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Financial risk management under market stress

Safe-havens and hedges in the 2020s

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ABSTRACT:

The purpose of this thesis is to investigate how financial risk management tools, such as safe-haven assets and derivative strategies, have performed under market stress, with a focus on crises in the 2020s, including the COVID-19 pandemic and the Russian invasion of Ukraine. The analysis concentrates on well-known safe-haven assets, such as gold, government bonds, and commodities, as well as derivative-based strategies like protective puts, delta hedging, and volatility derivatives. Building on portfolio theory and the literature on financial contagion, this study aims to answer two key questions: whether certain hedging or safe-haven assets outperform others in crises, and whether asset correlations increase during periods of market turmoil. The evidence suggests that certain assets and strategies offer better protection in crises, but that their effectiveness is strongly scenario dependent. The literature also provides support for the claim that correlations between assets tend to increase in market crises, reducing the benefits of diversification. The thesis offers investors an up-to-date overview of the performance of key hedging and safe-haven instruments and outlines potential practical applications for financial risk management. This study also finds areas in the research where there might be room for improvement and possible opportunities for further investigations.

KEYWORDS: [Safe-haven, Hedging, Contagion, Market crisis, Russian invasion of Ukraine 2022, COVID-19 pandemic]

Footnote
AI (artificial intelligence) tools were used in the preparation of this thesis. Keenious was employed to help identify potentially relevant academic articles, while Grammarly and ChatGPT were used to support language, formulation and clarity. All AI-generated or AI-suggested content has been critically evaluated, edited, and fact-checked by the author. More details will be provided upon request.

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1 Introduction

Recent equity market gains have been highly concentrated in a small group of large technology-focused firms. In the first three quarters of 2025, the “Magnificent Seven” accounted for 32.2% of the S&P 500’s market capitalization and 41.8% of its 14.8% total return, showing how dependent indexes have become on just a handful of companies (First Trust, 2025). Recent analysis cited by Yale Insights (Sonnenfeld & Henriques, 2025), reports that AI-related capital expenditure has surpassed household consumption as the primary driver of U.S. economic growth in the first half of 2025, contributing around 1.1 percentage points to GDP growth, while AI-linked stocks account for the majority of S&P 500 returns, earnings growth, and capital spending growth since late 2022.

At the same time, traditional safe-haven assets have also surged. World Bank (Temaj & Khadan, 2025) figures show that gold prices rose by over 40% in 2025, briefly exceeding US$ 4,300 per ounce amid heightened geopolitical tensions and strong safe-haven demand. The Bank for International Settlements, cited by Reuters (Jones, 2025), notes that gold is up about 60% in 2025 and over 150% since 2022, and that this simultaneous “explosive” rise in both gold and equities is unprecedented in the past 50 years, raising concerns about a potential “double bubble.”

These developments make risk management a highly relevant topic, particularly in relation to safe-haven assets and hedging strategies. Both investors and corporations use financial instruments to manage risk, though not always for the same reason. For investors, hedging is mainly about shaping the risk–return profile of a portfolio in line with modern portfolio theory (Markowitz, 1952). For corporations, risk management is also linked to cash-flow stability, financing conditions, and firm value as discussed by Smith and Stulz (1985).

Today’s financial markets offer a wide range of instruments that can potentially serve as hedges or safe havens, from traditional assets such as gold and government bonds

(Cheema et al., 2025), to more complex derivative strategies (Hull J. C., 2021, pp. 23-41). It is not obvious which instruments provide the most reliable protection when markets come under stress. The central aim of this thesis is therefore to examine a selected set of relatively well-known hedging and safe-haven assets and to assess how effective they have been in recent and possibly future crises.

1.1 Purpose of the study

The purpose of this study is to examine how well different hedging and safe-haven assets protect investors in major market crises, with a focus on gold, government bonds, commodities, and key derivative-based strategies, which are protective puts, delta hedging, and volatility-based instruments. The aim is to compare their ability to limit losses and reduce risk in recent crises in the 2020s, with a particular focus on the COVID-19 shock (2020) and the Russia–Ukraine war (2022).

The first hypothesis builds on modern portfolio theory, which states that investors combine assets with different returns and correlations to improve the risk–return trade-off (Markowitz, 1952). Empirical work on safe havens shows that assets such as gold, bonds, and certain currencies sometimes provide protection in crises, but not uniformly across markets or time horizons (Baur & Lucey, 2010; Baur & McDermott, 2010; Cheema et al., 2025). Thus, the first hypothesis:

> H1: Some hedging and safe-haven assets provide better protection in market crises than others.

The second hypothesis is motivated by the literature on contagion and market stress, which finds that correlations between risky assets often increase in downturns, reducing diversification benefits (Longin & Solnik, 2001; Forbes & Rigobon, 2002; Hartmann et al., 2004; Brunnermeier & Pedersen, 2009). Thus, the second hypothesis:

> H2: Correlation between assets will increase in market crises

1.2 Structure of the study

The hypothesis and purpose of the thesis are introduced in the first chapter. Chapter two covers the theoretical definition of risk and why investors and corporations want to manage it. Chapter three covers the assets and strategies that we will examine. In chapter four, we examine the concept of financial contagion a bit further. In chapter five, we look at recent studies on the performance of the assets and strategies. Finally, in the last chapter, we conclude our findings and point out some key observations.

1.3 Literature selection criteria

When researching the topic, relevant literature was primarily identified through academic databases such as Wiley Online Library, Cambridge University Press, ScienceDirect, and the AI-assisted tool Keenious. Additionally, a snowballing approach was also used, where articles found in these databases often led, through their reference lists, to other studies examining the same or closely related themes. This is a narrative literature review, so no original econometric analysis is performed.

The main criteria for selecting studies were
(i) their relevance to the research questions, and
(ii) the JUFO classification of the publication outlet.

Assessing relevance required more than simply checking titles and abstracts. Not all studies directly examined asset performance. Thus, it was necessary to interpret how each study related to the crises of interest mentioned above. Articles that did not focus on either of these specific crises were included only when there were no other relevant studies or had a clear line to the research question. As outlined above, the analysis focuses on gold, government bonds, commodities, protective puts, delta hedging, and volatility derivatives. These instruments were chosen because they represent common and relatively well-known assets and strategies in the financial sector. It must be

acknowledged that other relevant assets and instruments exist, such as cryptocurrencies or credit default swaps (CDS), but these are excluded in order to keep the scope of the thesis sufficiently focused.

