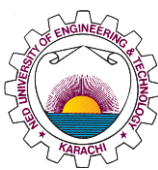


## Final Year Project Showcase Batch-2020 Year 2024

<b>Department: Mathematics</b> Programme: <b>Computational Finance</b>	
<b>1</b>	<b>Project Title</b> Sovereign Debt Sustainability: A Machine Learning Approach
<b>2</b>	<b>Project Idea</b> The risk of a sovereign default has been a longstanding worry for several nations, including Pakistan. For years, there has been ongoing debate and speculation about Pakistan potentially facing a debt crisis and being unable to fulfill its obligations.
<b>3</b>	<b>Process</b> We adapted the Q-Learner Black & Scholes Model for corporate default risk and modified it to calculate the sovereign default risk for Pakistan. We started by formulating a combined balance sheet which included four assets and four liabilities. The four assets were international reserves, net fiscal asset, credit to other sectors, other public assets. The four liabilities included 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 Total Assets, sigma, Distress Barrier, Local Currency Liabilities(LCL), Estimated LCL. 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 further calculated the risk indicators, which were Distance to Distress, Value of Foreign Currency Liabilities, and Risk Neutral Spread.
<b>4</b>	<b>Outcome</b> This study uses a robust quantitative model 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, risk-neutral spreads, distance to distress and value of foreign currency liabilities from the year 2001 till 2022. According to our calculations, the risk-neutral probability of sovereign default (Pakistan) in 2001 was 0.822778 and in 2022 was 0.841467. The RNS in 2001 was -0.07252 and in 2022 it was 1.86070. The Distance to Distress in 2001 was 0.550434 and in 2022 it was 0.484709. The Value of Foreign Currency Liabilities in 2001 was 14,646,628,141.66 and in 2022 it was 9,526,523,553.94. These are the approximate values based upon our calculations. We also created a ShinyApp in RLanguage 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.
<b>5</b>	<b>Evidence (Theoretical Basis)</b> The risk of sovereign default has long troubled countries like Pakistan. Persistent discussions about a potential debt crisis have spurred this study, which uses a modified Q-Learner Black-Scholes model to analyze Pakistan's likelihood of default. Inspired by early exposure to debates on financial stability, we examine the risk-neutral probability of default. Our quantitative framework assesses credit risk dynamics, providing insights into factors affecting default potential. We calculated the risk-neutral probabilities of sovereign default, model-implied credit spreads (risk-neutral spreads), distance to distress, and foreign currency liabilities from 2001 to 2022. Findings show the risk-neutral probability of default



	<p>was 0.822778 in 2001 and 0.841467 in 2022. The RNS was -0.07252 in 2001 and 1.860709 in 2022. Distance to distress was 0.550434 in 2001 and 0.484709 in 2022, while foreign currency liabilities were approximately \$14.65 billion in 2001 and \$9.53 billion in 2022. To enhance visualization, we developed a ShinyApp in R-Language, enabling users to easily explore our findings. This analysis aims to assist policymakers, investors, and other stakeholders in understanding Pakistan's economic landscape for better decision-making. Macro-stabilization strategies are vital for managing economic imbalances and preventing crises. Adopting a flexible exchange rate and prudent fiscal and monetary policies are key. For instance, the State Bank of Pakistan (SBP) could let the Pakistani Rupee float freely. Fiscal sustainability requires reforms such as boosting domestic revenue and improving public expenditure quality. Tax reforms that expand the tax base and enhance collection efficiency are essential. Structural reforms are crucial for long-term growth, focusing on productivity, investment, and competitiveness. Business-friendly reforms, such as streamlining registration and reducing administrative barriers, can attract investment. Addressing human capital development, especially high stunting rates and learning poverty, is critical. The government could launch a national campaign to improve early childhood nutrition and healthcare. To tackle high fuel prices and ensure energy security, the energy sector needs financial viability through reduced subsidies and promotion of renewables. International cooperation and implementing IMF-EFF program reforms are necessary for new disbursements and refinancing. Transparency in policy decisions and effective communication of reform strategies will boost public support and investor confidence. By following these recommendations, Pakistan can achieve sustainable growth, improve socio-economic conditions, and enhance resilience amid global uncertainties.</p>
6	<p><b>Competitive Advantage or Unique Selling Proposition</b></p> <p>One of the key features of this project is its significant contribution to achieving the Sustainable Development Goals (SDGs) in Pakistan. By delivering more precise and timely assessments of sovereign default probabilities, our project supports SDG 1 (No Poverty) by aiding the government in effective debt management, thereby mitigating the risk of financial crises that can exacerbate poverty and inequality. This presents a strong incentive for the industry and stakeholders to invest in or adopt our solution.</p> <p><b>How:</b> The project utilizes advanced computational methods and data analytics to enhance sovereign risk assessment, facilitating more informed decision-making.</p> <p><b>Why:</b> Pakistan faces considerable challenges in economic stability and poverty alleviation. By providing a more accurate evaluation of sovereign default risks, our project addresses these issues by improving fiscal responsibility and resource allocation.</p> <p><b>When:</b> This benefit is pertinent now and for the foreseeable future, as maintaining economic stability and promoting sustainable development are ongoing priorities for Pakistan.</p> <p><b>What:</b> Our project provides a sophisticated and dependable tool for government agencies, financial institutions, and investors to evaluate sovereign risk, leading to improved financial planning and risk management, and aligning with the country's sustainable development goals.</p>
a	<p><b>Attainment of any SDG</b></p> <p>This project can contribute to SDG #1: No Poverty by aiding Pakistan in more effective debt management, thereby lowering the risk of financial crises that could worsen poverty and inequality in the country.</p>



