

What characterizes a *safe haven asset* and how does it perform across market cycles?

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WHAT CHARACTERIZES A “SAFE HAVEN ASSET” AND HOW DOES IT PERFORM ACROSS MARKET CYCLES?

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"History provides a crucial insight regarding market crises: they are inevitable, painful and ultimately surmountable."

Shelby M.C. Davis (2003)

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Contents

List of Abbreviations	7
Introduction	9
Literature review	12
1 Unearthing the origins of safe-assets	13
1.1 Precious metals	13
1.2 Government Bonds	15
2 Significance of Safe-Haven Currencies	18
2.1 US Dollar	18
2.2 Japanese Yen	18
2.3 Swiss Franc	19
3 Alternative investing as safe-haven	20
4 Technology advancement and sustainability as emerging paradigms	22
4.1 Green Bonds	22
4.2 Cryptocurrencies	23
5 Conclusion	24
Data and Methodology	26
1 Models used in previous studies	26
2 Data	27
3 Methodology	34
3.1 DCC – GARCH model	34
3.2 Safe-haven test	38
Results	40
1 Volatility statistics	40
2 Parameters Estimation	42
3 Dynamic Correlations Analysis	42
4 Estimation results	59
5 Average DCC Heatmap	62
Conclusion	64
Limitations	66
Appendix	67
1 Appendix 1: Time series Graph	67

2	Appendix 2: ADF Test	68
2.1	Appendix 2.1: Lag Length Selection	68
2.2	Appendix 2.2: ADF results	68
3	Appendix 3: Descriptive statistics	69
4	Appendix 4: Correlation Matrix	69
5	Appendix 5: DCC Fit - Parameter estimates	69
	References	73
	Executive summary	82

List of Abbreviations

ADF - Augmented Dickey Fuller
bps - basis points
CFI - Corporate Finance Institute
CHF - The international abbreviation for the Swiss Franc
Cov – Covariance
COVID-19 - Coronavirus Disease 2019
DCC - Dynamic Conditional Correlation
ECB - European Central Bank
ETFs - Exchange-Traded Funds
Euro - The official currency used in the Eurozone
Forex - Short for foreign exchange
Fx - Foreign exchange
GARCH - Generalized Autoregressive Conditional Heteroskedasticity
GDP - Gross Domestic Product
GICS - Global Industry Classification Standard
ICMA - International Capital Market Association
IMF - International Monetary Fund
JPY - The international abbreviation for the Japanese Yen
LBMA - London Bullion Market Association
log – logarithm
N – Normal
NASDAQ - National Association of Securities Dealers Automated Quotations
NYSE - New York Stock Exchange
OLS - Ordinary Least Squares
REITs - Real Estate Investment Trusts
S&P - Standard and Poor's 500
T – time
UK - United Kingdom
US - United States
USD - The international abbreviation for the United States Dollar
USDT - Tether tokens
VAR - Vector Autoregression
WGC - World Gold Council
WHO - World Health Organization
Yen - The official currency of Japan

Introduction

Since the year 2007, both the global economy and financial markets have experienced a prolonged period of instability, with only brief intervals of stability lasting no more than 2 or 3 years. This instability began with the subprime crisis and has since been marked by numerous crises and recessions, including the Global Financial Crisis (2007-2009), European Sovereign Debt Crisis (2010-2012), Chinese Stock Market Crash (2015-2016), Brexit (2016), the COVID-19 Pandemic (2020-2021) directly followed by an energy price boom and a geopolitical conflict between Ukraine and Russia that have a significant impact on the whole economy (Mbah et al., 2022).

The impact of these crises on financial markets has been extensively studied by researchers such as Acharya et al. (2009), Reinhart and Rogoff (2011) and even Ammy-Driss et al. (2021). Their findings indicate that these crises have led to high volatility in the stock market, resulting in significant uncertainty and a decline in investment spending, which in turn has caused a substantial decrease in stock prices.

In the present day, particularly since Brexit in 2016, crises of various natures - including health, geopolitical or ecological - have occurred in rapid succession, creating a continuous kind of "roller-coaster" effect on financial markets. As it enters June 2023, a new recession is underway, triggered by a period of high inflation, escalating energy prices, reduced household consumption due to higher prices for essential commodities also caused by supply chain disruptions resulting from the Russia-Ukraine war and tighter monetary policy (Kayral et al., 2022). The uncertainty surrounding stock market indices, whether they represent offensive or defensive assets, has reached unprecedented levels since 2008. Investors are now considerably more pessimistic about the future and are actively seeking assets that can help them navigate these turbulent times. Especially in Europe, since this continent is a significant export market for both nations involved in the current war. As a result, it is now more important than ever for investors to place a high priority on portfolio diversification by integrating safe-haven assets and hedging methods to reduce the risks driven by these insecure conditions (Kayral et al., 2022).

A safe-haven asset, as defined by Roberto Rivero (2023) in its revue "What Are Safe Haven Assets?" and also defined by Baur and Lucey (2009), corresponds to a financial instrument that has the potential to hold or rise in value during times of market volatility due to an economic crisis, taking the role of a reliable shield against their negative effects and being uncorrelated or negatively correlated to the market trend. Previous studies have demonstrated that individuals typically turn to assets that have shown past effectiveness or have the reputation to be safe as a means of seeking risk-free options during a crisis (Caballero et al., 2017). In times of recession, individuals tend to be more risk-averse and seek refuge in less volatile assets to fight price declines. Some assets are perceived as safer than others, although the concept of safety is subjective and

influenced by individual perceptions and market dynamics. Consequently, investors gravitate towards so-called "safe-haven assets" phenomena such as government bonds, gold as well as other perceived low-risk instruments. In the course of the literature review, it is clear that this concept of refuge developed and gained recognition following a succession of historical events, to limit the risk within portfolios and ensure minimal losses. Esteemed authors like Robert J. Shiller (2000) and Baur et al. (2009-2021) have extensively discussed the effectiveness of such assets during times of crisis.

Besides, over the ages, the search for and production of various forms of secure financial assets has been an important aspect of human economic activity. According to Caballero et al. (2017), in recent decades, the supply of safe assets has not kept pace with global demand, primarily due to the slower growth of advanced economies compared to high-saving emerging economies such as China. This shortage of safe assets has led to a continuous increase in their prices and a decline in global safe interest rates. Moreover, they clearly noticed a shift towards safer assets and away from riskier ones in financial turmoil. For these reasons, safe assets play a critical role in the economy, affecting transaction efficiency, savings, financial crises, macroeconomic activity as well as monetary policy. The significance of safe assets became more apparent with the decline of government-insured demand deposits and the rise of short-term wholesale funding in the US financial system since the late 1970s (Gorton, 2016).

Although there have been numerous articles and studies showing that gold can be considered a safe haven or that long-term US government bonds can be relatively stable over time, no scientific study has yet been carried out to determine "what are the characteristics or properties that make an asset a safe haven?". Moreover, even if studies about refuge assets frequently feature the same names of financial instruments, it's important to understand that not all assets designated as safe havens in the past literature are universally suited to all crashes in the markets (Rivero, 2023). The idea of a safe haven asset depends on the current economic conditions, which might change significantly over time and even if there is no specific literature about it yet, the search for safety goes hand in hand with the search for the best combination of assets as well because some of the most cited safe-havens or strong hedges, such as Gold, are now more acting as complement rather than substitute (Bouoiyour et al., 2019; Dyhrberg, 2016). The question "Is there an asset that performed as a refuge investment across all crises?" seems simple to answer, the question of what kind of asset still has the properties to provide safety as well as whether there are any new sources of assets that could perform as a safe haven in the near future look more relevant to analyze. Markets have been constantly suffering since COVID-19 and beyond. It is then also essential for every investor to find a pattern that could help them mitigate their risks. Given these observations, conducting a study on this topic is of great interest while not very easy to answer taking into account the huge uncertainty we are facing and the lack of literature about it.

The objective of this paper is to provide a broad comprehensive examination of the safe-haven concept, with a specific focus on identifying and explaining the similarities and characteristics of assets commonly cited and utilized as 'refuge' across different market cycles including new forms of assets, such as cryptocurrencies and sustainable finance investments. The analysis will primarily concentrate on assets that have historically been recognized and regarded as safe havens, including precious metals, notably gold, long-term governmental bonds, selected strong currencies, and more recent additions such as real estate or some alternative investments. On top of that, the goal is also to assist investors in making informed decisions and effectively manage their

portfolios by testing the properties across the last turbulent period, from before the corona crisis to the actual turbulent economic and geopolitical conditions.

The paper will therefore start by examining the theoretical origins and background of the concept to understand why certain assets have become safe havens or could be considered as such, followed by a quantitative statistical and econometric analysis of the most cited and relevant safe havens in the literature over a period from 2018 to 2023.

Literature review

When the values of financial assets dropped during the latest health crisis, investors and professionals once more turned their attention to the less risky assets. A solid means of protection is also a top concern for everyone since we all worry about another recession occurring after the current crisis. In the past, a good solution for alleviating the impact of a market downturn on a stock portfolio was to turn on the concept of a “safe haven”, which was used as a savings account where you could keep your money without being influenced by market turbulences; the kind of account where you feel your money is safe and where you could even, over the long run, have an infinitely small gain.

There are many definitions of this concept and these have evolved over the years from only being an asset that has a fixed rate of return (Fishburn et al., 1976) to a financial instrument that works as a kind of risk diversifier that is uncorrelated with the current market and that is kept in a portfolio to mitigate the consequences of a negative economic shock (Flavin et al. 2014).

Indeed, safe-haven assets are the kind of assets that are sought after by investors during times of market turbulence or economic uncertainty. This kind of investment is believed to provide a stable or even rising value, relative to other types of assets. Similarly, Gorton et al. (2013) have explored the role of refuge values in the economy, which according to them, secure investments whose real value remains stable even when faced with various shocks. The study investigates the reasons behind the demand for this kind of assets or the incentives of agents, and examines the central bank’s role in their provision. It demonstrates the interdependence of monetary policy and macroeconomic prudential policy, highlighting that they cannot be separated due to their impact on the stability of the financial system. Indeed, the authors showed that changes in the supply or demand for safe assets can have implications for the effectiveness of monetary policy and the stability of the financial market. Additionally, macroprudential policies can influence the demand for safe assets and the transmission of monetary policy.

Notwithstanding, it is important to note that the concept of a safe-haven asset should not be confused with hedging (Baur et al, 2009). Although there may be situations in which safe-haven assets can also act as hedges, the two are not fundamentally the same. Hedging techniques entail deliberately managing risks through certain positions or instruments to balance possible losses in a portfolio, whereas safe-haven assets are largely chosen for their perceived uncorrelation with other stocks, stability, and preservation of value during difficult times. In simpler terms, Baur et al (2009), as well as Chang et al (2020), argued that a hedge is a security that can help reduce the risk of adverse price movements of another asset, while a safe haven is a security that can help protect against losses due to a market crash and that is even expected to retain or increase its value during extreme market conditions. For instance, while a refuge asset could help reduce the

risk of a portfolio in normal market conditions thanks to its hedging function, it is also only a safe haven during extreme market conditions so a security that is a hedge may not necessarily be a safe haven.

Indeed, according to the Corporate Finance Institute¹, a hedge serves as a safeguard for a person's financial resources, shielding them from potential losses caused by risky circumstances that could diminish their value. Nonetheless, it's important to note that hedging does not guarantee immunity to investment losses. A hedge refers more to a strategy called a hedging strategy than an asset itself. Still, according to the CFI (2023), the concept of a safe haven relates to an investment that is expected to retain or appreciate its value when the economy experiences a downturn. These types of investments are considered secure choices for investors because they are not influenced by economic fluctuations. Therefore, even in the midst of a financial crisis, the value of such investments is not likely to decrease. In summary, a hedge is a risk management strategy that safeguards against potential losses, whereas a safe haven is a type of investment providing protection during challenging economic times (Robiyanto, 2018).

Various types of assets have been identified in the literature as "safe-haven" assets. Extensive research conducted by Azzimonti et al. (2019), Baur et al. (2016), Gorton et al. (2013) and Kacperczyk et al. (2017,2021) have categorized these assets into three primary types. Firstly, there are public safe assets, such as state bonds or currencies, issued by governmental or public entities. Secondly, private safe assets, including real estate, are created and held by private individuals, institutions or entities. Lastly, portable safe assets encompass precious metals and Art (Oosterlinck et al., 2023).

1 Unearthing the origins of safe-assets

1.1 Precious metals

The need and search for assets that could hold their values and protect from a crash have been going on for hundreds of years and is related to the evolution of financial markets and the various recessions the world has experienced. From the oldest and the most recent literature, similar techniques to the now well-known refuge assets were frequently employed by ancient monarchs and emperors from the Antiquity period to safeguard their wealth, well analyzed by Ogden (1992) when he studied the origin and use of gold in his article: Gold in Antiquity. Moreover, the book "The Power of Gold: The History of an Obsession" written by Peter L. Bernstein in 2000 also focuses on the attractiveness of gold throughout history and across civilizations. It brings further insights and historical facts to Jack Ogden's work by analyzing the cultural, economic and psychological influences that have contributed to the fascination with gold, providing early hints to understand why gold has been used as a safe haven across cycles. What is more, gold is often considered the ultimate safe-haven asset by current researchers such as Baur and Lucey (2010), Baur and Mcdermott (2010 - 2016), Corbet et al. (2020), Robiyanto (2018) or Kayral et al. (2022) because it has maintained its value for years and is not subject to the same market forces as other assets.

¹CFI is the top worldwide supplier of productivity tools and training for finance professionals. It provides the knowledge, qualifications and tools necessary to further a career in banking and finance. <https://corporatefinanceinstitute.com/about-cfi/>

According to Bernstein (2000), the fascination with gold comes from Greek mythology and the Roman Empire. Indeed, it was seen as a symbol of dominance and wealth even before becoming a medium of exchange due to its inherent attributes. First of all, it was really hard to find some pieces of gold, which made it rare and precious, in addition to the fact that this metal was really resistant and not subject to degradation over time (Healy, 1979), a first good sign about its role of store and preserver of wealth across cycles. Then, the author also mentions that kings or any wealthy individuals from bygone days used to accumulate gold to protect their status if any war or unexpected events occurred, which can be translated by the definition of a safe-haven asset used in the introduction of this paper related to the fact that it is especially to be protected under periods of turbulent financial market conditions that investors are looking for refuge assets.

Another historical aspect that helped to build the safe-haven status of gold is also the fact that it has been a medium of exchange for thousands of years (Bernstein, 2000), empowering the stability and wealth preservation role of gold over time and increasing the historical trust in that precious metal universally across nations and civilizations.

One other reason for gold's appeal as a secure asset is its limited supply. Indeed, as described earlier, gold cannot be easily produced or expanded, unlike current fiat currencies or any kind of stocks that can be generated in larger quantities. This attribute has historical connections to the gold standard, which was a monetary system where currencies were directly pegged to the value of gold (Bordo et al., 1990-1995). Indeed, this meant that gold was convertible into currency at a fixed rate and vice versa, adding a new perspective to the scarcity of gold and its high level of liquidity, which made it relatively resistant to the effects of inflation. Also, when the First World War occurred, the abolition of the gold standard came. Due to this suspension of gold convertibility, there was a loss of confidence in fiat currencies as a result of unknown currency valuations. Indeed, countries' exit from the Gold Standard gave them more latitude to modify their monetary policies. This independence nevertheless came with drawbacks. Now that nations could devalue their currencies, there were worried about currency conflicts. Gold, which couldn't be depreciated at the whim of a government, became then an even more appealing safe-haven asset as a result of the risk of devaluation (Bordo et al., 1990-1995; Knafo, 2017; Brown et al., 2020). As a result, individuals started using gold as a protection against inflation and currency depreciation to protect their wealth. Therefore, the increased demand and the scarcity of gold as a result of nations concentrating on their war efforts, pushed gold prices to increase drastically (Bernstein, 2000), another proof of the historical efficiency of gold in times of crisis that will be improved after the second world war. In fact, during the Second World War, when people and especially governments tried to safeguard their financial wealth from the unforeseen consequences and inflationary pressures, the view of gold as a credible safe-haven asset grew significantly (Bernstein, 2000; Oosterlinck et al., 2023).

However, research into the defensive aspect of gold emerged even more mainly after the sub-prime crisis, when gold demonstrated its ability to hold its value while other financial assets, such as equities, plummeted (Robiyanto, 2018). Although it has also been extensively demonstrated as an investment source offering a solid long-term hedging strategy, making it possible to effectively defend against currency risk or protect against potential losses in other financial assets (Robiyanto, 2018; Bredin et al., 2014; Hood et al., 2013). To support this statement, according to Jaffe (1989), adding gold to a variety of fictitious portfolios raised the average return while lowering the standard deviation.

Additionally, when stock market conditions fall drastically, investors tend to transfer their assets into gold to secure their investment because the price of gold tends to increase as investors seek to protect their wealth from inflation and other financial risks (Robiyanto, 2018). As a result, gold is also used as a refuge to protect the money of individuals against price volatility and currency fluctuations (Baur et al., 2010).

Nowadays, compared to the past with the Gold Standard or the Bretton-Woods system (Bernstein, 2000), gold is not tied to any specific government or central bank, which further adds to its appeal as a store of value. This implies that gold has historically demonstrated the ability to retain its purchasing power (Dubey et al., 2003) and enhances the attractiveness of gold as a reliable way to maintain its worth over time (Faugère, 2013). According to Baur and Lucey (2010), gold's safe-haven status is reinforced during times of financial crisis, when investors seek refuge from volatile equity and bond markets. Additionally, gold's liquidity, portability and divisibility make it an attractive asset for investors.

Nevertheless, more recently, Akhtaruzzaman et al. (2021) noticed a surprising result during the Covid crisis. In short, they have analyzed if gold was acting as a real risk-less investment during all phases of the pandemic. Their results showed up with a new important question. Indeed, they focus their research on trying to differentiate the role of "safe haven" with a simple hedging strategy as Baur and Lucey (2009) did in the past. The study found that gold served safely for stock markets only during the first phase of the COVID-19 pandemic but lost its securing role during the second phase so that the notion of "safe haven" could be reinterpreted. Facts that were challenged by Kayral et al. (2022), who demonstrated that gold was a solid hedge and safe haven during the pandemic and, mixed with Ustaoglu (2023), it has still been going strong recently during the war in Ukraine.

In summary, gold is seen as a safe haven because of its historical track record as a store of value, limited supply, tangible nature and liquidity. These elements contribute to its perceived stability and ability to preserve wealth during economic uncertainty. However, some more recent research tends to downgrade its status as a strong hedge against market deviation.

1.2 Government Bonds

Secondly, the role of long-term bonds such as American or German ones come also a lot of it. If we look at the work of Chan et al. (2011), they used a "Markov switching model" to confirm the previous statement and also emphasize other kinds of defensive assets, such as real estate or the oil price.

Indeed, U.S. Treasuries are another commonly cited safe-haven asset. As gold, we have to go back in early history to see the first emergence of bonds as an investment (Cummins, 2014). Indeed, according to Bozovic (2017) and Taylor (2013), the first kind of governmental bond appeared a thousand years ago in Venice. Actually, in medieval times, thanks to the political, economic and financial changes it brought forth, the Republic of Venice was a significant economic force (Puga et al., 2012). These bonds, known as the Prestiti², were vital in preserving the Venetian Repub-

²Prestiti was the first government bond issued in 1172 in order to finance a war according to Edward Bace of World's first sovereign war bonds - issued by the Mediterranean state of Venice 25th Annual International Congress Masaryk University, Brno, Czech Republic. In: 25th Annual International Congress of Mediterranean Studies Association, May 31 - June 3, 2023, Masaryk University, Brno, Czech Republic. [Conference or workshop]

lic's financial stability since they were used to fund the public debt accrued in financing the war (Bozovic, 2017). Moreover, these bonds were covered by precious metals such as gold to ensure honoring them. Knowing all the trust put in the value of those metals demonstrated previously in this paper, it goes without saying that it significantly helped to boost investor confidence in these bonds. This could be the first time that a new form of safe haven has been acknowledged as being reasonably trustworthy in investment portfolios. However, the Prestiti turned to not be that safe across cycles and suffered a lot from the accumulation of wars (Taylor, 2013). So, Prestiti, although it has not been a safe haven across all market cycles, has been a pillar in the recognition of certain government bonds as safe havens and in the evolution of the world of secure investments in general, from only precious metals to immaterial financial investment. One interesting thing to highlight is that this issuance and emergence of governmental bonds have improved the financial market transparency (Scalia, 1999) and as a result, the confidence of investors in these instruments. That's the reason why, as crises and financial markets have evolved (Reinhart and Rogoff, 2009), investors have also turned to government bonds as safe assets (Habib et al., 2020).

In accordance with the paper of Hager (2017) and Habib et al. (2020), governmental bonds became a safe haven also thanks to several strong properties, for instance, the propensity of bond yields to remain constant over a given period, despite changes in market conditions. Secondly, it insists on the fact that only nations with good institutions and a sizable debt market are more likely to create safe assets. Therefore, most authors on the subject suggest the US long-term Treasuries as the main bond recognized as a refuge investment (Eichengreen and Mody (1998), Chan et al. (2011), He et al. (2016), Cummans (2014), Rennison (2023), Hager (2017), Greenwood et al. (2008), Baur and Lucey (2010) and Kopyl and Lee (2016)). They are debt securities issued by the US government to fund its operations and are widely regarded as one of the safest investments in the world (He et al. 2016). This is due to the fact that the US government has never defaulted, or at least really exceptionally, on its debt even though the US has recently faced the possibility of defaulting if the right steps were not taken to increase or suspend the debt ceiling and make sure it has enough money to pay its debts (Rennison, 2023). They were used as a complement to precious metals in investment portfolios during the Great Depression of the 1930s to hedge against various market risks (Cummans, 2014), and by deduction, it is clear that it became really recognized as a refuge after the Second World War and the Bretton Woods Agreement with Gold and the US dollar since the role of the US as a dominant global power making the US dollar as the primary global reserve currency linked to gold (Cesarano, 2006, 2007 and IMF³).

