Quantifying Downside Risk in Euro Area Stock Markets: A Value at Risk Study

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ARTICLE DETAILS	ABSTRACT
	The present research paper aims to assess and quantify the downside risk of Euro Area stock markets using the Value at Risk (VaR) methodology over a substantial time frame spanning 26 years. The study employs daily closing price data from the main stock exchanges of Euro Area nations. Using the historical simulation method, VaR estimates are calculated for each country's stock index, providing valuable insights into market performance and risk levels during both normal and crisis periods. The non-parametric nature of the historical simulation approach is favored due to its flexibility in dealing with non-normal distribution data, making it suitable for this analysis. The findings reveal significant variations in downside risk among Euro Area countries. Certain nations consistently exhibit lower VaR estimates, indicating comparatively lower downside volatility and potential losses. These markets may prove attractive to risk-averse investors seeking stability during adverse market conditions. In contrast, some countries consistently demonstrate higher VaR estimates, signaling heightened downside risk, which may offer higher potential returns but may not align with risk-averse investors' preferences. During periods of crisis, certain Euro Area markets display a lower level of downside volatility, showcasing their resilience during turbulent times. This information can guide investors in constructing diversified portfolios that can withstand adverse market conditions. Additionally, policymakers can draw upon these findings to formulate targeted monetary policies to support financial markets during economic uncertainty. Overall, this study contributes valuable insights into downside risk and market performance in Euro Area stock markets, providing investors, policymakers, and financial participants with essential information to make informed decisions and navigate the complexities of global financial markets effectively.

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1. Introduction

In finance and investment, "downside risk" refers to the potential for an investment or asset to decrease in value (RoY, 1952). Jorion (2007) defined downside risk as "the dispersion of unexpected outcomes owing to movements in financial variables". It represents the possibility of incurring losses or negative returns (Best, 1999; Estrada, 2006). Investors and financial analysts often use downside risk as a measure of the potential downside volatility or the likelihood of an investment performing worse than expected (Estrada, 2007). Understanding and managing downside risk is essential for investors (Chen and Chen, 2004) to make informed decisions and construct portfolios that align with their risk tolerance and investment objectives. By analyzing downside risk, investors can better assess the potential losses they might face during adverse market conditions and take steps to mitigate the impact. Diversification, hedging, and risk management strategies are often employed to minimize downside risk and protect investment portfolios from significant declines. In the dynamic and interconnected world of global financial markets, managing risks effectively is of paramount importance for investors, financial institutions, and policymakers. One of the key tools used to assess and quantify market risks is the Value at Risk (VaR) methodology. Dowd (1998) defined it as "VaR is the maximum expected loss over a given horizon period at a given level of confidence". Value at Risk (VaR) estimates the potential downside losses and risk levels associated with financial assets or portfolios (Jorion, 2007), providing valuable insights to guide decision-making and risk management strategies. The historical simulation technique is regarded as the most popular and reliable Value at Risk (VaR) estimation approach among all (Perignon & Smith, 2009). This notion has been supported by various scholars such as Ammann & Reich (2001). The present study aims to employ the historical simulation method to evaluate the VaR estimates of Euro Area nations' stock indices over the last 26 years. It is really difficult to manage the downside risk when the financial market around the world is fluctuating, and to minimize the downside risk (Rizwan, Ahmad and Ashraf, 2020; Liu *et al.*, 2022); everyone recognizes the importance of managing it. Risk management provides various models or tools for managing downside risk. The different ways of measuring risk that have emerged in financial markets in recent decades raise concerns about their validity. The most advanced and preferred risk management model has to be Value at Risk (VaR) because it is simple to understand and easy to interpret. Value at Risk (VaR) is the primary measure of downside risk often used by stock market stakeholders (Atilgan & Demirtas, 2013; Chen & Chiang, 2016; Jin, 2018). Its the most prominent risk measurement method often used by investors, institutional investors, FIIs, fund managers, hedgers, risk managers, regulators, policymakers, and other participants. Over the last decade, Value at Risk (VaR) has evolved as one of the most important risk measuring approaches in finance. When implementing Value at Risk (VaR) systems, it attempts to anticipate future asset prices using prior market data.

This research paper aims to investigate into the analysis of VaR estimations in the context of the Euro Area stock markets, covering a substantial time frame spanning 26 years. The Euro Area comprises a diverse group of countries with varying economic conditions and financial market characteristics, making it an intriguing subject of study in terms of risk evaluation and market performance during both normal and crisis periods.

