

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND
TECHNOLOGY, KUMASI

COLLEGE OF SCIENCE
DEPARTMENT OF MATHEMATICS



MODELLING PROBABILITY OF DEFAULT FOR MICROFINANCE
INSTITUTIONS USING THE COX PROPORTIONAL HAZARD MODEL

By

Daniel Asare Akuffo
(BSc. Actuarial Science)

A THESIS SUBMITTED TO THE DEPARTMENT OF MATHEMATICS, KWAME
NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY IN PARTIAL
FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MSC
ACTUARIAL SCIENCE

May 20, 2019

Declaration

I hereby declare that this submission is my own work towards the award of the MSc. degree and that, to the best of my knowledge, it contains no material previously published by another person, nor material which had been accepted for the award of any other degree of the university, except where due acknowledgement had been made in the text.

Daniel Asare Akuffo (PG7043916)

Student

Signature

Date

Certified by:

Mr. Derrick Asamoah Owusu

Supervisor

Signature

Date

Certified by:

Prof. Mrs. A.O. Adebajji

Head of Department

Signature

Date

Dedication

I would like to dedicate this project to the Almighty God and my family.

Acknowledgements

I would like to thank the almighty God who ensured my well being and provided immense inspiration throughout this project. I would also like to acknowledge the immense support of my supervisor and lecturer, Mr Derrick Owusu Asamoah. I would also like to thank Dr. Atinuke Adebajji for her encouragement throughout this whole course of study.



Abstract

In the developing countries, Small and Medium Enterprise (SMEs) has been the main engine for the needed economic growth and development. In Ghana, few work has been done on the determinants of default for microfinance institutions. The loan default by clients with its consequences within of the MFI environment in Ghana is additionally not explored. This study attempts to determine the impact of borrower characteristics on default probability changes over the life of a loan by using Survival Analysis technique. Data was acquired from the XDS Credit Bureau (authorized by the Bank of Ghana) with variables such as Time (period in months), gender of customers, amount overdue, months in arrears and age of customers. Survival Analysis was utilized to investigate the extent of covariates on default over time and to predict the probability of the default in Non-Banking Financial Institutions (Micro-finance Institutions). The cox proportional hazard regression model was used to further explain the probability of default in Non-Banking Financial Institutions in Ghana. This work demonstrated that the variables amount overdue (2.537), months in arrears (4.084), age (3.542) and gender (4.016) have highly statistically significant coefficients. There is a significant distinction between the default for male and female customers, in truth showing that Females have higher risk of defaulting than their male counterparts. This subsequently leading us to conclude that Gender, Month in arrears and Amount overdue does indeed determine the chance of defaulting in Non-Banking Financial Institutions in Ghana. This study concluded that older age, higher months in arrears and higher amount overdue are associated with poorer survival (default).

Contents

Declaration	i
Dedication	ii
Acknowledgment	iii
Abstract	iv

List of Tables	viii
1 Introduction	1
1.1 Background of Study	1
1.2 Problem Statement	3
1.3 Objectives	4
1.4 Methodology	4
1.5 Scope of Study	5
1.6 Justification	5
1.7 Limitation of the Study	5
1.8 Organization of the Study	6
2 Literature Review	7
2.1 Introduction	7
2.2 The Microfinance Story	7
2.3 The Micro Finance Industry in Ghana	10
2.3.1 Segment Two	11
2.3.2 Segment Three	11
2.3.3 Segment Four	11
2.4 Related Literature	12
2.5 Management of MFIs in Crisis	13
2.6 Survival Analysis	15
2.7 Survival Models	15
3 Methodology	19
3.1 Introduction	19
3.2 Survival Analysis Setup	19
3.3 Survival Function $S_x(t)$	19
3.4 Hazard Function $h_x(t)$	20
3.5 Non-Parametric Model	20
3.6 Semi-Parametric model	21

3.6.1	Cox Proportional Model	21
3.6.2	Test of Cox danger proportionality (Schoenfeld test)	24
3.7	Probability of Defaults	25
4	Analysis	26
4.1	Introduction	26
4.2	Data Supply and Design	26
4.3	Variables Description	26
4.4	Statistics of Data	27
4.5	Kaplan-Meier Model	27
4.6	Cox Proportional Hazard Model	30
4.6.1	Regression Coefficients	30
4.6.2	Hazard Ratios	31
4.6.3	Test of Proportional Hazard Assumption	32
4.7	Determining Probability of Defaults	34
5	Conclusion	36
5.1	Introduction	36
5.2	Summary of Findings	36
5.3	Recommendation	36
	References	38