Another point is that the Treasury market is one of the largest and most liquid in the world. In accordance with the paper of He, Krishnamurthy and Milbradt (2016), US government bonds were considered secure investments also due to the high demand for safe assets worldwide. To exemplify this, the authors explain that during periods of economic turmoil, such as the 2008 financial crisis, yields on US Treasury bonds fall even further, indicating their status as safe assets. The low yields on these bonds are driven by the fact that safe asset investors have limited alternatives and hence invest in US government bonds.

One interesting remark is the point of view of the behavior of investors regarding this type of asset, especially for the reason why they bought some in the past and how they select which asset to buy. According to Baur and McDermott (2016), investors are usually more backward-looking

³https://www.imf.org/external/np/exr/center/mm/eng/mm_dr_01.htm

regarding the impact of such assets and then often invest without looking at their current risk. For example, still according to them, the most often used defensive asset is gold, which was also the riskiest if we compare it with 10 Years of Treasury Bills. A bond has indeed by definition a fixed return over its maturity period while the value of gold may fluctuate over time. A governmental bond is a type of bond issued by a government to finance its spending activities; when buying it, investors make a loan to the government and receive interest payment in return (Chandy, 1986).

Furthermore, the work of Greenwood et al. (2008) coupled with Baur and Lucey (2010) emphasizes that during times of economic uncertainty and market volatility, investors tend to flock to US Treasuries because of their perceived safety and low risk but also as a way to preserve their capital and avoid potential losses in other investments. This increased demand drives up the price of US Treasuries, which in turn lowers their yields.

Additionally, another study conducted by Eichengreen and Mody (1998) supports this viewpoint, they argued that US Treasuries are particularly attractive to investors during times of currency crises because they offer a hedge against currency devaluation. Moreover, US Treasuries have a low correlation with other assets, which makes them an attractive diversification option for investors.

More recently, Kopyl and Lee (2016) used and tested 32 different assets in order to analyze their safe attitude through some OLS tests and set some assumptions to make the differentiation between hedging strategies and safe haven assets. According to the findings in this research, some assets that investors typically view as safe havens are really less correlated than others during crises. Long-term US bonds and an unmentioned source of safe haven, a foreign currency: the Japanese yen, are the assets that most closely match the description and are the least impacted during a crisis. These would, in fact, have a negative correlation with global market returns.

From the point of view of He et al. (2016), the main factors that make a governmental bond safe depend on the strength of its underlying fundamentals compared to other potentially safe assets. The long-term US Treasuries, for instance, are considered safer when their economic stability, fiscal health, political stability or creditworthiness, are relatively stronger in comparison to other refuge candidates. They then recognize that different assets have varying levels of safety and a government bond's safety is judged based on its relative strength compared to other alternatives. On top of that, the authors add that when the global demand for safe assets is high, having a significant amount of government debt can enhance its safety because it increases its liquidity.

To summarize, government bonds, such as U.S. Treasuries, play a crucial role as an additional source of safe-haven investments thanks to their perceived safety, historically low correlation with other assets and reliability, and rather low risk associated with the long-term bond itself and the strong fundamentals of the issuing government compared to other potential safe assets. The safety of these bonds is increased by the size and liquidity of the Treasury market, particularly during times of economic uncertainty when demand for secure assets is strong. However, it is crucial to remember that investors' perception of safety is in most cases backward-looking and not necessarily reflective of the current risk.

2 Significance of Safe-Haven Currencies

2.1 US Dollar

Another asset to consider, already introduced with the Japanese Yen above, is the currencies. As stated by Habib et al. (2020), one other characteristic that has built the consideration of US Treasuries as a safe haven is the fact that the US dollar was also considered as a refuge value thanks to its reliability, reserve currency role and the fact that the majority of investors embrace and employ it in international trade (Hossfeld et al., 2015; Coudert et al., 2014; Todorova, 2020). For a long time, the U.S. dollar has been viewed as a stable currency to invest in, especially during global uncertainties and tumultuous events in history (Todorova, 2020). It is commonly understood that one factor that enhances the trust in the US dollar is its past relation to Gold (Bordo et al. 1990-1995), which was historically the first safe-haven currency taking into account the role of gold as a means of exchange. Further supporting the idea that the US dollar is a safe-haven currency is the simple fact that the US government and Federal Reserve have grown used to taking action to stabilize the economy in times of crisis (Todorova, 2020). But opinions diverge. Based on specific studies, the US dollar lacks proper safe-haven characteristics and instead exhibits procyclical behavior with stock markets, which means that it moves, during some phases of crisis, in the same direction as global stock markets under pressure (Ranaldo et al., 2010).

2.2 Japanese Yen

Subsequently, a study conducted by Yuki Masujima (2019) supports the fact that the Japanese Yen is also a safe haven. Todorova (2020) even mentioned that it is seen as the best refuge currency in the Forex market. In order to prove it, Masujima (2019) created a safe haven index based on the correlation between currency fluctuation and changes in market uncertainty. The study also examines the connection between market turbulence and changes in safe-haven currencies' exchange rates. The main results of the paper demonstrated that investing in the Japanese currency can be considered a safe placement because the Yen tends to appreciate during risk-off episodes. In a comparable way, it has been shown many times that the Japanese Yen is considered the safest currency and the only real one that has a significant appreciation while market uncertainty increases (Fatum et al., 2014). Fundamentally speaking, it is the strongest safe-haven currency (Cho et al., 2021).

Typically, safe haven currencies are characterized by their stability and minimal risk of losing value throughout a period of market uncertainty (Lee, 2017). Japanese current account surplus (Horioka, 2015) and debt level, low level of inflation and interest rate (Yorucu et al., 2021), and political stability (Shizume, 2020) are the main reasons why the yen is commonly viewed as safe (Todorova, 2020; Aggarwal et al., 1996). Additionally, the yen is frequently used as a funding currency for carry trades, which boosts yen demand during challenging market times (Mikhaylov et al., 2018; Gagnon et al., 2007).

A paper by Habib et al. (2012) already made a study taking 52 currencies and searching for the most riskless one regarding market turbulences. Basically, they came up with 3 main ideas regarding safe currencies. First of all, the fact that a currency is riskless or that it couldn't be influenced by the nation issuing the currency's inherent risk profile. In instances of increased global risk aver-

sion, a nation that is inherently less risky, regarding the economic or political situation, may be favored. Then, it's possible that currencies that are supported by developed nations and liquid financial markets such as the United States of America, Switzerland, Singapore, Japan, or even Canada, could be safe havens. Finally, nations that are more open to the outside world, particularly in the financial sector, may see various effects of the globe's instability. Taking these pieces of information into account and combining them with the results of Todorova (2020), Rinaldo and Soderlind (2010) with the ones of Hossfeld and MacDonald (2015) we can identify three main currencies that could be considered risk-less: the Japanese Yen, the American dollar and the Swiss franc. To exemplify this, Jäggi et al. (2019) strengthened this assumption and made an empirical analysis with the help of significance tests of the impact of market surprises on these currencies. The results were that there are two unique ways that global factors might influence safe-haven currencies: macroeconomic surprises and the overall market situation.

2.3 Swiss Franc

Then, as mentioned above and according to Grisse et al. (2015), the Swiss Franc is also particularly attractive to investors during times of global financial instability. This is because the Swiss Franc has been seen as a reliable currency for many years and the Swiss National Bank has a reputation for intervening in the foreign exchange market to maintain the value of the Franc (Todorova, 2020). Switzerland is indeed known for its political neutrality and stable economy (Trampusch, 2011), which have contributed to the Swiss Franc's safe reputation and the fact that investors tend to flock to the Swiss Franc because of its perceived stability and low risk. The CHF's value and reputation as a refuge increased very rapidly after its launch in 1845, not least because it reached parity with other currencies very quickly but also because a legal mandate required the CHF to be backed by at least 40% gold reserves (Todorova, 2020).

Similarly, the work of Grisse et al. (2015) emphasizes that unstable periods intensify the association between Swiss franc returns and risk variables and that there is statistically significant temporal fluctuation in this relationship. Actually, these findings align with the historical origins of the Swiss franc's safe-haven status. It can be traced back to Switzerland's decision to remain neutral and not participate in the First World War. This neutrality attracted a substantial inflow of capital into the country (Todorova, 2020). Coupled with Switzerland's stable political and economic environment, this influx of capital played a crucial role in establishing the Swiss franc as a refuge currency (Baltensperger et al., 2016). Despite this widely held belief, the results of a study conducted by Coudert et al. (2014) challenge this notion. Indeed, while the Swiss franc has exhibited a long-run appreciation trend over the cycles, the research highlights a significant limitation because it tends to be correlated to the euro during crisis times and the euro is really not considered as a safe currency for multiple reasons. Firstly, the euro is a currency that is shared by a number of heterogeneous nations within the Eurozone, making it vulnerable to the political and economic dynamics of all members and causing fragility due to their susceptibility to liquidity crises and potential defaults (Bekkour, 2015; De Grauwe, 2022; Todorova, 2020 and Unmack, 2020). This implies that financial markets have more weight than sovereign governments, which could put at risk the stability of the euro affected by its political uncertainty (Todorova, 2020). The potential risks attached to the euro are further highlighted by past crises and the necessity for ECB initiatives (De Grauwe, 2022).

Moreover, Minoru Tachibana (2018) used a Copula statistical approach to show that the Swiss franc was especially a hedge currency for both the UK and Euro area stock markets over the period 1999–2016 but not specifically a safe haven. Nonetheless, the Swiss franc is still one of the most popular safe currencies and has more literature in favor of this statement than the contrary. It is even sometimes demonstrated as a better defensive asset against extremely negative stock market conditions than gold (Tronzano, 2022) and future developments should maintain the Swiss franc's hedging as well as safe-haven characteristics.

To conclude, safe-haven currencies, such as the Japanese yen, US dollar, or Swiss franc, are considered stable and reliable due to factors like current account surpluses, low inflation rates and political stability. These currencies are supported by industrialized nations with liquid financial systems. However, the stability of currencies used by many countries, like the euro, is questioned because of their susceptibility to political and economic events in the Eurozone (Todorova, 2020; Unmack, 2020). In addition, the security of a country's currency can be affected by the accessibility of its financial system to foreigners. The value and stability of the currency can be affected by increased vulnerability to global instabilities and economic shocks, thus reducing its safe-haven status.

3 Alternative investing as safe-haven

More recently, Dimitriou, Kenourgios and Simos (2020) tried to update all the knowledge we have on this subject. They used a fractionally co-integrated VAR model analysis in order to broaden the current literature on safe-haven assets by concentrating on other types of less typically cited assets: rare coins, wine, real estate, commodities, crude oil, and Baltic dry throughout two important periods that are the global financial crisis and the European sovereign debt crisis. They also argued in agreement with another opinion from the work of Balasubramanian et al. (2022) that real estate or other popular assets start to return lower satisfaction to the investors than before.

Anyway, real estate can be considered a safe investment due to its tangible nature, which is often viewed as a store of value. During periods of economic uncertainty, investors may turn to real estate as a safe haven because it is less prone to sharp price fluctuations than other asset classes (Hoesli, Lizieri, & MacGregor, 2008). Additionally, real estate can generate a dependable stream of income through rental yields, which may help offset potential losses in other investments (Lizieri & Ward, 2001).

On the other hand, based on Abuzayed et al. (2020)'s analysis, it can be inferred that real estate may not function as a refuge investment during times of market turmoil. In fact, the study highlights a significant change in correlation coefficients between real estate and stock markets during periods of financial and economic stress, so that correlation with stock markets suggests that real estate investments are likely to be exposed to risks of fluctuations similar to those of the stock market, which could compromise their perceived safe-haven characteristics.

Next, alternative investments such as art and luxury goods can also be considered refuge assets, although they may not be as widely recognized as traditional safe-haven. Real estate, art and luxury goods can be viewed as a store of value and are less prone to price volatility during times of economic uncertainty (Bialynicka-Birula, 2013; Georgiev et al., 2003; Dirix, 2019).

Moreover, they are also recognized as safe-haven assets because they are often perceived as a store of value that is not correlated with traditional financial markets. In particular, the art market has been shown to have a low correlation with other asset classes, making it an attractive diversification option for investors (McAndrew, 2019). Notwithstanding, some authors discuss the frequent discussions about art as a secure investment. First, a noteworthy work from G  raldine David (2014) challenges the commonly held belief that art serves as a safe investment during times of crisis. Using an original database of 22,000 records, she created an art price index for the French art market throughout the First World War and the post-war period in France. The findings indicate that, in terms of risk-return, pieces of art performed less well than gold, real estate, bonds and stocks during the First World War. Several market quirks may be used to explain this underperformance. Indeed, during the war, investors tended to choose inexpensive paintings and ancient masters since they were less volatile. The resulting conclusion was that art didn't always act as a safe investment during a crisis. Then, it was demonstrated by   zt  rkkal et al. (2020) and a long-run art auction sales data analysis that art, particularly Turkish-based one, may act as a hedging mechanism to boost returns, reduce portfolio risk, and gain from diversification during economic instability. This was enhanced by the fact that art was a viable investment option for portfolio diversification during the subprime crisis (Higgs, 2010).

However, it observed weak support for the "safe-haven" hypothesis and that the performance of the art index aligns with the challenging environment of financial crises (  zt  rkkal et al, 2020). As a matter of fact, art returns exhibited during these difficult periods a positive correlation with various volatility indices, indicating a degree of sensitivity to market fluctuations. On top of that, the average art returns decreased in the midst of the 2008 financial crisis (Higgs, 2010), indicating some degree of fragility. However, it demonstrated better performance in the periods before and after the crises, suggesting potential resilience and recovery in those periods.

Considering these points, it can be concluded that the role of art as a safe haven during times of crisis is complex and context-dependent. While art may offer diversification benefits and act as a hedging mechanism through its portable aspect (Oosterlinck, 2023), the evidence for it being a consistent safe haven asset is not definitive. The correlation between art and market volatility, as well as its performance during specific crises, indicates that art investments are subject to market fluctuations and may not always provide absolute stability. As a result, it advises individuals to exercise prudence when looking to art as a refuge during difficult times.

Luxury goods, such as high-end watches, luxury bags and jewelry, can also hold their value well during economic downturns, as they are often viewed as a status symbol and may hold sentimental value for their owners (Dirix, 2019).

Nevertheless, it is important to consider that alternative investments such as art and luxury goods can be highly illiquid (Higgs, 2010), which may make them less desirable as safe-haven assets for some investors (Lai, 2021). Additionally, the value of these assets can be highly subjective and may fluctuate depending on market trends and other factors, which may make them a riskier investment than traditional safe-haven assets such as gold and U.S. Treasuries (McAndrew, 2019).

4 Technology advancement and sustainability as emerging paradigms

4.1 Green Bonds

The question of whether green bonds may be viewed as safe-haven across economic cycles has attracted a lot of interest in the latest economic research. What is called a “green bond” refers to a type of bond instrument that can be issued by a government, companies, financial institutions and so on with the main goal of financing or refinancing environmentally friendly projects (ICMA⁴, 2021). These projects, more known as “eligible green projects”, fit the four core pillars of the Green Bond principles: project evaluation and selection, use of proceeds, management of proceeds and reporting. In fact, the market for green bonds has developed drastically since its beginning and has the potential to raise considerable sums of money for the shift to a low-carbon economy (Gurría, 2016). The origin and historical event that could be the starting point of the interest in sustainable finance as a refuge is the Paris Agreement in 2015 and the increasing global emphasis on sustainability (Buchner et al., 2019). Indeed, it is not surprising that some individuals believe this kind of investment may be risk-free, as a result of the increasing awareness of the serious environmental issues we are currently facing and the growing need for sustainable financial solutions. As the effects of climate change become more apparent it goes without saying that investors are seeking assets that not only offer financial stability but are also in accordance with their environmental principles when considering the match between long-term investments and sustainable financing. In times of economic instability, green bond proponents argue that their emphasis on sustainable investments and increased awareness of environmental concerns make them appealing. According to a study by Boermans (2023), the environmental aspects of green bonds may increase their toughness and viability as a safe haven. Furthermore, Hacıömeroğlu et al. (2022) discovered proof that suggests corporate green bonds provided a refuge throughout the covid-19 crisis.

Then, another reason why they should be regarded as safe havens is their capacity to enhance risk management and overall portfolio stability. Indeed, for the majority of asset allocation methodologies, it has been demonstrated that portfolios using green bonds as a diversifier have more effective risk-return profiles than portfolios that use standard bonds (Han et al., 2020). Secondly, research by Arif et al. (2021) indicated that long-term investors in traditional financial assets have found the green bond index to be a valuable diversifier asset for portfolio management during the covid-19 crisis. While their role as a refuge was somewhat limited, they have demonstrated their efficacy as effective hedges in times of market volatility (Ul Haq, 2021).

As a result, this shows that green bonds have the potential to act as a refuge during turbulent times, but that this potential is currently only available under certain market circumstances and for a limited length of time. Moreover, the growth of the green bond market is also constrained by a number of factors, such as the lack of globally uniform standards, the dangers of greenwashing, the perception that issuers will incur higher costs, the dearth of green bond offerings for investors and the market’s overall immaturity (Deschryver and de Mariz, 2020). Therefore, we cannot already affirm that investing in green bonds is completely risk-free according to all the uncertainties around, but that this kind of asset still has in a way promising future characteristics.

⁴The International Capital Market Association (ICMA) represents all the global players in the international financial markets, which include issuers in the public and private sectors, financial intermediaries, asset managers and many others. <https://www.icmagroup.org/>

4.2 Cryptocurrencies

At the same time, the world of finance has changed due to the quick development of technology, giving birth to an unfamiliar player: cryptocurrencies. Cryptocurrencies are a subset of digital currencies that rely on decentralized blockchain technology, allowing online payments to be sent directly between parties without going through a financial institution (Nian et al., 2015). These features set cryptocurrencies apart from conventional safe havens like gold or government bonds. In addition to that, the reputation of crypto's stability is not as well known as the one of gold and there is not enough past empirical evidence from their defensive role in a crisis situation to directly assess that it is a safe investment across market cycles. It's important to note that there is evidence showing that investing in cryptocurrencies can be risky and there are not enough guarantees yet to know whether they will exist in a long-term perspective or whether their value will increase over time (Nian et al., 2015).

First of all, according to studies by Dyhrberg (2016) and Baur and Dimpfl (2018), cryptocurrencies may face substantial fluctuations in prices during recessions. To exemplify that, they demonstrated that Bitcoin is inappropriate as a refuge investment because of its significant price volatility.

Secondly, the poor integration of cryptocurrencies into the mainstream financial system is another argument against them. According to research by Ciaian et al. (2016), variables unique to digital currencies, such as the attraction of cryptos to investors and users, as well as more general market dynamics of supply and demand, affect the price of virtual currencies. Additionally, they frequently show weak to no correlation with conventional safe havens (Corbet et al., 2018). Correspondingly, Klein et al. (2018) claim that Bitcoin behaves completely opposite to Gold and add that it is also positively correlated with bear markets, indicating that Bitcoin and the most historically popular refuge asset have fundamentally distinct characteristics and divergent connections to stock markets in general.

On the other hand, proponents believe that because of their inherent aspects as a store of value, crypto-currencies may act as a refuge. Based on research by Bouri et al. (2017) and Wu et al. (2019), some investors view particularly bitcoin as a hedge against inflation and a safeguard against currency depreciation. Also, in times of political and economic uncertainty, cryptocurrencies decentralized characteristic is viewed as something to consider. Indeed, even if they are uncorrelated with refuge assets in general times, during economic instabilities, the study by Bouri et al. (2017) and Ustaoglu (2023) indicates that bitcoin may hedge global uncertainty. To support this statement, Oosterlinck et al. (2023) analyzed the efficiency of Bitcoin during the Russia-Ukrainian War and find out that it works as a good diversifier, especially for the oil risk.

However, as demonstrated previously in the paper, if an asset works as a hedge, it doesn't necessarily mean that it is a safe haven. The record of Bitcoin throughout the course of the COVID-19 crisis unequivocally shows that it is not a safe haven in downturns, that its price declines at a pace equal to that of the S&P 500, and even a tiny allocation to Bitcoin dramatically raises the downside risk of the portfolio (Conlon et al., 2020). In addition to Ustaoglu (2020), who showed that Bitcoin has not the required properties to act as a safe haven.

From another point of view, in the cryptocurrency field, stablecoins have grown significantly in importance because, as their name suggests, they are intended to be stable. A stablecoin is a form of crypto asset that tries to control the value of real currencies in the volatile crypto market. It is intended to keep its market value constant by being linked to a reliable asset, such as fiat money or a commodity (Bullmann et al., 2019). In addition to that, Baumöhl et al. (2020) claim that not all stablecoins can be considered a strong safe investment but some of them, especially the USDT, a crypto with a price that is pegged to the US dollar, have potentially safe haven properties. In fact, during times of market stress, this asset displayed a negative correlation with other crypto that are usually not safe like Bitcoin and Ethereum. Knowing that it was demonstrated earlier that gold and Bitcoin are not correlated either, this indicates that these stablecoins typically maintained or even increased their value during periods of severe volatility in the cryptocurrency market, making them a possible safe haven for investors (Vukovic et al., 2021).

