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Comparative Analysis of Government Bonds of Emerging vs Developed Economies: Monte Carlo VaR

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ABSTRACT

This paper aims at providing a thorough comparative analysis of government bonds of emerging and developed economies. Government bonds are crucial when it comes to providing citizens a relatively risk free and stable investment opportunity and for funding government projects undertaken for the nation's benefits. VAR Monte Carlo simulation has been utilized to compare the risk aspect of the government securities of emerging and developed economies. Multi-regression has been performed to back the VAR results. Moreover, the literature review synthesizes the existing research on the intricacies of the government bonds in both types of economies.

Keywords: Government bonds; Value at risk; Bond Yield Analysis; Macroeconomic Impact.

1. Introduction

Global financial markets have seen tremendous growth and witnessed various changes over recent decades, and this research paper aims at uncovering the growth and changes particularly in the bond markets of emerging and developed economies. With the growing integration of markets worldwide, understanding the dynamics of various bond yields is vital for investors, policymakers as well as researchers. Bond yields represent a blend of economic elements that significantly influence a nation's financial well-being and its appeal to different investors. This study intends to perform a comparative analysis of bond yield factors in an emerging economy, namely India, and a developed economy, the United States, focusing on bonds with a three-year maturity. This research paper aims to reveal the intricacies in bond yield behaviours by analysing macroeconomic factors like real interest rates, inflation, and GDP growth in two different economic environments.

Because of their reliability and consistent interest payments, bonds are a popular investment. Because they frequently do well during market downturns, they provide a lower-risk option to stocks and aid in portfolio diversification. Optimising investing strategies across various economic environments requires an understanding of how variables such as inflation, interest rates, and economic growth affect bond yields.

The Indian financial system is changing fast, marked by strong economic growth, more robust markets, and considerably greater efficiency. But to add to its world-class equity markets, and growing banking sector, the country needs to improve its bond markets. While the government and corporate bond markets have grown in size, they remain illiquid. The corporate market, in addition, restricts participants and is largely arbitrage-driven. (WELLS; SCHOU-ZIBELL, 2008)

Regression analysis and VAR modelling are also used in our analysis. The VAR method highlights the disparity in risk sensitivity to macroeconomic conditions between the US and India by quantifying the possible losses in bond yield for a specific confidence level. We have further employed regression analysis to supplement our study in order to verify the robustness of the VAR results and ascertain the distinct impacts of the three independent variables—real interest rate, inflation, and GDP growth rate—on bond yields. When combined, these two methods seek to provide a more complete and in-depth knowledge of the variables affecting bond yield in many economic contexts.

In order to determine how India and the US vary in terms of bond yield sensitivity and risk, this study will examine these correlations. Our results are meant to contribute to the literature on emerging vs developed economies and to give stakeholders insights on managing bond portfolio risks in the face of shifting macroeconomic conditions. For investors, financial analysts, and legislators looking to maximise bond investment methods and reduce risk in a variety of economic contexts, this paper is pertinent.

2. Literature Review

Government bonds have emerged to be a prominent debt-based investment for the public and even corporates. It is safe to say that these debt instruments play a key role in national economies for both governments and individuals as they directly facilitate money supply, fund government operations, provide a stable investment opportunity and are an additional source of income for many. The comparison of government securities from emerging and established economies is vital for highlighting differences in the risk levels, arriving at conclusions about the stability of said economies and to identify the growth potential between nations at various development stages. The primary objective of this literature review is to examine and synthesize the existing research on government bonds from both emerging and developed economies by focusing on aspects such as the macroeconomic factors influencing bond markets, risk assessment and credit ratings, investor performance and behavior and technological changes in the bond market.

2.1 Macroeconomic factors influencing the bond market:

Macroeconomic factors have a significant impact on the overall workings of the bond market with the key determinants being interest rates, inflation and GDP. *(NYAKERI, 2012)* talks about the negative relationship of interest rates with the yields of bonds by taking the Nairobi Securities Exchange as the sample for his study. As interest rates rise, bond yields fall and vice versa. The economic condition and environment including the inflation rate and ongoing monetary policy of a nation play a critical role in the formation of the interest rate-bond yield dynamic *(DARSONO et al., 2024)* and these are generally affected by central bank decisions. Although the final impact of interest rate changes remains unchanged, the degree by which emerging and developed nations are affected may be different due to various factors ranging from market sensitivity to independence of monetary policy. Inflation has almost always led to an increase in bond yields given that investors demand for compensation for decreased purchasing power *(KOROLEVA; KOPEYKIN, 2022).* This becomes very relevant for emerging economies that have higher inflation rates in general. Changes in inflation expectations leads to increased volatility as investors reassess their strategies based on anticipated future economic conditions. Studies in Nigeria and Africa show that high inflation may have an undesirable impact on bond market capitalization *(AHWIRENG-OBENG; AHWIRENG-OBENG, 2020).* GDP growth majorly influences bond yields and there are findings that suggest that rapid growth may lead to higher yields due to inflationary pressures.*(MAHIRUN; FUADAH; JANNATI, 2024)*.

