Journal of Modern Accounting and Auditing, February 2021, Vol. 17, No. 2, 110-124
doi: 10.17265/1548-6583/2021.02.005

Corporate Probability of Default (PD) Modelling for Banks in Emerging Economies: A Case Study of Zimbabwe Stock Exchange (ZSE) Listed Counters

Ephraim Matanda
Great Zimbabwe University, Masvingo, Zimbabwe
Vharawei Matanda
Great Zimbabwe University, Masvingo, Zimbabwe
Ropafadzo Mhizha
Reformed Church University, Masvingo, Zimbabwe

The paper extends Merton's Probability of Default (PD) model to the case for transaction costs or market friction for estimation of the PDs of listed banking corporations. A closed form formula for the PD model is obtained and validated using financial data drawn from banks listed on the Zimbabwe Stock Exchange (ZSE). It has been observed that most corporations in emerging economies have been finding it extremely difficult to list, continue listed or manage risk emanating from credit exposures undertaken. In the absence of risk the role of the financial sector of an economy to efficiently and effectively allocate resources between the public and private sectors would be simplified, economically and rationally determined. Reliable or precise computation of the Probability of Default (PD) of a borrower is one of the most critical tasks in credit risk management for commercial banks that were applying the Internal Rating Based Approach (IRBA) under the Basel Capital Accords II and III frameworks. The study sought to develop a Probability of Default (PD) model that banking corporations in emerging economies such as Zimbabwe could adopt and implement in the Multiple Currency System (MCS) in their desire to grow and develop through their lending businesses. The research study adopted a PD model similar to the Asset Valuation Model (AVM) by Merton (1974) and initially extended by Black-Scholes (1973) and Crouhy et al. (2000) and applied it on a basket of Zimbabwe Stock Exchange listed counters after having adjusted the model for the transaction cost variable. The study therefore succeeded in coming up with a PD model that was worth adopting and implementing by Zimbabwe Stock Exchange (ZSE) listed corporations in their desire to grow towards sustainable development. It was realised that a contemporary PD model adjusted for transaction cost is pertinent for reflection of practical conditions banks face in estimation of their risk metrics such as PD. Transaction costs faced by banks in emerging economies are very huge that they cannot be assumed to be insignificant when it comes to valuation of PDs of banking corporations. The inclusion of transaction costs in estimation of PDs of ZSE listed

Ephraim Matanda, MSc Finance and Investment, Department of Banking and Finance, Great Zimbabwe University, Masvingo, Zimbabwe.
Vharawei Matanda, MSc Special Needs Education, Department of Special Needs Education, Great Zimbabwe University, Masvingo, Zimbabwe.
Ropafadzo Mhizha, MCom Finance, Department of Finance and Business Management, Reformed Church University, Masvingo, Zimbabwe.

banks is likely to create a paradigm shift in financial theory on risk metrics in the modern world. The study ends by recommending the need for all Zimbabwean listed corporations to adopt and implement an AVM adjusted for transaction costs if they were to successfully measure and manage both their investment and credit exposure endeavours in the multiple currency system period.

Keywords: Probability of Default (PD), transaction costs, emerging economies, credit exposures, internal rating based approach, Multiple Currency System (MCS)

Introduction

Risk is a critical component in any institution or corporation that influences financial behaviour of all economic players both from within and without the organization. Therefore in the absence of risk, the role of the financial sector to efficiently and effectively allocate and distribute resources to economic players would be simplified, rational, and dynamic. In such a world very few institutions and markets would be needed and the practical orientations of financial management would then relatively require basic modelling and analytical tools. The majority of global financial systems that we see in practice on a daily basis are popular, efficient, and effective in distribution and management of various types of financial risks which include liquidity and default or credit risk. Hanson and Schuermann (2005) define credit risk as the loss resulting from default or failure of obligors to honor their payments whose modelling cornerstone is the Probability of Default (PD). According to Hamilton and Contort (2006), the measurement of PD for a corporate exposure over a given investment horizon is the first step in credit risk modelling, management, and pricing.

Many financial market practitioners base their parameter estimates on corporate results reported in rating agency default studies. The comparability of corporate default rates reported by agencies has increased in recent years. However there are many differences that exist in corporate default rate calculation methodologies and therefore care should be taken to understand how these differences may limit the comparability of such methodologies. The financial decisions made by individuals, institutions governments, and corporate bodies are centred on minimization of risk as far as cost of financing businesses and returns to investments are concerned. Crouhy et al. (2000) studied credit risk modelling in Canadian Imperial Bank using Credit Migration Approach based on the Bank of International Settlement (BIS, 1998) capital requirements for market and credit risks for the bank's trading book. The Credit Migration Approach, as proposed by Morgan with Credit Metrics is based on the probability of an obligor moving from one credit quality to another including default within a given time horizon. The approach is discussed together with the option pricing or structural approach, as initiated by Asset Valuation Model (AVM) and which is based on the Asset Valuation Model (AVM) originally proposed by Merton (1974).

Literature Review

The Basel Capital Accords postulated by the Basel Committee have created the dire need to develop and implement various models of Probability of Default (PD) by listed banking corporations, the world over, depending on their circumstances and economic conditions of countries where they are situated. A study was carried out by Leland (2004) on prediction of default probabilities in structural models of debt in corporations in California. Leland examined two credit risk models namely those with "exogenous" default boundaries as propounded by Longstaff and Schwartz (1995) and those with "endogenous" default boundaries as postulated

by Leland and Taft (1996). He found out that when default costs and recovery rates were matched, exogenous and endogenous default boundary models fitted observed default frequencies equally well. The two models predicted very well or accurately longer-term default frequencies for both investment and non-investment grade bonds. However the two modelling frameworks on the other hand tended to underestimate shorter-term default frequencies, implying that a jump component should be included in asset value dynamics.

Masatoshi and Hiroshi (2009) used a Default Probability Estimation (DPE) model to study asset values in Japanese corporations. By asset value of a company they meant the sum of total market value of stock and debt values owned by the banking firm. The starting point for Masatoshi and Hiroshi (2009) was the estimation of the mean value and variance of the sum of a Japanese company's asset values using the first and second moments. The study discovered that there was a new variable for which fluctuations during an evaluation period of a firm's performance conformed to the two moments and followed a Brownian motion. Therefore a Default Probability Estimation model is constructed on the condition that the variable was regarded as the asset value of the company. For construction of an Expected Default Probability (EDP) model, Masatoshi and Hiroshi (2009) partially followed Levy's way in which a new variable used for average option was assumed. The EDP model was examined compared with the conventional structural approach with respect to a company in Japan where default was actually caused and the corporation was free from default.