List of Tables

3.1	Non-Parametric model Table	20
-----	--------------------------------------	----

KNUST



Chapter 1

Introduction

1.1 Background of Study

Default in the Basel system is characterized as the risk that a borrower will neglect to reimburse a sum owed to a bank which is reflected in the sum past due and the time (in days) for which dispensing the facility is postponed (Basel Committee on Banking Supervision, 2005). The demise of indigenous banks has set back efforts at ameliorating indigenous Ghanaian Businesses to control our economy by structurally building solid institutions. Bank of Ghana in the Banking Sector Report (January 2018) uncovered that Bank's load of non-performing advances had expanded to GH8.58 billion from GH6.14 billion from December 2016 to December 2017. This as indicated by the report has brought about the moderate downing of Banking industry advances from 17.6% in December 2016 to 6.4% in December 2017. This is a noteworthy difficulty to Economic development for a nascent and burgeoning nation as Ghana.

In third world countries, Small and Medium Enterprises (SMEs) have been a principal motor for much required financial development and improvement (Floyd and McManus 2005). A burgeoning SMEs sector in part is critical to ensure consistent advancement and monetary development for these countries. (Berger and Udell 2006). The official census conducted in 2010 on Population and Housing revealed that a significant percentage of 93.1% of the working populace are found in the self owning private segment of businesses (Ghana Statistical Service, 2012). This working populace has difficulties in obtaining borrowing facilities which hinders the advancement of that casual segment of the economy. Commercial banks are hesitant to provide credit to SMEs primarily due to the absence of security that can be utilized as a guarantee in customary practice.

These banks, so as to manage the high rates of Non-performing advances within a comfortable risk appetite propose stringent hazard appraisal criteria in screening credit candidates upsetting the development of SME's. The Ghana Growth and Poverty Reduction Strategy Two, (GPRS II) has as it's mandate to ensure that the nation accomplishes among others reasonable economic developments with minor turbulence, decelerate destitution and to guarantee assurance of the marginalised under a decentralized and transparent based system. This approach was adopted to diminish as much as possible general neediness and was also driven towards the expansion of salary bands with emphasis among the poor which speaks to the more noteworthy extent of the working masses. The marginal growth of MFIs in the nation throughout the decade has been in part due to the opportunities that it affords regular citizens mainly through credit availability as a method for running or setting up a start-up due to the simplicity of getting advances or administrations.

The MFIs have turned out to be continuously associated with giving monetary administrations to Small and Medium scale Enterprises (SMEs) with emphasis on the decrease of destitution and the financial survival of the most unfortunate of poor people.

As indicated by an investigation in Kenya which has comparatively similar money related and banking difficulties as Ghana, the default rate inside the MFI segment is generally higher contrasted with universal banks, with default rates spanning from 10% - 20% while universal banks have under 5% default rate (Kiraka et al., 2013).

In any case, between 2013 to 2018, Ghana has seen an extraordinary breakdown of MFIs. Disregarding the processes they have undertaken to meet the fundamental requirements for authorization by the Bank of Ghana (Addo, 2014). It is in this regard that this investigation, looks at the likelihood of default among MFIs in Ghana after they have obtained these loan facilities and the factors that result in their default.

1.2 Problem Statement

The worldwide financial debacle commencing in 2008 has put the investigation of bank lending defaults high on the planning horizon of institutional oversight bodies. In August 2017, the Bank of Ghana (BoG) declared the demise of two nearby banks (UT and Capital banks) since they were "profoundly insolvent." after a year, the BoG pulled back the general banking licenses of five other exclusive indigenous-owned banks, and issued a permit to a recently enacted body – Consolidated Bank Ghana (CBG) Limited, to continue their businesses. The banks are BEIGE, Sovereign, Construction, UniBank and The Royal Bank. The point of microfinance is the arrangement of monetary advances to the low-salaried and the poor family units (Bystrom, 2007).

