Downside Risk and VAR-Based optimal Portfolio Including Corporate Bonds and CDS

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Abstract

This study examines the risk management characteristics, to seek diversification and hedging benefits of investment portfolio for pair of 5-year industrial corporate bonds and CDS of same industry, different techniques; VaR Reduction, expected shortfall reduction, semi VaR Reduction and Regret Reduction is applied on 3 types of portfolio strategies, i.e. Risk minimization strategy portfolio (P2), Variance minimization portfolio strategy (P3), equally weighted Portfolio strategy (P4). The dataset used in this study comprises of daily closing quotations of 9 US industry's bond return indices and their analogous 5-year industry's CDS spread index. The industries included in the analysis are Energy, Industrials, Utility, Health, Telecommunications, Utilities, Banks, Information and Technology (Infotech) and Leisure. Thomson Reuters DataStream is the source for all data of markets. The results indicate that Risk reduction benefit is negative for all the industries for pair of their corporate bonds and respective CDS is negative for both P2 (Risk minimization portfolio) and P4 (equally weighted Portfolio), which makes them less attractive for portfolio diversification and unable to reduce downside risk for investment portfolios in which both of these pairs are included simultaneously.

Introduction

In this high-risk, unpredictable climate, to assess the downside risk/return profiles is the need of the era. Especially after the financial crunch of 2007/2008, the credit markets experienced a catastrophic financial crisis that concluded in the Great Recession, encouraging risk aversion and a preference for safe havens (Hammoudeh, et.al 2013). Despite the subsequent recovery, increased risk and uncertainty have perplexed investors, portfolio managers, and policymakers. In such a context, it will be helpful and useful to investigate credit tools' behaviors that are marked by extreme occurrences and such as the 2007/2008 financial crisis, which touched almost all credit markets. Bur after the financial crunch credit default swaps went through the harsh criticism for the role they played in creating abnormal leverage in the U.S credit market (Panda, A., & Deb, S. G. 2024).

Credit derivative like CDS which are considered safe havens and securities against risk, have seen tremendous price and return rises in recent decades. This has increased the potential downside risk and exposed them to black swan events. Value-at-Risk (VaR) can be a robust measure for examining investment-related market downside risk.The risks of the benchmark portfolio including both 5 year industrial CDS and corporate bonds and three mixed asset portfolios (II, III, and IV) can be compared, to measure the down side risk and the portfolio maximization benefits get by the investors by including both industrial corporate bonds and their

respective derivative tools (CDS) together. Value at Risk, or VaR reduction portfolio, calculates the likelihood of underperformance or downside risk (Glasserman, et.al 2000).

Literature Review

The need for widely utilizing VAR models to manage downside risk on the part of investors and fund managers. This scenario also rise point the need for more research to be conducted in order to develop more effective risk management strategies for downside risk measurement, especially considering their intricate structure and asymmetric return distributions (Panda, A., & Deb, S. G. 2024). Values at Risk (VaR) assessments are computed for important insights into market performance and risk levels in both regular and crisis situations. The historical simulation approach's non-parametric character is used because it can handle data with non-normal distributions with flexibility, which makes it appropriate for this investigation (Ghulam, Y. A., & Joo, B. A. 2023). Strong intra-class connectivity clusters and time-varying trends to highlight excessive risk spillovers during crisis situations can be found in the financial markets.

Several recommendations made for politicians, investors, and everyone involved in the financial system by using VAR methods to calculate downside risk (Naeem, et.al 2023). A large time variation in CDS spreads and systemic risk depending on the time-series variation in CDS spreads can be noticed (Wang, X. & Zhao, S. 2023). The most popular kind of credit derivative is called a credit default swap (CDS) and after the global financial crisis 2007-2008, it really important to measure and keep on examining the downside risk faced by this derivative market (Bomfim, A. N. 2023). Credit default swaps (CDS), the most hotly debated derivatives instrument since the global credit crunch of 2007-2008, can still be considered the topic of much theoretical and practical discussion. More than a decade after significant advances in CDS literature, insights for usage of CDS to manage and hedge downside credit risk can still be added to the literature; (Tabassum, & Yameen, M. 2024).