Quantitative measures of credit risks in banks have become indispensable in completing satisfaction and requirements of Bank of International Settlement (BIS) restrictions (Basel Accords) determined by the Basel Committee on Banking Supervision. Since the year 1980 the international monetary market has been expanded with great strides while severity of cumulative bank debts has been worsening and risk control of increased derivative transactions has become a real problematic phenomenon. For this reason, it has become very important for financial institutions or general corporations in possession of stocks or bonds to evaluate their management abilities and credit power or policies, in a fair and simplified manner. Financial institutions including banks needed soundness in financial management in order to perform international business endeavours and make financial transactions competitive enough to cope with foreign financial institutions in a financial field of international competitions. The process of quantification of risk, monitoring, analysis, and controlling, let alone allocation requires economic players to employ a wide range of very complex mathematical, financial, and computational tools.

It is prudent to argue that contemporary mathematical models of financial practices are made up of some of the most complicated applications of optimization, probability, and linear regression estimation theoretical frameworks. These financial applications have become the greatest challenges facing some of the most popular and powerful computational technologies used the world over. Risk management frameworks in institutions, markets, and government organizations cover the components, designs and operational systems, modelling techniques and processes as well as the interactions between the internal and external environments to risk management in financial organizations. According to Crouhy et al. (2000), mathematical models of risk evaluation and assessment are at the centre of modern risk management systems in both public and private organizations. They theorists go further to argue that there are no risk management systems can be effective in the absence of well-designed and organized performance measurement and testing strategies.

The presence of such strategies in organizations would serve two purposes, namely to estimate risk exposures (ex-ante) and provide an ex-post assessment of such risk estimates relative to expectations (predictions) as feedback on the performance of the financial system of an economy as a whole. Hence every

organization on the global financial system, including Central Banks and Stock Market Exchanges relied upon financial economic or mathematical models of risk valuation and assessment if they were to grow and attain sustainable development by the end of the day in their business endeavors. Memmel (2012) wrote Paper Number 36 of 2012 on the "Common Drivers of Default Risk" using unique data sets drawn from German banks' loans issued to the German real economy such as volumes of loans per bank and industry for the period 2003-2011. The study found out that bank loans' maturity structures were responsible for driving the bank-wide loss rates in credit portfolio. It was also deduced that nation-wide loss rates had the most impact on bank loans followed by maturity structure and the industry composition.

The paper by Memmel (2012) postulates that Germany nation-wide banks' credit portfolio losses are influenced by volumes of loans and their maturity structures as well as industry of operation, which factors explained 26% of the time variation in the loss rates. On the other hand for regional banks in Germany the loss rate was less than 8%. Duffie and Wang (2007) came up with an article in their Journal of Financial Economics Number 83 Pages 635-665 based on a model for United States listed industrial firms. The theorists used data generated from over 390,000 firm-months of data for over 2,700 firms for the period 1980 to 2004. The study found out that there was a significant dependence of the level and shape of the term structure of conditional future default probabilities on a corporation's distance to default (a volatile-adjusted measure of leverage), United States interest rates and stock-market returns, among other variables. Variation in a company's distance to default was found to have a substantially greater effect on the term and structure of future default hazard rates than that of a comparatively significant change in any of the other covariates.

Simons and Roaves (2009) carried out a *Macroeconomic Based Default Modelling and Stress Testing* study on De Nederlandsche banks. The study used a macroeconomic model to estimate corporate probabilities of default for Dutch banks. The first paper focused on the relationship between macroeconomic variables and the default behaviour of Dutch firms. The study found out that there was a significant relationship among PD and GDP growth and oil prices, and a weak relationship among PD and interest and exchange rates. The second paper assessed default behaviour based on a stress scenario of two consecutive quarters of zero GDP growth in an economy as required by the Basel II Capital Framework. It was concluded that zero GDP growth did not influence the economy's default rate significantly. Therefore the study under consideration developed interest to examine the risk faced by a bundle of Zimbabwean Stock Market listed counters in the desire to come up with a risk management model that suited the counters in question in the dollarization era.

The efficient and effective performance of a country's Stock Exchange was taken to be synonymous with the economy's financial soundness, discipline and performance as measured by macroeconomic fundamentals such as employment, general price level, economic growth and development as well as the Balance of Payments (BOP) and ability to lure Foreign Direct Investment (FDI). The study was also motivated by the continuous decline in the number and poor performance of Zimbabwe Stock Exchange (ZSE) listed corporations in the period under review. Most listed firms were observed to be defaulting on their credit obligations. Hence the need for the study is to assess corporate probability of default for a basket of ZSE listed counters in order to come up with findings so they could adopt and implement to their own advantage. According to the Asset Valuation Model (AVM) by Li (2000) and Kalemanova, Schmidt, and Werner (2007), default is triggered if the asset value falls below a certain threshold. The barrier to default is represented by the algebraic equation:

$$\mathrm{K} = \emptyset\,(1 - \mathrm{pk}) \tag{1}$$

where: the variable *pk* = Probability of Default over the whole time interval in the market model; the term *K* =

Threshold, normally taken to be a constant for a Collateralized Debt Obligation (CDO) type of contract. For the time dependent case, we can have a time, t "asset value" using the algebraic equation:

$$A(t) = \emptyset^{-1}(1\text{-}pk) \tag{2}$$

where: In the formula above, default is triggered if the value A(t) falls across the default barriers, K, that is:

$$A(t)<K \text{ or } \emptyset^{-1}(1\text{-}p(t))< \emptyset^{-1}(1\text{-}pk) \tag{3}$$

In other words as ϕ^{-1} function decreases in value when $p(t)$ becomes bigger, this means then that A(t) < K and $p(t) > pk$. Default occurs when a firm's value drops below some Default Barrier (DB) which in the Merton (1974) model is represented by the Future Value (*FV*) of Debt, F at its maturity value and hence *PD* = Probability ($VT \leq F$) where PD = Probability of Default.