2. Objectives

The paper tried to accomplish the following objectives:
- to evaluate the downside risk on the Euro Area by utilizing the Value at Risk methodology;
- to recommend the most desirable market(s) among the Euro Area that present the least amount of downside risk, thereby aiding investors in their portfolio selection;
- to check if diversification opportunities are available among Euro Area during crisis period;
- to assist policymakers in their policy formulation.

3. Data and Methodology

To achieve the research objectives, this paper employs daily closing price data obtained from the primary stock exchanges of Euro Area nations, covering an extensive period from January 1, 1996, to December 31, 2021. The adjusted daily closing prices for all Euro Area economies were obtained from sources shown in Table 1. The daily log return of the stock indices is computed using the log difference method. The use of log return is justified due to its symmetry property, as suggested by Danielsson (2011), making it a suitable choice for this analysis. Additionally, VaR estimates are scrutinized for the entire Euro Area, offering a comprehensive view of market performance. We calculated the continuously compounded or log return in R software by taking the difference in price indices' logarithm. i.e.

$$R_{it} = log \left(\frac{P_{it}}{P_{it-1}}\right)$$
 Equation 1

where;
R_{it} is log difference return at time t,
P_{it} and P_{it-1} are two successive weekly closing prices of an ith stock exchange.

Parametric and non-parametric are the two categories into which VaR estimates fall (Ammann and Reich, 2001). While parametric VaR deals with normal distribution data, it is not applicable in our case of dailly returns data. Therefore, we have employed a non-parametric historical simulation method to evaluate the value at risk (VaR) estimates. In MS Excel, we have determined the yearly Value at Risk (VaR) estimates at a 99% confidence level (Linsmeier and Pearson, 1996) for the stock return of Euro Area countries. The study used the historical simulation approach to calculate the yearly Value at Risk (VaR) values using daily return data for the major exchanges of the Euro area economies from January 1, 1996, to December 31, 2021.

3.2   Specified empirical model

The Historical Simulation method is a popular approach for calculating Value at Risk (VaR). It is a non-parametric method that uses historical data to estimate potential losses in a portfolio over a given time horizon (Best, 1999). The equation for the Historical Simulation method of VaR is as follows:

VaR (level, horizon) = α-th percentile of the portfolio's return distribution

where:
- VaR is the Value at Risk.
- Level is the confidence level, typically expressed as a percentage (e.g., 99% confidence level).
- Horizon is the time horizon over which the VaR is estimated (e.g., one year).
- α is the significance level, calculated as 1 - confidence level (e.g., for a 99% confidence level, α = 1 - 0.99 = 0.01).

The α-th percentile is a value below which α% of the historical returns lie. In other words, it's the cut off point for the lower (1 - α)% of the portfolio's return distribution. The study followed series of steps in calculating Value at Risk (VaR) using the Historical Simulation method given by Dowd (2002).

TABLE 1 SOURCES OF STOCK PRICE DATA.

| Country	Main Index	Source
Austria	ATX	Ceic dataset
Belgium	BFX	Ceic dataset
Croatia	(CROBEX)	Ceic dataset
Cyprus	Cyprus Main Market	Ceic dataset
Estonia	Tallinn SE General	Ceic dataset
Finland	OMX Helsinki 25	Ceic dataset
France	FCHI	Ceic dataset
Germany	GDAXI	Ceic dataset
Greece	Athens General Composite	Ceic dataset
Ireland	ISEQ Overall	Ceic dataset
Italy	(IT40)	Ceic dataset
Latvia	Riga General	Ceic dataset
Lithuania	Vilnius SE General	Ceic dataset
Luxembourg	LUXX	Ceic dataset
Malta	MSE	Ceic dataset
the Netherlands	AEX	Ceic dataset
Portugal	PSI	Ceic dataset
Slovakia	SAX	Ceic dataset
Slovenia	Blue-Chip SBITOP	Ceic dataset
Spain	IBEX	Ceic dataset