	<b>Any Environmental Aspect</b>	
<b>b</b>	Although the project is not directly focused on environmental issues, its potential to stabilize the economy and attract investment can indirectly foster environmental sustainability by generating resources for green initiatives and sustainable urban development projects.	
<b>c</b>	<b>Cost Reduction of Existing Product</b> While this project may not directly lower product costs, it can indirectly generate cost savings for the Pakistani government by offering more precise sovereign risk assessments. This enhanced accuracy can lead to improved debt management and reduced financial burdens.	
<b>d</b>	<b>Process Improvement which Leads to Superior Product or Cost Reduction, Efficiency Improvement of the Whole Process</b> In Pakistan, enhancing the accuracy and efficiency of sovereign risk assessments can provide substantial benefits. It can lead to more informed debt management decisions, ensure efficient allocation of resources, and mitigate the financial risks linked to sovereign borrowing.	
<b>e</b>	<b>Expanding of Market</b> This project can indirectly facilitate market expansion in Pakistan by boosting investor confidence in the country's sovereign bonds. Improved risk assessment can attract greater investment in Pakistan's financial markets and encourage foreign investors to participate, thereby broadening the market's size and depth.	
<b>f</b>	<b>Capture New Market</b> In Pakistan, there is an opportunity to tap into a new market by offering your computational model as a service to smaller financial institutions and investors who may not have access to advanced risk analysis tools. This can address an underserved segment of the market.	
<b>g</b>	<b>Any Other Aspect</b> Consider the effects on social welfare programs and political stability in Pakistan. By aiding the government in more effective debt management, your project can indirectly bolster social welfare initiatives and contribute to political stability in the country.	
<b>7</b>	<b>Target Market</b> In Pakistan, our target market for the product or service includes financial institutions, government agencies like the State Bank of Pakistan, investors, multinational corporations operating in the country, and risk analysts specializing in Pakistan's economic landscape.	
<b>8</b>	<b>Team Members</b>	<ol style="list-style-type: none"> <li>1. Syed Abbas Mehdi (<a href="mailto:abbas.mehdi595@gmail.com">abbas.mehdi595@gmail.com</a>)</li> <li>2. Muhammad Farooq Siddiqui (<a href="mailto:mfaroox02@gmail.com">mfaroox02@gmail.com</a>)</li> <li>3. Syeda Rida Kirmani (<a href="mailto:ksrida14@gmail.com">ksrida14@gmail.com</a>)</li> <li>4. Anosha Tariq (<a href="mailto:anoshatariq0022@gmail.com">anoshatariq0022@gmail.com</a>)</li> </ol>
<b>10</b>	<b>Supervisor Name</b>	<ul style="list-style-type: none"> <li>• Dr. Salman Zaffer (<a href="mailto:salmanfar@gmail.com">salmanfar@gmail.com</a>)</li> <li>• Mr. Sami Ullah Qureshi (<a href="mailto:samiaerc@neduet.edu.pk">samiaerc@neduet.edu.pk</a>)</li> </ul>
<b>11</b>	<b>Video (If any)</b>	Please provide the link of the video

**Pictures (to be pasted below)**