Sources with a JUFO score below 1 were not considered. The theoretical framework relies mainly on high-quality and well-established journals. The aim was to emphasize publications with JUFO scores of 2 and 3. However, for the very recent crises, there were fewer studies in top-tier outlets, and consequently, a substantial share of level-1 sources was used. These are still considered academically sound, and there was no attempt to cherry-pick findings to support a predetermined conclusion.

Most empirical papers employed standard econometric methods, such as GARCH-type models and various regression frameworks. Some studies used more novel or specialized methods with which I was less familiar. In these cases, the interpretation of the results relied heavily on the methodological descriptions and discussions provided by the original authors.

2 Theoretical background

This chapter presents the theoretical background of the thesis. It first defines financial risk and the main risk measures used in modern portfolio theory and risk management. It then discusses why investors hedge, drawing on portfolio theory, factor models, and behavioral motives. The chapter continues by explaining why corporations hedge despite the irrelevance of risk management in perfect capital markets, and finally clarifies the key concepts of hedging, safe-haven assets and market stress, including a brief introduction to option-based hedging through the Black–Scholes–Merton framework.

2.1 Financial risk and risk management

Risk, in a broad sense, refers to the possibility that real outcomes differ from expected outcomes. In finance, risk is typically the uncertainty of future cash flows, asset prices, or returns. This uncertainty can lead to potential losses for investors and firms. Financial risk can be broken down into two main parts: systematic and unsystematic risk.

Systematic risk, also called market risk, non-diversifiable risk, etc. comes from factors that affect assets simultaneously. Examples include changes in interest rates, pandemics, recessions, or political shocks. It is commonly thought that these factors cannot be eliminated by diversification. Unsystematic risk, also called idiosyncratic or diversifiable risk, is specific to a single firm, sector, or project. It includes credit risk, operational risk, or currency risk. According to the theory, these risks are not too highly correlated across firms, thus allowing them to diversify the risk away. This has been considered to be the only free lunch in finance. It must be noted that theory does not always perfectly describe reality, and some risks can blur the line between systematic and unsystematic risk. (Sharpe, 1964)

2.1.1 Quantitative measures of risk

In modern portfolio theory, created by Markowitz (1952), the primary measures of risk are **variance** and **standard deviation** of returns. To be more specific, risk is defined as the variability of returns around their expected value. A higher variance implies a greater dispersion of outcomes and is therefore interpreted as higher risk. Standard deviation is the square root of variance and is often used because it is expressed in the same units as returns. The use of standard deviation as the main proxy for total risk is also embedded in early empirical asset pricing, for example in the Sharpe ratio, which evaluates excess return per unit of standard deviation (Sharpe, 1966). Both measures treat positive and negative deviations from the mean symmetrically, which implies that large gains and large losses are counted equally as risky, even though investors are usually more concerned about downside movements.

A second important risk measure is **Value-at-Risk** (VaR). The basic idea of focusing on downside losses has roots in early portfolio theory: both Markowitz (1952) and Roy (1952) discuss safety-first and shortfall-type criteria, which can be seen as precursors to modern VaR-style downside risk measures. VaR focuses explicitly on downside risk by estimating the potential loss over a given time horizon at a chosen confidence level. For example, a one-day 99% VaR of 1 million euros implies that, under the model assumptions, the loss should not exceed 1 million euros on 99% of days. VaR is therefore particularly useful in the context of market stress, where the magnitude of potential losses is of central importance. However, VaR is model-dependent and often relies on distributional assumptions that may underestimate extreme **tail events** (those being the rare events on a probability distribution), especially during crises (Hull J. C., 2021, pp. 514-537).

Beta (β), as used in the Capital Asset Pricing Model, measures the sensitivity of an asset's return to the overall market and captures the systematic component of risk (Sharpe, 1964). The concept of beta has also been developed into other ideas and models where beta measures the sensitivity, sometimes called a factor loading, to a specific factor (Ross,

1976). Although beta is a key concept in finance, in this literature review the sources focus primarily on variance, standard deviation and VaR as the key metrics for assessing and comparing the effectiveness of hedging strategies and safe-haven assets.

2.1.2 Financial risk management

Financial risk management can be defined as the process of identifying, measuring and managing financial risks that may affect an organization's assets, cash flows or long-term viability. This typically involves measuring exposures to market, credit and liquidity risks, setting risk limits and policies, selecting appropriate instruments and strategies to alter the risk profile, and monitoring and adjusting these positions over time as conditions change. In financial institutions and corporations, risk management frameworks usually combine quantitative models with qualitative judgment, organizational structures, and governance arrangements that define responsibilities and risk appetite. Financial risk management is a broad field that includes, for example, capital structure decisions, liquidity management, and internal controls (Hull J. C., 2023, pp. 30-49). In this thesis, the focus is on hedging strategies and safe-haven assets as specific tools for managing market risk during periods of market stress.

2.2 Why investors hedge

Hedging allows investors to influence the risk characteristics of their portfolios. This section presents three complementary perspectives on why investors hedge: mean–variance optimization and diversification, factor models and hedging of specific risks, and behavioral motives related to portfolio insurance.

2.2.1 Diversification

According to modern portfolio theory, investors should seek to maximize expected return for a given level of risk. In this framework, risk is usually measured by the variance

of portfolio returns. The optimization for risk to return creates the efficient frontier, where you theoretically get the best return for a given amount of risk (Markowitz, 1952).

Diversification plays a central role in this theory. By combining assets that are not perfectly correlated, investors can reduce the variance of portfolio returns without necessarily sacrificing expected return. A core aspect of this framework is, therefore the use of correlation in constructing portfolios. A low or negative correlation between assets can help reduce idiosyncratic risk and move the portfolio closer to the efficient frontier (Markowitz, 1952). However, correlations are not constant over time. This phenomenon can be viewed as a manifestation of undiversifiable or systematic risks. As market-wide shocks dominate asset price dynamics, the benefits of diversification largely disappear. We will examine this further in chapter 4.

2.2.2 Factor models

While mean–variance optimization focuses on the overall variance of returns, factor models such as the Arbitrage Pricing Theory (APT) by Ross (1976) decompose portfolio risk into exposures to several underlying systematic factors. Arbitrage Pricing Theory allows the risk of a portfolio to be broken down into specific risk factors, such as market-wide movements, interest rates, inflation, exchange rates, and sector-specific influences. Each asset has a factor loading that indicates how sensitive that asset is to each factor.