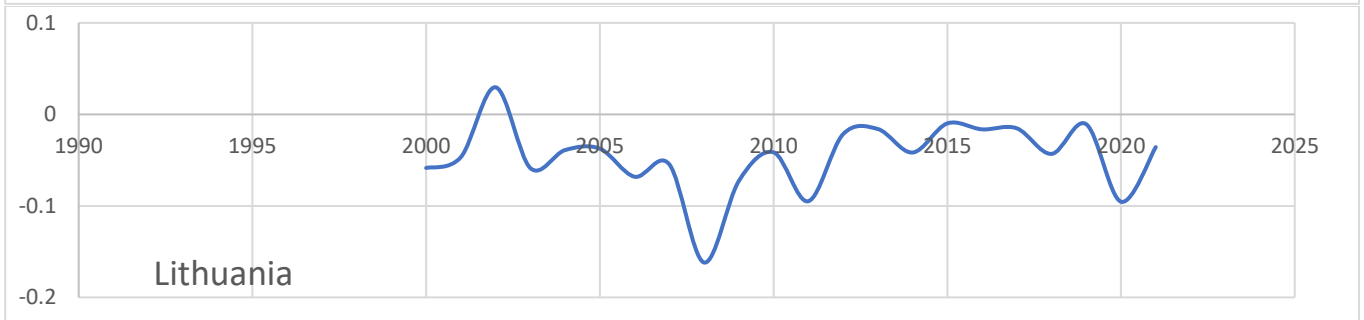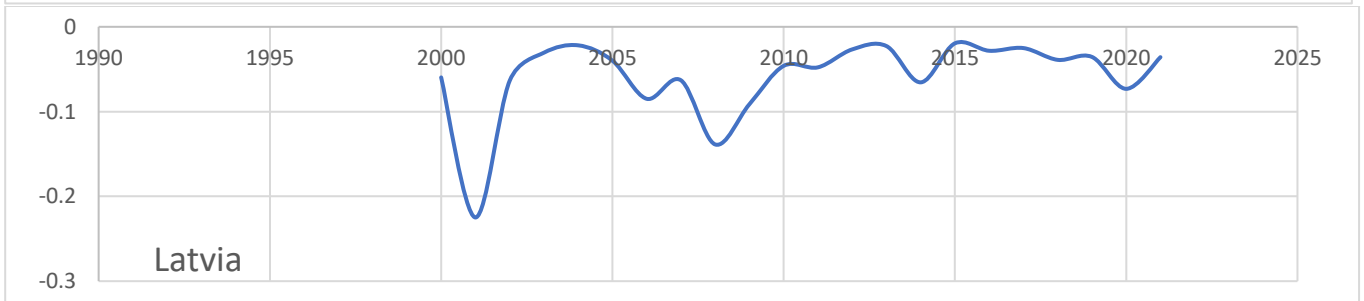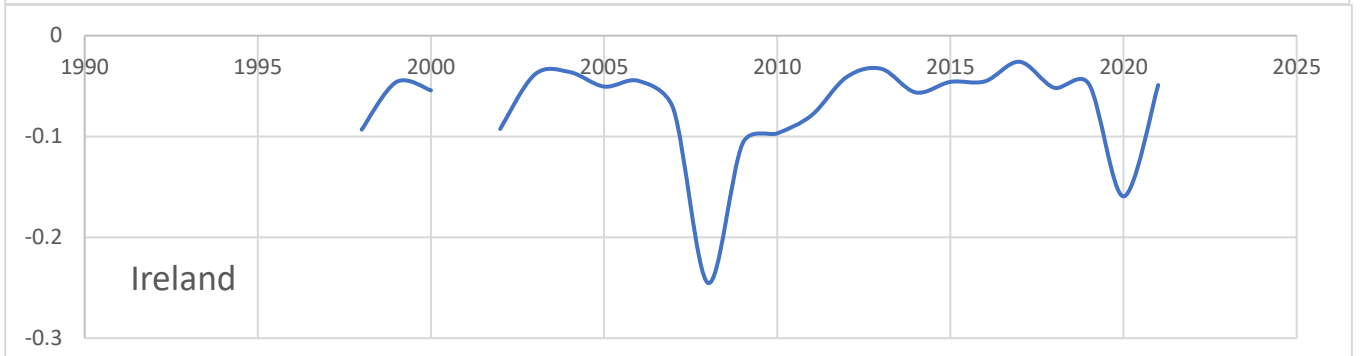