According to Crouhy et al. (2000), PD is a robust hypothesis confirmed by the actual delta. In this respect the PD of a bank is stated in natural logarithmic form as:

$$Ln\ (VT)\ \approx \frac{\emptyset[\boldsymbol{LnV_0} + \left(\boldsymbol{\mu_v} - \frac{\sigma_v^2}{2}\right)T]}{\boldsymbol{\sigma_V^2 T}} \tag{4}$$

$$\text{PD} = \text{Prob}\ (\ln VT \leq F) \tag{5}$$

Combining Equations 4 and 5 above, we obtain the final equation:

$$\text{PD}\ = \frac{\emptyset[\text{Ln}\ V_0 + (\boldsymbol{\mu_v} - \frac{\sigma_v^2}{2})T]}{\sigma_v\sqrt{T}} \tag{6}$$

or

$$\text{PD}\ = \emptyset\ (-d_2^*)$$

Therefore the PD formula in Equations 5 and 6 above only holds for a firm operating at the maturity stage of its growth or term, T, expected at t = 0 and t = T, when *Vo* is known with certainty. On the other hand $\phi(d_2)$ is the probability that the European call option will be exercised by the equity holder and the company will not default on the obligation. The term $\emptyset\ (-d_2^*)$ = The physical or real world PD while $\Phi(\text{-}d_2)$ = The PD in the risk neutral world (from use of risk free rate of return on market traded instruments). Therefore the study postulated a PD model based on the AVM originated by Merton (1974) and extended by Li (2000), Kalemanova, Schmid and Werner (2007) and Crouhy et al (2000).

Therefore the study postulated a PD model based on the Asset Valuation Model (AVM) originated by Merton (1974) and extended by Li (2000), Kalemanova, Schmidt, and Werner (2007), and Crouhy et al. (2000). The new AVM model above was adopted and implemented by the study to value Zimbabwe Stock Exchange (ZSE) listed counters in the multiple currency system or dollarization era because of its adjustment for transaction costs which were great in undertaking credit transactions in emerging economies. The model would be outlined in detail in next section before it could be tested for its implementation capacities and user friendliness in turbulent and volatile economic system like Zimbabwe. The paper is structured in such a way that it kicks off with the introduction, then the problem statement before it proceeds to formulate the model for corporations listed on the ZSE, the techniques and methodologies forwarded by other scholars and ends with model implementation, conclusions, and recommendations.

Problem Statement

It has always been the case that listed counters in emerging economies that are successful to manage their credit exposures have grown in their financing and investments endeavours worldwide. More often than not successful investments by Stock Exchange listed firms have always been made out of financial resources generated through credit exposures or provided through Foreign Direct Investment (FDI), capital inflows by Multinational Corporations (MNCs) and Transnational Corporations(TNCs) and World Financial Institutions such as World Bank and International Monetary Fund. However, coming from the 2006-2008 economic meltdown experienced in Zimbabwe, an emerging economy, most ZSE listed corporations have found it very difficult to exploit market investment opportunities that are available on the domestic bourse. Since the inception of the multiple currency system in Zimbabwe in 2009, the prevalence of listed firms crowding out of the country across all the sectors of the economy has been massively increasing becoming a serious cause of concern to all economic players. The study therefore sought to develop a Probability of Default (PD) model for ZSE listed counters that investing corporate firms could adopt and implement in their desire to grow and develop through effective management of their credit exposures in the multiple currency system era.

Justification of the Proposed PD Adopted by the Study

Merton (1974) gave birth to the AVM that has been widely used, the world over in the valuation of the underlying assets in derivative transactions particularly bonds and equities. However, over the years there have been more models that have been developed in finance for valuation of bonds and options. The Black-Scholes model for instance has been used in the pricing of options-based on equities, bonds, future-styled securities, forward interest rate captions, swaptions and interest rate floortions. The theory on the model was based on the major assumption that asset returns were normally distributed and free from autocorrelation. It was argued that the Black-Scholes model had the capacity to value or price options under the continuity of time variables. The model assumed that the price of the underlying (reference) asset, St was a continuous process that followed the Brownian motion. The study therefore adopted a PD model that was derived from the Merton (1974) and Black-Scholes (1973) models. The major assumptions upon which the Black-Scholes model was built are:

- Market consists of at least one risky asset (stock) and one risk free asset (bond).
- There is a risk free rate of return, r, on riskless assets which is constant.
- The log return of stock prices follows a Geometric Brownian motion with constant drift and volatility, σ.
- Stock does not pay a dividend.
- There is no arbitrage opportunity on the market that one cannot make riskless profit.
- Possible to borrow and lend any amount even a fraction of cash at risk free.
- Possible to buy and sell any amount even a fraction of a stock including short selling.
- The financial transactions do not incur any fees or costs (frictionless market).

The general form of the Black-Scholes model for pricing of options was given by:

$$Vc = Se^{-\sigma T}N(d_1) - Ke^{-rT}N(d_2) \text{ (for all call options)} \quad (7)$$

and

$$Vp = Ke^{-rT}N(-d_2) - Se^{-\sigma T}N(-d_1) \text{ (for put options)} \quad (8)$$

where:

S = The value of the firm's stock and K = The book value of the firm's liabilities,

dv = Market friction or transaction cost (dividend paid) by the firm in a year,

T = The tenure of the asset,

μ = The risk free rate of return obtaining in the Stock Market,

$N(d_1)$ = Cumulative normal probability distribution of the Z-score, d_1 and $N(d_2)$ = Cumulative normal probability distribution of the Z-score, d_2.

The Z-scores, d_1 and d_2 are calculated using the formulae,

$$d_1 = \frac{\left(\ln\left(\frac{VA}{Xt}\right) + (r + 0.5\sigma^2 A)T\right)}{\sigma A\sqrt{T}} \tag{9}$$

and

$$d_2 = d_1 - \sigma A\sqrt{T} \tag{10}$$

where:

Xt = The book value of the liabilities of a firm drawn from its statement of financial position (Balance sheet),

ln = The natural logarithm of the ratio of the firm's assets to its liabilities and,

Sigma, σA = The volatility of the firm's assets.