By estimating these factors at the asset or portfolio level, an investor can identify which risk factors are considered to be important for the portfolio. This information can then be used to design targeted hedging strategies. For example, interest rate risk can be managed through interest rate swaps and bond futures, while exchange rate risk can be hedged using currency forwards or currency swaps (Hull J. C., 2021, pp. 172-196). In this way, APT provides a framework that not only explains how different factors drive returns but also helps investors identify and hedge specific systematic risk exposures, rather than treating portfolio risk as a single undifferentiated variance term.

2.2.3 Behavioral motives

Traditional portfolio theory assumes that investors are rational and care only about expected return and variance. Behavioral finance suggests that investors may, in practice, be more sensitive to losses than to gains and may have preferences that place particular value on avoiding large downside outcomes.

Leland, (1980) introduces the idea that some investors may optimally choose to insure their portfolios against significant losses, even though such insurance is costly. This can be implemented through “portfolio insurance” strategies, such as buying put options on an index or on the portfolio or using dynamic trading strategies that replicate option-like payoffs. While purchasing insurance reduces expected return, it can increase the investor’s utility by limiting worst-case outcomes. From this behavioral perspective, hedging is not only about reducing variance but also about shaping the distribution of returns so that extreme negative outcomes are less likely. This provides an additional motive for hedging beyond the purely mean–variance diversification framework.

2.3 Why corporations hedge

According to theory, investors can adjust their own portfolios to achieve their preferred level of risk, which raises the question of why corporations engage in risk management. This section first presents the irrelevance of corporate hedging in perfect capital markets and then explains how market imperfections, especially contracting costs, can make hedging value-enhancing at the firm level.

2.3.1 Perfect markets

In a world of frictionless and complete capital markets, corporate risk management should not increase firm value. This is the essence of the irrelevance result by Modigliani and Miller (1958). The key assumptions include no taxes, no transaction costs, no

bankruptcy costs, symmetric information, and that investors can freely diversify and adjust their portfolios. Under these conditions, shareholders can achieve any desired risk profile on their own by trading in financial markets. If a firm reduces its risk through hedging, investors can undo this by adjusting their portfolios. As a result, corporate hedging would not meaningfully change the overall risk carried by shareholders, and it would therefore be irrelevant for firm value in a perfect-market setting. Thus, if corporate hedging is observed to increase firm value in practice, this must be due to deviations from the assumptions of perfect markets. These deviations create channels through which risk management can affect expected cash flows or the discount rate applied to those cash flows.

2.3.2 Contracting cost

Smith and Stulz (1985) argue that corporations may find it optimal to hedge because of taxes, contracting costs and managerial risk aversion. In the context of this thesis, contracting costs are particularly relevant. These costs arise from the contracts a firm enters with various stakeholders, especially its lenders.

One important source of contracting costs is the cost of financial distress. When a firm experiences poor performance and is unable to meet its financial obligations, it may enter distress or bankruptcy. Financial distress is costly due to legal and administrative expenses, asset sales at depressed prices, and disruptions to business relationships and operations. By reducing the volatility of cash flows and earnings, hedging can lower the probability that the firm enters such a costly state, thereby increasing expected firm value (Smith & Stulz, 1985).

A second source of contracting costs relates to debt covenants. Debt contracts typically include covenants that restrict the firm's actions or require that certain financial ratios, such as leverage or interest coverage, remain within specified bounds. If a firm violates these covenants, lenders may impose penalties, accelerate repayment, demand higher

interest rates or obtain additional control rights. Such covenant violations can be costly and may constrain the firm's investment and financing decisions (Smith & Stulz, 1985).

By stabilizing earnings and key financial ratios, hedging can reduce the probability of covenant violations and therefore lower expected contracting costs. A consistent and transparent hedging policy can also improve lenders' perception of the firm's risk profile, potentially leading to more favorable borrowing terms. In this way, corporate hedging can create value for shareholders in the presence of market imperfections, even though it would be irrelevant in a frictionless market (Smith & Stulz, 1985).

2.4 Hedging, safe-havens and market stress

In the existing literature, the terms hedging and safe haven are sometimes used interchangeably; for clarity, this thesis makes a distinction. Hedging refers to more active strategies that use derivatives or dynamically adjusted positions to offset risks, whereas safe-haven assets are securities that tend to attract demand and preserve value in times of heightened uncertainty. This section clarifies these concepts and relates them to periods of market stress, and it also briefly introduces the Black–Scholes–Merton framework and the notion of delta as a central tool in option-based hedging.

2.4.1 Hedging

Hedging is commonly defined as taking a position that reduces or offsets the risk of adverse price movements in an existing exposure, often by using derivatives. Unlike speculation, the goal of a hedger is to reduce risk rather than generate profit (Hull J. C., 2021, pp. 23-41).

Options are widely used instruments for managing risk, and as mentioned above, for hedging. The Black–Scholes–Merton (BSM) framework provides a theoretical model for valuing European options and for analyzing how their prices depend on the underlying

asset price, volatility, time to maturity and interest rates. A key concept in this framework is **delta**, which measures the sensitivity of an option's price to changes in the price of the underlying asset. Simply put, delta measures the rate at which the option's price changes in relation to the underlying asset. So, a delta of 0.5 means that if the underlying asset moves 2 the option will move 1 in the corresponding direction. A **call option** has a positive delta, while a **put option** has a negative delta, while short selling the option has the opposite effect (Black & Scholes, 1973; Merton, 1973; Hull J. C., 2021, pp. 299-300).

2.4.2 Safe haven

In addition to actively hedging with derivatives, investors may seek protection through so-called safe-haven assets. In the theoretical and empirical literature, **safe-haven assets** are typically defined as assets that maintain their value, or lose only limited value, when markets are under stress and risky assets experience sharp declines. In some cases, they may even appreciate in value during such periods.

A key feature of a safe-haven asset is its correlation with risky assets during episodes of market turmoil. Rather than focusing on average correlations over the full sample, the safe-haven property is concerned specifically with the behavior of correlations in stressed conditions. An asset is considered a safe-haven if its returns are uncorrelated or negatively correlated with the returns of a given market, for example, equities, during crisis periods or extreme market downturns, even if the correlation in normal times is positive or close to zero (Baur & Lucey, 2010). This definition emphasizes the asset's performance conditional on negative market states, which is precisely when protection is perceived to be valuable to investors.