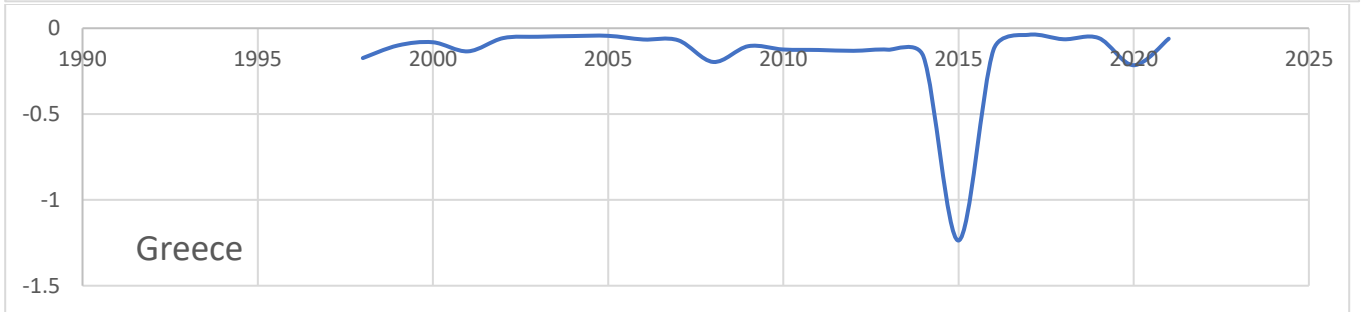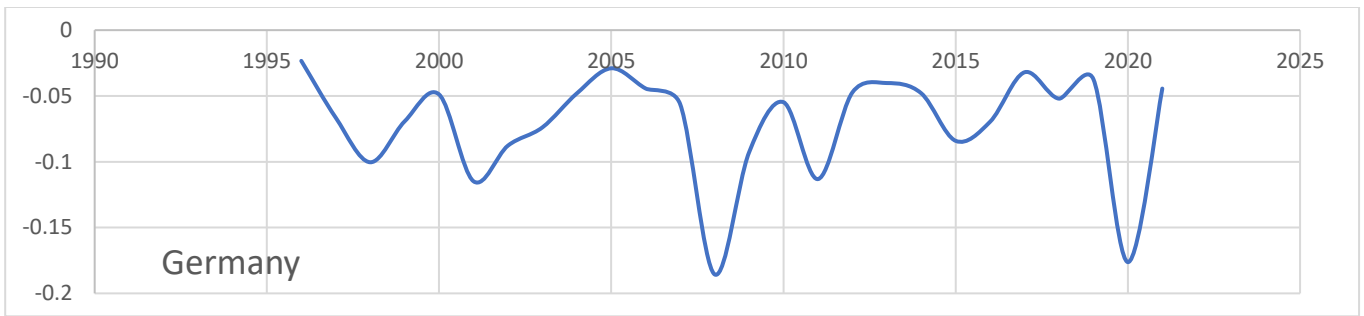**Source:** Authors' elaboration.