Overall, a lot of past and recent studies show that a cryptocurrency cannot be considered a safe-haven asset yet, rather as a risky asset (Baur et al., 2021), but that it has strong properties to act as an effective diversifier during market downturns (Rubbiani et al., 2021; Corbet et al., 2020). Notwithstanding these statements, it is crucial to understand that all of these studies are analyzing only the behavior of crypto during the COVID-19 crisis or a very short period of time. As with the case of the green bonds, it is too soon to conclude if it has or not the characteristics that make them safe havens. But the case of the stablecoins needs to be taken into account in this analysis, given its potential.

5 Conclusion

In order to make a first conclusion, the main objective was to retrospectively figure out what makes an asset the most reliable investment during a market downturn based on the historical perception of the safe-haven concept. This research was extremely helpful in trying to define what kind of asset worked as a refuge for financial actors, facilitating an in-depth understanding of their shared properties and the common characteristics that make an asset safe. In the following parts of this working paper, we will analyze and test the different hypotheses and insights we have retained from this first part. As it has been shown in this literature review, safe haven assets possess a range of characteristics and properties that make them attractive during economic crises. These include historical stability and quality - therefore, a role of preservation of value - a negative correlation with the general stock market during times of economic instability that induce diversification benefits and a high liquidity translated by an easiness to exchange.

On the other hand, a recent study by Baur et al (2021) is more than important to consider. Indeed, this latest research on the subject also describes how safe-haven assets interact with the market and proposes a new method, the quantile regression, to identify them by examining the returns of potential refuge investments under all economic conditions including periods of financial instability. This research has proved more than useful in helping to determine the properties to be taken into account when identifying assets that can be qualified as safe havens in times of crisis. As a matter of fact, the results of the study find out that there is a difference between an asset that is classified as a refuge investment and a simple safe asset. As stated by Baur et al. (2021), safe assets are investments that are believed to provide steady returns over time, whereas

safe-haven assets are those that are considered strong enough to perform well during periods of market turmoil or economic uncertainty. The author also identifies Gold and the US Treasuries as the ultimate safe-haven assets. Therefore, based on this analysis, we can conclude that offering a long-term stable historical return on an investment is a characteristic of a safe asset and since past studies proved that Gold and US 10 Year Treasuries kept a steady value over time such as Faugère (2013) and He et al. (2016), it implies that being a safe asset - so, keeping a constant value throughout time - could be a necessary but not sufficient condition to be categorized as a refuge investment that needs additional criteria such as a low correlation with the market. Of course, this will be taken into account and analyzed in depth in the course of this thesis.

Data and Methodology

The literature review has helped to define some hypotheses regarding the different patterns that determine an asset as a refuge such as the historical stability over time, the low correlation with global stock indexes or the diversification benefits of these investment tools. The following empirical part of this paper will focus on testing the individual properties of refuge investments identified in the past including three types of assets still not covered a lot when speaking of safe assets: luxury goods, stablecoins and green bonds. We will especially test the role of value preservation and the low or negative correlation of these assets with the general stock market. Focusing at first glance on a general study with historical daily data, the research methodology employed in this thesis draws on statistical and econometric methods to examine the relationships between identified characteristics and asset performance during the most recent economic crises, in order to uncover the specific attributes that make an asset reliable and resilient at present times. Then, we will analyze the more in-depth behavior of these safe havens during very specific shock periods.

1 Models used in previous studies

Researchers have used a variety of approaches in previous research to examine the characteristics and properties of refuge investments. But when it comes to analyzing volatility and correlation, one particular methodology stands out as the most widely used. Indeed, the study will follow the methodology utilized by Baur and Lucey (2010), Baur and McDermott (2010), She (2013), Song et al. (2019), Akhtaruzzaman et al. (2021), Oosterlinck et al. (2023), and Kayral et al. (2022), which is a Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model. According to these authors, it is a statistical model that describes the evolution of the volatility of financial assets over time using the squared values of previous observations and their variances. Engle (2002) then added a new variant, which is the DCC-GARCH, or Dynamic Conditional Correlation GARCH which measures the conditional correlation between variables and reflects the time-varying volatility, allowing the use of the most suitable method to analyze the main characteristics of safe-haven assets.

It is also worth noting that Baur et al. (2021) tested variables using a model of quantile regression to analyze the link between safe-haven assets in the context of unusual and normal market fluctuations. However, the period covered in the data in this analysis contains only turbulent times with the succession of recent past crises and is hence mainly representative of extreme market conditions rather than a wider combination of usual and unusual economic conditions. Therefore, it won't bring any more nuanced analysis to test the data over different quantiles of the distri-

bution. Nevertheless, it will be relevant to select very short specific periods in the full sample to observe the reaction to a specific and sudden shock, which will be done directly with the help of a time dummy or a simple formula in the R software.

Then, it is crucial to understand that this paper does not intend to exclusively analyze the diversification techniques and use our selected safe haven in a diversified portfolio. This has previously been proven several times in past investigations, making it even simpler to understand. For instance, Matos et al., 2017 as well as Lin et al., 2020 both found that gold has diversification benefits during a crisis, at least from a short-run perspective. Then, based on the research of He et al., 2016, although not directly mentioned, the fact that US government bond yields have remained unchanged and make up a sizable proportion of safe-haven portfolios, despite the significant increase in US public debt relative to GDP, is compelling proof of the diversification function they fulfill. Moreover, according to research by Winters et al. (2008), investors seeking to diversify their portfolios outside local assets and lower risk can profit from the Japanese yen. Other authors have also demonstrated the diversification performance of other assets such as Green Bonds (Han et al., 2020), the CHF (Groux et al., 2011) or even alternative investments such as Art (Jurevičienė et al., 2012) and real-estate (Śmietana, 2014). From an academic point of view, testing the diversification impact of those assets may then not be entirely useful for this study. Even if the fact diversification in a portfolio has numerous times been proven to be a good strategy to mitigate the downturn risks of a crisis for rational informed investors (Pham, 2021; Attia et al., 2021), the question of whether or not it is a safe-haven strategy won't be covered in this paper since this thesis is focusing on assets individually. Therefore, we will just test if each potential refuge investment acts more as a hedge or a diversifier in stable economic conditions.

Furthermore, this research will not try to test the riskiness of all used assets because it is never mentioned that a safe-haven asset is a risk-free investment. In agreement with the work of Baur et al. (2020), safe investments, despite their denominations, include risk. Because there is always a chance of a reversal, as already detailed in the literature review, gold hasn't been risk-free during all phases of the 19 years of crisis (Akhtaruzzaman et al., 2021). The primary objective is therefore to move beyond portfolio construction to a more in-depth analysis of fundamental economic factors.

2 Data

Within the scope of this research, the study of safe-haven assets across market cycles relies on historical data to draw meaningful conclusions. The selected data provides insights into the behavior of various assets across a daily period of 4 years from the end of 2018 to the start of 2023 worldwide in order to cover the main recent crisis such as the COVID-19 Pandemic, the energy crisis and the start of the conflict between Russia and Ukraine.

The dataset used in this analysis came from reputable and reliable databases, well-recognized in both the financial and economic industries. Refinitiv Eikon⁵, a financial software that is used by many schools and universities as a financial database with a focus on transactions and portfolio construction, was the major database utilized in this study. This platform is extremely valuable

⁵<https://eikon.refinitiv.com/>

since it offers data with a long history. Refinitiv⁶ further asserts that its data originate from a vast network of 2,000 sources. Then, data were also collected on the “Investing.com”⁷ website which is a well-known trading platform, according to the Investing.com team itself, that offers live financial information and data, prices, charts, but also investment tools for more than 300,000 financial products on 250 international exchanges. The data on Investing.com cover commodities, crypto-currencies, indices, currencies, bonds, funds, interest rates, ETFs, futures and options in addition to international stock markets. Many trustworthy marketers seeking local and world-wide visibility across all platforms have been drawn to it because of its reliability as a publisher.

This paper also finds some data on the Federal Reserve Economic Data⁸ (FRED) and the World Gold Council⁹ (WGC) website. The FRED is an online database managed by the Federal Reserve Bank of St. Louis, providing a vast collection of economic time series data from multiple sources (FRED, 2023). It also offers, still according to them, interactive tools for understanding, displaying, and disseminating data. FRED includes popular figures reported by various recognized institutions and has expanded to include international, national and regional data series. Moreover, it records individual data revisions, giving users access to accurate historical data.

The last database used for this analysis is the World Gold Council. As the leading authority in this field, it possesses a lot of expertise and valuable on-time information about gold. The WGC works to increase awareness of the gold market and emphasize the significance of gold to investors by drawing on its global perspective. It sets standards, facilitates the availability of gold and tackles barriers to its adoption, with the aim of stimulating demand and ensuring the long-term vitality and viability of the gold market. They specifically offer the Gold-related data that we require for analysis and study (WGC, 2023).

Considering the objectives of this study and the availability of analyzed data, especially historical data for the crypto stablecoin and the Green bond, the empirical analysis covers the period from November 2018 to February 2023 on a daily basis. The inclusion of data from 2018 allows for the examination of the latest significant market events and economic cycles that have not been extensively analyzed yet. By selecting a daily time frame, a significant sample size is guaranteed, allowing for a robust study of long-term trends, correlations and volatility patterns.

The empirical part of this paper will aim to compare all the types of safe havens discovered in the literature review with a selection of benchmark indices representing the overall performance of global stock markets. The analysis incorporates the daily prices of all these assets. The selection of the data and their respective denominations for this analysis are displayed in Table 1 for the selected safe-haven assets and Table 2 for the global market indexes.

Firstly, the daily prices of gold, denominated in US dollars, were collected on the World Gold Council database and correspond to the US dollar units per troy ounce. The returns were computed based on the LBMA Gold Price PM and Bloomberg’s calculated Fx rates. Then, the daily yields of the 10-Year US Treasury (DGS10) were created by the Board of Governors of the Federal Reserve System (US) and come from the database of the Federal Reserve Economic Data. They are the market yields on US Treasury Securities at 10-Year constant maturity, quoted on an investment

⁶<https://www.refinitiv.com/fr>

⁷<https://www.investing.com/>

⁸<https://fred.stlouisfed.org/>

⁹<https://www.gold.org/>

Table 1: List of safe-haven variables used in the analyses

Variable code	Description	Origin
Gold	Daily prices of Gold units per troy ounce in USD	World Gold Council
US-bond	10-Year US Treasury yields daily	FRED
USD	Daily prices history of the Nominal Broad U.S. Dollar Index	FRED
JPY	Daily prices of the USD/JPY FX Spot Rate	Refinitiv Eikon
CHF	Daily prices of the USD/CHF FX Spot Rate	Refinitiv Eikon
R_E	Daily industry prices of the MSCI World REITs index in USD	Refinitiv Eikon
Lux	Daily prices history of the S&P Global Luxury Goods Index in USD	Refinitiv Eikon
USDT	Daily stock prices of the Tether tokens expressed in USD	Investing.com
Green-b	Daily prices of the iShares USD Green Bond ETF	Investing.com

Table 2: List of benchmark variables used in the analyses

Variable code	Description	Origin
S&P500	Daily prices of the S&P 500 index	Investing.com
Stoxx 600	Daily prices of the Stoxx Europe 600	Refinitiv Eikon
Nikkei 225	Daily prices of the Nikkei 225 index	Investing.com
MSCI-wrld	Daily prices of the MSCI World index	Refinitiv Eikon

basis in percent.

Regarding the currencies, as a proxy for the American Dollar, the daily price history of the Nominal Broad US Dollar Index (DTWEXBGS), more commonly known as the Trade-weighted US Dollar Index, was also chosen from the FRED. The US Federal Reserve developed this index to follow the value and trend of the dollar confronting a group of key currencies that have been weighted based on how important they are in international trade (Logue and Rasura, 2022). Both the Japanese Yen and the Swiss Franc were obtained on the Refinitiv Eikon datastream, representing the historical daily price of the US Dollar/Japanese Yen FX Spot Rate and US Dollar/Swiss Franc FX Spot Rate. The analysis refers to the closing rate of each currency.

Subsequently, as a benchmark for global real estate performance, the daily industry prices of the MSCI World REITs index (.DMIWO0RI00PUS) were also collected from Refinitiv Eikon. For analysis purposes, the end-of-the-day quote in US dollars was chosen. According to MSCI, they are market capitalization indexes that take into account free float and measure the presence of large- and mid-cap firms across 23 industrialized nations globally that are all weighted according to their importance in the real estate industry, such as for instance, the United States, which are represented at 84 percent. Each stock in the index is categorized in the REIT industry within the real estate sector, taking into account the GICS regulations. The sub-industries tracked by the index are: industrial REITs for 15.39 percent, 14.84 percent represent the Telecom Tower REITs, 14 percent the Retail REITs, the Multi-Family Residential REITs for 10 percent, Data Center REITs for 9.5 percent, and the other ones that are all represented around 5 percent are Health Care REITs, Self-Storage REITs, Other Specialized REITs, Single-Family Residential REITs, Office REITs, Diversified REITs and other ones (MSCI Inc., 2023). This index is particularly helpful and comprehensive since it offers an in-depth overview of the real estate industry, covering a variety of property types that reflect

the market's broad trends.

In order to represent the alternative investments, the daily price history of the S&P Global Luxury Goods Index (.SPGLGUP), from Refinitiv Eikon once again, has been chosen to reflect the daily trend of the luxury goods market as a safe-haven asset. It is an index used to assess the performance of 80 multinational corporations engaged in the sale of luxury goods and services. The different firms included are chosen from the S&P Global BMI index and are weighted based on variables including their exposure to the luxury market, country of reference or, of course, their market capitalizations (S&P Dow Jones Indices, 2023).

However, despite all efforts, it is regrettable that the performance of the Art market as a safe haven had to be excluded from this empirical study. The main constraint was the lack of reliable open resources. Indeed, the best notable proxies prove to be the Artnet platform or the Sotheby's Mei Moses which were not available for unrestricted access despite repeated requests. It goes without saying that it represents a real limitation for this investigation. To keep this research transparent and rigorous, it is important to be aware of and understand the impact of this restriction. Although the dynamics of the art market cannot be captured by quantitative analysis, it is crucial to acknowledge the value and significance of the art market as an investment choice that deserves further investigation in future research.

For the most recent sources of refuge assets, respectively, the stablecoins and the Green bonds, the Tether tokens (USDT) and iShares USD Green Bond ETF were chosen. Both are daily data about their stock price expressed in USD and come from datastream Investing.com. The USDT has a time frame from 2014, its creation date, to 2023. The iShares USD Green Bond ETF, created by BlackRock, is issued by US and non-US entities to finance environmental projects and tracks an index composed of investment-grade green bonds denominated in US dollars and issued by the US. It is a useful tool for investors to gain exposure to green bonds as a safe haven, however, there are limitations to consider. Due to the selection process of the many green bonds that make up the ETF, its composition and construction methodology may introduce some biases. Additionally, this ETF has a short historical track record given that it was only introduced in 2018 (iShares, 2023). Furthermore, in addition to the exclusion of the art market from our quantitative analysis, it should be noted that these values have less data coverage than the other variables, which calls for certain data transformations and considerations.

Then, as often done in the literature (Baur et al., 2021; Oosterlinck et al., 2022; Mikhaylov et al., 2018; Kayral et al. 2023), for comparison purposes, global stock-market indices will be used. First of all, the daily prices of S&P 500 (SPX) index have been chosen and obtained on Investing.com. Including this index is crucial for this analysis because the S&P 500 represents 500 top businesses from the most powerful sectors of the United States economy and accounts for around 80 percent of the market capitalization that is currently accessible. It is usually recognized as the finest single indicator of large-cap US stocks (S&P Dow Jones Indices, 2023). The daily prices of the Stoxx Europe 600 (.STOXX), from Refinitiv Eikon, are also part of this comparative analysis. This wide European stock market index, which is a component of the STOXX Global 1800, tracks the performance of 600 equities from 17 different European nations (Qontigox, 2023). Moreover, the Nikkei 225 index will also be included in the analysis. The Nikkei 225, constituted of the 225 large-cap Japanese businesses listed on the Tokyo Stock Exchange, is the primary stock market index for the Japanese economy (Nikkei Inc., 2023). Finally, as a last benchmark index, the daily trends of the

MSCI World Index will also be taken into account. This index represents big and medium-sized businesses in 23 developed countries. The index, which has 1,512 members, accounts for almost 85 percent of the total market capitalization across all sectors and countries (MSCI, 2023).

Shifting gears, since we have some data from different sources and in different units, it will be important to standardize these data. Instead of analyzing the daily prices of the different assets, the day-to-day variation for each asset will be calculated on an Excel sheet using the log differences of prices formula:

$$\text{Log-Daily-Returns}_{\text{asset}_x} = \log \left(\frac{\text{Daily value}_{\text{asset}_x}(t)}{\text{Daily value}_{\text{asset}_x}(t-1)} \right)$$

By calculating and analyzing the daily returns of the variables, it reduces the impact of any underlying trends that might exist. Indeed, the presence of any trends in the variables could be a source of non-stationarity, increasing the risk of spurious relationships in the variables (David, 2007).

Then, a unit root test was performed to identify and evaluate the stationary properties of the variables, which is essential when conducting a time series analysis to guarantee the validity and reliability of the model (Mushtaq, 2011). The Augmented Dickey-Fuller test (ADF test) was chosen to take into consideration the potential existence of auto-correlation in the data set. The ADF test adds more lagged differences between the variables in the regression equation compared to the simpler Dickey-Fuller test. Based on the work of Mushtaq (2011), the respective test looks as follows:

$$\Delta y_t = \alpha + \beta_t + \gamma \cdot y_{t-1} + \delta_1 \cdot \Delta y_{t-1} + \dots + \delta_p \cdot \Delta y_{t-p} + \varepsilon_t$$

Where:

- Δy_t represents the differenced variable at time t . $y(t)$ being respectively the value of the time series at time t for each variable.
- α is the intercept term.
- β represents the coefficient on the lagged level of the variable.
- γ is the coefficient on the lagged first difference of the variable.
- δ_1 to δ_p are the coefficients on the additional lagged differences of the variable.
- ε is the error term.

The null hypothesis of the test assumes that the time series variable has a unit root so that $\beta=0$ while the alternative hypothesis says that the variables are stationary with the $\beta < 0$.

The results of the test are displayed in Table 9 of Appendix 2.2 and show that all the variables (Gold, US Government bonds, USD, JPY, CHF, Real estate, Luxury goods, the stablecoin, the green bonds, S&P500, Stoxx 600, Nikkei 225 and MSCI World) have a smaller test statistic than the critical values provided in the results. Based on this interpretation, in addition to the very small P-values provided ($<2.2e-16$), the null hypothesis is rejected, suggesting strong evidence in favor of stationary properties.

Figure 1 displays the time series plots for each variable in order to give a comprehensive visual representation of the behavior of each variable across the examined period. These graphs provide a graphical representation of the underlying trends and patterns found in the previous test. After closely examining Figure 1, it becomes evident that the variables exhibit stationary characteristics, indicating the absence of significant non-stationary elements such as trends or systematic patterns.

If these graphs are combined with the results of the descriptive statistics computations applied

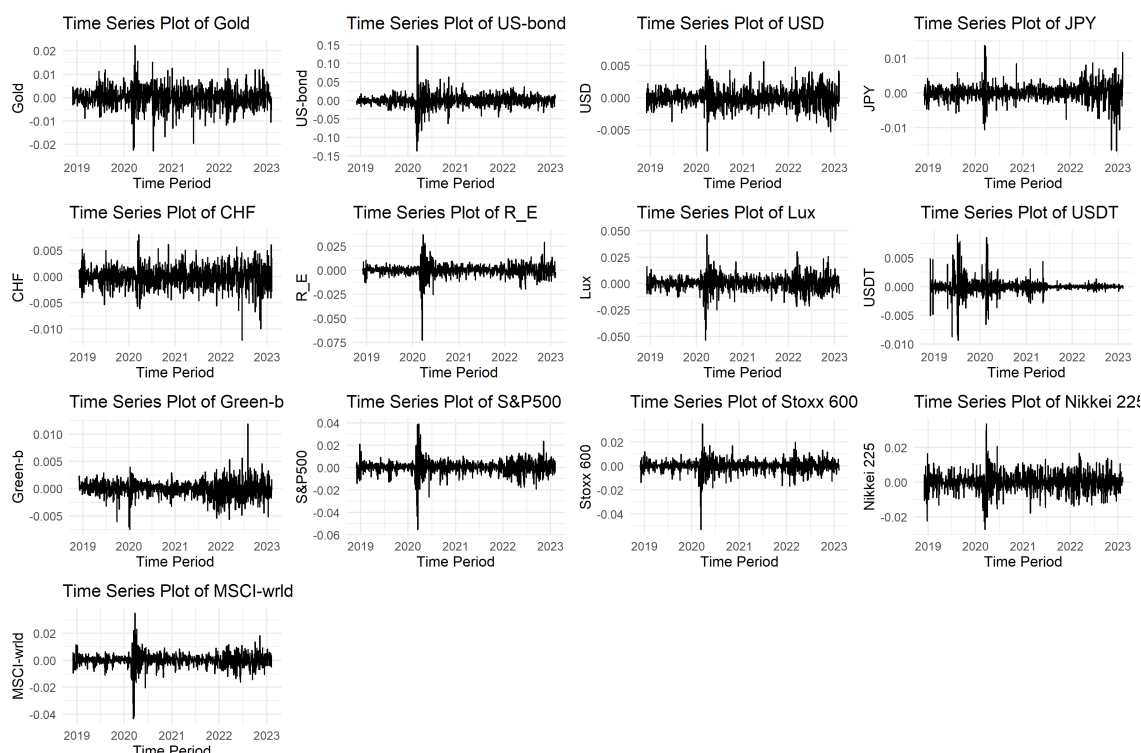


Figure 1: Daily log-returns time series
Source: Refinitiv Eikon, FRED, WGC, Investing.com

to all variables, as Hasan et al. (2021) did, which are displayed in Table 10 of Appendix 3, it provides a preliminary understanding of the data's average returns, volatility and range. Indeed, the results provided show that all the variables have an average daily log return of approximately zero, indicating that there is little change in prices from one day to another for the benchmark indexes as well, even if the log transformation has standardized the data. It is worth mentioning that Gold, US Treasuries, the Japanese Yen and the luxury goods market have a very slight positive mean, that could provide initial evidence of the value-reserve role of safe-haven assets.