Typical examples discussed in the literature include high-quality government bonds and gold, which have often exhibited low or negative correlations with equities during financial crises (Baur & Lucey, 2010; Baur & McDermott, 2010). In this sense, safe-haven assets represent a relatively passive form of protection: their defensive properties arise from their historical behavior in stressed markets rather than from an explicitly

engineered payoff structure, as is the case with derivative-based hedging strategies such as put options.

2.4.3 Market stress

In this thesis, **market stress** refers to periods in which financial markets experience elevated volatility, sharp declines in the prices of risky assets, widening credit spreads, and heightened uncertainty or fear about future economic conditions. In such environments, the distribution of returns becomes more concentrated in the downside, and the risk of a portfolio, in terms of the variance and standard deviation of returns, as well as downside measures such as Value-at-Risk, increases markedly (Markowitz, 1952; Roy, 1952).

A core aspect of modern portfolio theory is the use of correlation in constructing portfolios. By combining assets that are not perfectly correlated, investors can reduce idiosyncratic risk and improve the risk–return trade-off through diversification (Markowitz, 1952). In normal market conditions, relatively low or moderate correlations between assets support this logic and make diversification an effective tool for reducing the variance and standard deviation of portfolio returns. However, correlations are not constant over time. In periods of market crisis, correlations between risky assets may increase and, in extreme cases, approach a positive one, meaning that assets tend to move more closely together (Longin & Solnik, 2001). This phenomenon can be viewed as a manifestation of undiversifiable, or systematic risk: wide-scale shocks dominate asset price dynamics, and the benefits of diversification largely disappear.

When correlations rise in this way, traditional risk models that rely on historically estimated variances, standard deviations, and correlations may understate the true extent of downside risk. In such situations, hedging strategies and safe-haven assets become more important as alternative tools for influencing the risk profile of a portfolio when diversification alone is no longer sufficient. The behavior of correlations during market stress and the implications for risk measures, diversification, hedging, and the role of safe-haven assets will be examined in more detail later in this thesis in chapter 4.

3 Financial risk management strategies

Hedging and safe havens are a central part of financial risk management, as discussed in chapter 2. In this chapter, we focus on two main groups: safe-haven assets, such as gold, government bonds, and commodities, and derivative-based strategies, including protective puts, delta hedging, and volatility futures and options. The purpose here is to outline how these approaches work and how they are typically used, providing the basis for the empirical evaluation of their performance in chapter 5.

3.1 Traditional safe-haven assets

Traditional safe-haven assets, as covered in 2.4.2, are instruments that have historically been used to preserve wealth and reduce portfolio risk, particularly during periods of market stress. This subsection briefly describes the role of gold, government bonds, and major commodity groups, with an emphasis on their historical co-movement with other asset classes.

3.1.1 Gold

Gold has long been regarded as a “safe” asset, partly because of its historical role in monetary systems and official reserves, and partly because of its behavior relative to equities and bonds. Empirical studies show that gold has often displayed low or negative correlations with stock returns on average and has, in many cases, acted as a safe-haven during extreme stock market downturns, particularly in major developed markets (Baur & Lucey, 2010; Baur & McDermott, 2010). In other words, when equity markets have experienced large negative shocks, gold has tended, at least historically in several markets, to move differently enough from equities to offer some degree of protection. This empirical pattern has helped cement gold’s status as an established safe-haven asset in both academic work and market practice.

3.1.2 Bonds

High-quality government bonds, especially those issued by advanced economies, have traditionally been viewed as safe assets and are commonly used as proxies for the risk-free rate in asset pricing models. Historically, episodes of financial turmoil have often been associated with “flight-to-safety” flows from risky assets such as equities into government bonds, accompanied by changes in the stock–bond correlation structure. Research on the risk–return trade-off between stocks and bonds documents that, in stressed conditions, investors tend to rebalance toward safer government securities, and stock–bond correlations can turn negative as a result (Adrian et al., 2019) (Beber et al., 2009). This historical pattern has contributed to the perception of government bonds as a traditional safe-haven against equity market risk, even though the strength and sign of stock–bond correlations can vary over time.

3.1.3 Commodity hedges

Commodities represent another broad group of assets that can play a role in portfolio hedging. The main categories typically considered are energy products (such as crude oil), soft commodities (such as agricultural products) and metals (including industrial and precious metals). Empirical literature suggests that broadly diversified commodity futures indices have historically exhibited relatively low, and in some periods even negative, correlations with stocks and bonds, suggesting potential diversification and hedging benefits (Gorton & Rouwenhorst, 2006).

At the same time, correlations differ substantially across commodity groups: correlations tend to be higher within some groups, for example, within energy or within metals, and lower between groups. Implying that oil, soft commodities and metals can behave quite **differently** from each other, in relation to traditional financial assets. On this basis, it has been argued that commodity markets should be analyzed within a different asset universe from traditional stocks and bonds, which further supports their theoretical role as

hedging and diversification instruments against equity and bond market risk (Daskalaki et al., 2014).

In this thesis, commodities are therefore included among safe-haven assets primarily because of this historical evidence of distinct and, at times, low correlation with equities and bonds, rather than because of any single, uniform safe-haven role across all commodity types. Their detailed performance under market stress is examined later in the literature review.

3.2 Derivatives-based strategies

Derivatives are financial contracts whose value is derived from the price of an underlying asset, index, or rate. Common examples include options, futures, forwards, and swaps. Derivatives can be used to replicate specific payoff structures and, therefore can alter the risk profile of a portfolio in a targeted way (Hull J. C., 2021, pp. 227-243). In this section, the focus is on three broad types of derivative-based hedging strategies: protective put strategies, delta hedging, and volatility derivatives.

3.2.1 Protective put

A protective put combines a long position in an asset with a long-put option of the same asset. Mechanically, this creates a floor for the value of the portfolio at roughly the strike price of the option, minus the premium paid. Thus, if the asset price falls below the strike, the put moves into the money and its value increases, offsetting losses on the underlying position. On the other hand, if the asset price remains above the strike, the option expires worthless, and the investor retains the upside on the asset while having paid the option premium as an insurance cost (Hull J. C., 2021, pp. 270-284)

In payoff terms, the protective put transforms the linear payoff of the long asset into a portfolio in which downside beyond the strike is limited but upside remains largely intact, making it a straightforward way to cap losses over a given timeframe while not restricting

upside, thus fitting naturally into the portfolio insurance framework discussed by Leland (1980).