2.2 Risk assessment and credit ratings:

Credit ratings have contrasting differences in the government bonds of emerging economies vis-à-vis developed economies. In emerging economies, the ratings given to government bonds often serve as a ceiling to other bonds issued in the country which implies that if a state/city or a company is relatively stable both financially and economically, they won't get a credit rating higher than that of the government *(MOHAPATRA; NOSE; RATHA, 2016)*. This essentially means that if a government bond is risky in nature, all the other bonds in that country (sub sovereign bonds) are automatically considered to be risky as well. If the rating of a government bond improves or worsens, the sub sovereign bonds follow the same direction. Ideally if a government bond has a higher credit rating its yield would be lower given that it's a safer bet. However in the case of developed economies, this does not hold true entirely and the dynamics at play are much more complex. Prevailing interest rates, market sentiments and investor expectations may not change the bond yields at all or in some cases cause them to increase *(SZULC; WLEKLIŃSKA, 2019)*. This clearly highlights the asymmetric relationship exhibited.

2.3 Investor performance and behavior:

Investor behavior is one aspect that can make or break the fate of not just government bond performance but also the global capital markets and the world economy. In developed economies domestic banks are some of the biggest investors in government bonds and since they are so heavily involved their capacity of lending to the private sector decreases leading to tighter credit policies *(ADAMANTI; SAFUAN; HUSODO, 2022)*. Emerging markets are often viewed to be lands of opportunities and thus the amount of foreign investment in government bonds is quite significant. The high foreign involvement in government bonds in developing markets leads to lower bond yields but causes a rise in volatility and this complicates the overall management of the fiscal policy of such economies. There are several behavioral factors that can affect bond yield spreads. During the European sovereign debt crisis there was a lot of investor fear and negativity about the GIIPS region which include the countries of Greece, Italy, Ireland, Poland and Spain led to higher yields which implied higher borrowing costs for governments (XIAO, [s.d.]). In times of crisis, negative sentiments can push bond yields up.

2.4 Technological Changes:

The bond market has witnessed a decent amount of innovation and new ideas both financially as well as technologically. There has been a drastic increase in the adoption of electronic platforms for the purpose of buying and selling both equity as well as debt securities and this has streamlined the entire trading process by lowering costs and increasing transaction speed. Algorithmic trading has also picked up well although there are still some concerns about market fragmentation and cybersecurity*(CHEE HONG, [s.d.])*. The introduction of cryptocurrencies and AI in the financial markets could potentially destabilize traditional bond markets and there may be a necessity for more regulatory frameworks to tackle the same *(KREGEL; SAVONA, 2020)*.

3. Research Objective

The primary objective of this research is to conduct a comparative analysis of bonds in emerging and developer economies, with a specific focus on analyzing and contrasting the risk profiles and influencing macroeconomic factors of bond yields across different maturities. The study aims to:

1. Assess and compare the risk associated with 1, 5, 10-year government bond yields in both the emerging market (India) and developed market (United States) using value at Risk (VaR) through Monte Carlo Simulation.
2. Using multiple regression analysis, examine the long-term effects of important macroeconomic factors-inflation, GDP growth rate, and real interest rate on the yields on 10-year government bonds in both economies.

3. Determine the main distinctions and trends between developing and developed countries in terms of bond yield volatility and macroeconomic influence.

4. Research Methodology

1. Data Collection:

- Obtained historical Bond yields data (1, 5, 10-year maturities) from the investing.com and macroeconomic variables data (inflation, GDP Growth rate and Real Interest rates) from World Data Bank.

2. Value at Risk (VaR) Analysis Using Monte Carlo Simulation:

- Performed monte Carlo simulation across all three maturities for both the economies and compared the risk levels, exposure and stability.

3. Multiple Regression Analysis:

- Conducted multiple regression on 10-year yields to evaluate the impact of inflation, GDP Growth rate and Real Interest Rates on both the economies.

4. Comparative Analysis:

- Integrate findings from the VaR and regression analyses to provide a comprehensive comparison of risk and economic influence on bond yields between emerging and developed markets.

