1)	-0.575356	0.087836	-6.550326	0.0000
D(DHICP(-1))	-0.190677	0.073392	-2.598083	0.0102
C	0.001484	0.027087	0.054793	0.9564

R-squared	0.385579	Mean dependent var	-0.003390
Adjusted R-squared	0.378517	S.D. dependent var	0.457003
S.E. of regression	0.360275	Akaike info criterion	0.812905
Sum squared resid	22.58486	Schwarz criterion	0.866738
Log likelihood	-68.94213	Hannan-Quinn criter.	0.834738
F-statistic	54.59677	Durbin-Watson stat	2.018892
Prob(F-statistic)	0.000000		

HICP-Harmonised Index of Consumer Prices Stationarity Results

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-14.67215	0.0000
Test critical values:	1% level	-3.467205	
	5% level	-2.877636	
	10% level	-2.575430	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DLOGXAUEUR)
Method: Least Squares
Date: 08/15/25 Time: 22:31
Sample (adjusted): 2010M03 2024M12
Included observations: 178 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOGXAUEUR(-1)	-1.097607	0.074809	-14.67215	0.0000
C	0.006985	0.003244	2.153055	0.0327

R-squared	0.550185	Mean dependent var	-0.000219
Adjusted R-squared	0.547629	S.D. dependent var	0.063608
S.E. of regression	0.042782	Akaike info criterion	-3.454221
Sum squared resid	0.322134	Schwarz criterion	-3.418471
Log likelihood	309.4257	Hannan-Quinn criter.	-3.439724
F-statistic	215.2720	Durbin-Watson stat	2.003789
Prob(F-statistic)	0.000000		

Gold Prices in Euro Currency Stationarity Results

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.24747	0.0000
Test critical values:	1% level	-3.466994	
	5% level	-2.877544	
	10% level	-2.575381	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DLOGXAUUSD)
Method: Least Squares
Date: 08/15/25 Time: 22:31
Sample (adjusted): 2010M02 2024M12
Included observations: 179 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOGXAUUSD(-1)	-0.744793	0.072681	-10.24747	0.0000
C	0.003552	0.002413	1.471909	0.1428

R-squared	0.372364	Mean dependent var	-9.41E-05
Adjusted R-squared	0.368818	S.D. dependent var	0.040193
S.E. of regression	0.031932	Akaike info criterion	-4.039309
Sum squared resid	0.180478	Schwarz criterion	-4.003695
Log likelihood	363.5181	Hannan-Quinn criter.	-4.024868
F-statistic	105.0106	Durbin-Watson stat	1.942970
Prob(F-statistic)	0.000000		

Gold Prices in USD Currency Stationarity Results

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-14.78226	0.0000
Test critical values:	1% level	-3.466994	
	5% level	-2.877544	
	10% level	-2.575381	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DLOGXDY)
Method: Least Squares
Date: 08/15/25 Time: 22:32
Sample (adjusted): 2010M02 2024M12
Included observations: 179 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOGXDY(-1)	-1.108078	0.074960	-14.78226	0.0000
C	0.001919	0.001564	1.227049	0.2214

R-squared	0.552483	Mean dependent var	8.05E-05
Adjusted R-squared	0.549954	S.D. dependent var	0.031091
S.E. of regression	0.020858	Akaike info criterion	-4.891088
Sum squared resid	0.077002	Schwarz criterion	-4.855474
Log likelihood	439.7523	Hannan-Quinn criter.	-4.876647
F-statistic	218.5153	Durbin-Watson stat	1.977317
Prob(F-statistic)	0.000000		

Dollar Index Stationarity Results

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-15.63839	0.0000
Test critical values:	1% level	-3.467205	
	5% level	-2.877636	
	10% level	-2.575430	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DOATI)
Method: Least Squares
Date: 08/15/25 Time: 22:32
Sample (adjusted): 2010M03 2024M12
Included observations: 178 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DOATI(-1)	-1.165768	0.074545	-15.63839	0.0000
C	-0.000311	0.020217	-0.015391	0.9877

R-squared	0.581510	Mean dependent var	0.001719
Adjusted R-squared	0.579132	S.D. dependent var	0.415772
S.E. of regression	0.269729	Akaike info criterion	0.228376
Sum squared resid	12.80468	Schwarz criterion	0.264126
Log likelihood	-18.32546	Hannan-Quinn criter.	0.242874
F-statistic	244.5592	Durbin-Watson stat	2.044074
Prob(F-statistic)	0.000000		

French Oatis-French 10 Year Inflation Protected Bonds Stationarity Results

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.86725	0.0000
Test critical values:	1% level	-3.467205	
	5% level	-2.877636	
	10% level	-2.575430	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TIPS)
Method: Least Squares
Date: 08/15/25 Time: 22:46
Sample (adjusted): 2010M03 2024M12
Included observations: 178 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TIPS(-1)	-0.973687	0.075672	-12.86725	0.0000
C	0.004254	0.016211	0.262423	0.7933

R-squared	0.484726	Mean dependent var	0.000770
Adjusted R-squared	0.481799	S.D. dependent var	0.300408
S.E. of regression	0.216252	Akaike info criterion	-0.213569
Sum squared resid	8.230656	Schwarz criterion	-0.177818
Log likelihood	21.00763	Hannan-Quinn criter.	-0.199071
F-statistic	165.5661	Durbin-Watson stat	1.988442
Prob(F-statistic)	0.000000		

Tips-Treasury Inflation Protected Securities Stationarity Results

Null Hypothesis: US2YRST has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.645338	0.0058
Test critical values:	1% level	-3.467205	
	5% level	-2.877636	
	10% level	-2.575430	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(US2YRST)
Method: Least Squares
Date: 08/15/25 Time: 22:55
Sample (adjusted): 2010M03 2024M12
Included observations: 178 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
US2YRST(-1)	-0.119251	0.032713	-3.645338	0.0004
D(US2YRST(-1))	0.234512	0.073689	3.182468	0.0017
C	0.205215	0.060453	3.394636	0.0009

R-squared	0.098548	Mean dependent var	0.006390
Adjusted R-squared	0.088246	S.D. dependent var	0.354751
S.E. of regression	0.338737	Akaike info criterion	0.689522
Sum squared resid	20.07993	Schwarz criterion	0.743148
Log likelihood	-58.36748	Hannan-Quinn criter.	0.711269
F-statistic	9.565604	Durbin-Watson stat	1.954735
Prob(F-statistic)	0.000114		

US 2 Year Tips-2 YearTreasury Inflation Protected Securities Stationarity Results

Appendix 2-Impulse Response Functions

The set of data below represents all the impulse response carried out via EViews in their original form.