The Merton's Asset Valuation Model (AVM) is used for estimating two unknowns which are VA and σA required in the calculation of the PD of a bank. The two simultaneous linear equations to be solved for these unknowns are given as follows:

Equation: Market Value of Equity,

$$VE = VA \times N(d_1) - e^{-rT}X \times N(d_2) \tag{11}$$

The volatility of equity of a firm,

$$\sigma E = \frac{VA}{VE} \times N(d_1)\sigma A \tag{12}$$

Phillip Morris Companies Inc. (April, 2001) model was used to generate monthly asset values and the corresponding standard deviations for two banks listed on the Zimbabwe Stock Exchange, namely Commercial Bank Zimbabwe (CBZ) and Barclays Bank. The financial data used were drawn from the banks' audited financial statements for the years 2010 to 2012. The variables used in the determination of asset values and standard deviations were market value of the firms' equity (VE), equity volatility (σE), firm's book liabilities (Xt), horizon (one year), and risk free rate of return for the firm. The calculated value of equity, its volatility, book liabilities, and risk free rates of return are the variables that were employed in the Risk Consulting Group—Credit Risk Toolbox model in order to come up with the monthly Probabilities of Default (PDs) for the two firms for the period January 2010 to December 2012.

Based on the Merton (1974), the probability of default for a firm is given by the formula:

$$Pi = N\left(\frac{-\ln\left(\frac{VA}{Xt}\right) + \left(\mu A - \frac{\sigma^2 A}{2}\right)T}{\sigma A\sqrt{T}}\right) \tag{13}$$

We came up with the following research model:

$$Pi = N\left(\frac{-\ln\left(\frac{VA}{Xt}\right) + \left(\mu A - dv + \frac{\sigma^2 A}{2}\right)T}{\sigma A\sqrt{T}}\right) \quad (14)$$

which can also be stated as:

$$Pi = N(-d_2) \quad (15)$$

where $\mu A =$ The risk free rate of return on stock A.

Validation of the Proposed Probability of Default (PD) Model

The following presentations relate to the results generated from the two models above on a month by month basis from the financial data collected from the banks' financial statements in the period 2010-2012 under consideration.

Asset Value Results for CBZ and Barclays Banks (2010-2012) ($ Millions)

Using the model outlined above, the study came up with the results illustrated below on a month by month basis for asset values for CBZ and Barclays Banks for the period 2010-2012:

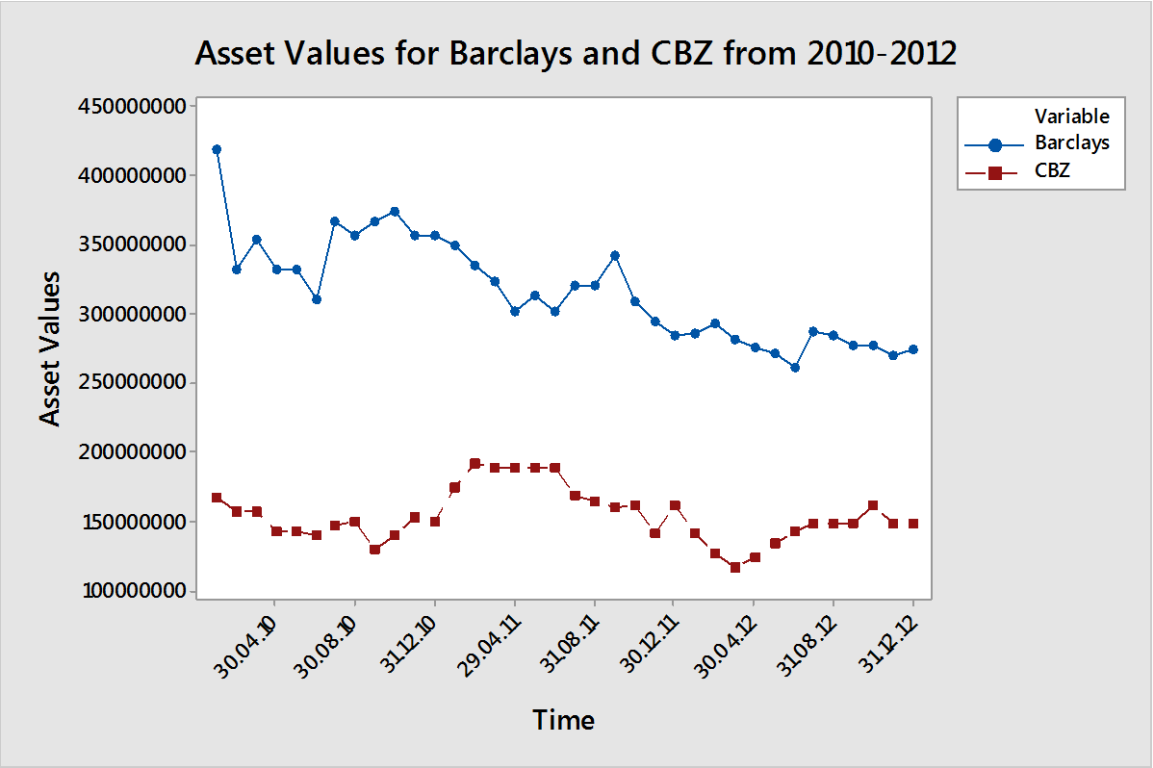

Figure 1. Graph showing distribution by monthly asset values for CBZ and Barclays Banks for 2010-2012 ($ Millions). Source: Author's own calculations.

CBZ attained its highest and lowest asset value of $167.5 and $126.9 million in the months of January and September 2010 respectively. The asset values of the rest of the months in 2010 for CBZ lay between $157.4 million and $139.5 million. The bank's total number of shares for the year stood at 684,144,546 and its market price per share fluctuated between 18.50c and 13.00c. The firm's equity prices on the market, however, tumbled between 18.5c and 11.00c in the period February to November 2010. For the period March to June 2011, the bank's market price per share was flat at 18.00c per month coupled with stagnation in the number of

CBZ issued shares which remained fixated over the two years. The organization attained a total asset value of $192.4 million in February and a lowest asset value of $141.1 million in November 2011. However for the period March to June 2011, CBZ assets value was flat at $188.98 million.