5. Data Analysis and Results

5.1 Monte Carlo VaR- Interpretation & analysis:

This analysis focuses and evaluates the downside risks of two government bond markets, the Indian and the US and compares them with different economic conditions to demonstrate how these factors affect volatility and potential losses. Therefore, employing the Monte Carlo VaR analysis, we are able to assess the various risk characteristics in developed (US markets) and emerging (Indian markets). It shows how risk characteristics of bonds are influenced by factors such as inflation, policy stability and investor confidence.

Standard Deviation (Volatility) Analysis - US 10-year bonds are much more volatile than 10-year bonds in India as they are highly sensitive to long-term economic developments such as inflation and central bank policy. Indian bonds have lower volatility over maturities, so inflation pressure might already be built into long-term yields. This contrast illustrates the different risk dynamics, with US bonds becoming more sensitive over longer terms.

Monte Carlo VaR Interpretation – The values for Monte Carlo Value at Risk in figure (0.0) are subject to a change in the range of approximately ₹500 due to the excel function “Rand()” function that has been used for the purpose of the analysis.

In line with the riskier nature of emerging markets, Indian bonds show higher VaR values across all maturities, indicating a larger potential downside at a 95% confidence level. In the 10 year bonds, the difference is especially noticeable, as India’s higher VaR indicates increased sensitivity and a higher chance of loss. On the other hand, despite their higher volatility, US 10 year bonds have a comparatively low VaR, which indicates that investors have faith in the US government’s ability to preserve economic stability. Compared to US bonds, the higher VaR for Indian bonds has led to an increase in their future expectations of returns.

Government Bonds	Standard Deviation (Volatility)	Monte Carlo VaR
US (1 year)	0.65%	₹2,861
US (5 year)	0.83%	₹11,116
US (10 year)	2.98%	₹3,508
India (1 year)	0.65%	₹4,496
India (5 year)	0.83%	₹18,704
India (10 year)	0.58%	₹86,075

Table 1: VaR summary table

Overall, the analysis results derived from Monte Carlo VaR exhibit how the risk-return profile of developed (US) and emerging (India) government bonds differ. The higher yields and VaR of bonds issued in India reflect the characteristics of an emerging market, where more returns are expected for undertaking greater amounts of risk. US bonds on the other hand, offered lower yields but presented more stability. Higher VaR in Indian bonds; especially at long-term maturities, exhibits higher risk that is seen in the emerging markets due to factors like inflation risk, currency fluctuations and frequent policy changes. The lower VaR observed in US bonds points towards investors being more likely to invest in the country's long term economic stability despite the existence of long term volatilities. Hence, investors are likely more comfortable with the idea of government backed US bonds as compared to the Indian bonds, which reduces perceived risk.

Relationship between VaR and Standard Deviation:

It is observed that the there is higher VaR for India's 10-Year bonds despite a lower standard deviation.

Compared to US bonds, Indian bonds have higher expected returns, especially for longer maturities, which is associated with a higher potential for monetary decline. The risk of emerging markets is reflected in the VaR, which is amplified by the larger initial yield. Because of uncertainties like inflation, currency volatility, and policy changes, investors in India demand a significant risk premium, which raises the potential losses and VaR. On the other hand, despite greater daily volatility, US bonds, which are thought to be more stable, limit the possible downside, particularly in the long run. A higher VaR for Indian bonds is a result of the Monte Carlo simulation's ability to capture extreme scenarios, such as abrupt economic shocks. Moreover, India's higher yield and risk premium over the long run translate into a higher VaR, reflecting the higher downside risks in emerging markets relative to the stability of developed markets like the US, even though US bonds exhibit somewhat higher volatility.

5.2 Multi Regression- Interpretation:

To investigate why the Value at Risk (VaR) of Indian 10-year government bonds is higher than that of U.S. bonds, a multiple linear regression analysis was performed to understand the relationship between bond yields and other important macroeconomic factors, by taking bond yields as the dependent variable and key macroeconomic indicators like GDP growth rate, real interest rates and inflation as the three independent variables.

India 10-Year Bond Yield Regression Results

Regression analysis of 10-year India bond yields reveals that there is Statistically significant correlation with macroeconomic variables and multiple R of 0.853 show positive significant relationship between the independent variables and 10 year Indian bond yields. In addition, an R Square of 0.728 means

that 72.8% of bond yields can be accounted for by the model, which is reasonably high. The most significant determinant is real interest rates with a coefficient of 21.71% meaning a 1% increase in real interest rates brings a 21.71% rise in the bond yields (p = 0.018). Furthermore, GDP growth has a positive effect on bond yields (coefficient 0.112, p = 0.026) while inflation has a comparative smaller impact (coefficient 0.318, p = 0.067).