Early empirical work by Figlewski et al. (1993) illustrates this trade-off between protection and cost in practice. Studying equity index portfolio insurance strategies that systematically buy put options, they show that protective puts are effective in decreasing large losses and reducing downside risk, but that the insurance premia paid for the options creates a persistent drag on returns in normal market conditions. Their results underline that a protective put offers genuine downside protection, but at the expense of lower average performance relative to an unhedged position.

3.2.2 Delta hedging

Delta hedging is a dynamic hedging technique used to reduce the sensitivity of a position to small changes in the price of the underlying asset. As defined in the theoretical section, delta measures how much the option price changes when the underlying price changes by one unit, and the position is delta-neutral when the sum of all deltas in the portfolio is approximately zero. In practice, a trader who is long on an option will take an offsetting position in the underlying asset such that the combined delta of the option and the underlying position is close to zero. As the underlying price, time to maturity, and implied volatility change, the option's delta changes as well, so the hedge must be rebalanced periodically (Hull J. C., 2021, pp. 421-427; Black & Scholes, 1973; Merton, 1973)

The purpose of delta hedging is mainly to reduce risk rather than to generate extra profit. The idea is to keep the value of a position relatively stable within a certain range of underlying prices by offsetting small price movements. Because delta is not constant, it changes as the underlying price, time to maturity, and volatility change; the hedge must be recalculated, and the portfolio rebalanced over time. Compared to buying safe-haven assets or protective puts, delta hedging offers a more continuous and controlled way to manage risk (Hull J. C., 2021, pp. 421-427). Although delta-hedged option positions can also be used to speculate on volatility and potentially earn profits from differences

between implied and realized volatility, the focus in this thesis is on delta hedging as a risk management tool rather than as a speculative strategy.

3.2.3 Volatility derivatives

Volatility derivatives are instruments whose payoff depends on the level of volatility rather than the price level of an underlying asset. Prominent examples in equity markets are futures and options on volatility indices such as the Chicago Board Options Exchange (CBOE) Volatility Index (VIX), which reflects the market's expectation of near-term volatility implied by S&P 500 index options (Hull J. C., 2021, pp. 358-359).

A long position in VIX futures, or in a call option on the VIX, typically gains value when expected volatility rises, which often coincides with falling equity prices. From a hedging perspective, this allows an investor to build positions that are designed to pay off when volatility spikes, providing a form of protection against turbulent markets (Hull J. C., 2021, pp. 358-359). Conceptually, these strategies extend traditional hedging from price risk to volatility risk. Instead of directly offsetting losses on the underlying asset, they generate gains from increased volatility that can partially compensate for losses elsewhere in the portfolio.

4 Market stress, contagion and correlation

Market stress was described in 2.4.3 as a state in which volatility rises, downside risk increases, and correlations between risky assets tend to move upward. This chapter briefly discusses financial contagion and liquidity-driven mechanisms that help to explain why shocks can spread across markets and why correlations may rise during crises.

Financial contagion refers to the transmission of financial distress from one institution, market, or asset class to others, beyond what would be expected from fundamentals alone. In theoretical models, contagion often arises through balance-sheet interlinkages and feedback effects. Allen and Gale (2000) model banks in different regions that hold interregional claims on one another to share liquidity risk. When an adverse liquidity shock forces some banks to liquidate assets, fire sales depress asset prices and weaken the balance sheets of otherwise solvent banks holding similar assets. This pecuniary externality can turn a local shock into a system-wide crisis through a chain reaction of losses and further liquidations. From this perspective, contagion captures the self-reinforcing dynamics through which fear, forced sales, and declining prices propagate distress. Even if the initial shock is local, the network of exposures and common asset holdings can cause losses and funding problems to spread and undermine confidence in other parts of the system.

While contagion can be modelled in banking networks, similar ideas apply to asset markets. Hartmann et al. (2004) study extreme co-movements in international stock and bond markets using tools from extreme value theory. Instead of focusing on average correlations, they examine the joint behavior of large negative returns. Their results suggest that asset markets can become more tightly linked in periods of stress, especially across equity markets, while also finding episodes in which investors shift from risky assets into safer ones such as government bonds. They find statistically and economically meaningful evidence of contagion, but they also emphasize that the statistical identification of contagion is delicate and that earlier work may have overstated its pervasiveness.

Contagion in modern financial markets is closely linked to liquidity conditions. Brunnermeier and Pedersen (2009) show how shocks to funding liquidity (the ability of traders and institutions to obtain financing) can force investors to sell assets, depress prices, and reduce market liquidity, which in turn worsens funding conditions and triggers a self-reinforcing “liquidity spiral” across markets. When this happens, traders withdraw from providing liquidity in several markets at once, causing more synchronized price movements and higher correlations between assets. In terms of the risk concepts introduced earlier, these dynamics increase systematic risk and help explain why diversification becomes less effective in crises and why hedging strategies and safe-haven assets play a particularly important role when liquidity conditions deteriorate.

While several studies report evidence consistent with contagion, there is also an important strand of literature that questions whether crises truly lead to a structural increase in cross-market linkages. Forbes and Rigobon (2002) show that some tests are biased in the presence of changing volatility and argue that, after correcting for this bias, many prominent crisis episodes are better described as interdependence rather than contagion. Similarly, Morales and Andreosso-O’Callaghan (2014), do not find significant contagion effects from U.S. stock markets during the global financial crisis (2008) and instead interpret the evidence as reflecting strong but largely stable cross-market linkages and spillovers. While these papers might question the exact definition of contagion and its implications, the core idea of risk transferring from one market to another remains the same.

5 Literature review: The performance of the hedging strategies in market crisis

This chapter reviews the empirical evidence on how the hedging and safe-haven assets discussed in Chapter 3 have performed during major market crises, with a particular focus on the COVID-19 pandemic and the Russia–Ukraine war in the 2020s. The aim is to interpret these recent findings and to relate these results to the two hypotheses of the thesis.

5.1 Safe-haven assets

This section goes through recent empirical evidence on how traditional safe-haven assets have performed during major market crises. For each asset class, the findings are evaluated in relation to the two hypotheses of the thesis.