The rest of the asset values of the bank fluctuated between $188.98 million and $168.46 million in the year. However in comparison with 2010, the asset value dispersion for 2011 was wider and more unstable. The total number of issued shares for CBZ in 2012 remained pegged at 684,144,546 meaning that the bank did not issue any new shares to both existing shareholders and the public over the 3-year period. The corporation's market price per share sank to lowest levels reaching a minimum of 5.50c in March 2012 and a peak of 12.00c for the month of October 2012. Otherwise the common market price per share for 2012 was 10.00c for the period of July to December 2012, except for October. The asset value of the bank fell significantly in the period January to December 2012 relative to the preceding two years. The year commenced with the bank owning an asset value of $141.6 million, which then fell steeply down to reach a level of $117.6 million in March 2012. The firm's asset value then rose from $117.6 million to a total value of $148.5 million in December 2012.

On the other hand Barclays Bank of Zimbabwe's equity was pegged at 301,258,325 issued shares in January 2010 and ended the year at 193,732,165 shares. However, the firm's equity market price which was at 45.27c per share in January 2010 fell drastically to 15.28c per share by December of the same year. The bank's asset value for January 2010 was $417.86 million. The rest of the months in 2010 saw the firm's asset values gradually undertaking an upward trend ranging from $331.77 million in February to $373.1 million in October 2010, serve for June 2010 which had $310.3 million. The firm's state of affairs on the ZSE was worse off in 2011 as compared to 2010. Although the inflation rate had been compacted in the economy, political and financial risks remained more prevalent in the country and had the potential to scare investors. The corporation's equity continued to sink from 193,732,216 in December 2010 through 150,465,354 to a total of 92,567,398 shares in December 2011. On the other hand, the market price per share behaved the same reaching a peak of 30.83c in April, but having sunk greatly in February 2011 to a meagre 5.50c per share.

Barclays Bank's asset value in 2011 was highest in January where it was $348.65 million and it ended the year at its minimum of $283.68 million. The rest of the year saw the firm's assets tumbling between $334.66 million and $294.44 million as at the end of November 2011. Although Barclays Bank continued to operate at a level well above that of CBZ in terms of capitalization, the level of disinvestment and continued falling in the market price per share left a lot to be desired. The year 2012 kicked off with Barclays Bank attaining a market equity base of 61.12c per share in January 2012 to attain 10.29c in February of the same year. The share prices then proceeded to fluctuate in the range of 11.00c to 21.82c, except for the month of September 2012 which recorded the lowest share price of 7.36c for the bank. The market asset value of the bank was $286.03 million in January and $292.5 million in February, before it declined steadily to $260.78 million in July 2012. The bank's asset value fell further down to $248.81 million in August and settled at $269.74 million by end of November of the same year. By end of December 2012 the bank's assets had risen to a value of $274.04 million. The bank's asset values were best in 2010 and lowest in 2012, even though its capitalization continued to outweigh that of CBZ on the ZSE.

Asset Standard Deviation Results for CBZ and Barclays Banks for 2010-2012 (%)

The graphs below represent the asset standard deviations for the two corporations in the period 2010-2012 under consideration.

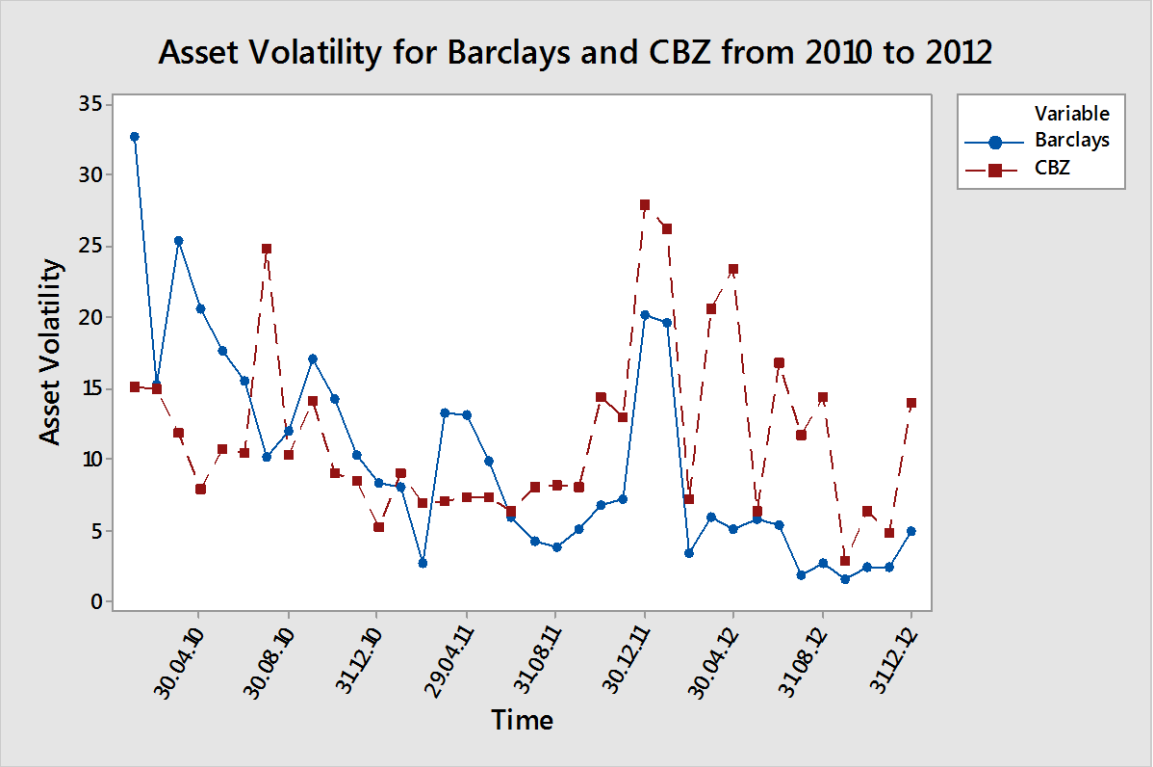

Figure 2. Showing standard deviations for CBZ and Barclays Banks for 2010-2012.
Source: Author's own calculations.