Regarding the standard deviation, it gives insight into the dispersion of the log returns. It appears that the ones of the safe-haven assets are smaller than the ones of the benchmark indices and are also pretty low; only the real-estate index and the luxury market are higher than the benchmark ones and induce moderate volatility. Indeed, lower standard deviations, in descriptive statistics analysis, generally imply lower volatility in the data, indicating a more stable performance for

safe-haven assets. However, the standard deviation of the log returns of the US Treasuries seems a bit alarming regarding the volatility of the indices.

Nevertheless, the use of descriptive statistics alone is not enough to draw any conclusions about the volatility of the assets; it is common in the literature to use more advanced techniques to assess volatility more rigorously and accurately to draw more robust conclusions, while the interpretation of these statistics just offers a comprehensive understanding of the data's trend at first sight.

A last point to consider before starting the deeper analysis is the correlation between each variable. Table 11 of Appendix 4 represents the correlation matrix between all the variables in the data set. As followed by Helwig (2017), the correlation coefficient matrix, here denoted as "R", is a square and symmetric matrix that displays the Pearson correlation coefficients between each pair of variables in a data collection, denoted as " r_{jk} ".

$$R = \begin{pmatrix} 1 & r_{\text{gold} \times \text{US Gov}} & r_{\text{gold} \times \text{USD}} & \dots & r_{\text{gold} \times \text{MSCI}} \\ r_{\text{US Gov} \times \text{gold}} & 1 & r_{\text{US Gov} \times \text{USD}} & \dots & r_{\text{US Gov} \times \text{MSCI}} \\ r_{\text{USD} \times \text{gold}} & r_{\text{USD} \times \text{US Gov}} & 1 & \dots & r_{\text{USD} \times \text{MSCI}} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ r_{\text{MSCI} \times \text{gold}} & r_{\text{MSCI} \times \text{US Gov}} & r_{\text{MSCI} \times \text{USD}} & \dots & 1 \end{pmatrix}$$

Where

$$r_{jk} = \frac{\sum_{i=1}^n (x_{ij} - \bar{x}_j)(x_{ik} - \bar{x}_k)}{\sqrt{\sum_{i=1}^n (x_{ij} - \bar{x}_j)^2 \sum_{i=1}^n (x_{ik} - \bar{x}_k)^2}}$$

The findings reveal that Gold, JPY and green bonds exhibit correlation coefficients close to 0 or not above 0.21 with the benchmark indices. This suggests a weak but still positive linear relationship between these assets and the market represented by the benchmark indices.

Even if it is not a negative correlation, the correlation coefficient of approximately 0.1 indicates that the movements of the Japanese Yen and the Green bonds, in particular, could imply that these assets may not be correlated with the overall market conditions captured by the global indexes. Such a finding is in line with the traditional perception of them as safe-haven assets that tend to exhibit a low correlation with broader market movements. However, the correlation between Gold and the MSCI World Index seems surprising, even if relatively weak. Concerning the Swiss franc, the American Dollar and the crypto, they show negative correlation coefficients with the stock market indices. It means that these currencies frequently move against the market and reinforce their safe-haven properties.

On the other hand, the analysis reveals contrasting results for other variables. The US government bonds surprisingly exhibit a relatively strong positive correlation, with coefficients ranging up to 0.3, indicating a more significant relationship with the global indices. Similarly, the real estate and luxury market indexes demonstrate an even stronger positive correlation, with coefficients reaching 0.8, which could be explained by the fact that these indexes are part of a global index as well. Another surprising result is that historically secure assets are for the most part negatively correlated between them (especially gold) or have a correlation coefficient close to zero among

them, while global market indexes are strongly correlated. Further research will be done to understand the underlying causes and dynamics of these relationships, given some initial correlation analyses' unexpected results.

In order to understand the kind of shocks that influence the volatility of safe-haven assets and their correlation with the global market trend, four specific periods have been selected from the full data set for some concentrated study. First, the period before the Covid crisis, from November 2018 to April 2019, in order to capture and understand the underlying trend in a calm economic environment. Secondly, the start of the COVID pandemic from a week before the World Health Organization announced that COVID is a global pandemic, around early March 2020, to the end of June 2020. Then, the period covering the start of the Russia-Ukrainian war, including February 24, 2022, start date of the invasion. Finally, the summer of 2022 was a crucial period for financial markets, as central banks around the world announced a substantial 75 basis point increase in their key interest rates in response to inflationary pressures until November 2022 and with the aim of stabilizing economies (Boesler and Bloomberg, 2022; Cieslak et al., 2023; Amarasinghe, 2015). All these periods and their respective variable names are explained in Table 3 below.

Specific shocks are indicated by a dashed grey line in the graphs for each period in order to im-

Table 3: Selected Periods

Variable code	Time Period	Description
PreCovidTrend	2018-11-29 to 2019-04-16	Calm economic environment before the Covid crisis.
CovidOnset	2020-03-06 to 2020-06-30	Beginning of the Covid World pandemic.
RusUkrWarStart	2022-02-23 to 2022-06-30	Covering the start of the Russia-Ukrainian war.
RateRaiseResponse	2022-06-14 to 2022-11-07	Central banks raised rates to fight inflation.

prove readability and context. Table 4 below provides more information on the criteria used to choose these particular shocks.

Table 4: Selected Periods

Variable code	Date	Description
CovidPandemic	2020-03-11	WHO covid announcement
Invasion	2022-02-24	Invasion of the Ukraine
FEDPolicy	2022-06-15, 2022-07-27, 2022-09-21, 2022-11-02	Rates increase by 75 bps

3 Methodology

3.1 DCC – GARCH model

Our study will mainly follow the Dynamic Conditional Correlation (DCC) model elaborated by Engle (2002), reviewed more recently by Bouri et al. (2017), Akhtaruzzaman et al. (2021), Ustaoglu (2023) and Oosterlinck et al. (2023). With respect to the work of Engle (2002) combined with the one of Kouamé Kan Eulalie (2013), this is an extension of the GARCH model that takes into consideration conditional correlations between different variables that change over time and is performed in two steps. At first, we will have to estimate the conditional variance of the different

assets through an univariate GARCH (1,1) model in order to calculate each variable's estimated volatilities, then a dynamic correlation model to calculate the variables' evolving correlations over time, enabling to construct a conditional covariance matrix. Using an extension of GARCH models to estimate the conditional variance of safe-haven assets during recent periods of turbulence will provide a clear insight into the volatility of safe-haven assets as well as their correlations with the performance of benchmark indices.

Univariate GARCH (1,1)

Using the research of Bollerslev (1986), Orskaug (2009), Brooks and Burke (2010) and Bouri et al (2017), this first step aims to define the conditional variance of each asset's return. Therefore, separately for each asset i , the univariate GARCH(1,1) model may be expressed as follows:

Conditional Mean Equation:

$$r_{i,t} = \mu_{i,t} + \epsilon_{i,t} \quad (1)$$

Where:

- $r_{i,t}$ represents the log return of asset i at time t
- $\mu_{i,t}$ represents the conditional mean of the log return of asset i at time t .
- $\epsilon_{i,t}$ represents the residual log return of asset i at time t .

Conditional Variance Equation:

$$h_{i,t} = \omega_i + \alpha_i \epsilon_{i,t-1}^2 + \beta_i h_{i,t-1} \quad (2)$$

Where:

- $h_{i,t}$ represents the conditional variance of asset " i " at time t .
- ω_i is the constant term of the conditional variance of asset i .
- α_i and β_i are parameters that must be estimated which describe the influence or weight of respectively α and β , past squared returns and past conditional variance on the current conditional variance.

In order to estimate the model, we start by estimating the conditional mean equation (1) of asset " i " at time t to obtain the residuals from the regression in order to use them in the conditional variance equation. After identifying the autoregressive elements of volatility, the squares of the residuals are regressed on their lagged values. Then, in order to take the moving average component of the volatility, the conditional variance will regress also on its lagged values.

To preserve the stability and accurate interpretation of the model, several constraints are set on the parameters in GARCH modeling. Through the help of these restrictions, the estimated conditional variance, which depicts volatility, is kept acceptable and nonnegative.

If the null hypothesis, that there are no GARCH errors in the model, is true, meaning that the

volatility of asset returns shows no discernible persistence over time, this suggests that asset returns show significant fluctuations. The initial level of volatility is captured by the ω parameter. It has to be positive or equal to zero, which means that the unconditional variance can't be negative. The alpha (α) and beta (β) parameters must likewise be non-negative. Moreover, it is necessary for the sum of the alpha and beta coefficients to be smaller than 1 ($\alpha + \beta < 1$) in order to prevent explosive behavior in the conditional variance. When this result is greater than 1, a situation may occur where shocks have a cumulative amplifying impact on volatility, possibly resulting in extremely large fluctuations.

Given the previous statements and formulas, we now need to construct a diagonal matrix containing the conditional variances calculated above. This matrix will serve to obtain the D_t matrix (3) that will be used in the next steps.

$$D_t = \begin{pmatrix} \sqrt{h_{Gold,t}} & 0 & 0 & \dots & 0 \\ 0 & \sqrt{h_{US-bond,t}} & 0 & \dots & 0 \\ 0 & 0 & \sqrt{h_{USD,t}} & \dots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \dots & \sqrt{h_{MSCI-wrld,t}} \end{pmatrix} \quad (3)$$

Dynamic Conditional Correlation

The benefits of taking the dynamic correlations instead of static ones are multiple. Many complex correlations between different assets that evolve over time compose the financial markets nowadays and basic static correlations come with inherent limitations since they are, by definition, an evaluation of the degree of correlation between some financial assets that remain unchanged over a specific time frame (Meissner, 2019), therefore unable to capture the dynamic nature of relationships between assets. However, relationships between various assets could change radically, especially during times of financial crises. As previously mentioned, the DCC-GARCH model allows correlations to vary over time.

In the section below, we examine how the DCC-GARCH model quantifies these dynamic correlations and provides a more comprehensive perspective on market interdependencies.

The DCC-GARCH (1,1) equation is composed of:

$$r_t = \mu_t + \epsilon_t \quad (4)$$

Where:

- r_t a $n \times 1$ vector composed of the different $r_{i,t}$ log returns
- μ_t the $n \times 1$ vector composed of the different expected values of the conditional r_t
- ϵ_t the $n \times 1$ vector composed of the mean-corrected returns of all the assets at time t with $E[\epsilon_t]=0$ and $Cov[\epsilon_t] = H_t$

H_t being the $n \times n$ matrix that represents the conditional variances of ϵ_t and is equal to:

$$H_t = D_t R_t D_t \quad (5)$$

Where:

- D_t is the $n \times n$ diagonal matrix in (3) containing the conditional standard deviations of ϵ_t
- R_t being the $n \times n$ symmetric matrix of the conditional correlation of ϵ_t

$$R_t = \begin{pmatrix} 1 & \rho_{Gold.US-bond,t} & \rho_{Gold.USD,t} & \dots & \rho_{Gold.MSCI,t} \\ \rho_{Gold.US-bond,t} & 1 & \rho_{US-bond.USD,t} & \dots & \rho_{US-bond.MSCI,t} \\ \rho_{Gold.USD,t} & \rho_{US-bond.USD,t} & 1 & \dots & \rho_{USD.MSCI,t} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \rho_{Gold.MSCI,t} & \rho_{US-bond.MSCI,t} & \rho_{USD.MSCI,t} & \dots & 1 \end{pmatrix} \quad (6)$$

Where:

$$\rho_{ij,t} = \frac{E_{t-1}(\epsilon_{it}, \epsilon_{jt})}{\sqrt{E_{t-1}(\epsilon_{it}^2) \cdot E_{t-1}(\epsilon_{jt}^2)}} \quad (7)$$

- $\rho_{ij,t}$ is the conditional correlation coefficient between asset i and asset j at time t.

Then, in order to define the equation of R_t , it is necessary to introduce matrices Q_t (8), which depicts the evolution of asset correlations over time and Q_t^* (12), which is a diagonal matrix containing the square root of only the diagonal elements of the matrix Q_t .

$$Q_t = (1 - \alpha - \beta) \cdot \overline{Q_t} + \alpha \cdot \mathbf{e}_{t-1} \cdot \mathbf{e}_{t-1}^T + \beta \cdot Q_{t-1} \quad (8)$$

Where:

- $\mathbf{e}_t \sim \mathcal{N}(0, R_t)$ represents the standardized disturbances: $\mathbf{e}_t = D_t^{-1} \epsilon_t$ (9)
- $\overline{Q_t}$ represents the unconditional covariance matrix of \mathbf{e}_t and is estimated as

$$\overline{Q_t} = \frac{1}{T} \sum_{t=1}^T \mathbf{e}_t \cdot \mathbf{e}_t^T \quad (10)$$

- α and β are pretty comparable to those provided in the GARCH part but now also cover the covariance matrix and correlation components and have to satisfy additional conditions in order to guarantee that the unconditional variances stay positive.

$$\alpha \geq 0, \quad \beta \geq 0, \quad \alpha + \beta < 1 \quad (11)$$

$$Q_t^* = \begin{pmatrix} \sqrt{q_{Gold.Gold,t}} & 0 & 0 & \dots & 0 \\ 0 & \sqrt{q_{US-bond.US-bond,t}} & 0 & \dots & 0 \\ 0 & 0 & \sqrt{q_{USD.USD,t}} & \dots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \dots & \sqrt{q_{MSCI.MSCI,t}} \end{pmatrix} \quad (12)$$

These steps are used to determine the symmetric Dynamic Conditional Correlation matrix R_t that is represented in (6) and is also defined by the equation (13).

$$R_t = Q_t^{*-1} Q_t Q_t^{*-1} \quad (13)$$

As said previously, the analysis will compare the performance of six historically recognized safe haven assets—gold, US Treasuries, the US dollar, Japanese Yen, Swiss franc and real estate—and three potential new sources of refuge investments—the luxury goods market, green bonds and a stablecoin—against the four global indexes used as proxies for the market trend. Then, while a general analysis of the whole period will provide us with a comprehensive understanding of time-series behavior, it will also be helpful to go more deeply into specific time periods to understand the volatility and correlation effects of key world events. With such a focused methodology, we are able to separate the consequences of historic shocks and provide a sharp understanding of their effects on financial markets and their interdependence.

Our goal is to objectively evaluate the direction of changes in volatility and correlation for our selected variables. This allows us to identify the events that have the biggest effects on financial dynamics, which helps us to answer the question of how the safe-haven assets perform across market cycles but also how strong the impacts of a crisis are on the volatility of a renowned safe asset and correlation with the global financial market trend and make better investment choices in the case of future shocks.

3.2 Safe-haven test

Later, to test the real current performance of the selected safe-haven assets since the COVID-19 crisis, especially knowing if we can still qualify them as a kind of refuge investment after all the recent turbulence in the financial markets, we will use the method proposed by Baur and Lucey (2010) and reworked by Oosterlinck et al. (2023), which tests whether gold has acted more as a hedging or diversification asset, or as a safe haven in times of crisis. The model they proposed can be derived as follows:

$$\rho_t = \delta_0 + \delta_1 \times C_t + u_t \quad (14)$$

Where:

- ρ_t represents the average of the dynamic correlations obtained from the DCC model.
- C_t is a time dummy variable that equals 0 before the start of the recent turbulent period (before the WHO announcement of the covid crisis) and equals 1 after the shock.
- δ_0 and δ_1 are the coefficients that have to be estimated and tested.
- u_t denotes an error term.

In their models, they took as a conclusion that if δ_0 was significantly negative, the asset behaved as a hedge, otherwise, it performed as a diversifier; and if δ_1 was significantly negative, the asset displayed safe-haven characteristics throughout the shock period since it meant that the correlation between the potential safe asset and the opponent decreased in time of crisis.

However, it is crucial to understand that based on the literature review, the low correlation with the global financial markets is not the only factor that makes an asset a safe haven. We have to add other criteria such as a high level of liquidity as well and foremost a low level of volatility or at least lower than the global market benchmarks during times of financial instability.

Despite the interest, for the lack of available data on the volume traded of the asset analyzed, we

won't be able to test the liquidity of the assets even though some authors like Benigno (2017) suggest that this liquidity property of safe havens is crucial, as it allows them to be useful in exchange for goods and services and ensures that they can serve as a reliable store of value. Although this restriction limits the scope of our investigation, it is crucial to acknowledge it and take it into account when drawing conclusions. The lack of a liquidity analysis does not contradict the general conclusions, but it does point to the necessity for a more comprehensive study when such information is made accessible.

Results and Discussion

1 Volatility statistics

This part tries to describe and evaluate the empirical results after presenting the reliable approach utilized to understand volatility dynamics and the interdependencies of the different assets. Starting our analysis, we look at the descriptive statistics this time for time-varying volatilities from univariate GARCH models. These statistics provide a thorough picture of each asset's volatility behavior and pave the way for the dynamic correlation analysis that follows. The underlying volatility statistics are depicted in Table 5 below. Starting the analysis with the mean volatility, which de-

Table 5: Volatility statistics
Source: Refinitiv Eikon, FRED, WGC, Investing.com

Variable	mean	sd	min	max	Skew	Kurt
Gold	0.0040	0.0009	0.0028	0.0095	2.2932	7.7113
US-bond	0.0146	0.0093	0.0067	0.0829	4.0466	20.5211
USD	0.0013	0.0004	0.0007	0.0034	1.6147	3.7580
JPY	0.0022	0.0010	0.0012	0.0070	2.0379	4.4601
CHF	0.0020	0.0005	0.0012	0.0048	1.7434	4.1929
R_E	0.0051	0.0035	0.0022	0.0325	4.1590	22.0796
Lux	0.0063	0.0032	0.0028	0.0257	2.6886	10.5322
USDT	0.0008	0.0008	0.0001	0.0044	2.0285	4.2518
Green-b	0.0014	0.0005	0.0007	0.0034	0.9015	-0.0146
S&P500	0.0053	0.0035	0.0022	0.0367	4.0835	23.9901
Stoxx 600	0.0046	0.0024	0.0023	0.0258	3.8809	22.2051
Nikkei 225	0.0051	0.0014	0.0034	0.0149	3.1921	14.4999
MSCI-wrld	0.0043	0.0028	0.0018	0.0284	4.1612	24.4489

scribes the average of the time-varying volatilities across the given period, we can clearly notice that the US Treasuries seem to be the most volatile asset among those listed with the highest average volatility at 0.0146. This observation contradicts a bit of what was stated in the literature and the historical belief of the US Treasuries as one of the premier refuges. It's worth pointing out that the results for the global benchmark indexes as well as the real estate and the luxury goods give more or less the same conclusions. However, contrary to the prejudices that some people such as Hoang and Baur (2021) or Grobys et al. (2021) may have about crypto-currencies in general, the USDT possesses the lowest mean volatility at 0.0008. Regarding the volatility range, covering the lowest and highest volatility during the period, the US government bonds once again stand out

with the widest range between minimum and maximum volatility, confirming their position as the most volatile assets during the full analyzed period with the benchmarks and the real estate index and the luxury goods on the list for now.

Secondly, most assets are positively skewed, meaning that their volatility distributions are skewed to the right, with longer tails on the right side and there are sometimes very high returns. In addition, the majority of assets show kurtosis values above 3 (except for green bonds), suggesting that these assets may experience extreme volatility values more frequently than would be expected from a normal distribution. As a result, assets such as US Treasuries or the real estate index exhibit both high average volatilities and high kurtosis values, as do the benchmark indices. This combination may indicate that they are more prone to significant volatility spikes in addition to being more volatile on average. In contrast, currency volatility appears to be minimal, more in line with the findings of the literature but with USDT being the least volatile. Figure 2 shows the time-varying volatilities of the different assets which are in line with the results from the statistics. All the graphs show a significant peak around March 2020, around the announcement of the COVID-19 pandemic by the World Health Organization (WHO), and a succession of relatively minor peaks around February 2022, possibly related to the start of the Ukraine-Russia war, having, of course, different scales for each asset returns in line with the statistics above.