5.1.1 Gold performance

The empirical literature on gold generally supports the idea that some hedging and safe-haven assets provide better crisis protection than others, but also shows that this protection is conditional and varies across episodes. Azimli (2024) examines gold as a hedge against U.S. dollar exchange rate risk and finds that gold can act as a safe-haven for several currency pairs during extreme conditions such as the COVID-19 pandemic and the Russia–Ukraine conflict, although the effect is not uniform across all exchange rates. Thuy et al. (2024) analyse gold, the U.S. dollar and Bitcoin across the global financial crisis, COVID-19 and the Russia–Ukraine war and conclude that gold's safe-haven role is time-varying: it offers protection in some markets and crises but not in others. Similarly, Živanović et al. (2022) show that gold acted as a hedge and safe-haven before the COVID-19 outbreak, but that its protective role weakened at the peak of the crisis when correlations with equities temporarily increased.

Ryan et al. (2024) further demonstrate that gold's behaviour depends on the nature of the equity downturn. They find stronger safe-haven properties when stock market declines are driven by macroeconomic news, but weaker protection in other types of selloffs, suggesting that the underlying shock matters for gold's performance. Cheema et al. (2025) extend this line of research by comparing eleven potential safe-haven assets across thirteen major stock market downturns. They show that safe-haven performance varies systematically across assets and crises and report that in their sample gold did not function as a safe-haven in the two most recent downturns (the COVID-19 pandemic and the Ukraine war), whereas some alternative assets provided more consistent protection. On this basis, they caution that investors should not rely solely on gold in times of market turmoil and suggest that safe-haven exposure should be diversified across several assets.

Overall, the evidence gives qualified support to H1. Earlier work often finds gold to be a hedge or safe-haven, but recent studies around COVID-19 and the Russia–Ukraine war show that it has not always preserved value when equities fell, and in some cases moved with stocks. This means gold can offer better protection than many risky assets in some crises, but its safe-haven role is clearly scenario-dependent. Regarding H2, gold sometimes maintains low or negative correlation with equities in stress, but in other episodes, its correlation rises, so it only partly offsets the correlation spikes described by H2.

5.1.2 Bond performance

Government bonds from advanced economies are traditionally treated as established safe-haven assets, but recent crises show that their protective role is highly regime- and country-dependent. During the initial phase of the COVID-19 bear market, Baek and Jackman (2021) find that U.S. Treasury bonds acted as a strong safe-haven for U.S. equities, outperforming gold in hedging extreme negative stock returns, suggesting that high-grade sovereign bonds still provided meaningful downside protection in the early pandemic shock. International evidence around COVID-19 underscores that sovereign bond behavior changes across states of the world: Jareño et al. (2022) show, using a quantile regression framework, that the sensitivity of government bond yields to global risk and

macro factors is state-dependent, with different drivers dominating in bearish versus normal regimes.

Cheema et al. (2025) provide a particularly relevant perspective by jointly analyzing a range of candidate safe-haven assets, including U.S. and Japanese government bonds, across multiple stock market downturns. They show that inflation and the monetary policy environment are crucial. In downturns associated with high inflation and rising interest rates, the safe-haven efficacy of U.S. treasuries is remarkably diminished, whereas Japanese government bonds, issued in an economy with low inflation and interest rates, often held their value and thus functioned as effective safe-havens. They also find that the geographical and economic proximity of the issuing country to the crisis matters: yen-denominated assets, including Japanese government bonds, provided safe-haven protection in almost all downturns studied, while Euro- and Swiss franc-denominated assets failed to do so in crises closely tied to the Euro area and the Ukraine war.

Recent work on stock bond correlation regimes reinforces this view. McMillan (2026) examines time-varying stock–bond correlations for the G7 over 1980–2023 and finds clear sign-switching behaviour: correlations move from positive to negative around the late 1990s/early 2000s and then back to positive toward the end of the sample. Inflation and interest rates exert a positive effect on the correlation, so that periods of higher inflation and rising rates tend to push stocks and bonds in the same direction, while low-inflation, low-rate environments are more conducive to negative correlations and stronger diversification benefits. These results imply that the safe-haven role of government bonds is strongest in low-inflation, low-rate regimes and can be significantly weakened in inflationary or tightening episodes such as parts of the post-COVID and Russia–Ukraine war period.

It seems that government bonds also support H1, but only under certain conditions. High-quality sovereign bonds, especially U.S. and Japanese, often provide downside protection in equity downturns, yet their safe-haven performance weakens in high-inflation,

rising-rate regimes and when the crisis is close to the issuer. For H2, stock–bond correlations show clear regime shifts: they tend to be low or negative in low-inflation periods but move towards positive territory in inflationary stress, reducing diversification benefits in line with H2.

5.1.3 Commodity performance

Białkowski et al. (2023) conduct a meta-analysis of 1,699 hedge ratio estimates from commodity futures studies and show that hedge effectiveness is strongly context dependent. On average, the optimal hedge ratio in commodity markets falls within a relatively wide band of roughly 0.60 to 1.20 once publication bias is taken into account. They also find that reported hedge ratios differ systematically across commodities, sample periods and estimation methods, as well as with other data and publication characteristics. Taken together, their results imply that there is no single “best” hedge ratio for commodity hedging and that hedge performance should be evaluated with respect to the specific market and setting under consideration.

Będowska-Sójka et al. (2022) analyse asset behaviour around the Russian invasion of Ukraine and show that market reactions are both asset-dependent and time-scale dependent in terms of magnitude and duration. They find that green bonds, gold, silver, the Swiss franc, and real estate are more resistant to increases in geopolitical risk across high- and low-frequency horizons, than some other assets. On this basis, they identify these assets as better-suited candidates for hedging portfolios against uncertainty induced by military conflict, while other assets, including many commodities, display more pronounced and persistent reactions to the invasion.

Han (2025) studies the COVID-19 shock by examining time-varying interconnectedness between U.S. equity and commodity futures markets across energy, metals and agricultural commodities. The results indicate that interconnectedness rose sharply at the onset of the pandemic, with Brent crude and heating oil acting as key transmitters of risk, but that these linkages reverted relatively quickly towards pre-crisis patterns. At the

same time, Han documents that certain soft commodities exhibit more favorable hedging characteristics for equities, pointing to unconventional hedging potential within this segment and drawing implications for policymakers concerned with market stability and food-related inflation risks.

