Final Year Project Showcase Batch 2019
Year 2023

	Department: Mathematics
	Programme: Computational Finance

1	**Project Idea** The risk of sovereign default has been a persistent source of concern for many countries, including Pakistan. For many years, there has been a heated discussion and speculation about Pakistan possibly experiencing a debt crisis and defaulting on its obligation.
2	**Process** We Adapt KMV-Merton model for the corporations and make it applicable for Pakistan by converting Merton model into our sovereign model. We start by formulating a combine balance sheet which includes four assets and four liabilities. The four assets are international reserves, net fiscal asset, credit to other sectors, other public assets. The four liabilities include international dominated currency debt, local currency dominated debt, guarantees and monetary base. Then we started to collect data from year 2001 till year 2022 from World Bank, IMF, State bank of Pakistan and other similar sources. After collecting the data, we started to calculate LCL, Distress Barrier, sigma, Total Assets, Estimated LCL, Sigma LCL, Implied Total Assets and Implied Sigma A. then we used our model to calculate the values of the probability factors then cumulative distribution of the probability factors. In which $N(-d_2)$ represents the risk neutral probability of the default. Then we find the values of Risky Debt, yield to maturity of the risky debt Y, model-implied credit spread ICS, distance to distress and value of foreign currency liability.
3	**Outcome** This study uses a rigorous quantitative framework to assess the country's credit risk dynamics and provide a thorough evaluation of the factors that affect its potential for default. We have calculated risk-neutral probabilities of sovereign default, model implied credit spreads or risk-neutral spreads, distance to distress and value of foreign currency liabilities from year 2001 till 2022. The risk-neutral probability of sovereign default (Pakistan) in 2001 was 0.7771 and in 2022 was 0.8456. The RNS in 2001 was 0.7159 and in 2022 it was 1.152. The distance to distress in 2001 was 0.5416 and in 2022 it was 0.2031. The value of foreign currency liabilities in 2001 was 6,901,815,792.17 and in 2022 it was 19,455,073,856.75. These are the approximate values based upon our calculations. We created a ShinyApp in R-Language which is used for making dashboards for better visualization and with the help of ShinyApp anyone can visit our webpage and can have a look at our findings which are easy to analyze over there.
4	**Evidence (Theoretical Basis)** The risk of sovereign default has been a persistent source of concern for many countries, including Pakistan. For many years, there has been heated discussion and speculation about Pakistan possibly experiencing a debt crisis and defaulting on its obligations. In light of the foregoing, this report uses a modified Black-Scholes-Merton model to investigate the likelihood of Pakistan's Sovereign Default. From an early age we have been exposed to discussions about Pakistan's financial stability and creditworthiness, which gave rise to the idea of looking into this risk-neutral probability of default. This study uses a rigorous quantitative framework to assess the country's credit risk dynamics and provide a thorough evaluation of the factors that affect its potential for default. We have calculated risk-neutral

probabilities of sovereign default, model implied credit spreads or risk-neutral spreads, distance to distress and value of foreign currency liabilities from year 2001 till 2022. The risk-neutral probability of sovereign default (Pakistan) in 2001 was 0.7771 and in 2022 was 0.8456. The RNS in 2001 was 0.7159 and in 2022 it was 1.152. The distance to distress in 2001 was 0.5416 and in 2022 it was 0.2031. The value of foreign currency liabilities in 2001 was 6,901,815,792.17 and in 2022 it was 19,455,073,856.75. These are the approximate values based upon our calculations. We created a ShinyApp in R-Language which is used for making dashboards for better visualization and with the help of ShinyApp anyone can visit our webpage and can have a look at our findings which are easy to analyze over there. We hope that this analysis will help stakeholders, including policymakers, investors, and investors better understand Pakistan's economic landscape and help them make well-informed decisions in a complex financial environment. First off, implementing macro-stabilization strategies will aid in managing economic imbalances and averting further crises. These strategies include adopting a flexible, market determined exchange rate and prudent fiscal and monetary policies. For instance, the Pakistani Rupee can float freely on the foreign exchange market if the State Bank of Pakistan (SBP) implements a flexible exchange rate regime. In order to achieve fiscal sustainability, the government should concentrate on fiscal reforms like raising domestic revenue mobilization and raising the caliber of public expenditures. For instance, the government could implement tax reforms that would increase the tax base and increase the effectiveness of tax collection. Thirdly, implementing structural reforms to raise productivity, investment, and competitiveness is crucial for long-term economic growth. To draw in more investment, Pakistan can implement business friendly reforms like streamlining the registration process and lowering administrative barriers. To improve socioeconomic conditions, it is essential to make investments in human capital development, especially by addressing high stunting rates and learning poverty. As an illustration, the government can launch a national campaign to enhance early childhood nutrition and healthcare. Furthermore, the energy sector must regain its financial viability to address high fuel prices and guarantee energy security. Pakistan can enact laws that will cut back on energy subsidies and promote the use of renewable energy sources. Additionally, international cooperation is essential, and putting into practice the policy reforms supported by the IMF-EFF program is required to open the door to new disbursements from regional partners as well as external refinancing. An example is Pakistan's successful negotiation of an IMF-EFF program, which included a commitment to fiscal restraint and policy reforms. Transparency in policy decisions and effective reform strategy communication will increase public support and investor confidence. In order to clearly explain its reform strategy to the general public and investors, the government can start a public awareness campaign. By implementing these recommendations, Pakistan can navigate its economic challenges and move towards sustainable growth, improved socio-economic conditions, and increased resilience in the face of global economic uncertainties.