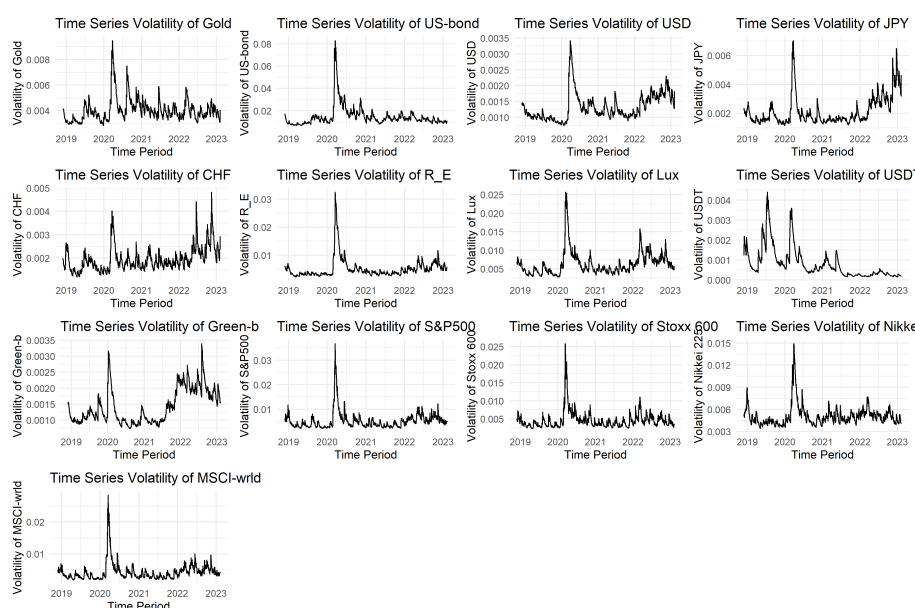


Figure 2: Volatility time series

Source: Refinitiv Eikon, FRED, WGC, Investing.com

Reflecting on historical events, the WHO announcement created a massive panic and uncertainties about the future around the world resulting in heightened volatility in financial markets, as investors shifted their portfolios towards more liquid or historically safer assets, leading to significant fluctuations in asset prices (Ullah, 2022 and Gherghina, 2023). Moreover, the smaller spike in volatility around 2022 suggests that, while the conflict between Ukraine and Russia was significant, its broader financial repercussions were perceived at first sight as more contained than

the pandemic, while the conflict had significant geopolitical implications. It's also probable that by 2022, markets would have improved from how they were at the beginning of 2020 in terms of dealing with geopolitical risks and outside shocks. More resilience in the financial ecosystem would have led to a more restrained reaction in terms of volatility. As a matter of fact, Izzeldin et al. (2023) compared the reaction of the Covid-19 shock and the global financial crisis to how the Russian-Ukrainian war influenced international financial markets. They demonstrated that the Covid-19 pandemic impact was stronger than the other two cases, even if the severity and duration of the pandemic were underestimated. In fact, financial markets replied to the Russian invasion more quickly, which could have minimized the severity of the war. These statements and impacts will be analyzed further specifically with the performance of each asset.

2 Parameters Estimation

Now that we are familiar with volatility statistics, we may better comprehend the underlying dynamics of volatility by estimating important parameters. Tables 12 and 13 from Appendix 5 are showing the results of the DCC fit of the estimations of the DCC-GARCH model's parameters. It's interesting to note that for the majority of assets, whether safe assets or global market indices, α_1 estimates, which show how past shocks have affected current volatility, are equal or very close to zero. This indicates that the model does not significantly account for the effects of previous shocks on the current volatility of these assets. What is more, each asset has a β_1 value close to 1, suggesting that once volatility changes following a shock, it remains at this new level for an extended period before returning to its mean. This persistence could prolong periods of high volatility, which can be the case at events such as COVID and correspond to the high spikes observed previously.

3 Dynamic Correlations Analysis

A deeper understanding of the dependency and co-movements of assets is provided by dynamic correlation analysis. This section examines the results of this analysis, focusing on the dynamic correlation between assets across the analyzed period. Indeed, according to our hypothesis and past literature, during market downturns, a safe-haven asset should ideally have a low (or even negative) correlation with the broader market (here we use the 4 global indices as proxy) as stated by the definition of Baur and Lucey (2010) or Roberto Rivero (2023). Therefore, we will mainly observe how correlations between each safe-haven asset and benchmark indices change over time. After having examined the broad trends, we will go deeper into the analysis by zooming into specific crisis periods.

The dynamic correlation between our chosen safe-haven asset and the four benchmark indexes is shown in each Figure of this section. These visualizations, rich in temporal nuances, are crucial for several reasons. Firstly, it provides an easy way to distinguish between periods when the safe-haven asset has moved in line with the benchmark indexes, the non-negative period and periods when it has diverged, the negative correlations. Then, periods of sharp declines in correlation could indicate times when the safe-haven asset really stood out, mixed with the volatility analysis we have done could show us which periods to analyze in more detail.

DCC between Gold and Global market

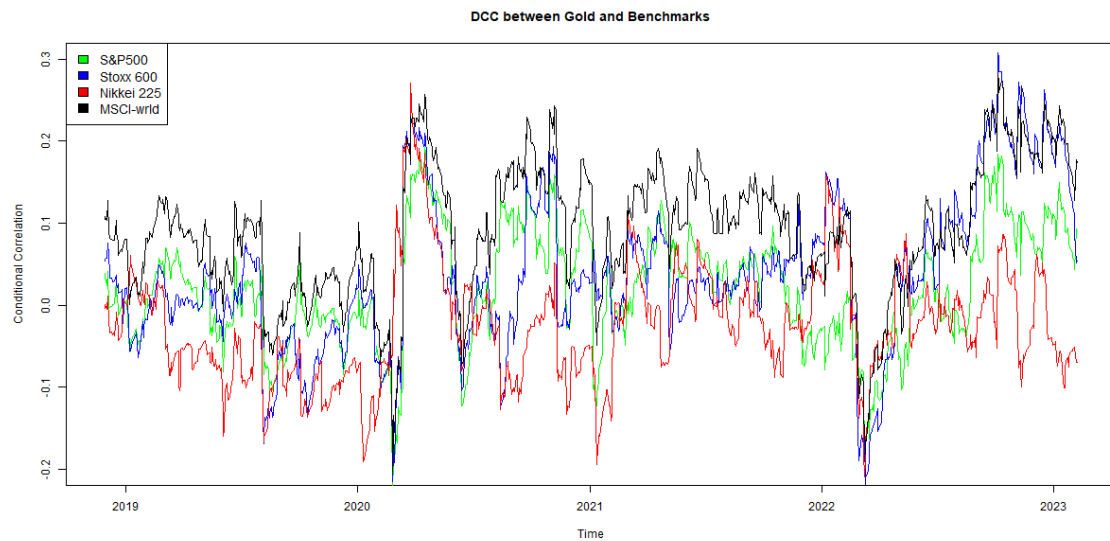


Figure 3: DCC time series between Gold and global indexes

Source: Refinitiv Eikon, WGC, Investing.com

As a reminder, Gold has always been thought of as a quintessential refuge investment by the majority of authors. The results provided by the graph from Figure 3 are then a bit mitigated at first sight. Of course, as a general view throughout the analyzed period, Gold's correlation with benchmarks seems to fluctuate around 0 or 0.1 and therefore appeared to remain fairly low over time. Moreover, in a normal economic environment, before the WHO announced the start of the Covid-19 pandemic, a downward shift of the correlation coefficients towards the negative realm can be observed. Indeed, Gold tends to be negatively correlated or has no correlation with the market when there is no shock. Figure 4 below also shows that it is a bit more correlated with the MSCI World Index than the other, while it is still very low.

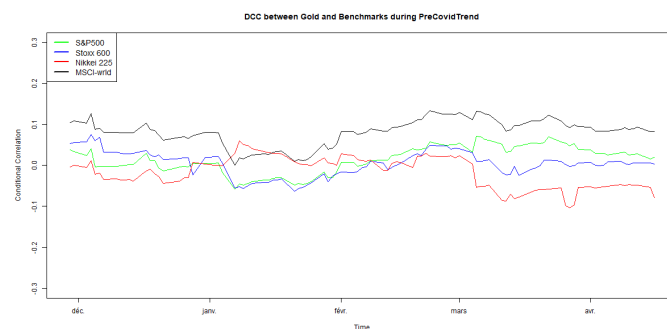


Figure 4: DCC of Gold with global indexes before the Covid

Source: Refinitiv Eikon, WGC, Investing.com

However, starting with the pandemic announcement, we note a clear variation from -0.2 to around

0.3 coefficient. Looking at Figure 5 below, it is clear that the start of the world pandemic, in this analysis we take the March 11 2020, had a huge impact on the volatility of Gold and its correlation with the market. From a short-term perspective, Gold showed a very sensitive behavior translated also by a decline in the price of gold (see the time series graph from the same period in Appendix 1). The fact that it stayed below a correlation coefficient of 0.3 showed that the decrease in price and volatility was smoother than the global trend during that period. These results are in line with the empirical findings of Akhtaruzzaman et al. (2021) stating that Gold was a clear safe haven during the first phase of the pandemic, when it was not a global threat to the financial markets yet but still already impacting but less after the WHO announcement.

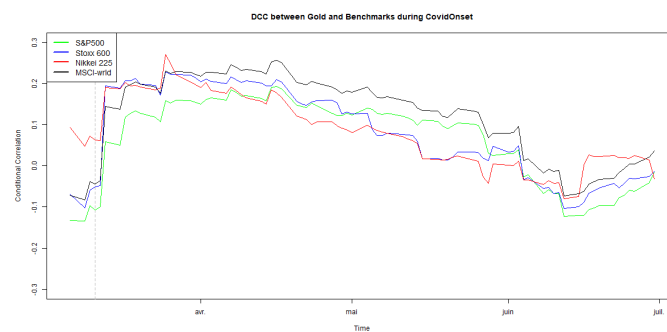


Figure 5: DCC of Gold with global indexes during the Covid
Source: Refinitiv Eikon, WGC, Investing.com

These shifts in correlation and volatility show the markets' rising concern and uncertainty at that period. A brief positive connection with global benchmark indexes was presumably caused by investors moving their money from riskier assets to gold, which is typically thought of as a store of wealth (Ullah, 2022; Gherghina, 2023). However, after the initial panic and the creation of a vaccine, possibly also because efforts were made worldwide to reduce the impact of the pandemic on financial markets, the correlation stabilized around 0.1 and below until the end of the crisis.

Then, when the conflict between Russia and Ukraine broke out, there was a quick decline in the DCC between gold and global market trend indices, going from around 0 to -0.2 from the end of February to the beginning of March 2022. This rapid decline accentuates gold's classic safe-haven properties and tends to underline the fact that, as geopolitical tensions intensified, investors quickly turned away from riskier assets to the safety of gold. This can be linked to articles by Boele (2022) and Oosterlinck et al. (2023), who argue that portable assets such as gold have risen in value during previous conflicts and wars in particular, so we can deduce that the same phenomenon occurred at the start of the conflict between Russia and Ukraine. However, it is not at first really in accordance with the statements of Ustaoglu (2023) stating that gold has lost its safe-haven power.

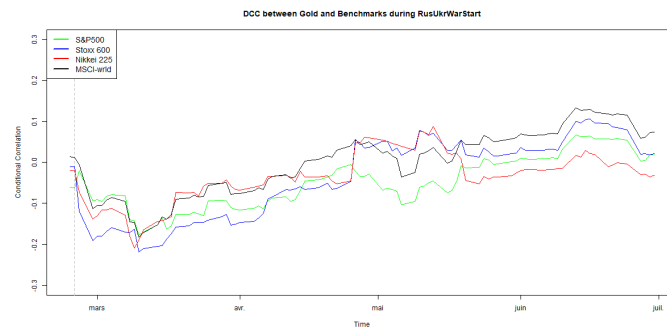


Figure 6: DCC of Gold with global indexes during the Russia-Ukraine conflict
Source: Refinitiv Eikon, WGC, Investing.com

Figure 6 also shows a continuous increase in the correlation after the first shockwave, from -0.2 to 0.15, lasting from mid-March to July 2022 and that could be explained by two main things. Comparing the time series graph of Gold and the global indexes from Appendix 1, it is clear that the initial rush to gold as a safe haven is beginning to level off as investors gain greater clarity on the geopolitical scenario. The value of gold tends to decrease as the ones of the benchmarks, surely due to the closing borders and halting foreign trade with Russia. Since the start of the war, the correlation has gradually increased and has stagnated at around 0.2 since the end of 2022. However, it is important to understand that an increase in correlation does not systematically correspond to a decrease in price, and could also be explained by the fact that yields are relatively stable after the first peak of the shock. These results, also depicted by Kayral et al. (2023) and Ustaoglu (2023), tend to show that Gold could serve more as a strong hedge nowadays than a real safe haven.

Additionally, the fact that gold's correlation with benchmarks stayed around 0.1 throughout the first rate rise period of the central banks showed that gold and the broader market responded somewhat in unison in response to the Fed's move. This may be because both the market and gold are attempting to understand and predict how the rate modifications would affect the overall economy.

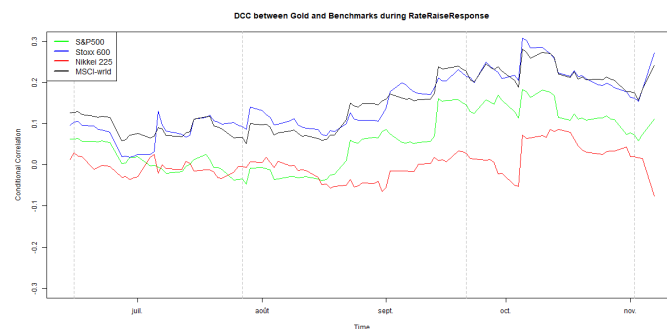


Figure 7: DCC of Gold with global indexes during monetary tightening conditions
Source: Refinitiv Eikon, WGC, Investing.com

Although the rate changes were considerable, the market may have anticipated them based on

the little drops and recovery in correlation during the previous rate hike. By the end of the analyzed period, the correlation had gradually increased to 0.3, indicating a continued correlation between the movement of global indices and gold prices that were probably caused by larger macroeconomic factors. However, the prices of all these 5 indexes have relatively been increasing since October 2022 so the DCC around 0.3 doesn't seem alarming.

DCC between US-bond and Global market

Regarding another well-recognized source of refuge investment, the US 10-year Treasury bonds, during the covered time, the DCC between these bond rates returns and the ones of the international proxies painted a picture of a market that was somewhat impacted by world events while also being controlled by its internal economic environment. Notably, major global shocks like the COVID-19 epidemic and when the FED changed its monetary policies have affected its connection with international benchmarks, in addition to its high volatility, its basic qualities seem to have changed.

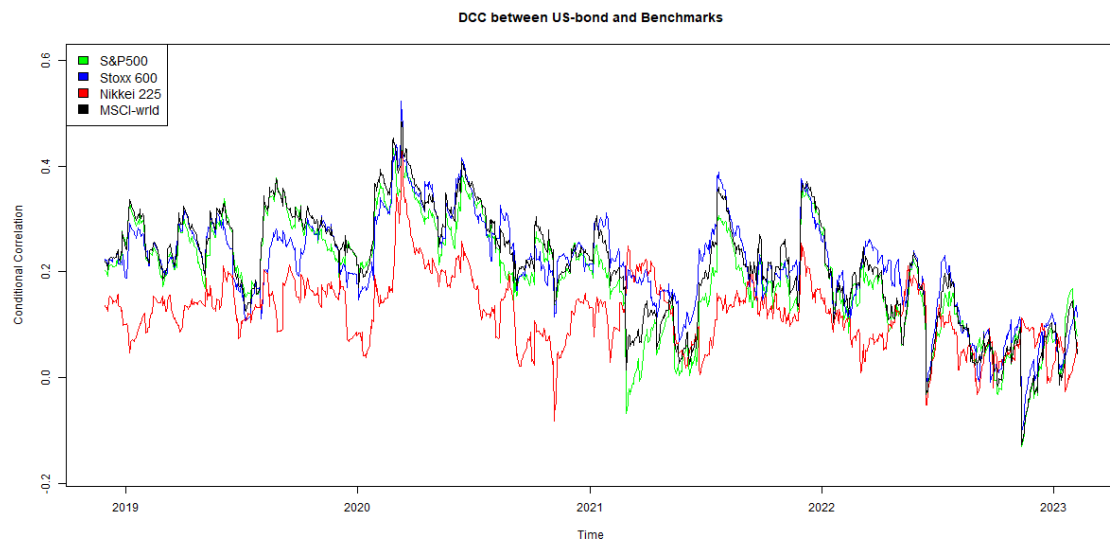


Figure 8: DCC time series between US Treasuries and global indexes

Source: Refinitiv Eikon, FRED, Investing.com

In fact, the correlation of US bonds with benchmark indices seems to fluctuate around 0.2 but remains relatively constant over time (varying between 0.1 and 0.4) and has a small downward trend. This is relatively in line with the study of Zhou et al. (2022) that showed the US Treasury yields were declining in accordance with the market during the covid-crisis.

In normal economic times, i.e. before the onset of the crisis, the DCC remains relatively constant, between 0.2 and 0.3 (Figure 9). This shows that under ordinary economic conditions, there is a modest relationship between these instruments, which translates into the results from the volatility statistics. However, it is clear that US bonds are less correlated with the Nikkei 225 index.

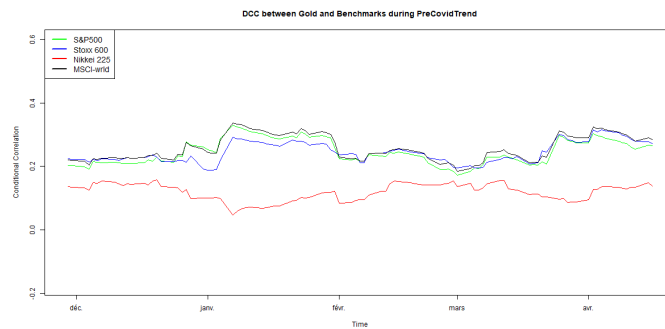


Figure 9: DCC of US bonds with global indexes before Covid
Source: Refinitiv Eikon, FRED, Investing.com

There was a clear change just before Covid's announcement (which corresponds to its DCC peak in Figure 10), from 0.3 to almost 0.6 coefficient, then a drop 1 month later which led to a new period of stagnation around 0.3. This shift in correlation was manifested by a decrease in the yield and the prices of the global indexes (Zhou et al., 2022).

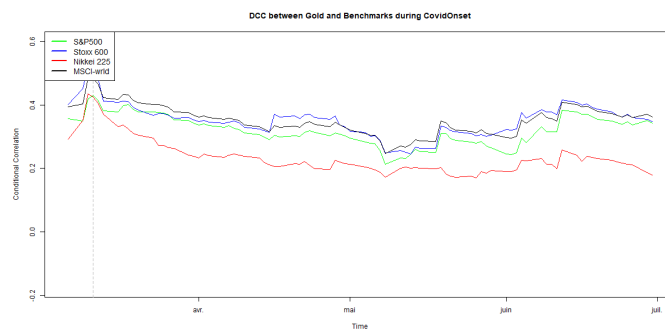


Figure 10: DCC of US bonds with global indexes during Covid
Source: Refinitiv Eikon, FRED, Investing.com

There were further peaks around September-October 2021 and December 2021-January 2022. After that, there was a steady decline to 0.1. The start of the conflict between Russia and Ukraine does not appear to have had any impact on the DCC or on the bond's long-term yield since it increased (see Appendix 1).

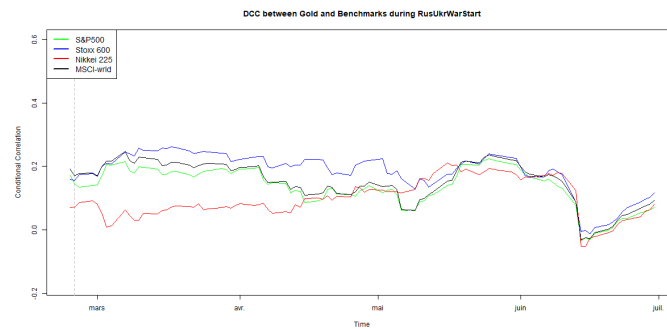


Figure 11: DCC of US bonds with global indexes during Russian-Ukraine conflict
Source: Refinitiv Eikon, FRED, Investing.com

The relative absence of any significant impact on the DCC during the Russia-Ukraine conflict could suggest that the bond market perceived it as a localized geopolitical problem with minimal implications for the US debt landscape. A further indication that investors perceived US bonds as significantly less unsafe despite global tensions is the subsequent increase in bond yield, which increased its demand and ultimately the bond prices.

The FED's first 75 base points rate hike on June 15, 2022, increased the DCC coefficient to 0.2 and lowered the yield. However, subsequent rate hikes appear to have had no impact on the DCC indicating that the market either anticipated them or viewed them as aligned with current economic conditions.