Methodology;

Risk Minimized Portfolio

First, in accordance with Kroner and Ng (1998), a risk-minimizing Portfolio (II) (such as industrial corporate bonds and respective CDS) is created without lowering the predicted returns. The ideal weights are provided as follows:

$$Wt^{AA} = \frac{h_t^s - h_t^{AAs}}{h_t^c - 2h_t^{AAs} + h_t^s}, \text{ with } Wt^{AA} = \begin{cases} 0 & Wt^{AA} < 0 \\ Wt^{AA} & 0 \leq Wt^{AA} \leq 1 \\ 1 & Wt^{AA} > 1 \end{cases}$$

The conditional covariance between the industrial corporate bonds return index and respective CDS return index at time t is denoted as $ht\mathfrak{f}^s$, the conditional volatility of an corporate bond return index by $ht^{\perp}$, and the conditional volatility of a CDS return index by ht^s. Rolling window analysis yields the optimal weight of the corporate bond (1 - Wt^{AA}) and, for each pair, the information on wt, or the one-step-ahead rolling conditional correlation between the corporate bond return index and the CDS return index derived from models. The rolling window size is the same as it was in the preceding section when the hedged portfolio was built.

Variance Minimized Portfolio

Second, the variance-minimizing technique is used in Portfolio III to establish the weights. For example, a long position in the 5 year industrial corporate bond and a short position in respective CDS are given as:

$$\beta t = \frac{h_t^{AAs}}{h_t^{AA}}$$

Equally Weighted Portfolio

Lastly, Portfolio IV is thought to be comparable to that of DeMiguel et al. (2009) since it consists of equal weights of a 5 year industrial corporate bond and respective CDS (2009). Given that these portfolios do well outside of the sample. This suggests that the corporate bonds and each of the CDS have an equal share of the wealth.

Risk and Downside Risk Measures

The performance of optimal portfolios is also compared using various risk and downside risk measures in the aftermath of Reboredo (2013), Hammoudeh et al. (2014), Chkili (2016), and Harrathi et al. (2016).

Risk Reduction Effectiveness

By comparing the percentage decrease in the multi-asset portfolio's variance to that of the benchmark Portfolio I, the only stock portfolio, one may determine the risk-reduction effectiveness (RE) of a multi-asset portfolio Pj:

$$REvar = 1 - \frac{Var\ (Pj)}{Var\ (PI)}$$

where Pj stands for the three distinct portfolios (II, III, and IV), and $Var(Pj)$ and $Var(PU)$ represent the variance of Portfolio I and the jth multi asset portfolio, respectively. A greater value denotes a higher variance reduction. The VdV values are between 0 and 1. Using various analytical risk measures, including value-at-risk, VaR reduction, Expected Shortfall (ES), semi-variance, and regret reduction, the portfolio diversification effects of REITs, 5 year industrial corporate bond return index, and respective industrial CDS return index are investigated using the one step-ahead rolling conditional correlation and volatilities.

Value-at-Risk Reduction Effectiveness

Using several analytical measures including Value-at-risk reduction, expected shortfall, semi-variance, and regret reduction, the portfolio diversification benefits of including both 5 year industrial corporate bond return and CDS return, and VIX are investigated using the one step-ahead rolling conditional correlations and volatilities. With an expected return of Rt on a given portfolio, the VaR gives information on the maximum loss in the portfolio at a given time t with a confidence level of 1-p. In other words,

Pr $(Rt \leq VaRt|\psi t-1)$ = p

But the VaR of a certain portfolio can be calculated as follows:

$VaRt\ (p)$ = $\mu t - t_v^{-1}\ (p)\ \sqrt{ht}$

Where the pth quartile of the t-distribution, the v degrees of freedom, the conditional mean, and the standard deviation of a given asset are represented by the symbols μt and $\sqrt{ht}$, respectively.

Expected Shortfall

Additionally, the expected short fall (ES), which represents the predicted magnitude of loss due to exceeding VaR, is defined as follows:

$$ES = E \, (Rt|Rt < VaRt \, (p) \,)$$

Semi Variance

In contrast to the variance measure, which assigns equal weights to positive and negative returns, the semivariance (SV) technique measures the variability of returns that fall below a particular threshold.