When it comes to VaR analysis, country specific factors such as; Gross Domestic Product (GDP) growth, inflation rates and real interest rates affect the yield volatility of bonds. High GDP increases bond yield risk by anticipating tighter monetary policies and inflation thus raising the VaR. Inflation has a relatively weaker influence on yield volatility (coefficient 0.318, p = 0.067), but when expressed in concert with other variables, it has a moderate effect. The coefficients of real interest rates are the highest (21.71, p = 0.018) explaining high yields and volatility during the high VaR throughout the rising rates. Overall, the regression analysis confirms that higher GDP growth and real interest rates correspond to greater bond yield volatility and risk, with inflation playing a secondary role.

US 10-Year Bond Yield Regression Results

A multiple R of 0.989 indicates an excellent positive correlation between the yields on 10-year U.S. bonds and macroeconomic factors, according to the regression analysis. The model explains 97.8% of the variation in bond yields, according to the R Square of 0.978. With a coefficient of 1.532, real interest rates have the greater effect, meaning a 1% increase in real interest rates results in a 1.532% increase in bond yields (p = 7.16E-06). With coefficients of 0.025 (p = 0.364) and 0.050 (p = 0.128), respectively, inflation and GDP growth have less of an impact, but they are not statistically significant at the 5% level.

Real interest rates have the biggest effect on bond yield volatility when it comes to VaR analysis. Rising interest rates increase both yields and volatility, which is directly correlated with higher VaR values. Even though they are less significant, inflation and GDP growth can have an indirect impact on bond yield risk by raising VaR through expectations of future policy changes. Overall, the regression model demonstrates that real interest rates are the primary driver of the increase in bond yield volatility and risk, with inflation and GDP growth having less of an impact.

All things considered, the US enjoys the advantages of a steady economy, predictable monetary policy, and high liquidity, which reduces bond yield risk and volatility. Greater yield fluctuations and a higher VaR are caused by India's lower market liquidity, higher inflation volatility, and macroeconomic instability. Ultimately, risk is lower in the US's developed markets than in India's developing market conditions.

6. Conclusion

In conclusion, the varying risk-return connections that are there between developing and established markets are shown by this comparison of bond rates in the US and India. Indian bonds routinely showcase high VAR values, indicating that there is a larger possibility for negative risk, according to the Monte Carlo Value at Risk (VAR) methodology. For instance, we see that the 95% confidence level VAR for Indian 10-year bonds is ₹86,075, which is much higher than the VAR of ₹3,508 for U.S. 10-year bonds. This is common in emerging economies, where investors seek a risk premium because of the heightened uncertainty, this disparity highlights India's greater economic instability, inflation danger, and policy unpredictability. On the other hand, although showing more volatility over longer periods, U.S. bonds have a lower VAR, indicating the stability of the mature

These risk differences are brought to light by the regression analysis, which identifies real interest rates as the primary driver of bond yield volatility in both economies. A 1% increase in real interest rates for Indian 10-year bonds results in a 21.71% increase in bond yields (p = 0.018), suggesting that inflation

and monetary policy changes have a substantial impact on Indian yields. Real interest rates also have a major impact on U.S. 10-year bonds, although the coefficient is less at 1.532 ($p < 0.001$), which shows that a more measured and calculated response to interest rate changes and also points to the resilience of the American economy in the 21st century.

Overall, our findings show that the investors have a clear balance between risk and reward amongst the two countries. While Indian bonds offer higher yields while carrying more risk and volatility, especially with long term maturities, U.S. bonds offer more stability and lower rates with their long term maturities. When choosing between an emerging and established economy for bond investments, our study highlights how crucial it is for investors to carefully consider various macroeconomic data and assess their risk tolerance. This analysis provides valuable insights for investors seeking to balance stability and returns in their bond portfolios. By understanding the differing risk profiles of emerging and developed markets, investors can find the correct ratio of risk and reward, and make more informed decisions that align with their risk tolerance and financial goals.

7. Limitations

Simplified Economic Assumptions: The study focuses on real interest rates, inflation and GDP growth as primary determinants of bond yields. While these variables are significant, omitting other potential factors such as investor sentiment, monetary and fiscal policy may limit the comprehensive scope of this analysis.

Data Limitations on Bond Prices: Due to data constraints, bond price information was not included, which could have provided additional insights or affected the results. This limits certain aspects of the analysis, particularly in relation to price volatility and investor returns.

Model Limitations: While Value at Risk (VaR) and regression analysis are useful tools for assessing risk and exploring relationships among variables, they also come with limitations. Value at Risk Simulations, for instance, may underrepresent the potential losses in extreme market events beyond the confidence threshold, while linear regression may not fully capture the complex, non-linear interactions between economic variables and bond markets.

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