4. Results and Discussion

4.1 Value at Risk (VaR) estimation

The research paper presents Figure 1, displaying the annual VaR estimations of stock indices data for Euro Area countries over the last 26 years. This analytical exercise provides critical insights into the performance of Euro Area markets, estimating downside risk and demonstrating the extent of potential losses and risk levels during different market conditions. The findings depicted in Figure 1 can be particularly valuable for stakeholders in the stock market, guiding them in constructing well-informed portfolios, especially during periods of crisis.

Figure 1. Historical simulation Value at Risk (VaR) of Euro Area countries' stock indices.

Germany

Greece

Ireland

Latvia

Lithuania
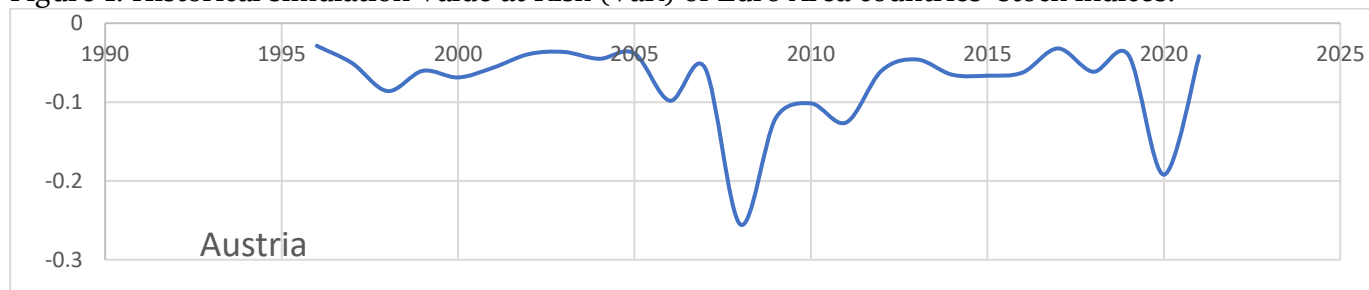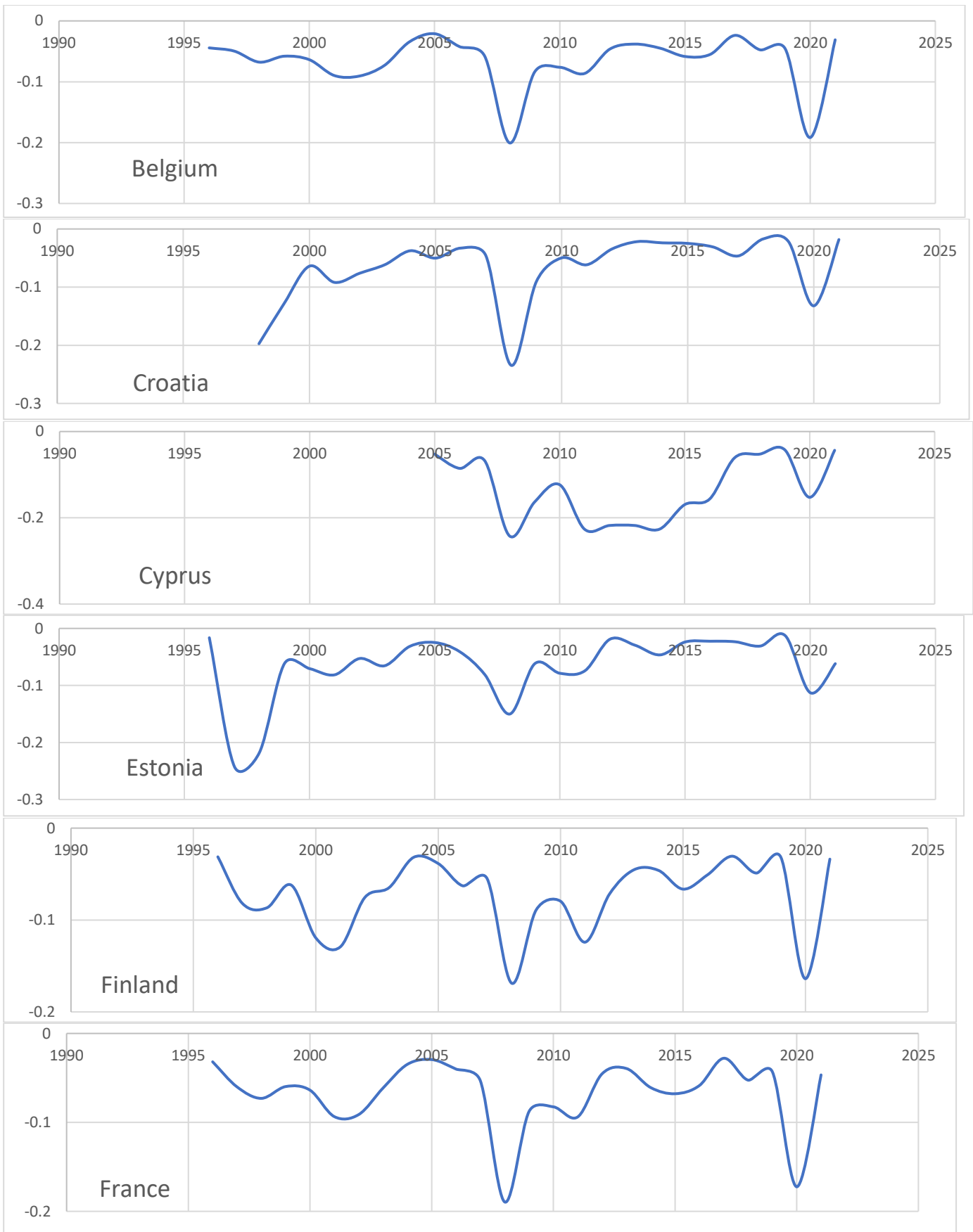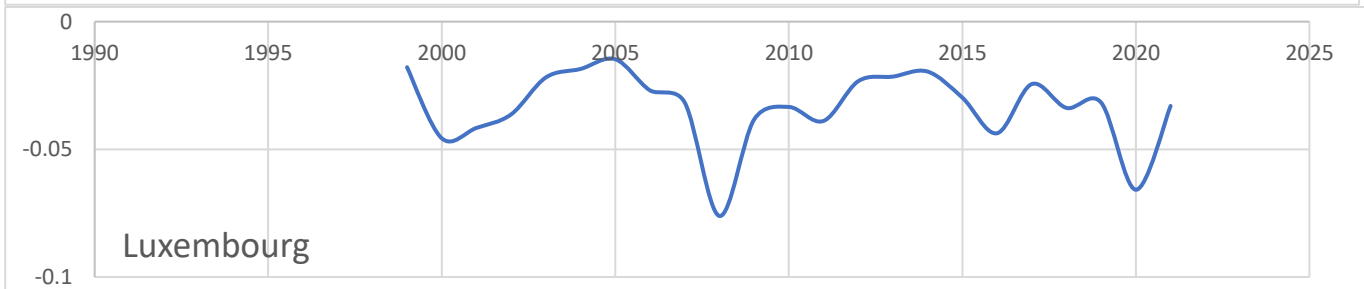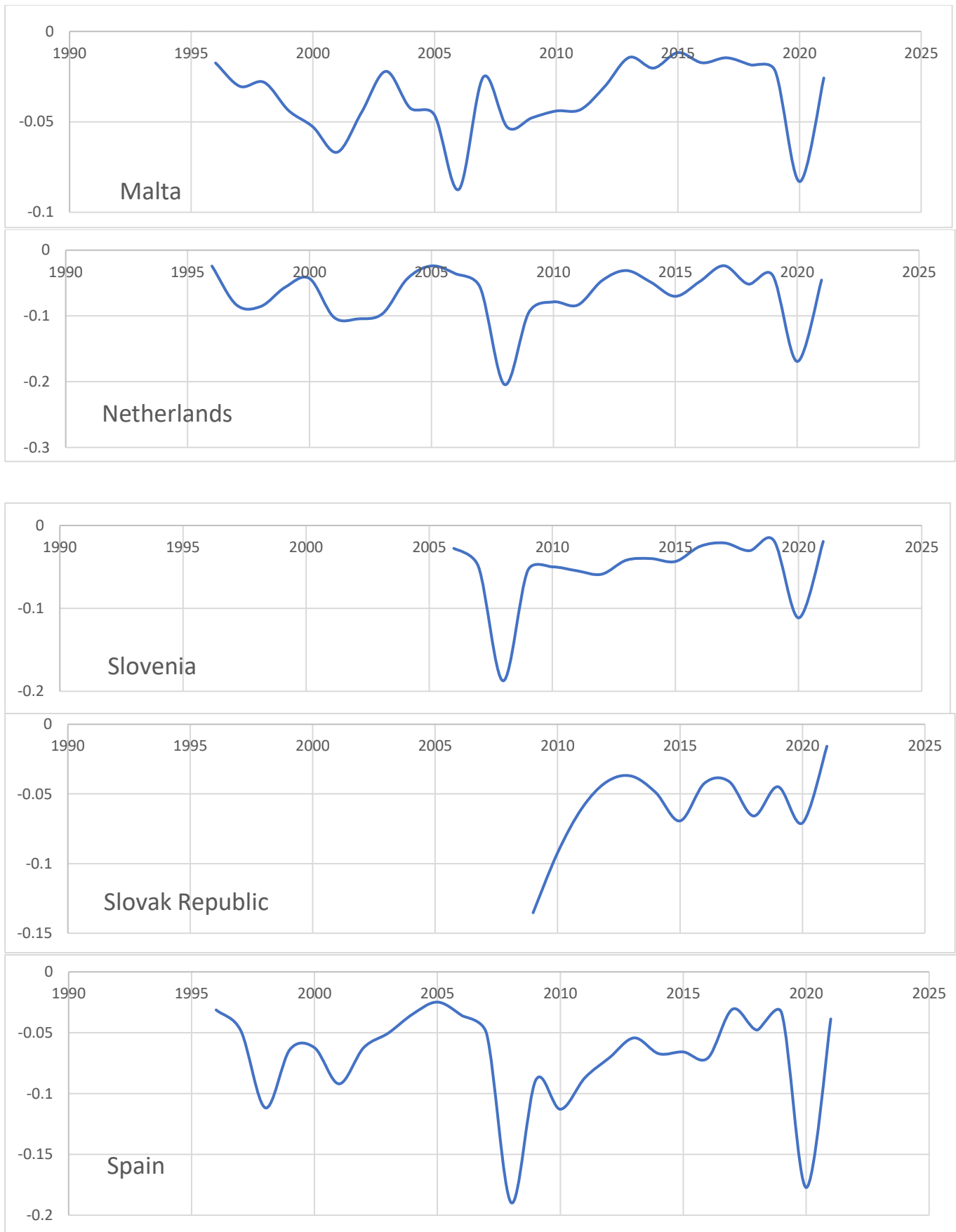
Luxembourg