Naeem et al. (2024) investigate commodity market dynamics across different types of crises, including the COVID-19 pandemic and the Russia–Ukraine war, and explicitly distinguish between health, geopolitical and financial shocks. They find evidence of systematic risk transmission across many commodity categories, consistent with strong tail-risk spillovers in stressed periods, but also identify commodities that behave as outliers, such as aluminum during the COVID-19 crisis, which does not fully conform to the risk patterns of the broader complex. Their results underline that commodity behaviour in crises is highly heterogeneous, with some contracts acting primarily as risk transmitters and others offering partial hedging benefits in specific episodes.

For commodities, H1 is partly supported. Broad indices and many energy contracts usually transmit, rather than hedge, risk in crises, while some soft commodities or metals provide partial protection in specific episodes, so no single commodity stands out as a consistently superior hedge. In relation to H2, correlations within and between many commodity markets and other risky assets typically rise in crises—especially for energy—reinforcing the pattern of higher systematic risk and weaker diversification.

5.2 Derivative-based strategies

In this section, the empirical literature on the performance of derivative-based hedging strategies is reviewed. The aim is to assess how these strategies have performed in recent crises and how their documented behavior relates to the hypotheses of this thesis. Because derivatives are often constructed to have specific relationships with underlying assets, changes in correlation do not operate in exactly the same way as for traditional assets. For H2, the focus is therefore on whether these strategies remain effective when

correlations between the underlying risky assets rise, rather than on changes in the correlations of the derivatives themselves.

5.2.1 Protective put performance

Recent studies compare protective puts with alternative option-based hedging strategies. Shivaprasad et al. (2022) analyse covered calls, covered puts, collars and synthetic long call (protective put) strategies on Indian equity index constituents over 2009–2020. Using panel regression and post-hoc tests, they find that option strategies can provide effective downside protection, but the covered call and covered put strategies generally deliver more favourable risk–return trade-offs in their sample, whereas collars and synthetic long calls offer weaker hedging effectiveness once costs are considered. Their results suggest that while protective put–type structures do hedge equity price risk, they may be less cost-efficient than some alternative option overlays in relatively calm or moderately volatile markets.

Kedžo and Šego (2021) examine the relative efficiency of several option hedging strategies, covered calls, protective puts, collars and ratio covered calls, using simulated returns and third-order stochastic dominance criteria. They compare the return distributions of these strategies against an unhedged stock position for investors who dislike downside risk and losses but value positive skewness. Their findings indicate that portfolios hedged with options are never overshadowed by the unhedged portfolio, and that protective puts work well under a range of market conditions, especially for investors who care strongly about avoiding large losses. This supports the view that protective puts are a robust form of portfolio insurance.

Focusing on broad index exposure, He and Kwon (2023) develop an optimization-based tail-risk hedging framework for S&P 500 investments using rolling long put positions. They construct portfolios that dynamically adjust put strikes and maturities based on variance and conditional value-at-risk criteria and test them on historical S&P 500 data. The optimized protective put strategy provides substantial protection in market

downturns while largely preserving long-horizon returns and outperforms both an unhedged index position and a static long-put strategy. Their results show that the traditional drawbacks of protective puts, notably high and persistent hedging costs, can be mitigated when strike selection and rebalancing are optimized rather than fixed.

In summary, later studies broadly confirm but refine the findings from Figlewski et al. (1993). Their work shows that rolling protective puts can provide a floor under portfolio value, but that the improvement in worst-case outcomes is limited once the recurring option premia are considered. More recent evidence (Shivaprasad S et al., 2022; Kedžo & Šego, 2021) supports this trade-off, finding that protective puts do deliver downside protection but are often less cost-efficient than cheaper overlays in calm markets. He and Kwon (2023) show that dynamically choosing strikes and maturities can significantly improve the performance of protective put strategies, suggesting that their cost–benefit balance depends crucially on how they are implemented. Overall, protective puts provide relatively clear support for H1, as they enhance crisis protection at the portfolio level, while their design as payoff floors rather than correlation-based diversifiers means they can remain effective even when correlations between risky assets rise, offering a partial antidote to the erosion of diversification implied by H2.

5.2.2 Delta hedging performance

Empirical studies on the performance of delta hedging are relatively limited compared with the extensive literature on the other assets and strategies considered in this thesis. It is nevertheless included here because delta hedging is a central tool in derivative-based risk management and therefore relevant to the overall topic. Much of the existing work evaluates hedging errors and risk–return trade-offs over long samples, often with the global financial crisis as the key stress episode e.g. (Shackleton & Voukelatos, 2013). By contrast, systematic analyses of delta-hedging performance during the most recent crises are scarce, and the available evidence is less developed than for other covered assets.

Hull and White (2017) analyze S&P 500 index options and estimate a minimum-variance delta designed to minimize the variance of hedging errors. They show that this empirically calibrated delta delivers smaller hedging errors than the standard Black–Scholes delta across a range of moneyness and maturities, indicating that classical delta hedging can be improved in practice but still leaves non-trivial residual risk. Han et al. (2015) investigate “robust” option-hedging strategies for S&P 500 and Taiwanese index options and find that volatility-based schemes can yield higher Sharpe ratios than more model-free approaches, although performance differs across markets. Shackleton and Voukelatos (2013) study Greek index options before and after the 2008 financial crisis and show that hedging efficiency and option-market behavior changed significantly after the crisis, suggesting that market stress can alter the effectiveness of delta-based hedging strategies.

More recent work has shifted towards data-driven hedging frameworks that treat classical delta hedging as a benchmark. Buhler et al. (2019) introduce “deep hedging”, using reinforcement learning to design hedging strategies under transaction costs and other frictions, and show that these strategies can achieve better risk to cost tradeoffs than standard delta-based approaches. Xia et al. (2023) propose a two-step delta-hedging approach that adjusts the hedge for the elasticity between volatility and the underlying price and find that the adjusted delta reduces hedging errors relative to the Black–Scholes delta.

A related line of research examines how option hedging feeds back into the underlying market. Anderegg et al. (2022) model and quantify the impact of delta hedging on spot market volatility in the foreign exchange market and show that net delta-hedging activity can either dampen or amplify volatility depending on the sign of aggregate gamma exposure, so that hedging flows may at times increase short-term volatility rather than stabilizing prices.