$$SV = E[\min \{0, Rt - E(Rt)\}]2$$

Regret Reduction Effectiveness

Lastly, the regret reduction (Re) yields the following values of expected returns that are below zero:

$$= -E[min\{0,Rt\}]$$

Results

The correlation between 5-year industry wise corporate bonds and CDS returns is positive for majority of under consideration industries (i.e. Banking, Utility, Telecom, Real-estate, Infotech, Industrial, Health and Energy) with an exception of Leisure Industry which stands negative with value of -0.0361. While the positive correlation of industries ranges from 0.0021 to 0.0241. The reflective influence of correlation patterns of risk and returns magnitudes, and consequently of asset allocation and diversification strategies, is supported by contemporary financial theories such as the Capital Asset Pricing Model (CAPM) and the Arbitrage-Pricing Theory (APT) (Linter, 1965; Ross, 1976; Sharpe, 1964). In order to reduce portfolio risks through diversification, it is generally considered that the returns of various assets should have the lowest correlation coefficient. The degree of correlation among the identified assets is correlated with the positive returns from an international portfolio. Investors are therefore urged to understand and notice the potential correlations and linkages among worldwide financial markets in order to develop the most advantageous portfolios (Bessler & Yang, 2003; Forbes & Rigobon, 2001; Forbes & Rigobon, 2002; Kiviaho et al., 2014).

In the findings of this study, the correlation stays strongest for pairs of corporate bonds and respective CDS for Infotech industry with a value of 0.0241. These positive correlations between corporate bonds and CDS can be comprehend that any positive shock in one of the credit instrument has a positive influence on the other, whereas any negative shock has a negative impact on the other. The low impact intensity is indicated by the smaller value in the number. All these industries which stemmed positive correlation among bonds and their respective CDS shows that a rise in the bonds index will also upsurge the CDS index which is favorable that CDS being the derivative instrument should behave according to the prevailing credit risk in the market to avoid any sort of financial or credit crunch in the market. In addition to this in case of investment portfolios that include both corporate bonds and CDS of same industry will make them more risky. So for the investors of these industries addition of corporate bonds and their respective CDS is not viable option for diversification, hence they need to look for other options

for diversification or to safeguard the risk of any respective industry. So it can be concluded that the relationship between the corporate bonds and their respective CDS are industry specific. And the week relationship for Banking, Utility, Telecom, Health and Energy shows that they are not strongly affected by each other. While the negative relationship for Leisure industry shows that benefit of hedging and diversification of investment portfolio can be gained in this industry and the pair is more durable for negative shocks of economy because of their negative correlation.

Value at Risk, or VaR reduction portfolio, calculates the likelihood of underperformance or downside risk. A statistical analysis of the downside risk is calculated. It also confidently at certain level displays the extreme possible losses that can be incurred on any portfolio over a specific period of time. To examine the risk management characteristics, to seek diversification and hedging benefits of investment portfolio for pair of corporate bonds and CDS of same industry, different techniques; VAR Reduction, Expected shortfall reduction, semi VAR Reduction and Regret Reduction is applied on 3 types of portfolio strategies, i.e. Risk minimization strategy portfolio (P2), Variance minimization portfolio strategy (P3), equally weighted Portfolio strategy (P4). The results indicate that Risk reduction benefit is negative for all the industries for pair of their corporate bonds and respective CDS is negative for both P2 (Risk minimization portfolio) and P4 (equally weighted Portfolio), which makes them less attractive for portfolio diversification and unable to reduce downside risk for investment portfolios in which both of these pairs are included simultaneously. While on the other hand P3 (Variance minimize portfolio) its positive but with a lesser numeric value, making it a better choice for safe guard against downside risk.

Conversely, in case of VAR reduction a similar trend is observed by the pair of industry corporate bonds and their respective CDS for   Risk minimization strategy portfolio (P2) and equally weighted Portfolio strategy (P4). Which renders them less desirable for diversifying investment portfolios and incapable of lowering downside risk for portfolios that contain both of these pairs at the same time. On the other hand, P3 (Variance minimize portfolio) is following the similar positive value but numerically it's too low to cater the shield against down side risk and can't give good VAR Reduction benefits to an investment portfolio when added in the portfolio together.

In contrast, expected shortfall (ES) reduction exhibits different pattern in values as compare to RR and VAR reduction, its positive with notably huge numeric values (which make them even better option) for Risk minimization strategy portfolio (P2) of all industry, making it a good option for weaving off downside risk and reducing expected shortfall risk. On the other hand for the Semi-Variance (SV) reduction and the regret reduction (RR) results are industries specific and show mix results with positive and negative coefficient. In the regret reduction Risk minimization strategy portfolio (P2) coefficient is positive for utility, Telecom, Health and Energy Industries, showing risk reduction benefits can be attained when pair of these industry's corporate bonds and CDS are added in the risk minimizing investment portfolio together. Conversely, for equally weighted Portfolio (P4) all the values stay negative other than Energy Industry, making it not suitable against downside Risk of the portfolio. While five out of nine risk reduction measures of semi VAR are negative for P2. The data's overall findings indicate that,

when utilized for investing, both are vulnerable and exposed to shocks and down side risk. It is not practical to diversify an investment portfolio and to create a safeguard against downside credit risk by adding both 5-year industry wise corporate bonds and their respective CDS simultaneously to the portfolio, but some exceptional cases are seen in the case of expected shortfall reduction of a portfolio.