The asset volatilities for CBZ spread between 26.66% in July and 4.98% in December 2010. However the firm's asset volatilities were more stable in the year 2011 recording levels of 8.31% and 11.03% in January and November respectively. However, the asset volatility for the firm rose to an unprecedented level of 32.09% by end of December 2011. In the year 2012 CBZ's asset volatilities fell down to 22.88% by end of January before sharply attaining 6.42% by end of February. On the other hand Barclays Bank attained the greatest asset dispersion of 32.64% at the end of January which sharply fell to 8.32% by end of December 2010. The asset volatility facing the firm continued to fall, making the shareholders' investments more certain and reliable, serve for the months of March (25.32%), April (20.61%), and September (17.01%). The following year 2011 had more consistent and predictable asset volatilities that scored a minimum of 2.69% in February a maximum of 20.20% in December. Barclays Bank's 2012 asset dispersion continued to fall relative to those of years 2010 and 2011. It scored an asset volatility of 19.67% in January realizing a 2.93% in March.

Findings and Discussion on PD Distribution for CBZ and Barclays Banks for 2010-2012 (%)

The PD model adopted by the study was derived from the Black-Scholes (1973) model. The new PD model took the form, PD = $\Phi(-d_2)$ after adjusted for transaction costs denoted by *dv* = dividend payout ratio (given in the complete model above). The Black-Scholes model was founded on the assumption that there were no transaction costs to be incurred on stock or financial markets by investing corporations, institutions, and individuals. The term ($-d_2$) in the new PD model was assumed to be a standard normal distribution score estimated using observable firms' market financial data. The study therefore started off by calculating Z-scores for the selected listed counters on the ZSE for the time period 2010-2012, before proceeding to determine the

firms' PDs one after the other. In this respect the PD model adjusted for transaction costs' effectiveness was compared to that of its predecessors such as Merton's AVM and Black-Scholes models which were based on the assumption that market players did not incur any transaction costs in their financial market transactions.

The following graphs show the PDs calculated using the PD model adopted for both CBZ and Barclays Banks, Zimbabwe for the period 2010-2012:

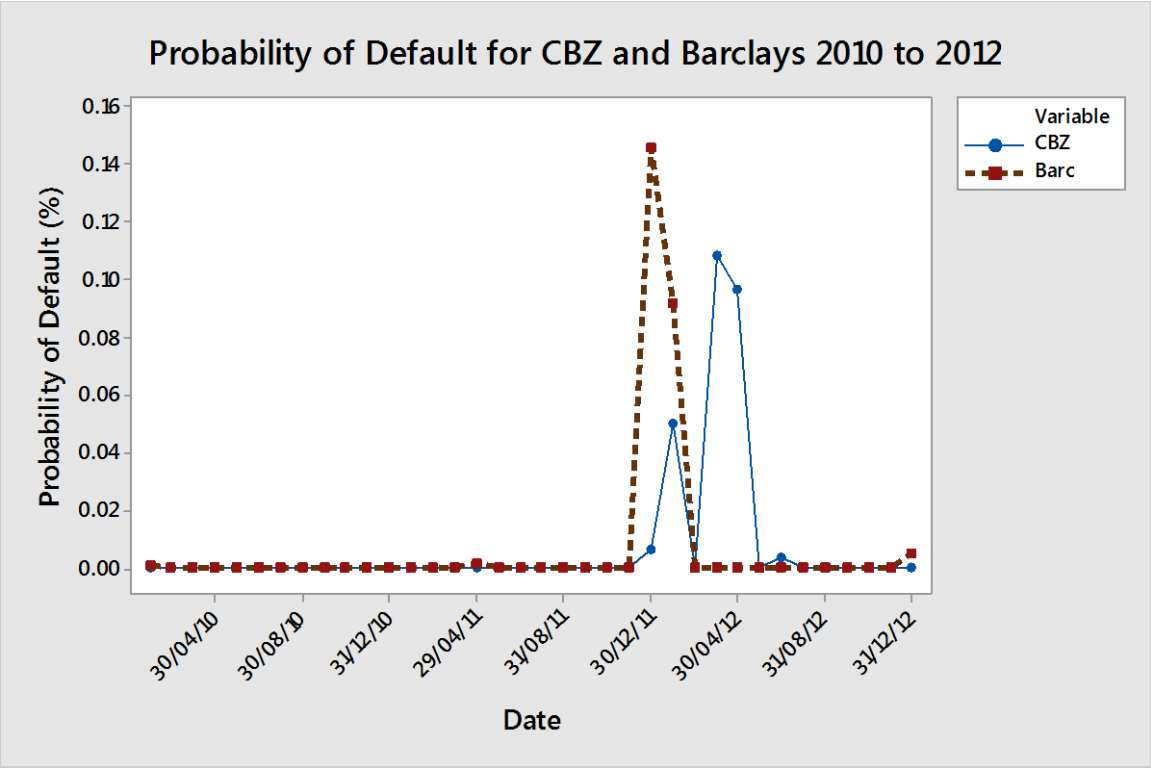

Figure 3. Showing PDs for CBZ and Barclays Bank 2010-2012.
Source: Author's calculations.

The study found out that the PDs of CBZ and Barclays Zimbabwe in the period 2010 to 2011 were almost congruent and very low or 0.00%. The dollarization of the economy was responsible for reducing the domestic inflation rate to a single digit below 5%. The economy's general price level was stable over the two years. The two firms' market capitalization, asset values, and volatilities were very high although those of Barclays were almost double those owned by CBZ which may be due to the nature of shareholders involved. The two financial institutions were found to be competing on equal deposit and investment drives and were giants in credit exposures on local markets. Barclays concentrated on corporate loans which in most cases were delinquent and CBZ on the other side was busy giving out short-term consumer loans to lowly salaried people including civil servants and political heavy weights because it was a government owned bank. Both banks' PDs in the period December 2011 to March 2012 were upward sloping though Barclays' rate was higher than that of CBZ. This could be attributed to the banks' response to continuous mutation by politicians on harmonized elections to bring to an end the Government of National Unity.

The call for elections saw most foreign investors pulling out of the market; loans were concentrated on lowly paid employees in servicing industries whose capacity to pay was very low. The cost of borrowing in the period under review was increasing while civil servants' salaries were very low, stagnant, and far below the

Poverty Datum Line (PDL). Barclays Bank for example by not venturing into consumer loans saw its PD which was far above that of CBZ drastically falling down from 0.15% to 0.00% by Feb. 2012. It was found out that Barclays Bank achieved such a very low PD because it had employed effective risk management strategies, professional credit rating systems of its potential borrowers, revisiting its credit policies, procedures, and standards in line with the concerns of borrowers. On the other hand CBZ suspended its consumer loans with the intention to track on those previously issued non-performing loans since certainty in the economy's financial sector had become oblique.