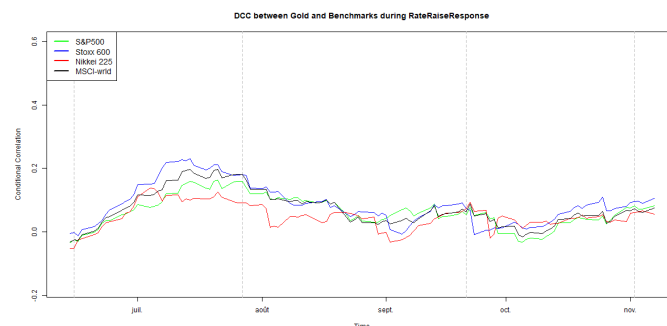
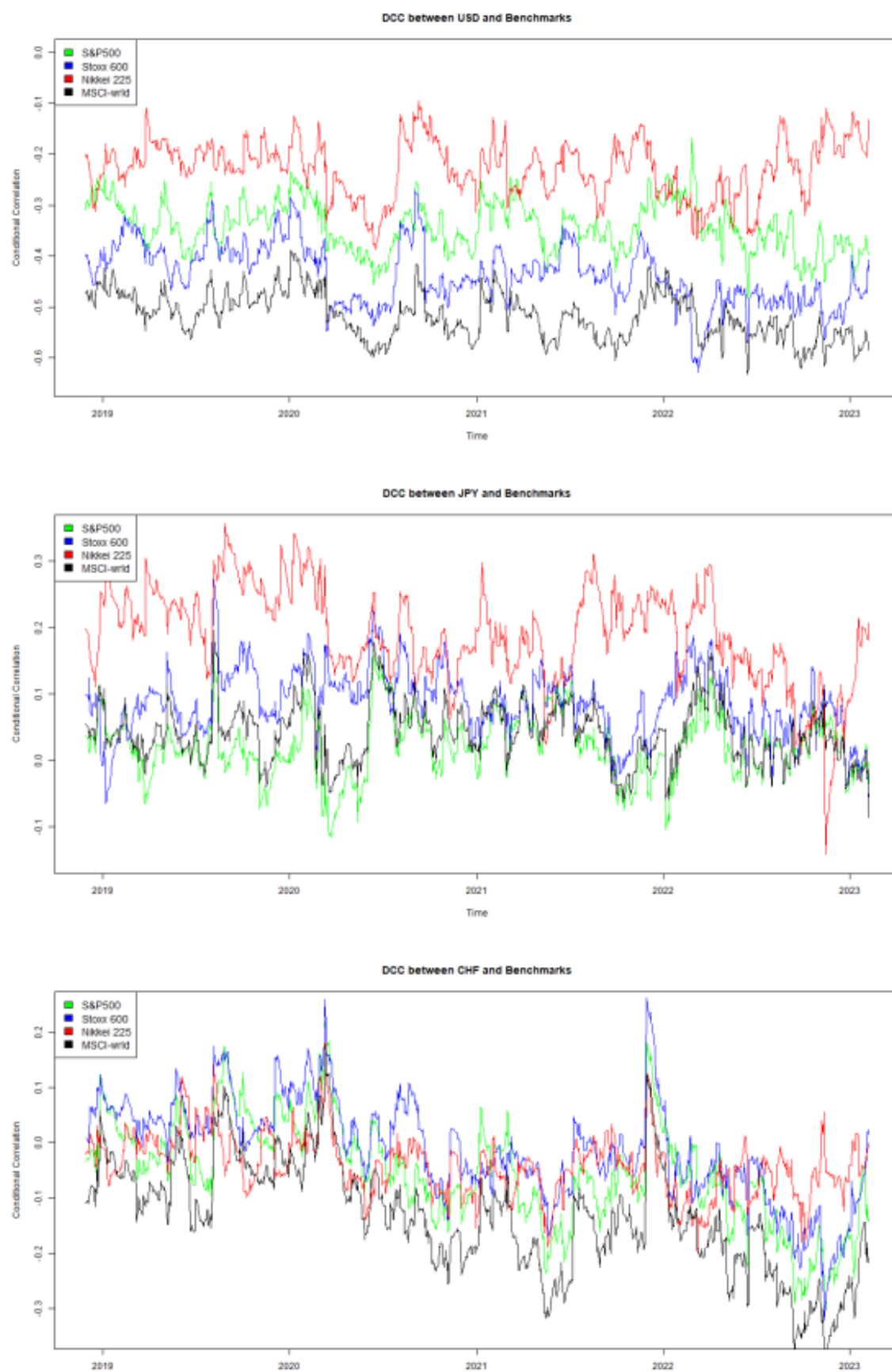


Figure 12: DCC of US bonds with global indexes during monetary tightening period
Source: Refinitiv Eikon, FRED, Investing.com

DCC between the safe-haven currencies and Global market

Over the analyzed period, from 2018 to 2023, the DCC of the three main safe-haven currencies with the four global benchmarks reveals consistent patterns and distinct characteristics for each currency.

In fact, looking at the graphs in Figure 13, we can see that, especially for the US Dollar and the Japanese Yen, all three currencies showed some common responses to major global events that could be consistent with the analysis of Ranaldo et al. (2007) and Todorova (2020).



Indeed, in a normal economic environment, they showed a relatively stable behavior with the benchmarks, with a bit more volatility for the DCC's of the Yen (Figure 15) before the WHO statement, this probably reflects the first tremors felt by Asian markets following the outbreak of the COVID-19 pandemic. Additionally, all three currencies experienced a peak in their DCC around the time of the WHO pandemic announcement. The general trend was a sharp increase in DCC coefficients, directly followed by a decline in the months that followed the shock date, indicating synchronized movements at first, but a return to more typical behavior when markets stabilized.

Following the war between Russia and Ukraine, neither the USD, JPY nor CHF demonstrated any substantial long-term change in their DCC with global benchmarks. This highlights the safe-haven character of these currencies, conforms to the literature review and demonstrates how resistant they are to local geopolitical developments. It is also in line with Todorova (2020) stating especially for the dollar that during periods of geopolitical unrest and intensifying conflicts, it consistently acted as a stable and trusted currency.

But reactions to the Federal Reserve's actions have been mixed (Figures 14, 15, and 16). Even while certain rate modifications had an immediate impact on the DCC's mirror to the work of Jäggi et al. (2019) that stated CHF and JPY are more sensitive to Macroeconomic changes, while the long-term correlation patterns mostly remained unaltered. This may imply that while rate adjustments may have a short-term impact on currency returns, they do not always change the core dynamics of correlation with international indexes.

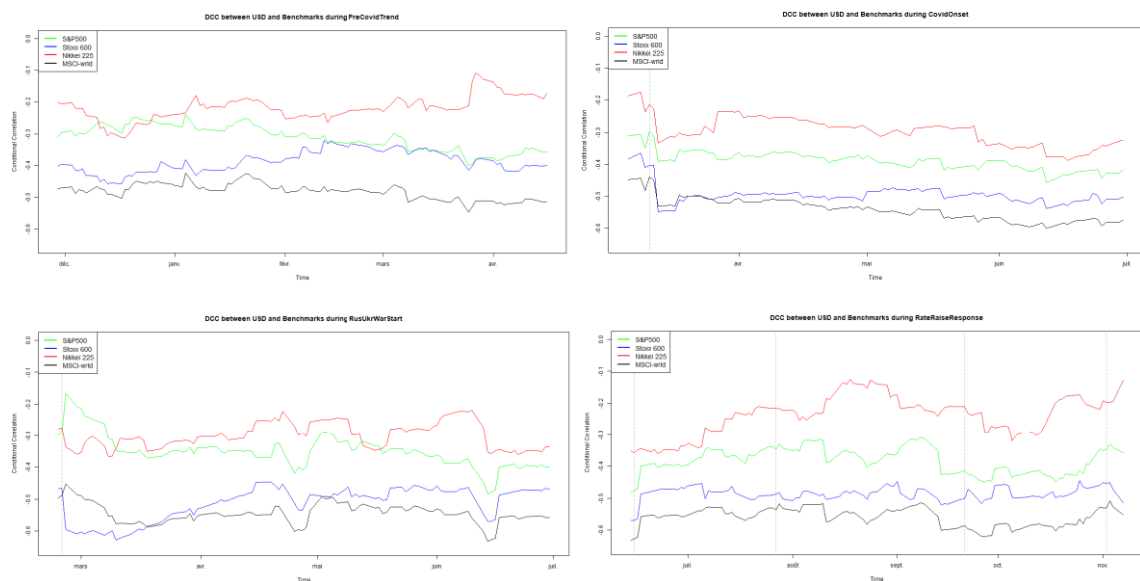


Figure 14: DCC of USD with global indexes during specific periods

Source: Refinitiv Eikon, FRED, Investing.com

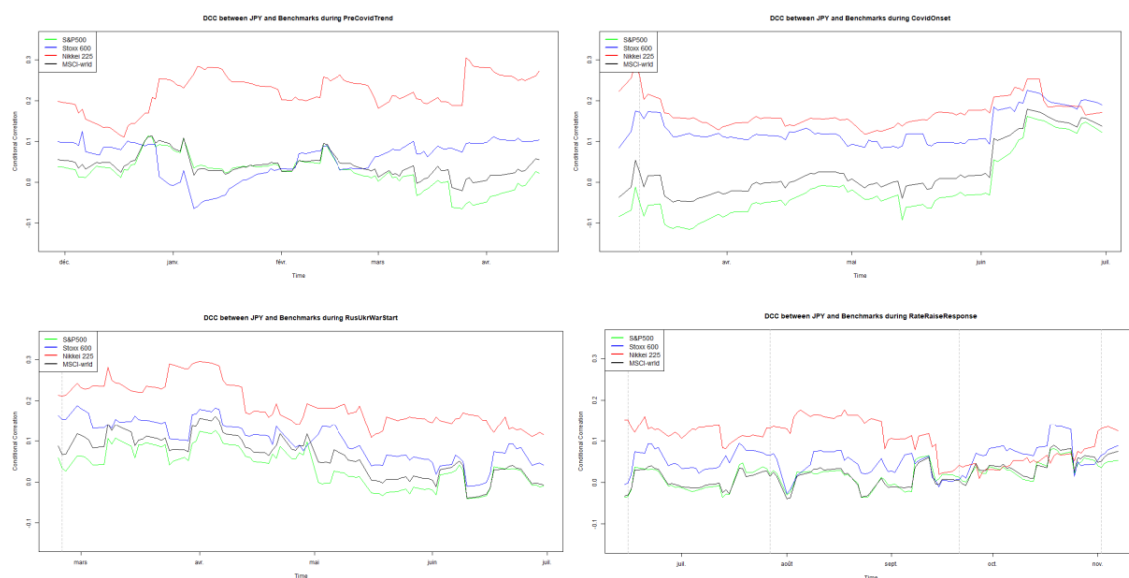


Figure 15: DCC of JPY with global indexes during specific periods
Source: Refinitiv Eikon, Investing.com

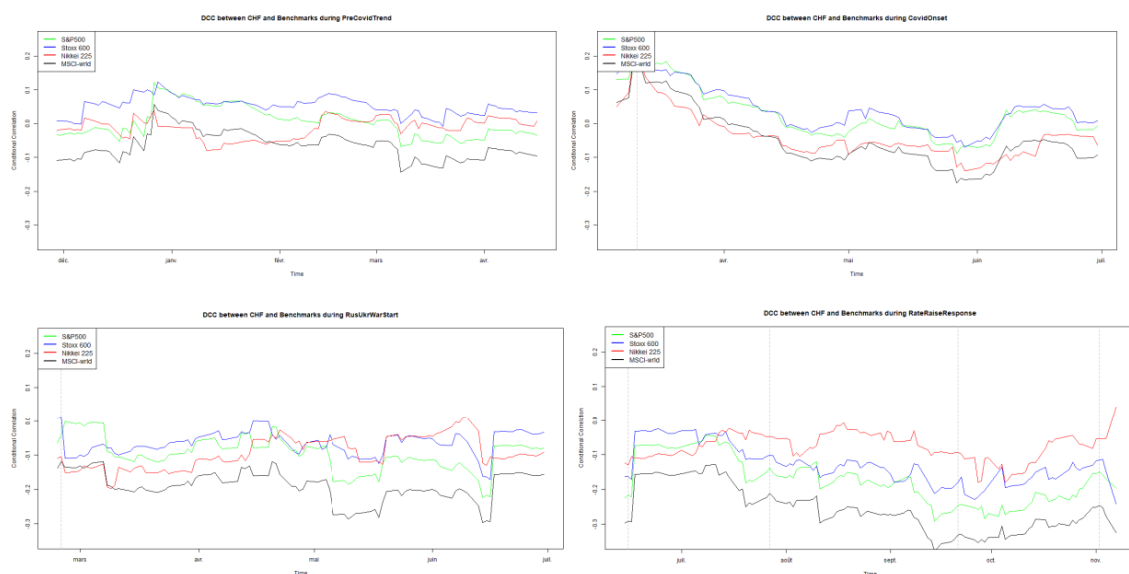


Figure 16: DCC of CHF with global indexes during specific periods
Source: Refinitiv Eikon, Investing.com

On the other hand, their unique economic contexts and roles in the global financial system have led to distinct DCC patterns and values of the coefficients compared to global market benchmarks.

Firstly, the US dollar has shown a negative correlation with the general stock market indexes over the entire period, reflecting the statements of Todorova (2020) and reinforcing its safe-haven status based on the definition, while, for instance, the Japanese Yen's DCC showed predominant positive values, that could contradict the findings in the literature, especially with the Nikkei 225.

The Swiss franc then had a declining trend in its DCC that was heading in the direction of zero or even negative values. This suggests a deteriorating synchronization with international benchmarks, which would strengthen its function as a stand-alone safe-haven currency.

DCC between the Real estate and luxury goods market proxy variables with Global market

Both indices appear highly correlated with the global benchmarks over the entire period. The real estate index has a slight upward trend, rising from 0.6 at the end of 2018 to almost 0.8 in February 2023. The index is more correlated with the S&P500 and MSCI-world indices than with the Stoxx 600 and Nikkei 225 which is in line with Abuzayed et al. (2020). This could be explained by the fact that real estate developments in these countries might be closely tied to this index but especially that the proxies we have chosen for the analysis are connected in a way with the MSCI World index (by 2.34% for the real estate according to MSCI) in their compositions. Chan et al. (2011) already noticed that in stable periods, real estate has strong positive returns, but in crises, real estate investments shifted towards higher-quality equities such as bonds. As for the DCCs of the luxury goods index with the benchmark indices, they appear to vary around a coefficient of 0.8 over all periods. Only the DCC with the Nikkei 225 index is lower and seems more volatile, having somewhat the same shape as that of the real estate index.

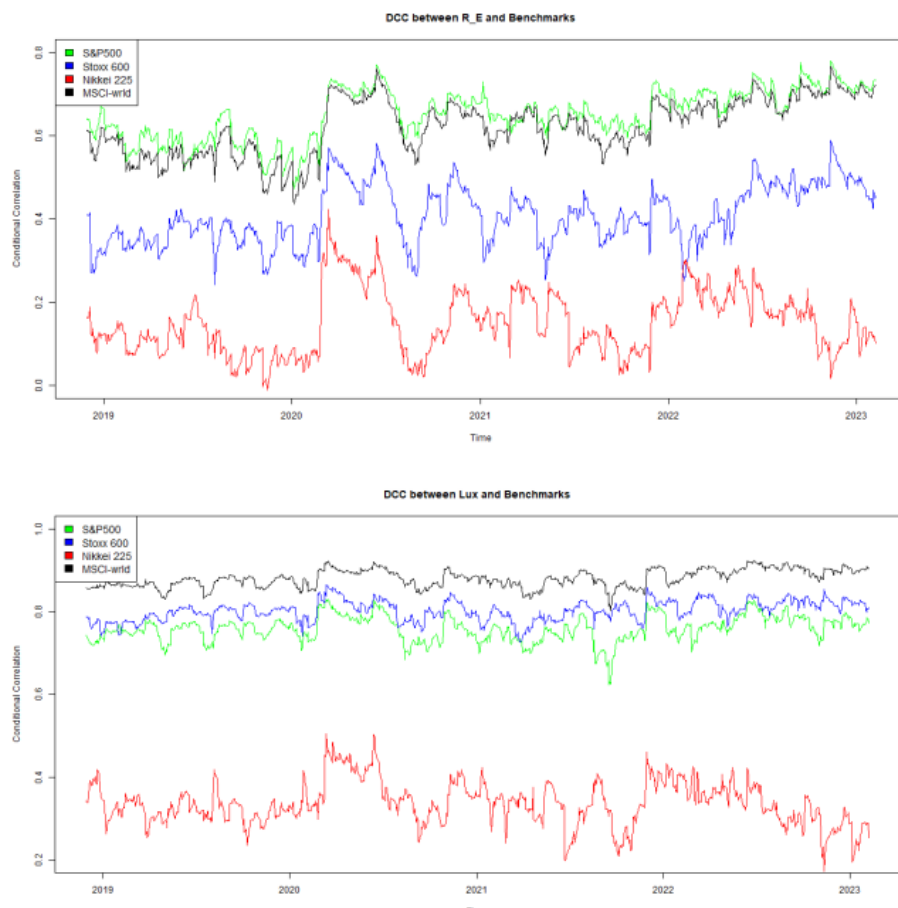


Figure 17: DCC time series between real estate and luxury goods proxies and global indexes

Source: Refinitiv Eikon, Investing.com

Regarding the shared events shock impact analysis, starting with the Covid pandemic, the real estate and luxury goods indices both experienced similar DCC behavior when the WHO announced the pandemic. The correlation increased significantly just after the announcement, as Chan et al. (2011) or Abuzayed et al. (2020) predicted for the real-estate behavior, indicating that the market as a whole reacted in union with the global health crisis. In addition to the fact that the war between Russia and Ukraine and the Federal Reserve's tightening of monetary policy had no impact on these sectors' correlation patterns. It may be the case because the fundamental forces that govern real estate especially are the interest rates, consumer confidence and purchasing power also for the luxury goods market, which could be affected by rising rates or fears that the war could turn global. If the rates are higher, the interest for real estate could decrease too, because it is often more expensive to borrow money.

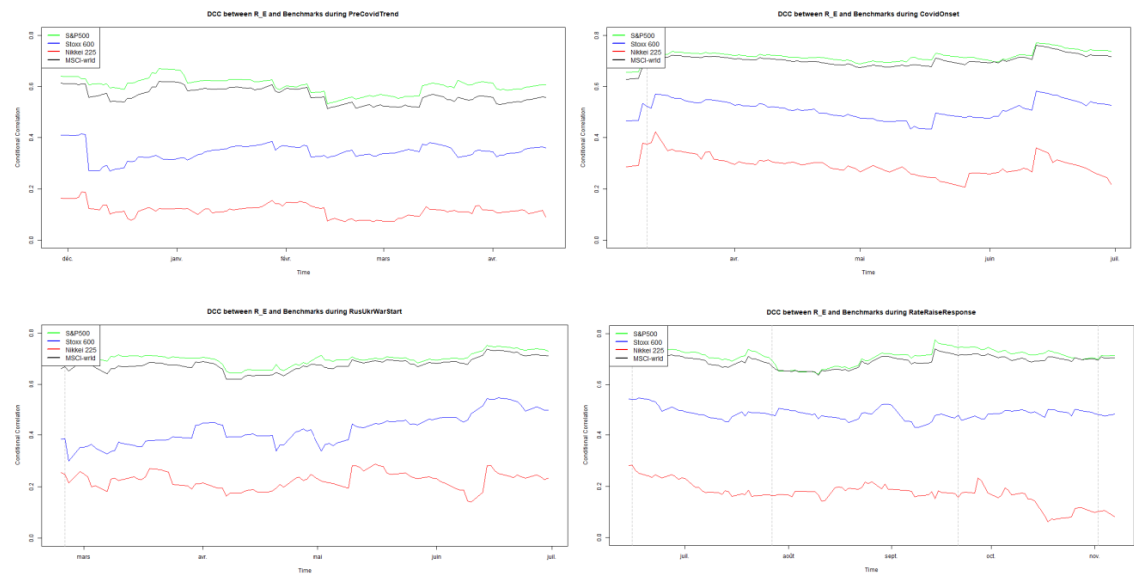


Figure 18: DCC of real estate with global indexes during specific periods

Source: Refinitiv Eikon, Investing.com

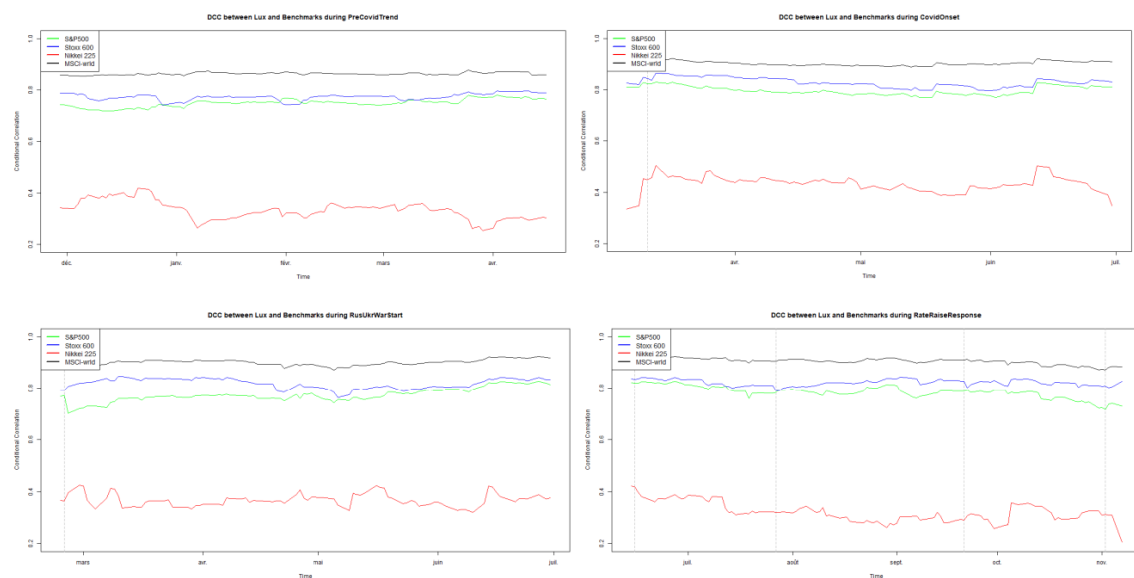


Figure 19: DCC of luxury goods market with global indexes during specific periods
Source: Refinitiv Eikon, Investing.com

DCC between the USDT and Global market

As mentioned in the data section, USDT is a cryptocurrency whose value is indexed to the US dollar. So we expect it to fluctuate in the same direction and have similar characteristics, i.e. a negative correlation with the overall market. When comparing the DCC of the USDT to international standards in Figure 20, the correlation is primarily null. This behavior is consistent with USDT's architecture, which, in contrast to other cryptocurrencies, tries to maintain parity with the USD and prevent extreme volatility. It's worth mentioning that there is a huge spike in the negative for DCC around April to May 2021. Looking at the time series presented in Appendix 1, this could be explained by the fact that global market indices have increased in value while the value of the USDT has remained constant. Given the previously defined concept of safe-haven assets and the fact that the value remains constant, it does not alter the properties that could make the USDT a refuge investment.