Source: Author's own elaboration.

The analysis of Figure 1 highlights significant variations among Euro Area countries. Several countries, including Belgium, Croatia, Estonia, France, Greece, Ireland, Latvia, Lithuania, Luxembourg,

Malta, Netherlands, Slovakia, and Slovenia, consistently exhibit the lowest VaR estimates, indicating relatively lower downside risk. In contrast, Austria, Cyprus, Finland, Germany, Italy, Portugal, and Spain consistently show higher VaR estimates, signifying heightened downside risk, which may not align with the preferences of risk-averse investors.

During the Global Financial Crisis of 2008 and the ongoing COVID-19 pandemic, the majority of markets in the Euro Area experienced a significant decrease in value, with only a handful of markets remaining relatively unscathed. Therefore, investors who are risk-averse may consider investing in markets such as Croatia, Estonia, Greece, Latvia, Lithuania, Luxembourg, Malta, and Slovakia, as these markets have demonstrated comparatively low levels of downside volatility during times of crisis. Conversely, markets such as Austria, Belgium, Cyprus, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, Slovenia, and Spain have exhibited higher levels of downside deviation during crisis periods, and may therefore be less appealing to risk-averse investors.

During the examination of Value at Risk appraisals of Euro Area nations, it was discovered that Austria, Belgium, Estonia, Finland, France, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, and Slovenia had the smallest Value at Risk appraisals in the studied period. Consequently, risk averse investors would opt for these three markets in Euro Area nations. Meanwhile, Cyprus, Germany, and Spain persistently generate considerably high Value at Risk appraisals throughout the studied period, thereby rendering these countries unappealing to most investors.

In times of crisis, certain Euro Area nations exhibit lower levels of downside volatility than others. Croatia, Estonia, Greece, Latvia, Lithuania, Luxembourg, Malta, and Slovakia are among those that are seen to possess this characteristic, while Austria, Belgium, Cyprus, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal, Slovenia, and Spain display a higher degree of downside deviation. Policymakers can draw from these findings to aid in the formulation of monetary policy.

A recent time period has seen Austria, Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal, and Spain exposed to a high level of downside risk, and in light of the volatile financial market, they ought to contemplate macroeconomic policies similar to those of Croatia, Cyprus, Estonia, Greece, Latvia, Lithuania, Luxembourg, Malta, Slovakia, and Slovenia. Furthermore, these shareholders in the stock market should take into account those markets in Euro Area countries that have some degree of immunity to extreme events. Additionally, financial economics theory posits that Value at Risk (VaR) should mirror anticipations concerning a nation's future economic performance, which in turn reflects the degree of economic activity.

The research discovered that Value at Risk is a crucial tool for various stakeholders in the stock market. This model helps to evaluate potential downside losses and risk levels for individual markets, which is significant for prudent risk management and portfolio strategies. Moreover, it is currently the most widely utilized technique for financial risk management, particularly for mitigating downside risk among financial firms, non-financial organizations, and regulators. Investors have the potential to increase their risk-adjusted returns by diversifying their portfolio among Euro Area countries. It is evident from the data that some of these countries remain immune to crisis periods, offering advantageous implications for stock market stockholders. It is recommended that investors should incorporate this into their stock price behaviour model, but with caution when interpreting the results,

due to the occurrence of a few extreme events during the study. This, however, presents diversification opportunities for investors, although it should be noted that none of the markets in the Euro Area countries are completely resistant to extreme events. Nevertheless, it has been observed that a few instances of extreme events result in the co-movement of stock markets in Euro Area countries.

5. Contribution and Future Research Agenda

The research paper makes several significant contributions to the field of financial risk management and stock market analysis. The paper's primary focus is on analyzing and interpreting VaR estimates for stock indices data of Euro Area countries over the past 26 years. The following are the key contributions of the research paper:

The research paper contributes valuable insights into downside risk analysis in the Euro Area stock markets. By utilizing VaR as a quantitative measure, the paper provides a comprehensive understanding of potential losses and risk levels associated with individual markets during various market conditions, including normal periods and crisis periods.