5	**Impact on Sustainability of Urban Regions or SDG-11 "Sustainable Cities and Communities"** In Pakistan, where urbanization is rapidly increasing, the computational calculation of sovereign default probabilities can indirectly impact urban sustainability by ensuring economic stability. Economic stability can attract investments in infrastructure development projects in cities, contributing to the goals of SDG-11 for sustainable and inclusive urbanization.
6	**Competitive Advantage or Unique Selling Proposition** One of the standout aspects of this project is its direct contribution to the attainment of SDGs in Pakistan. By providing more accurate and timely sovereign default probability

assessments, our project supports SDG 1 (No Poverty) by helping the government manage debt effectively, reducing the risk of financial crises that can lead to poverty and inequality. This is a compelling reason for the industry and stakeholders to invest in or adopt our solution.

How:
The project achieves this by leveraging advanced computational techniques and data analytics to improve sovereign risk assessment, enabling better-informed decision-making.

Why:
Pakistan faces significant challenges related to economic stability and poverty reduction. A more accurate assessment of sovereign default probabilities can directly address these challenges by enhancing fiscal responsibility and resource allocation.

When:
This advantage is relevant today and for the foreseeable future, as economic stability and sustainable development remain critical priorities for Pakistan.

What:
Our project offers a sophisticated and reliable tool for government agencies, financial institutions, and investors to assess sovereign risk, ultimately leading to better financial planning and risk management, which aligns with the country's sustainable development objectives.

a	**Attainment of any SDG** This project can contribute to **SDG# 01: No Poverty:** By helping Pakistan manage its debt more effectively, reducing the risk of financial crises that can exacerbate poverty and inequality in the country.
b	**Environmental Aspect** While not directly related to the environment, the project's potential to stabilize the economy and attract investments can indirectly support environmental sustainability by providing resources for green initiatives and sustainable urban development projects.
c	**Cost Reduction of Existing Product** While this project may not directly reduce product costs, it can indirectly lead to cost savings for the Pakistani government by providing more accurate sovereign risk assessments. This, in turn, can result in better debt management and reduced financial burdens.
d	**Process Improvement which Leads to Superior Product or Cost Reduction, Efficiency Improvement of the Whole Process** In Pakistan, improving the accuracy and efficiency of sovereign risk assessments can significantly benefit the country. It can lead to more informed decision-making in debt management, ensuring that resources are allocated efficiently and reducing the financial risks associated with sovereign borrowing.
e	**Expanding of Market share**

	This project can indirectly support market expansion in Pakistan by increasing investor confidence in the country's sovereign bonds. Enhanced risk assessment can attract more investments in Pakistan's financial markets and encourage foreign investors to participate, expanding the market's size and depth.	
f	**Capture New Market** In Pakistan, there is potential to capture a new market by offering your computational model as a service to smaller financial institutions and investors who may lack access to sophisticated risk analysis tools. This can cater to an unaddressed segment of the market.	
g	**Any Other Aspect** Consider the impact on social welfare programs and political stability in Pakistan. By helping the government manage its debt more effectively, your project can indirectly support social welfare initiatives and contribute to political stability in the country.	
7	**Target Market** In Pakistan, the target market for our product or service includes financial institutions, government agencies such as the State Bank of Pakistan, investors, multinational corporations operating in the country, and risk analysts who focus on Pakistan's economic landscape.	
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10	**Pictures (If any)**	
11	**Video (If any)**	NA