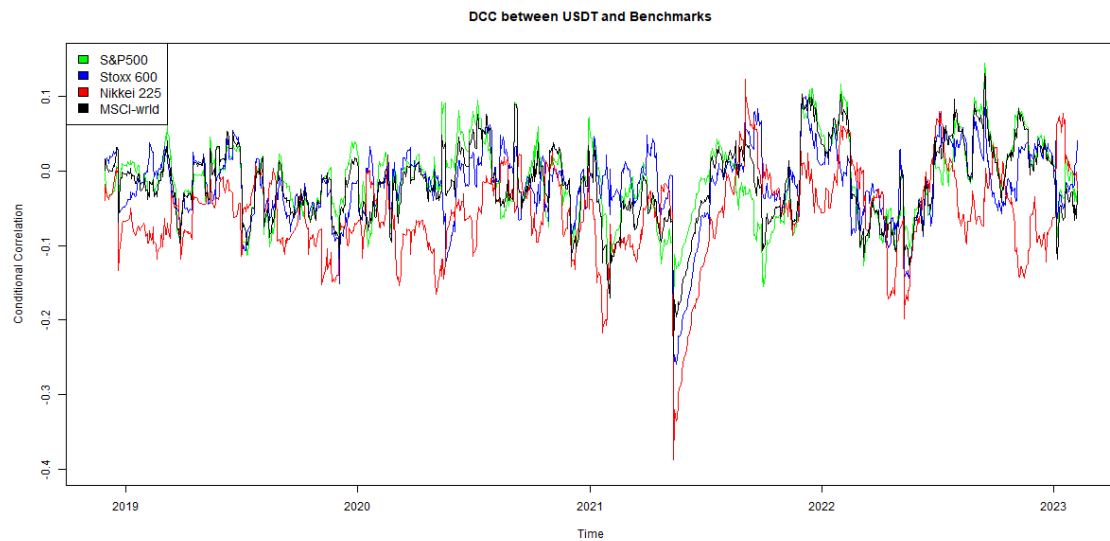


Figure 20: DCC time series between the Tether and global indexes
Source: Refinitiv Eikon, Investing.com

In ordinary economic conditions, as seen in 2018 and the first few months of 2019 from Figure 21, the DCCs between the USDT and the benchmarks are mostly steady near zero. A little decline at the close of 2018 that was swiftly regained by January 2019 may be the result of inconsequential market quirks or responses to other major world events or anticipations. If we look at the graphs in Appendix 1, the prices of the global market trend indexes were declining while those of the USDT were more volatile and also increased a bit.

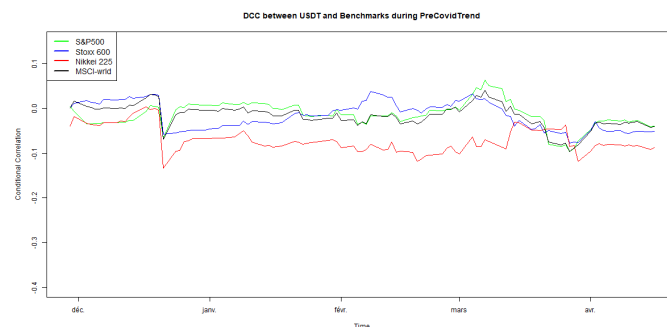


Figure 21: DCC of USDT with global indexes before covid
Source: Refinitiv Eikon, Investing.com

The WHO announcement itself doesn't seem to have had any specific impact on DCCs, confirming previous studies of Vukovic et al. (2021) or Rubbaniy et al. (2021) about crypto-currencies during the first waves of the pandemic, but there is a very slight increase towards 0.05-0.1 during the crisis with 2 peaks at the end of May 2020 (Figure 22).

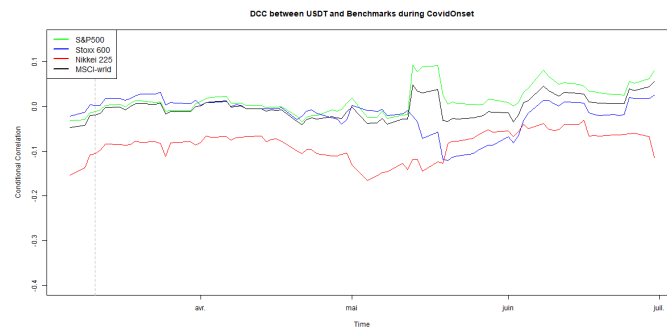


Figure 22: DCC of USDT with global indexes during Covid
Source: Refinitiv Eikon, Investing.com

Then, regarding the Russia-Ukraine conflict, the brief spike after the invasion suggests that global geopolitical events may influence the correlation in a transitory way. However, the more negative DCC during the actual war may have been a result of a brief flight to digital assets to protect against disruptions to traditional markets, so having more hedging property, more consistent with the Bitcoin behavior underlined by Kayral et al. (2023).

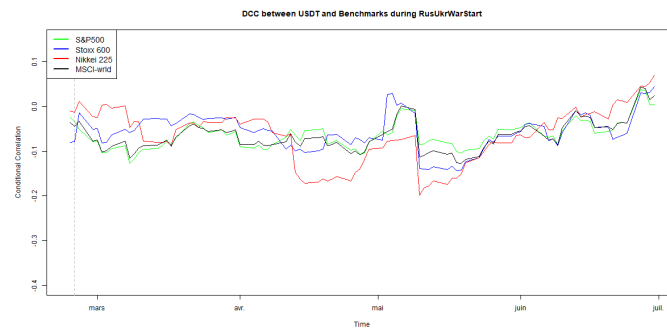


Figure 23: DCC of USDT with global indexes during Russia-Ukraine conflict
Source: Refinitiv Eikon, Investing.com

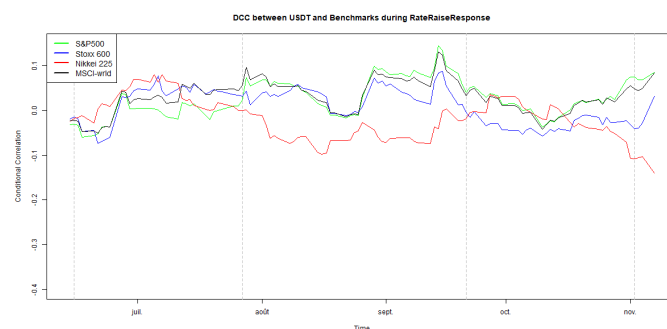


Figure 24: DCC of USDT with global indexes during monetary tightening period
Source: Refinitiv Eikon, Investing.com

The DCCs rose above 0 (around 0.05) during the period of monetary tightening, with a clear small peak in the very short term around the days when the FED raised rates by 75 basis points. Clearly, DCCs are more volatile during this period, while remaining between 0 and 0.1, showing increased transient synchronization between USDT and global benchmarks, suggesting a brief period in which investors may consider both traditional assets and crypto-assets when making investment decisions.

DCC between Green bonds and Global market

While green bonds offer a blend of ethical and financial value, their DCC behavior with global market benchmarks reveals that they are part of the global financial fabric. These instruments are influenced by some global events and DCCs attest to their adaptive nature in the face of such developments.

On the other hand, a good sign for qualifying them as safe havens is their very low, albeit non-negative, DCC with the global market, between -0.1 and max 0.2 coefficient (Figure 25).

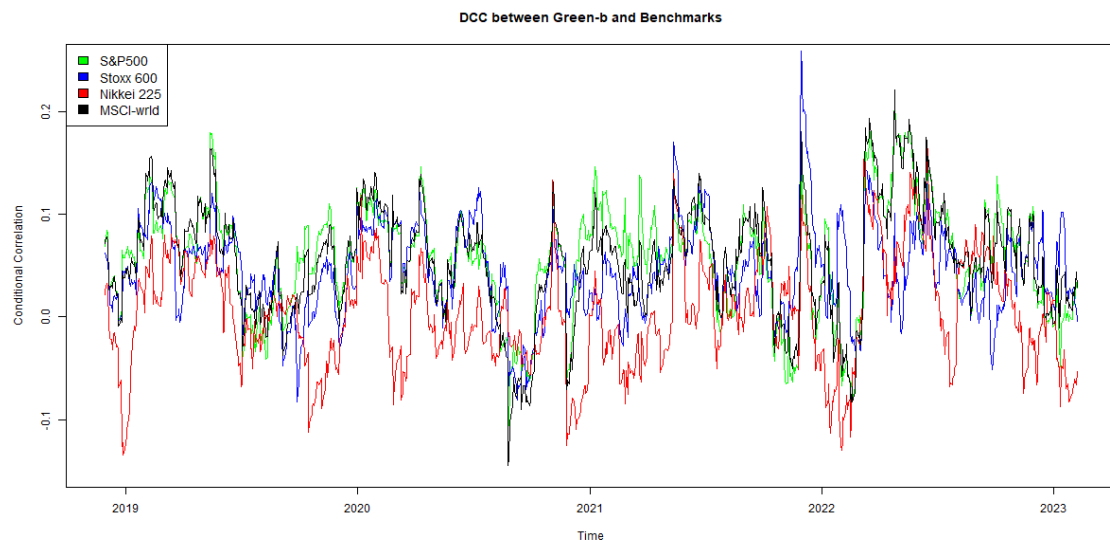


Figure 25: DCC time series between Green-bonds and global market

Source: Refinitiv Eikon, Investing.com

Prior to the upheaval caused by the pandemic, DCCs under general economic conditions were slightly positive, ranging between 0.05 and 0.1 for most global indices. However, the Nikkei 225's correlation was particularly volatile, suggesting that specific regional dynamics or investor behavior linked to the Japanese market could be behind this fluctuating relationship.

A slow, gradual increase can be observed after the covid announcement, with each index gaining 0.1 coefficient value in 1 month. Moreover, the curves remain volatile thereafter, even though the value of the DCCs is not greater (between 0 and 0.15 maximum, and even negative values for the Nikkei index). This upward trend suggests a growing link between green bonds and global markets during the health crisis, but the still low correlation could suggest strong hedging properties in line with Arif et al. (2022) or Hacıömeroğlu et al. (2021). However, the focus on sustainable

investments and therefore the demand for green bonds may have increased during this period as suggested by Arif et al. (2022). But overall, it seems that the Greenbonds could serve more as a strong diversifier or a hedge than a real safe-haven asset for now.

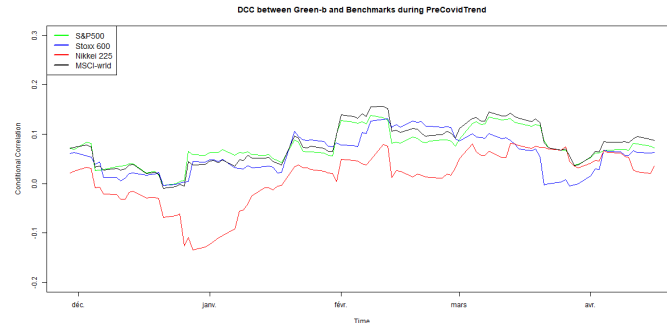


Figure 26: DCC of Green bonds with global indexes before Covid
Source: Refinitiv Eikon, Investing.com

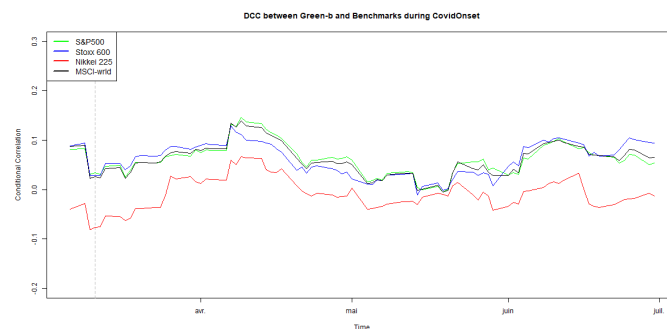


Figure 27: DCC of Green bonds with global indexes during Covid
Source: Refinitiv Eikon, Investing.com

The war between Russia and Ukraine clearly had an impact on the correlation, but not immediately. There was a considerable increase in the DCC coefficient value of 0.2 after 1 or 2 weeks following the sudden invasion. Then, around April 2022, the DCCs became highly volatile again, dropping from 0.2 to 0, with a peak at the end of April and then remaining volatile. It is probable that investors attempted to reallocate their capital to industries or assets they believed would be less affected by immediate threats during periods of increased geopolitical risk. Green bonds may have been thought of as being less vulnerable to the immediate economic effects of the geopolitical event because of their ethical and ecological nature. This does not imply that they are seen as a "safe haven", but rather that they are perceived as an alternative that is less exposed to the associated risks.

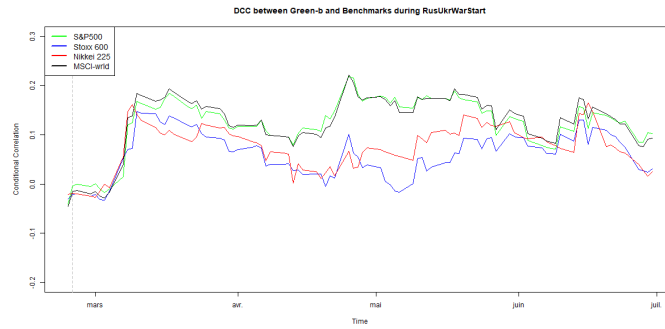


Figure 28: DCC of Green Bonds with Global Indexes during Russi-Ukraine conflict
Source: Refinitiv Eikon, Investing.com

Finally, contrary to conventional expectations but echo to Ul Haq et al. (2021), Greenbonds correlations fell shortly after each Federal Reserve rate hike, indicating real safe-haven utility in a period of policy uncertainty. Although these were short-lived declines, with DCCs quickly returning to their initial levels, this indicates an immediate, albeit transitory, recalibration by investors in response to changes in monetary policy.

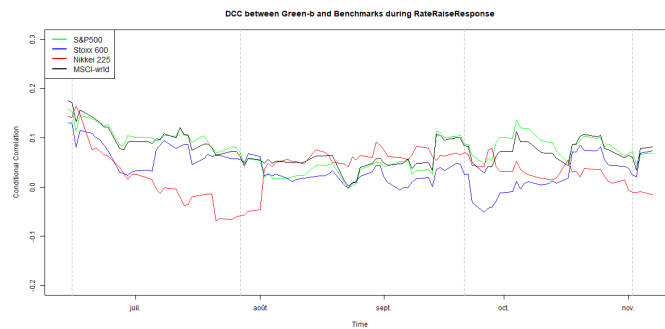


Figure 29: DCC of Green bonds with global indexes during monetary tightening conditions
Source: Refinitiv Eikon, Investing.com

4 Estimation results

Now that we've analyzed the global trends of the DCCs of each asset with the world market indices and also analyzed the responses to shocks over the short term to understand the behavior and reactions of safe havens during a crash, it's now time to test the performance of these assets over a longer-term period. As mentioned in the methodology section, we'll assume that if the DCCs were negative before the covid, i.e. in a more stable period, then we'll be strongly convinced that the assets are global market hedges. Subsequently, if the DCC's values for the period after the WHO announcement have fallen, meaning that the coefficient associated with the dummy variable is negative, then the assets are likely to be behaving like safe havens at present. The results of the test also used by Oosterlinck et al. (2023) and proposed by Baur and Lucey (2010) are depicted in Tables 6 and 7. First of all, the traditional perception of gold as a safe haven has been somewhat challenged by the most recent crises, in particular since the Covid-19 pandemic. While

Table 6: Safe-haven regression results for different assets (Part 1)

Source: Refinitiv Eikon, FRED, WGC, Investing.com

Asset	δ_0	Conclusion	δ_1	Conclusion
Gold				
S&P500	-0.0172***	Hedge	0.0532***	/
Stoxx 600	-0.0233***	Hedge	0.0862***	/
Nikkei 225	-0.0651***	Hedge	0.0574***	/
MSCI-wrld	0.0396***	Diversifier	0.0724***	/
US bond				
S&P500	0.2605***	Diversifier	-0.0954***	Safe-haven
Stoxx 600	0.2428***	Diversifier	-0.0412***	Safe-haven
Nikkei 225	0.1383***	Diversifier	-0.0222***	Safe-haven
MSCI-wrld	0.2720***	Diversifier	-0.0847***	Safe-haven
USD				
S&P500	-0.3175***	Hedge	-0.0361***	Safe-haven
Stoxx 600	-0.3868***	Hedge	-0.0726***	Safe-haven
Nikkei 225	-0.2073***	Hedge	-0.0299***	Safe-haven
MSCI-wrld	-0.4811***	Hedge	-0.0523***	Safe-haven
JPY				
S&P500	0.0190***	Diversifier	0.0041***	/
Stoxx 600	0.0927***	Diversifier	-0.0073***	Safe-haven
Nikkei 225	0.2465***	Diversifier	-0.0817***	Safe-haven
MSCI-wrld	0.0481***	Diversifier	-0.0089***	Safe-haven
CHF				
S&P500	0.0252***	Diversifier	-0.1115***	Safe-haven
Stoxx 600	0.0654***	Diversifier	-0.1104***	Safe-haven
Nikkei 225	-0.0023***	Hedge	-0.0546***	Safe-haven
MSCI-wrld	-0.0461***	Hedge	-0.1254***	Safe-haven

gold has historically served as the ultimate safe haven (Baur and Lucey, 2010; Baur and McDermott, 2016; Baur et al, 2021), our results tend to be more in line with more recent literature such as Kayral et al. (2023), Melin and Pettersson (2022), who argue that gold is no longer a safe haven asset but should still be used as a solid hedge against equities in general. Nevertheless, even if the correlation coefficients are positive, they are still somewhat low, and we have seen that Gold returns are not behaving in the same way for all kinds of crises, as shown by the decline in the DCC at the beginning of the conflict in Ukraine. The fact that gold could act as a strong hedge while keeping some safe-haven properties for specific crises or against specific markets has been extensively studied by authors such as Bredin et al. (2014), Hood and Malik (2013) or more recently by Akhtaruzzaman et al. (2021) and Ustaoglu (2023). When we combine the findings from Table 6 with our earlier time series analysis of selected shocks and also consider the relatively low mean of time-varying volatility, it becomes evident that Gold doesn't consistently act as a safe haven

across all crises. Before deeming an asset as a refuge, it's crucial to first understand the nature of the event we're addressing. Given the current circumstances, it's more appropriate to view Gold as a hedge rather than a consistent safe haven.

Then, the results for the US Treasury bills resonate more with the asset's historically safe reputation. Indeed, the conclusions provided showed that they displayed diversification properties and acted as a safe haven in relation to all market indices during the turmoil as He et al. (2016) and Baur et al. (2021) concluded too. The same findings for the currencies, except for the JPY against the S&P 500 and for the USD in particular, they showed hedging capabilities and acted as a safe-haven in relation to global market indices as Todorova (2020) did. JPY and CHF just showed mixed results regarding the hedging property. Unfortunately, the results for the performance of the real

Table 7: Safe-haven regression results for different assets (Part 2)

Source: Refinitiv Eikon, FRED, WGC, Investing.com

Asset	δ_0	Conclusion	δ_1	Conclusion
R_E				
S&P500	0.5840***	Diversifier	0.0963***	/
Stoxx 600	0.3543***	Diversifier	0.0778***	/
Nikkei 225	0.0994***	Diversifier	0.0716***	/
MSCI-wrld	0.5473***	Diversifier	0.1086***	/
Lux				
S&P500	0.7527***	Diversifier	0.0084***	/
Stoxx 600	0.7908***	Diversifier	0.0167***	/
Nikkei 225	0.3244***	Diversifier	0.0171***	/
MSCI-wrld	0.8673***	Diversifier	0.0188***	/
USDT				
S&P500	-0.0208***	Hedge	0.0089***	/
Stoxx 600	-0.0254***	Hedge	0.0096***	/
Nikkei 225	-0.0638***	Hedge	0.0074***	/
MSCI-wrld	-0.0237***	Hedge	0.0077***	/
Green-b				
S&P500	0.0646***	Diversifier	-0.0103***	Safe-haven
Stoxx 600	0.0476***	Diversifier	-0.0031***	Safe-haven
Nikkei 225	0.0054***	Diversifier	-0.0026***	Safe-haven
MSCI-wrld	0.0644***	Diversifier	-0.0126***	Safe-haven

estate and the luxury goods market are in line with the previous findings suggesting that none of them could be considered as a refuge investment. The results of the first parameter even tend to suggest that they cannot serve as diversifiers. From another point of view, it's also possible that real estate investment has lost its safe-haven status as a result of the current crisis. Since the Covid-19 crisis, the real estate market has seen many upheavals. The latent threat of escalating war on a global scale has probably sown the seeds of fear of direct physical consequences, deterring many investments, particularly in countries bordering Ukraine. In addition, the growing

effects of global warming, as explained in the article by Boland et al. (2022), pose a significant risk to the real estate market. All the more so as recent events such as devastating floods and forest fires have caused colossal damage. These incidents, which have heightened uncertainty and anxiety, may well have undermined investor and buyer confidence in the real estate sector. Moreover, as mentioned previously, both indexes may not reflect the real trend and quote of both commodities since they are just proxies.

However, it is important to remember that the index for the luxury goods market encounters all the luxury commodities, from clothes and bags to jewelry. The paper from Dirix (2019) mentioned only very luxurious bags and watches could consider a safe investment. Knowing that these bags are for the most part made of high-quality leather and the watches surely contain some gold or other precious metals, it could be interesting to consider these commodities as a strong diversifier option or for watches and pieces of jewelry to draw the same conclusion as for gold.