Table 1 Risk Reduction Measures

Industry	Bank	utility	Telecom	Real Estate
Correlation	0.002	0.004	-0.003	-0.015
Portfolio 2 weights - DCC	0.0677	0.02497	0.064021	0.14141
Portfolio 3 weights - DCC	-0.0001	-0.0001	-0.0001	-0.001
RR P2	-0.7425	-0.91616	-0.74689	-0.4521
RR P3	0.0001	0.001	0.0004	0.0004
RR P4	-46.6919	-383.01691	-52.7479	-8.4225
VAR Reduction P2	-0.2205	-0.36349	-0.29148	-0.1674
VAR Reduction P3	0.0003	0.0001	0.0002	0.0002
VAR Reduction P4	-5.1674	-18.26311	-6.11047	-1.9476
ES Reduction P2	3.2683	1.7758	1.4434	1.6083
ES Reduction P3	0.0001	0.001	0.0001	0.0001
ES Reduction P4	-2.2429	0.2016	-3.7151	-1.0243
Semi VAR Reduction P2	-0.0681	0.0176	-0.3354	-0.0651
Semi VAR Reduction P3	0.0001	0.0001	0.0001	0.0001
Semi VAR Reduction P4	-3.9654	-3.74981	-7.0677	-1.6744
Regret reduction P2	0.0030	0.03686	-0.04146	-0.01072
Regret reduction P3	0.0002	0.0001	0.0001	0.0001
Regret reduction P4	-2.2171	-0.68334	-1.84976	-0.6848

Industry	Leisure	Infotech	Industrial	Health	Energy
Correlation	-0.036	0.024	0.017	-0.0063	-0.007
Portfolio 2 weights - DCC	0.0983	0.0216	0.0389	0.0502	0.0679
Portfolio 3 weights - DCC	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
RR P2	-0.5679	-0.9653	-0.8827	-0.7948	-0.7247
RR P3	0.0004	0.000246793	0.0003	0.0004	0.0004
RR P4	-20.1332	-513.9403	-153.2369	-88.8432	-46.2507

VAR Reduction P2	-0.2294	-0.3704	-0.3413	-0.3008	-0.1715
VAR Reduction P3	0.0002	0.0002	0.0002	0.0002	0.0001
VAR Reduction P4	-3.4962	-21.0269	-11.0595	-8.1098	-4.8394
ES Reduction P2	1.1365	1.6518	1.2633	1.6132	1.8788
ES Reduction P3	0.0001	-0.0001	0.0001	0.0001	0.0003
ES Reduction P4	-3.1283	-8.5914	-7.3553	-1.8345	1
Semi VAR Reduction P2	-0.2031	-0.1515	-0.2378	-0.0757	0.2033
Semi VAR Reduction P3	0.0001	-0.0004	0.0001	0.0001	0.0002
Semi VAR Reduction P4	-3.5032	-13.7265	-9.4843	-4.4923	0.6598
Regret reduction P2	-0.10413	-0.0604	-0.0893	0.0196	0.2786
Regret reduction P3	0.0001	0.0002	0.0001	0.0001	0.0004
Regret reduction P4	-1.6256	-3.96047	-2.6718	-1.3382	0.7398

Conclusion

The correlation between 5-year industry wise corporate bonds and CDS returns is positive for majority of under consideration industries (i.e. Banking, Utility, Telecom, Real-estate, Infotech, Industrial, Health and Energy) with an exception of Leisure Industry. These positive correlations between corporate bonds and CDS can be comprehend that any positive shock in one of the credit instrument has a positive influence on the other, whereas any negative shock has a negative impact on the other. The low impact intensity is indicated by the smaller value in the number. In order to reduce portfolio risks through diversification, it is generally considered that the returns of various assets should have the lowest correlation coefficient (Bessler & Yang, 2003). In addition to this in case of investment portfolios that include both corporate bonds and CDS of same industry will make them more risky. So for the investors of these industries addition of corporate bonds and their respective CDS is not viable option for diversification, hence they need to look for other options for diversification or to safeguard the risk of any respective industry. So it can be concluded that the relationship between the corporate bonds and their respective CDS are industry specific.

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