## DEPARTMENT OF STATISTICAL & ACTUARIAL SCIENCES

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Internship report on auditing Trade Floor Risk Management (TFRM) with the scope of Market Risk

Trade Floor Risk Management, and my experience during the internship at Scotiabank. The Audit Department, as the third line of defense, is responsible for providing independent assurance reports of the effectiveness of operational procedures, risk management, control function, and governance processes and procedures to the management. Trade Floor Risk Management (TFRM) provides market risk oversight for

above-Global Banking and Markets (GBM) Audit group in auditing TFRM and developed a tool using python to

contained any sensitive wo

Plastic in our Waterways: Characterizing Plastic Resin Pellet Pollution on Great Lakes Beaches

Plastic resin pellets are an industrial product manufactured to be molded into final products for consumers. Increasingly, they are being found in the waterways and coastlines of the world, presumably released during manufacturing and transport. Recently, such pellets have been identified by the thousands on the shores of the Great Lakes. Plastic pellets in water and on beaches have a negative impact as wildlife confuse these for food, resulting in illness or death. Additionally, the pellets act as a vehicle for pollutants and can release toxic substances into the water. The aim of this project was to determine which geological and anthropogenic factors influence the number of pellets found at a given location using data collected concerning microplastic abundance on beaches around the Great Lakes. Two count models were investigated to accurately model the number of pellets occurring at each location to account for the relatively high number of locations where no pellets were observed: the zero-inflated model and the hurdle model. The covariates considered in these models include human-related factors such as population, proximity to industrial plastic facilities and major transport routes, as well as environmental factors such as the shape of the coastline, the grain size of the beach sand and the proximity to a river mouth.

Validation of wholesale credit risk models

Risk is inherent in any financial models because model outputs are estimates that rely on statistical techniques and data and/or mathematical approximations to simulate reality or provide estimates of future outcomes. Model risk also arises from potential misuse of models by the users. Risk models are primarily anchored on the three components of Expected Credit Loss (ECL) estimate namely, 1) Probability of Default (PD) during lifetime, 2) Loss Given Default (LGD) accounting loss forecast derived from economic loss forecast, and 3) Exposure at Default (EAD). Model development (MD), model validation (MV) and corporate audit are the 1st, 2nd and 3rd lines of defense in the risk management strategies of an enterprise. Model -established model risk management framework that

manages model risk in the model life cycle. Part of the second line of defense, model validation provides 1) independent validation of model and effective challenge to its conceptual soundness, 2) approval / rejection of model and 3) ongoing monitoring of implemented model. Monitoring is value added, especially if there is material deterioration in model performance and / or changes in regulatory requirement, products, or market conditions necessitating re-assessment of the model. As a part of MV group at Bank of Montreal Financial Group (BMO), I have reviewed the performance monitoring report for the wholesale Advanced Internal Rating-Based (AIRB) models and also the annual review of International Financial Reporting Standards -Financial Instruments (IFRS 9) which documents the prediction of PD, LGD and EAD for different portfolios and assess the model performance ratings and compliance with appropriate regulatory standards. Performance monitoring report documents credibility of the implemented models based on the realized PD, LGD and EAD over one quarter and determines if any additional step proposed by MV has to be taken by the MD. Linear and logistic regressions have been widely used in these models. In particular, linear regression has been used to predict the LGD and EAD based on the macro-economic variables like gross domestic product (GDP), S&P 500, S&P/TSX composite index. Logistic regression has been widely used to predict the probability of default as a function of macro-economic variables. Thus, I found Regression and Advanced Data Analysis courses extremely useful in the industry.

Evaluation of retirement portfolio using conditional Monte Carlo simulation

: The objective of this project is to evaluate risk characteristics of the retirement portfolio which consists of risk reduction pool (option strategy), low volatility fund and bond fund using Monte Carlo simulation. All these fund components are a function of the underlying stock return. However, the risk reduction pool is not a simple linear function of the underlying stock return and it should be evaluated through time on each simulated path. It should be considered that each path is also regime dependent and conditional on what happened prior to that point. To calculate the risk characteristics of the portfolio such as three months rolling returns, first covariance and transition matrix on each regime are estimated according to historical data. Then, the weekly simulated underlying stock return is generated which will require mean reverting adjustment. Afterward, it fed into the option strategy and finally the weekly profit and loss of the strategy with respect to simulated underlying stock return on each path is evaluated.

## 3-factor Loan Portfolio Credit Risk Model

: Traditional banking business takes deposits and lends on these deposits, thus bringing together borrowers and lenders and making profit on the interest rate differential. This business is not without risk. The focus of this project is on the credit risk associated with retail and commercial loan portfolios. Banking regulators require measures of this credit risk for capital requirements as do internal risk management processes.

In simple word, generally, Credit risk is defined as the risk of loss resulting its obligations and it is the largest source of risk faced by banking institutions world-wide. There are three basic components of credit risk on an obligor level:

k was exposed to the obligor at the time of default,

on his loan

in a certain period, usually a year.

Historical evidence from retail banking data has indicated that PD, LGD, and EAD are not independent. This means that credit loss models which ignore this correlation will underestimate credit losses. Recent work by Avusuglo, Metzler, and Reesor provides a deep investigation into the properties of 2-factor models involving PD and LGD correlations.

In this project, we will extend the above mentioned 2-factor model framework to 3-factor models for PD-LGD-EAD dependency. This will be a first step in extending this work to 3-factor models. We will perform Monte Carlo simulations and other numerical work to investigate the properties of this proposed model. The main attention will be given to understanding the effect of account-level correlations on the portfolio-level quantities of interest, namely default rate and portfolio loss given default.

Keywords: Loan Portfolio, Credit Risk Model, 3-factor models