Overall, the evidence suggests that delta hedging reduces risk relative to unhedged positions, particularly when deltas are empirically calibrated or enhanced with more flexible, data-driven methods. However, the empirical literature on its performance remains relatively narrow, for the reason mentioned above, so support for H1 is necessarily tentative. Performance also appears highly sensitive to volatility estimation, liquidity and transaction costs, which further complicates comparisons with more traditional hedging and safe-haven instruments. In relation to H2, delta hedging can mitigate the impact of correlation spikes on individual portfolios by reducing directional exposure, but concentrated hedging flows may also contribute to higher volatility and co-movements at the market level, leaving its overall link to broader correlation dynamics ambiguous.

5.2.3 Volatility futures and options performance

Volatility derivatives, particularly VIX futures and options, provide direct exposure to implied equity volatility and are widely used as tail-risk hedges. Rather than hedging price movements of the underlying index, these instruments hedge movements in expected variance, which is closely related to the risk measures introduced earlier in the theoretical framework 2.1.1.

Bangsgaard and Kokholm (2024) show that in calm markets, VIX futures and S&P 500 futures are only weakly linked, but in volatile periods they become strongly negatively related and VIX futures tend to move first, indicating that VIX futures react quickly to rising equity risk. Božović (2024) uses this information in practice by constructing so-called VIX-managed portfolios that scale equity exposure up when the VIX is low and down when it is high, and finds that this simple rule improves risk-adjusted performance and stabilizes portfolio weights. Together, these results suggest that VIX levels and VIX futures provide timely signals that can be used to hedge or dynamically manage equity risk.

Eraker and Yang (2022) take a more structural perspective and develop an equilibrium model that jointly prices equity returns, VIX futures, S&P 500 (SPX) options, and VIX

options. Calibrated to market data, their model replicates key features of VIX futures returns and the implied volatility surfaces of both SPX and VIX options, including episodes of extreme stress. They document substantial time variation in the shape of the VIX option implied-volatility surface and a time-varying hedging relationship between SPX and VIX options. During crisis periods such as the global financial crisis (2008-2009) and the COVID-19 pandemic outbreak in 2020, out-of-the-money VIX call options behave as tail-end insurance, delivering large payoffs when volatility spikes. This suggests that VIX options can provide powerful downside protection, but that the cost and effectiveness of this protection are highly state-dependent and reflect a sizeable variance risk premium.

While the classic VIX indices relate to equity volatility, similar concepts have been extended to credit markets. Bouri and Alsagr (2024) study the hedging effectiveness of newly introduced CBOE credit VIX indices for investment-grade and high-yield corporate bond indices in North America. They find that credit VIX is an effective hedge for its corresponding bond index, with high-yield credit VIX providing more stable and effective hedging than investment-grade credit VIX. They also show that conditional correlations between credit VIX and the underlying bond indices declined during the Federal Reserve's post-COVID 19 tightening cycle, which enhanced hedging effectiveness. These results indicate that volatility indices can function as safe-haven–like instruments not only for equities but also for credit risk.

Overall, the literature indicates that volatility futures and options can provide meaningful protection in turbulent markets and improve risk-adjusted performance when used in dynamic strategies. VIX futures, VIX options and credit VIX indices tend to deliver large gains when equity or credit markets are under severe stress, offering some of the strongest support for H1 among derivative strategies. Their effectiveness, however, is highly scenario and strategy-dependent.

6 Conclusion

The purpose of this thesis was to examine how well different hedging and safe-haven assets protect investors during major market crises in the 2020s, with a particular focus on the COVID-19 pandemic in 2020 and the Russia–Ukraine war in 2022. The analysis combined a theoretical discussion of financial risk, hedging motives and contagion with a literature review of recent empirical studies on gold, government bonds, commodities, protective puts, delta hedging, and volatility derivatives. Two hypotheses were formulated: (H1) some hedging and safe-haven assets provide better protection in market crises than others, and (H2) correlations between assets increase in crises.

The evidence reviewed in Chapter 5 broadly supports H1, but only in a conditional sense. Gold and high-quality government bonds often provide downside protection, yet their safe-haven properties are not constant. Recent work shows that gold has failed to act as a reliable safe-haven in the latest downturns and that the effectiveness of government bonds depends on the country-specific political, economic, and geopolitical factors. Commodities display highly **heterogeneous** behavior, with some contracts transmitting risk and others (such as certain soft commodities) offering partial hedging benefits in specific episodes.

Derivative-based strategies such as protective puts and volatility derivatives generally succeed in limiting extreme losses, but their cost-effectiveness depends heavily on implementation choices and market conditions. Evidence on delta hedging suggests that it reduces risk relative to unhedged positions and can be improved through empirical calibration or data-driven methods, but systematic results for the most recent crises are still limited. Overall, some assets and strategies are suggested to offer better crisis protection than others, yet no universal best hedge emerges.

The findings also largely support H2. The theoretical and empirical literature on contagion and correlation regimes indicates that correlations between risky assets tend to increase during periods of market stress. Some safe-haven assets, such as certain

government bonds, currencies or commodities, can maintain low or negative correlations with equities in specific crises. Overall, however, the pattern that correlations among risky assets rise in severe downturns is robust and consistent with the intuition behind H2.

These results have several practical implications. **First**, investors should be cautious about relying on gold as an automatic safe-haven: recent crises show that its protection has been weaker and less reliable than often assumed. By contrast, Japanese government bonds have displayed relatively robust safe-haven properties in several downturns, reflecting Japan's low inflation, low interest rates and distance from recent geopolitical shocks, and illustrate that not all sovereign bonds behave alike.

Second, non-traditional assets such as certain soft commodities may offer useful diversification benefits precisely because they appear less financialized and less tightly integrated with equity and bond markets, although their hedging role is still episode-specific.

Third, derivative-based strategies such as protective puts and volatility derivatives provide explicit downside insurance for portfolios and can be particularly valuable for more risk-averse investors who place a high weight on limiting large losses. However, these strategies involve ongoing hedging costs and implementation complexity, which means they are often more suitable for investors with clear risk-management mandates and sufficient scale.

The thesis also has limitations that point to directions for future research. The analysis is based on a narrative literature review without original econometric estimation and focuses mainly on developed markets. The empirical literature on some derivative-based approaches, particularly delta hedging, remains relatively narrow for the most recent crises. Future work could provide more systematic cross-country evidence, examine derivative-based hedging in the COVID-19 and Russia–Ukraine episodes in greater detail.

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