In the period 30 April to 31 December 2012 we discovered that Barclays Bank maintained a very low PD, and suspended loans to corporate, institutions, and individuals because the economy's future was full of uncertainties. CBZ in the period under review concentrated on offering consumer loans to Salary Service Bureau (SSB) paid civil servants hoping to reduce its PD. The bank's PD rose from 0.00% to 0.10% by end of May 2012 which may be due to its exposure to politicians as earlier on alluded to. The majority of politicians got loans but did not respond accordingly when the obligations became due for settlement. However by June 2012 the bank's PD had fallen down to 0.00%. It was noted that stringent monetary policy strategies and government intervention to rescue the situation in its bank could have led to such a minimal PD that reached the level achieved by Barclays Bank in the period 30 June to 31 December 2012.

Conclusions and Recommendations

The study concluded that a PD model adjusted for transaction costs was more realistic, appropriate, pragmatic, and robust for adoption and implementation in emerging economies such as Zimbabwe where most transactions were performed manually giving rise to huge transaction costs whose bearing on firm value was very significant. Hence the new PD model stood firm relative to some of its predecessors such as the Merton (AVM) and Black-Scholes models which perhaps suited very well efficient market conditions and advanced technological levels that prevailed in developed economies. It was therefore postulated that because of different economic conditions countries of the world faced, it was critical that credit risk management models adopted and implemented by banking corporations as per Basel Capital Accords II and III were adjusted for market friction faced on the domestic markets of operation. The study concluded that credit ratings, volumes of exposures, and estimated PDs were different for international and indigenous commercial banks operating in Zimbabwe in the multiple currency regime.

The research study also concluded that Zimbabwe needed to urgently come up with economic policies that were rational, consistent, and prudential if its desire to turn the fortunes of the economy around was to be turned into a reality soon. The country's ZSE capitalization and financial soundness were entirely dependent on capitalization, investment levels, and sustainability of listed firms with specific reference to banks and similar financial institutions. The study also concluded that Zimbabwean banks needed to be better capitalized through wider asset bases and minimal asset volatilities in their desire to advance their market shares and grow the economy through sound corporate governance and prudential business ethics. The study also concluded that PDs experienced by both banks from January 2010 to June 2012 were very marginal numerically, implying that the banks had benefited from dollarization and their credit exposure business. It was also concluded that low levels of PDs enabled banks to draw nearer and nearer to meeting their Central Bank minimum capital requirements since they were able to recapitalize interests drawn from their loaning businesses.

The study further concluded that the banks' performance in 2011-2012 period could have been affected by government actions for example pending elections and economic policies such as the indigenization and economic empowerment act, corruption, nepotism, preferences and tastes of consumers, general price level, salaries and wages, crowding out of the private sector's and lack of foreign direct investment(FDI). CBZ was used by the government in funding of Constitution Making Process in preparation for harmonized elections a development that affected its operations seriously. Some of the financiers of the Constitution Making Process had withdrawn due to political interventions in the process. The banks' probability of moving closer to meeting the Reserve Bank of Zimbabwe (RBZ)'s minimum capital requirements massively decreased in the period under review. The study finally concluded that all Zimbabwean banks needed to be independent and autonomous in order to be free to adopt and implement an AVM model adjusted for transaction costs in their credit exposure business if they were to grow and develop in their financial services provision to the nation.

The study came up with a number or recommendations if the economy's financial sector was to attain prudence, efficiency, effectiveness and market discipline in its service delivery to the nation. Banks should put in place credit risk management techniques or models which can respond to any market information swiftly in order to reduce their PDs. It was also recommended that both public and private banks needed autonomy and independence if they were to operate to attain the traditional objectives of profit maximization and wealth generation for their shareholders as well as meet the minimum capital requirements set by the Central Bank (RBZ in this case). Policies such as the Indigenous and Economic Empowerment Act (IEEA) which was retrogressive should not be enacted targeting the financial sector if the domestic economic environment was to be conductive to luring FDI needed for growth and development of the economy. The RBZ, as the regulator and supervisor of banks, needed to be autonomous in order to direct the economic activities of the country in a prudent, rational, and effective manner.

Zimbabwean listed commercial banks were encouraged to adhere to the Basel Committee recommendations and King II Stipulations on Ethics and Corporate Governance in their desire to grow and develop market shares in the domestic economy. It was also recommended that all domestic banks should join the global financial market system in their desire to improve their capitalization and number of financial assets they owned through reaching out to foreign investors. Banks needed to diversify and reach out to players in various sectors of the economy to avoid the risk of concentration on specific economic sectors. Economic sectors' failure would translate into higher PDs for banks. Internal banks were advised to put in place efficient and effective risk management models and Credit Rating Bureaus (CRBs) and policies that were to be adhered to in order to avoid loaning to borrowers who were not creditworthy.

References

Black, F., & Scholes, M. (1973). The pricing of options and corporate liabilities. *Journal of Political Economy, 81,* 637-659.

Buhm, C., Overbeck, L., & Wagner, A. (2003). *An introduction to credit risk modeling*. New Delhi: Chapman and Hall/CRC Financial Mathematics Series.

Crouhy, M., Galai, D., & Mark, R. (1998). *A comparative analysis of current credit risk models*. Toronto: Canadian Imperial Bank of Communication, MRM 162.

Crouhy, M., Mark, R., & Galai, D. (2001). *Risk management.* New York: Mc-Graw Hill.

Duffle, D., Saita, L., & Wang, K. (2007). Multi-period corporate default prediction with stochastic covariates. *Journal of Financial Economics, 83,* 635-665.

Hamilton, D. T., & Cantor, R. (2006). *Measuring corporate default rates.* New York: Special Committee.

Hanson, S., & Schuermann, T. F. (2005). *Confidence interval for Probability of Default.* New York: Reserve Bank of New York.

Hull, J., Predescu, M., & White, A. (2009). The valuation of correlation-dependent, credit derivatives using a structural model. *Journal of Credit Risk, 6*, 99-132.

Hull, J., & White, A. (2008). Dynamic models of portfolio credit risk: A simplified approach. *Journal of Derivatives, 15*, 9-28.