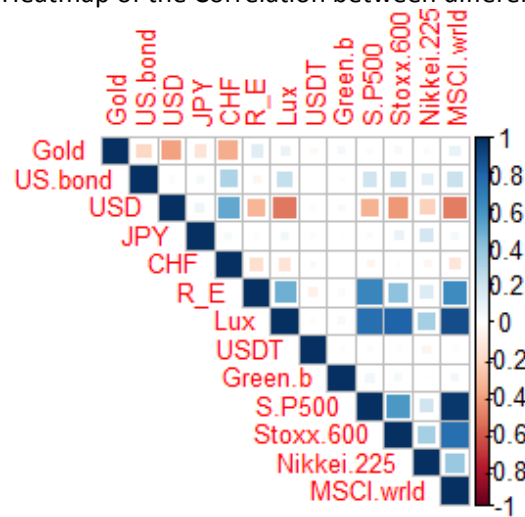
The case of stablecoins is another point of concern. Actually, the status of cryptocurrencies, and Bitcoin in particular, as safe assets is the subject of debate. While Kayral et al (2023) found them to be hedged in times of crisis, Ustaoglu (2023), Melin and Pettersson (2022), and Baur et al (2021) all concluded that Bitcoin did not serve as a safe haven in a variety of situations. However, we're analyzing a different type of crypto here, and the results, while consistent with the findings for Bitcoin, are encouraging. Indeed, while the USDT didn't receive a conclusion as a safe haven for the analyzed period, by simple computation, it keeps a negative correlation value with all market indices, indicating that even if the correlation is increasing in a period of turmoil, it is maybe more than an asset to only use for hedging purposes.

Lastly, Green bonds have emerged as a strong hedge in normal times and as a safe haven since the COVID pandemic. This aligns with the findings of Chopra and Mehta (2023) and shows that a focus on ethics and sustainability could attract more risk-averse investors in periods of uncertainty.

5 Average DCC Heatmap

A final aspect of the correlation analysis between these different assets that was interesting to look at and rarely done in previous literature is to look at the correlation between potential safe-havens. The heatmap of the average Dynamic Conditional Correlation (DCC) of all assets under consideration, presented in Figure 30, provides a brief insight into these interrelationships. Upon close inspection, this heatmap reveals a surprising pattern: the correlations between the identified safe-haven assets are generally low. This lack of correlation between the various assets, such as gold, government bonds and strong currencies, opens doors for innovative investment strategies but also encourages the notion that the ultimate safe haven may indeed be a thoughtfully constructed blend of these assets.

Figure 30: Heatmap of the Correlation between different assets



Source: Refinitiv Eikon, FRED, WGC, Investing.com

Conclusion

In the ever-changing landscape of global financial markets, the last two decades have been tumultuous, to say the least. Markets have been relentlessly tested and have suffered from heightened volatility and uncertainty, resulting in a series of cascading effects on global economies and, by extension, on investor behavior. Combining the definition from the introduction and the understanding from the literature review, a safe-haven asset is often linked to a specific historic event: wars for gold, policy decisions for the US bonds and the USD, sustainable decisions for Green-bonds, and should be characterized by a value reserve role resulting from keeping a steady value over time, negative correlation with global indices in turbulent times or at least with the stocks that dominate the market, while having a high degree of liquidity and being independent of monetary actions. Through an exhaustive empirical analysis encompassing volatility statistics and the dynamic conditional correlations from the DCC-GARCH, this study sheds light on the performance of various assets considered in the past as sources of safe-haven investment in times of economic turbulence and tests new forms of assets that can either replace assets overtaken by events or provide an additional source of diversification.

Firstly, our research reveals a notable increase in volatility in global markets following the outbreak of the COVID-19 pandemic. Such a surge in volatility is concomitant with economic downturns, highlighting the significant economic repercussions of global events such as pandemics, monetary tightening periods or geopolitical conflicts.

Secondly, our analysis using the DCC model indicates differing behaviors of assets in correlation with world market indices. Gold, traditionally viewed as a safe haven, presented ambiguous results. While it maintained some hedging properties, its role as a universal safe-haven asset has come under scrutiny. On the other hand, US Treasury bills and the USD respectively displayed their historical roles as safe havens and hedges, respectively, remaining consistent even amidst the turmoil. However, the US bonds showed some high levels of volatility and should be kept in sight. The JPY and CHF showed a mixed bag of results with both assets possessing hedging properties against some indices and acting as safe havens.

When exploring newer or less traditional assets, our findings align with the burgeoning literature. Real estate and luxury goods, for instance, did not emerge as refuge investments, potentially also due to the limitations of our proxy indices and the lack of literature to confirm our findings. Meanwhile, while the debate continues about cryptocurrencies' role as safe assets, our analysis suggests stablecoins, particularly the USDT, possess negative correlation values with all market indices, pointing towards more than a potential hedging utility in the near future.

A significant revelation from our study was the role of Green bonds. Not only did they act as

hedges during more stable periods, but they also emerged as safe havens post-COVID, implying that in times of instability, investors may find a connection with sustainability and responsible investing.

However, it is essential to remember that the safe-haven status of particular assets could alter depending on the situation of the economy or the direction of the market. The characteristics that have been identified for safe-haven assets are generally relevant and applicable, offering a foundation for determining if a particular asset holds the potential to serve as a refuge in times of crisis. When evaluating the findings, vigilance should be used because not all of the assets considered above in the paper review will serve as safe havens in all situations and conversely. In fact, the individual attributes and context of the crisis under discussion determine whether or not a particular asset could work. In addition, heat map analysis of the average DCCs reveals a low correlation between the various safe-haven assets, suggesting that the ultimate safe-haven may not be a single asset but a strategic combination of these assets, offering diversified protection against market turbulence.

To conclude, this study enriches the existing literature by offering a comprehensive empirical analysis of asset performance during economic shocks, using the most recent and significant crises such as the COVID-19 pandemic, the Russia-Ukraine War and the period when the FED increased 4 times in a row the rates from 75 base points from the summer 2022 as a backdrop. While traditional assets like gold and US Treasury bills retain their importance in portfolios, emerging assets, especially those with a focus on sustainability, present promising avenues for investors seeking hedging or safe-haven properties.

Limitations

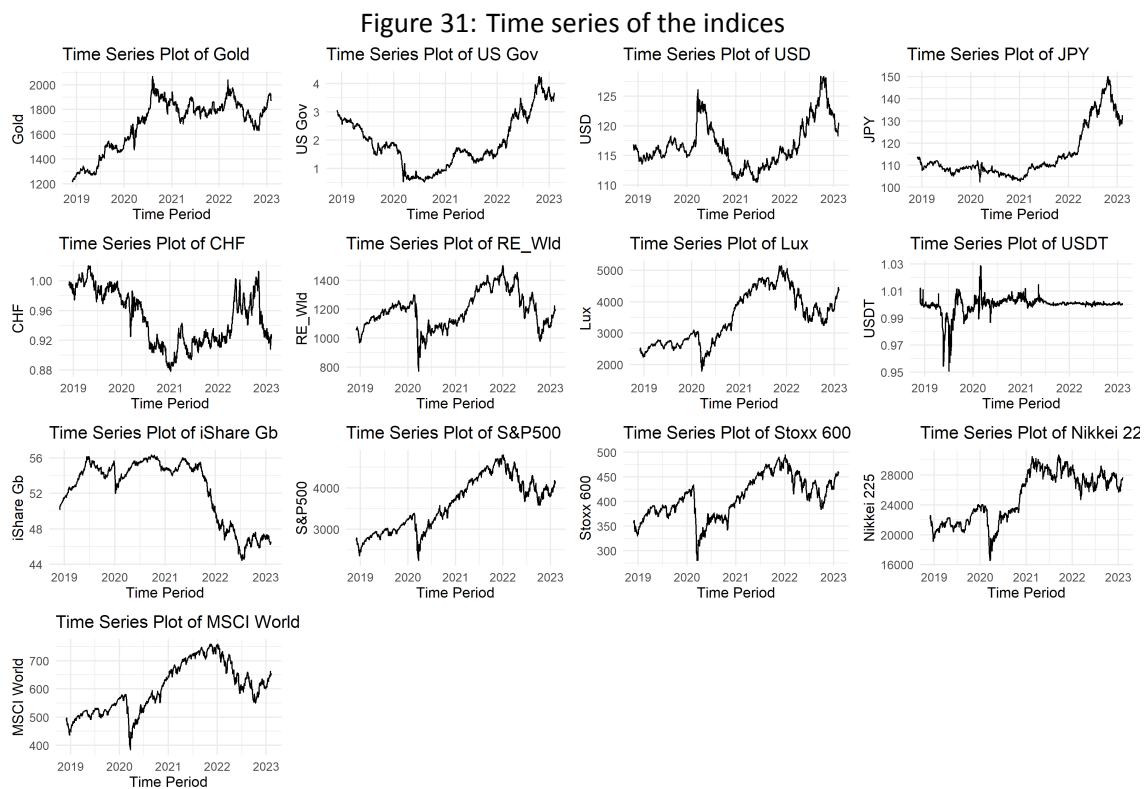
However, as with any global research effort, this study is not without its limitations. First of all, we were limited by the accessibility of certain data sets. The art market is a pertinent example. Given its unique characteristics and potential as a safe-haven investment, the absence of empirical analysis on this market segment represents a significant limitation. Furthermore, although our research addressed the role of liquidity in determining the viability of safe-haven assets, a comprehensive analysis was hampered by the unavailability of volume data for all the assets considered.

Moreover, although mentioned, a more thorough and detailed analysis of the relationship between changes in monetary policy and asset returns would be beneficial. Monetary policy has a significant impact on inflation, interest rates and investment environments, which in turn affects asset values and their safe-haven properties. Consequently, a closer examination of this connection may yield priceless information about the refuge investment market as a whole.

Given these limitations, it is clear that the field of safe-haven assets remains fertile ground for further research. Future studies could strive to incorporate data from previously ignored market segments, such as the art market, and establish richer correlations between asset liquidity, changes in monetary policy and resulting returns. In so doing, researchers will be able to provide investors with a more holistic set of tools for navigating ever-volatile financial markets.

Appendix

1 Appendix 1: Time series Graph



Source: Refinitiv Eikon, FRED, WGC, Investing.com

2 Appendix 2: ADF Test

2.1 Appendix 2.1: Lag Length Selection

The methodology followed to determine the lag length for each asset in the unit root tests was carried out using Akaike's information criterion (AIC), as Ozcicek (1999), Hanck et al. (2023) or Ng et al. (2001). In order to do so, the VARselect() formula was used on Rstudio software for each asset. The results are displayed in Table 3.

Source: Refinitiv Eikon, FRED, WGC, Investing.com

Table 8: Lag length selection				
Variable	AIC(n)	HQ(n)	SC(n)	FPE(n)
Gold	6	6	1	6
US-bond	9	9	9	9
USD	1	1	1	1
JPY	1	1	1	1
CHF	8	1	1	8
R_E	10	9	4	10
Lux	9	7	2	9
USDT	9	6	4	9
Green-b	5	1	1	5
S&P500	9	9	9	9
Stoxx 600	9	7	1	9
Nikkei 225	2	2	1	2
MSCI-wrld	10	9	9	10

2.2 Appendix 2.2: ADF results

Table 9: Results of Unit Root Test
Source: Refinitiv Eikon, FRED, WGC, Investing.com

Variable	Lag	T-statistic	P-value	Critical Value	Conclusion		
Gold	6	-13.7661	$< 2.2e - 16$	-2.58	-1.95	-1.62	Reject H0
US-bond	9	-10.8033	$< 2.2e - 16$	-2.58	-1.95	-1.62	Reject H0
USD	1	-21.7807	$< 2.2e - 16$	-2.58	-1.95	-1.62	Reject H0
JPY	1	-23.648	$< 2.2e - 16$	-2.58	-1.95	-1.62	Reject H0
CHF	8	-11.9952	$< 2.2e - 16$	-2.58	-1.95	-1.62	Reject H0
R_E	10	-9.6497	$< 2.2e - 16$	-2.58	-1.95	-1.62	Reject H0
Lux	9	-10.0163	$< 2.2e - 16$	-2.58	-1.95	-1.62	Reject H0
USDT	9	-11.7867	$< 2.2e - 16$	-2.58	-1.95	-1.62	Reject H0
Green-b	5	-12.5215	$< 2.2e - 16$	-2.58	-1.95	-1.62	Reject H0
S&P500	9	-9.4302	$< 2.2e - 16$	-2.58	-1.95	-1.62	Reject H0
Stoxx 600	9	-9.1962	$< 2.2e - 16$	-2.58	-1.95	-1.62	Reject H0
Nikkei 225	2	-18.2154	$< 2.2e - 16$	-2.58	-1.95	-1.62	Reject H0
MSCI-wrld	10	-9.2643	$< 2.2e - 16$	-2.58	-1.95	-1.62	Reject H0

3 Appendix 3: Descriptive statistics

Table 10: Descriptive statistics
Source: Refinitiv Eikon, FRED, WGC, Investing.com

Vars	n	mean	sd	median	min	max	rg	se
Gold	1094	0.0002	0.0041	0.0002	-0.0229	0.0223	0.0452	0
US-bond	1094	0.0001	0.0172	0.0000	-0.1368	0.1484	0.2853	0
USD	1094	0.0000	0.0014	0.0000	-0.0083	0.0081	0.0164	0
JPY	1094	0.0001	0.0024	0.0001	-0.0168	0.0137	0.0305	0
CHF	1094	0.0000	0.0020	0.0000	-0.0122	0.0080	0.0202	0
R_E	1094	0.0000	0.0062	0.0004	-0.0728	0.0369	0.1098	0
Lux	1094	0.0002	0.0070	0.0004	-0.0538	0.0463	0.1000	0
USDT	1094	0.0000	0.0012	0.0000	-0.0094	0.0090	0.0184	0
Green-b	1094	0.0000	0.0015	0.0000	-0.0075	0.0119	0.0194	0
S&P500	1094	0.0002	0.0062	0.0002	-0.0554	0.0389	0.0944	0
Stoxx 600	1094	0.0001	0.0051	0.0004	-0.0529	0.0350	0.0880	0
Nikkei 225	1094	0.0001	0.0054	0.0000	-0.0272	0.0336	0.0608	0
MSCI-wrld	1094	0.0001	0.0050	0.0003	-0.0434	0.0350	0.0784	0

4 Appendix 4: Correlation Matrix

5 Appendix 5: DCC Fit - Parameter estimates

Table 11: Correlation Matrix
Source: Refinitiv Eikon, FRED, WGC, Investing.com

	Gold	US-bond	USD	JPY	CHF	R_E	Lux	USDT	Green-b	S&P500	Stoxx 600	Nikkei 225	MSCI-wrld
Gold	1	-0.1039	-0.3760	-0.1140	-0.3298	0.2389	0.1646	-0.0381	0.0209	0.1575	0.1246	0.0404	0.2126
US-bond	-0.1039	1	-0.0155	-0.0238	0.2875	0.2267	0.2665	0.0091	-0.0112	0.3291	0.3050	0.1616	0.3213
USD	-0.3760	-0.0155	1	0.0336	0.5391	-0.4027	-0.5505	0.0189	-0.0417	-0.3635	-0.4757	-0.2435	-0.5195
JPY	-0.1140	-0.0238	0.0336	1	0.0361	-0.1008	-0.0036	-0.0022	-0.0079	-0.0934	0.0566	0.1048	-0.0647
CHF	-0.3298	0.2875	0.5391	0.0361	1	-0.1560	-0.1886	0.0325	0.0116	-0.0606	-0.0237	-0.0745	-0.1429
R_E	0.2389	0.2267	-0.4027	-0.1008	-0.1560	1	0.6460	-0.0128	0.0446	0.7972	0.5653	0.2599	0.7979
Lux	0.1646	0.2665	-0.5505	-0.0036	-0.1886	0.6460	1	0.0078	0.0505	0.7702	0.8159	0.3890	0.8760
USDT	-0.0381	0.0091	0.0189	-0.0022	0.0325	-0.0128	0.0078	1	0.0426	0.0127	-0.0064	-0.0547	0.0032
Green-b	0.0209	-0.0112	-0.0417	-0.0079	0.0116	0.0446	0.0505	0.0426	1	0.0545	0.0523	0.0075	0.0605
S&P500	0.1575	0.3291	-0.3635	-0.0934	-0.0606	0.7972	0.7702	0.0127	0.0545	1	0.6310	0.2394	0.9545
Stoxx 600	0.1246	0.3050	-0.4757	0.0566	-0.0237	0.5653	0.8159	-0.0064	0.0523	0.6310	1	0.3651	0.7780
Nikkei 225	0.0404	0.1616	-0.2435	0.1048	-0.0745	0.2599	0.3890	-0.0547	0.0075	0.2394	0.3651	1	0.3965
MSCI-wrld	0.2126	0.3213	-0.5195	-0.0647	-0.1429	0.7979	0.8760	0.0032	0.0605	0.9545	0.7780	0.3965	1

Table 12: Parameter Estimates for Different Assets (Part 1)

Source: Refinitiv Eikon, FRED, WGC, Investing.com

Asset	Parameter	Estimate	Std. Error	Pr(> t)
Gold				
	μ	0.010894	0.028739	0.704632
	ω	0.003123	0.002986	0.295526
	α_1	0.000000	0.002897	0.999999
	β_1	0.997049	0.000373	0.000000
US bond				
	μ	-0.001469	0.029136	0.959802
	ω	0.009089	0.005083	0.073769
	α_1	0.001474	0.004903	0.763721
	β_1	0.989665	0.000260	0.000000
USD				
	μ	0.016047	0.028964	0.579566
	ω	0.001097	0.002227	0.622180
	α_1	0.000000	0.002151	0.999999
	β_1	0.999000	0.000052	0.000000
JPY				
	μ	-0.002331	0.029873	0.937796
	ω	0.001109	0.001937	0.567011
	α_1	0.000000	0.001928	1.000000
	β_1	0.999000	0.000066	0.000000
CHF				
	μ	0.008910	0.029036	0.758953
	ω	0.001124	0.001540	0.465359
	α_1	0.000369	0.001509	0.806908
	β_1	0.998631	0.000068	0.000000
R_E				
	μ	-0.033825	0.029019	0.243764
	ω	0.001095	0.001355	0.419265
	α_1	0.000000	0.001301	0.999996
	β_1	0.999000	0.000047	0.000000
Lux				
	μ	-0.054378	0.029255	0.063064
	ω	0.001074	0.001803	0.551541
	α_1	0.000000	0.001725	0.999999
	β_1	0.999000	0.000042	0.000000

Table 13: Parameter Estimates for Different Assets (Part 2)

Source: Refinitiv Eikon, FRED, WGC, Investing.com

Asset	Parameter	Estimate	Std. Error	Pr(> t)
USDT				
	μ	0.005070	0.039084	0.896788
	ω	0.001176	0.001163	0.311986
	α_1	0.000000	0.000961	0.999998
	β_1	0.999000	0.000042	0.000000
Green.b				
	μ	-0.037899	0.030156	0.208834
	ω	0.001089	0.001999	0.585996
	α_1	0.000000	0.001925	0.999997
	β_1	0.999000	0.000058	0.000000
S&P 500				
	μ	-0.059007	0.029160	0.043013
	ω	0.001068	0.002136	0.617009
	α_1	0.000000	0.002064	1.000000
	β_1	0.999000	0.000046	0.000000
Stoxx 600				
	μ	-0.059198	0.029100	0.041919
	ω	0.001211	0.002454	0.621841
	α_1	0.000000	0.002334	0.999999
	β_1	0.998840	0.000063	0.000000
Nikkei 225				
	μ	-0.025288	0.029778	0.395769
	ω	0.001040	0.002037	0.609461
	α_1	0.000000	0.001947	0.999999
	β_1	0.998999	0.000041	0.000000
MSCI.world				
	μ	-0.073674	0.028626	0.010064
	ω	0.001074	0.001951	0.581745
	α_1	0.000000	0.001870	1.000000
	β_1	0.999000	0.000046	0.000000
Joint				
	DCC_{α_1}	0.017696	0.002733	0.000000
	DCC_{β_1}	0.937866	0.012867	0.000000

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Executive summary

This paper undertakes a comprehensive review of the concept of safe haven assets, assessing and explaining the characteristics of historically significant assets, including new additions such as cryptocurrencies and sustainable financial investments within different market cycles. The research is motivated by recurring episodes of global financial instability and volatility, from the 2007 subprime crisis to the more recent geopolitical conflict between Russia and Ukraine.

Given the succession of crises and the resulting uncertainty, investors are increasingly looking for safe-haven assets capable of retaining or increasing their value in the event of market volatility, protecting their portfolios from potential losses. This type of asset is characterized by multiple properties such as a negative correlation with the general financial market trend during turbulent times, a constant low volatility across time and a high level of liquidity. Our study analyzes the performance of a range of potential safe-haven assets, including traditional options such as gold, long-term government bonds and certain currencies, as well as newer candidates such as cryptocurrencies and green bonds. Using a dataset of nine potential safe-haven assets and four global equity indices, we perform a quantitative analysis based on volatility statistics and the Dynamic Conditional Correlation of Generalized AutoRegressive Conditional Heteroskedasticity (DCC-GARCH) model.

Our findings indicate mixed performance across assets. Traditional assets like US Treasury bills and the USD retain their safe-haven status, while gold's safe-haven property appears less certain. Newer asset classes, particularly Green bonds and stablecoins like the USDT, emerge as promising candidates for safe-haven status, indicating the potential for sustainability and digital currencies to offer refuge during economic volatility. However, the study underscores the necessity for a dynamic understanding of the concept and points out that the safe-haven status of an asset could change depending on a specific crisis and economic context.

Keywords: safe-haven asset, financial instability, volatility, crisis, investment, correlation

⁹Word count from Introduction to Conclusion: 20,048 words.