The research paper identifies specific Euro Area countries that consistently exhibit low and high VaR estimates over the examined period. This categorization helps stakeholders, particularly risk-averse investors, to identify markets with relatively lower downside volatility during crisis periods and those that pose higher risks.

The paper's findings have significant implications for stakeholders in the stock market, including investors, financial analysts, policymakers, financial institutions, and regulators. The identified low downside volatility markets offer potential opportunities for constructing portfolios that can better withstand turbulent market conditions. Additionally, the paper highlights the importance of VaR as a crucial risk management technique in financial and non-financial organizations.

The paper's identification of countries with high downside risk during recent periods allows for specific policy recommendations. Policymakers can consider macroeconomic policies adopted by countries with low downside volatility during crisis periods, such as Croatia, Estonia, Greece, Latvia, Lithuania, Luxembourg, Malta, and Slovakia, to improve resilience against financial downturns.

Furthermore, the research paper on Value at Risk (VAR) estimations in Euro Area stock markets makes significant contributions to the field of financial risk management and stock market analysis.

6. Limitations of the study and scope for future research

While the research paper has provided valuable insights into the analysis of VAR estimates and its implications for stock market stakeholders in the Euro Area, there remain several areas for future research that can further enhance the understanding of risk management and portfolio strategies. The following future research agenda is proposed: The study ignored other important measures for downside risk and it is recommended for future researcher to use other downside risk measures. Moreover, to analyze the directional influence and interdependence among the Euro Area stock indices, the future researcher should perform econometric techniques. In addition to VaR, there are other risk metrics used in financial risk management, such as Beyond Value at Risk (CVaR), Downside Beta, and Tail Conditional Expectation (TCE). Comparative studies that assess the strengths and weaknesses of these risk metrics in the context of Euro Area stock markets can be a valuable future research direction. Also, the future research can explore the extent of international spillover effects between Euro Area countries and other global markets during crisis periods. Understanding the interconnectivity of

markets can aid in the development of more robust global risk management strategies.

7. Conclusion

This research paper's analysis of Value at Risk (VaR) estimations in Euro Area stock markets offers valuable insights into downside risk, diversification opportunities, and the most desirable markets with lower risk profiles. In conclusion, this research paper aimed to investigate and analyze the Value at Risk (VaR) estimates of Euro Area nations' stock indices over the last 26 years. The use of historical simulation method for VaR estimation provided valuable insights into the downside risk and potential losses associated with different Euro Area markets during normal and crisis periods. The findings from this study have several important implications for investors, policymakers, and financial market stakeholders. Firstly, the analysis of VaR estimations revealed significant variations among Euro Area countries in terms of downside risk. Certain countries consistently exhibited lower VaR estimates, indicating relatively lower downside volatility and potential losses. These markets, such as Croatia, Estonia, Greece, Latvia, Lithuania, Luxembourg, Malta, and Slovakia, may be more appealing to risk-averse investors looking for stability during adverse market conditions. On the other hand, countries like Austria, Cyprus, Finland, Germany, Italy, Portugal, and Spain consistently showed higher VaR estimates, suggesting heightened downside risk. While these markets may offer higher potential returns, they might not be suitable for risk-averse investors seeking more stable investments. Secondly, during crisis periods, some Euro Area nations demonstrated a lower level of downside volatility compared to others. The markets of Croatia, Estonia, Greece, Latvia, Lithuania, Luxembourg, Malta, and Slovakia showcased a higher level of resilience during turbulent times. In contrast, markets like Austria, Belgium, Cyprus, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, Slovenia, and Spain experienced higher downside deviation during crises. These findings provide valuable guidance for investors looking to construct diversified portfolios that can withstand adverse market conditions. By considering the VaR estimates and historical performance of different Euro Area markets, investors can make informed decisions to manage their downside risk effectively. Thirdly, policymakers can benefit from this research to formulate appropriate monetary policies during times of economic uncertainty and financial instability. Understanding the varying degrees of downside risk among Euro Area countries can help policymakers implement targeted measures to support financial markets and mitigate potential economic impacts during crisis periods. Finally, this research reaffirms the importance of Value at Risk (VaR) as a widely used and valuable risk management tool in the financial industry. Its simplicity and interpretability make it a preferred method for assessing downside risk, guiding decision-making processes for investors, fund managers, regulators, and other participants in the financial markets. In conclusion, this study contributes to the body of knowledge in finance and risk management, providing valuable insights into downside risk and the performance of Euro Area markets over a significant time frame

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