Kalemanova, A., Schmidt, B., & Werner, R. (2007). The normal inverse Gaussian distribution for synthetic CDO pricing. *The Journal of Derivatives, 14*, 80-94.

Kolb, R.W. (2010). *The global financial crisis, analysis and policy implications.* New York: John Wiley and Sons Ltd.

Leland, H. E. (2004). *Predictions of default probabilities in structural models of debt.* New York: University of California.

Leland, E. L., & Toft, K. L. (July 1996). Optimal capital structure, endogenous bankruptcy, and the term structure of credit spreads. *The Journal of Finance, 51*(3), 987-1019.

Li, D. X. (2000). On default correlation: A copula function approach. *Journal of Fixed Income, 9*(4), 43-54.

Lingren, F. A., & Ceik, M. (2009). International adoption of Basel II in a Centralized Bank (Thesis, University of Gothemburg, 2009).

Longstaff, F. A., & Schwartz, E. S. (1995). A simple approach to valuing risky fixed and floating rate debt. *The Journal of Finance, 50*(3), 789-819.

Masatoshi, M., & Hiroshi, I. (2009). *A default probability estimation model: An application to Japanese companies.* Tokyo, Japan: Kuki-Shi Saitama.

Memmel, C. (2012). Discussion paper, the common drivers of Default Risk. *Deutsche Bundesbank Number 36/2012.*

Merton, R. C. (1974). The structural approach to asset-option pricing. *Journal of Finance, 29*, 449-470.

Oksendal, B., & Sulem, A. (2009). *Applied stochastic control of jump diffusions.* New York: John Wiley and Sons Ltd.

Risk Consulting Group. (2000). *Credit risk tool box.*

Simons, D., & Rolwes, F. (2009). *Macroeconomic default modeling and stress testing.* Netherlands: De Nederlandsche Bank.

Appendices

Table A1

Monthly Asset Values for CBZ for 2010-2012 ($ Millions)

Month		J	F	M	A	M	J	J	A	S	O	N	D
Asset value	2010	167.5	154.4	157.2	143.6	143.6	140.1	147.7	150.4	129.9	139.5	153.8	150.4
	2011	175.3	192.4	189.0	189.0	189.0	189.0	168.5	168.5	160.3	161.6	141.1	161.6
	2012	141.6	128.0	117.6	124.6	134.8	142.4	148.5	148.5	148.7	162.2	148.5	148.5

Table A2

Monthly Asset Values for Barclays Bank for 2010-2012 ($ Millions)

Month		J	F	M	A	M	J	J	A	S	O	N	D
Asset value	2010	417.9	331.8	353.3	331.8	331.8	310.3	366.6	355.8	366.6	373.1	355.9	355.9
	2011	348.7	334.7	323.7	302.4	313.1	302.4	320.1	320.3	341.8	309.5	294.4	283.7
	2012	286.0	292.5	282.1	275.9	271.3	260.8	287.0	284.8	277.2	277.2	269.7	274.0

Table B1

Monthly Asset Standard Deviations for CBZ for 2010-2012 (%)

Month		J	F	M	A	M	J	J	A	S	O	N	D
Asset deviations	2010	14.84	14.80	10.91	7.18	10.72	10.37	26.66	8.99	12.42	12.42	9.71	4.98
	2011	8.31	8.16	6.50	8.66	6.52	6.52	7.06	8.24	7.20	14.94	11.03	32.09
	2012	22.88	6.42	18.91	16.95	7.03	14.24	12.49	14.74	2.31	6.26	4.64	14.28

Table B2

Monthly Asset Standard Deviations for Barclays Bank for 2010-2012 (%)

Month		J	F	M	A	M	J	J	A	S	O	N	D
Asset deviations	2010	32.64	15.31	25.32	20.61	17.63	15.56	10.21	12.06	17.01	14.31	10.32	8.32
	2011	8.15	2.69	13.28	13.17	9.90	6.04	4.31	3.91	5.14	6.76	7.22	20.20
	2012	19.67	3.41	5.93	5.12	5.84	5.40	1.86	2.69	1.66	2.50	2.52	4.99

Table C1

Monthly PDs for CBZ for Years 2010-2012

Month	2010	2011	2012
J	$1.1433*10^{-13}$	$4.2102*10^{-16}$	4.9960
F	$8.1634*10^{-13}$	$8.4414*10^{-34}$	0.000013
M	$3.2095*10^{-20}$	$1.6702*10^{-34}$	10.8297
A	$4.2734*10^{-39}$	$9.0182*10^{-28}$	9.6430
M	$6.6582*10^{-21}$	$4.4920*10^{-40}$	$5.7609*10^{-9}$
J	$2.3835*10^{-20}$	$4.4920*10^{-40}$	0.3477
J	0.001633	$1.8844*10^{-20}$	0.001023
A	$2.7348*10^{-25}$	$4.0557*10^{-17}$	0.029507
S	$2.5848*10^{-9}$	$4.0184*10^{-19}$	$3.65112*10^{-110}$
O	$4.8470*10^{-27}$	0.000065	$2.378886*10^{-18}$
N	$2.3767*10^{-35}$	0.00461	$1.156244*10^{-22}$
D	$1.0864*10^{-101}$	0.6694	0.0191426

Table C2

Monthly PDs for Barclays Bank Zimbabwe for Years 2010-2012 (%)

Month	2010	2011	2012
J	0.0859997	$2.319563*10^{-9}$	9.173235
F	$2.567*10^{-6}$	$4.795948*10^{-75}$	$3.24664*10^{-18}$
M	0.0268022	0.0293302	0.0005141
A	0.0031466	0.15903222	0.00014364
M	0.00012412	0.00080078	0.0069356
J	0.00105946	$3.0742188*10^{-9}$	0.0351166
J	$1.1228686*10^{-7}$	$1.0135312*10^{-1}$	$2.825889*10^{-19}$
A	0.00007944	$5.0064876*10^{-1}$	$2.814579*10^{-8}$
S	0.0202571	$1.524206*10^{-14}$	$1.646973*10^{-18}$
O	0.00047987	0.0001097	$4.516607*10^{-8}$
N	$5.1118447*10^{-7}$	0.009386	0.000417176
D	$5.208649*10^{-11}$	14.5746	0.5403062