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Abstracts of recent postgraduate theses and dissertations at South African universities

Causal inference on South African home loan take-up rates using propensity score methods

By C van der Merwe for MSc (Mathematical Statistics) at University of the Free State, 2018

Banks use data-mining techniques to draw inference in order to assist them with forming business strategies. In this paper we visit the idea of drawing causal inference to give business teams insight on causation rather than correlation/association. The trouble with correlation is that there may be other variables that influence the outcome – known as confounders.

An investigation is undertaken to understand the effect on take-up rates comparing clients that apply directly with the bank (in-house) and clients that apply through external companies (mortgage originators). In this study two hypotheses were assessed: the difference in take-up between in-house applicants compared to those who apply through mortgage originators; as well as the comparison of take-up rates between two popular mortgage originators.

The preferred method of drawing causal inference is a randomised experiment, however since we cannot force client behaviour, it is impossible to randomise the channel through which a client applies for a home loan. Thus, the purpose of this study is to establish the viability of using propensity score methods to draw causal inference on applicants' take-up of home loans. Propensity scores are used to create a balanced sample, where treatment and control groups are homogeneous except for receiving or not receiving the treatment (to control baseline characteristics when a randomised experiment is not possible). The five steps of creating propensity scores are: estimating the propensity scores, choosing a matching algorithm, verifying overlap, testing the matching quality and sensitivity analysis. The balanced sample is then used to build a predictive model to draw causal inference.

To truly isolate the effect of the treatment on the outcome, the same unit would have to receive the treatment and control. This is known as the fundamental problem in observational studies. To draw causal inference, two potential outcomes are required for one unit, implying that a missing data problem is created. The difference between the two outcomes for one unit is known as the causal effect. Multiple imputation can be used to impute a range for one unit's missing values. In this study, this was only done for the second hypothesis (comparing the take-up rate between two mortgage originators). Multiple causal effects can be calculated to create a prediction interval for the respective take-up rates.

In this study we prove the viability of using propensity score methods in the banking sector, as it makes it possible for business units to investigate cause-and-effect-related questions where a randomised experiment is not possible. The results of the study lead to interesting questions for further study that might lead to significant strides in business insight, for example investigating why the take-up rate through a certain mortgage originator is higher than another.

The effectiveness of smoothed bonus portfolios for mitigating investment risk in defined contribution pension funds

By CP Laue for MSc (Actuarial Science) at the University of Pretoria, 2018

The aim of this study is to investigate whether smoothed bonus portfolios (SBPs) are effective at managing the investment risk that members of a defined contribution pension fund are exposed to. Investment risk arises from the uncertainty of the performance of the assets invested in by the fund during the accumulation phase. This creates uncertainty for a member as to what the outcome at retirement will be. It is measured as the value at risk as well as conditional tail expectation, calculated on a member's simulated savings at retirement. The effectiveness of an SBP is investigated through applying three methodologies, namely 1) a return/risk analysis where the contribution of each of the features of an SBP to its return and return/risk ratio is analysed; 2) comparing the simulated outcome at retirement of an SBP with the outcome of two types of notional benchmark portfolios that apply simpler investment strategies, but are set up to have the same level of risk as the SBP; and 3) applying first-order stochastic dominance (FSD) rules. On a risk-adjusted basis, the guarantee and smoothing mechanism of an SBP make positive contributions to its performance. However, when comparing the outcome of the notional benchmark portfolios with that of the SBPs, the former consistently outperform the SBPs modelled. Applying FSD rules, the notional benchmark portfolios are found to be preferred to a greater extent than the SBPs.

The use of risk measures and its applications to portfolio optimisation

By R Sivnarai for MSc (Financial Engineering) at the University of Pretoria, 2017

In this dissertation, we study the application of risk measures to portfolio optimisation. We present the various risk measures in this dissertation within an axiomatic framework. Although Value-at-Risk (VaR) has been widely used, the Conditional-Value-at-Risk (CVaR) has become the more popular risk measure since it is a coherent and convex risk measure. We solve a CVaR-based optimisation model that is used for portfolio optimisation and hedging a target portfolio. Further, we include alternative risk measures such as distortion, spectral, drawdown and coherent-distortion risk measures (CDRM) and develop optimisation problems for each risk measure. We present a case study where a portfolio is optimised using CVaR, spectral and CDRM risk measures.