Advances portfolio presents the biggest working resources and financing for most MFIs (Proctor, 2003). In spite of the development of the microfinance industry, MFIs are overrun with numerous default issues which represent a genuine stress test to MFIs going concern. A paper issued by The Bank of Ghana (BoG) opined that the repudiation of transitory permits of 70 microfinance organizations, the demise of 30 MFIs and 211 dynamic yet troubled or likely to collapse out of a total of 566 MFIs authorized as at 2018. Forefront highlights including Noble Dream Microfinance,

Eden Microfinance, DKM Microfinance; God is Love Microfinance, Lord Winners Microfinance among others. The possibility that a microfinancing institution (MFI) may not obtain principal funds administered borrowers (in addition to premium) is to much consensus a position of defenselessness for most in the microfinance institutions and may unfavorably influence the opportunity for monetary gains by the micro-finance institutions. Irrespective of the instance where defaulting is arbitrary and a product of whimsical conducts of borrowers or whether it is affected by specific factors in a particular circumstance, in this manner, needs an exact examination with the goal that the discoveries can be utilized by micro financing institutions to control their credit programs to improve the current turmoil (Buvinic, 1997). Measurable models from survival examination are being proposed in budgetary hazard by the executives of these institutions as elective

instruments to show inner hazard parameters, as per advancement upgrades requested by the Basel II framework. This was requested basically due to persistent recurrence of failures in the institutions. (Louzada-Neto, 2006; Malik and Thomas, 2009; Thomas, 2010; Bonini and Caivano, 2013).

This sets up the bearing for this exploration to investigate the likelihood credit default by customers with its outcomes inside the MFI condition in Ghana

1.3 Objectives

The study sought to resolve the following specific objectives;

1) To evaluate and investigate the extent of covariates on default over time. 2) To develop a model to predict the probability of the default in Non-Bank Financial Institutions (Micro-finance Institutions) in the course of the loan being taken .

1.4 Methodology

This study employs Kaplan-Meier non-parametric analysis, Cox Proportional Hazard model in modeling the probability of default in Non-Banking Financial Institutions in Ghana.

Based on the objective of the research, we employed a data on defaults in NonBanking Financial Institutions (Micro-finance Institutions) from XDS Credit Bureau (authorized by the Bank of Ghana) in modeling the probability of default. The modeling process was aided by MS EXCEL and R software.

1.5 Scope of Study

This examination is planned to aid officials of most microfinancing institutions recognize the elements that may provoke the demise or fall of their organisations and take no chances based on scientific research to avoid the occasion of any avoidable winding-ups. It moreover seeks to discover the effect this disappointment has on clients of the organisations. The governing body will end better informed of the issues overlooked by most of these microfinances and give fitting interventions to such issues. The results of the examination would in like manner be used in defining ways to ensure effective assessment of request for financing by clients to the MFI's and deal with unnecessary losses to the microfinances. The examination therefore contributes to the increasing plethora of literature in the microfinance niche.

1.6 Justification

The examination narrows it's lenses on the massive failure of the microfinance industry in Ghana. The substance of this paper also focuses on the elements that prompts defaulting in Non-Banking Financial Institutions (MFIs), while distinguishing the association of factors to manage the subtle demise of the industry.

1.7 Limitation of the Study

This exploration has recognized among others the accompanying confinements were encountered:

- 1) The reluctance of the executives of MFIs to discharge data which ought to have enhanced the examination and furthermore settled a solid legitimacy and reliability.

2) Another significant constraint was the way that a solitary analyst gathered and investigate the information. Along these lines, a few clarifications might be skewed toward individual translations which may contort the significance of the results.

3) Furthermore, it is hard to get to certain data that might be valuable for the exploration. What's more, the specialist needs to consolidate scholastic work with his standard profession.

4) The outcomes distinguished may not be illustrative of the Microfinancing framework, since it is skewed toward specific Microfinance Institutions from which the Credit Bureau obtained data. However, it gives helpful surmising to the Microfinance condition.

1.8 Organization of the Study

The rest of this thesis is organized as follows:

1)Chapter two provides a synopsis of the relevant literary material and the theatrical background on credit scoring, credit availability model and loan pricing model. 2) Chapter three lays emphasis on the empirical models, the techniques for estimation of the data points, the data, and the data collection strategy.

3) Chapter four documents the results of the study and a review of the results generated by the analysis.

4) Chapter five summarises the major findings of the research, conclusions and recommendations for the future study.

Chapter 2

Literature Review

2.1 Introduction

This chapter depicts a general synopsis of the relevant literature and the theatrical background on credit scoring, credit availability model and loan pricing model.

2.2 The Microfinance Story

The authentic background of microfinancing is documented as far back as to the focal point of the 1800s when the subject matter expert Lysander Spooner was glossing the various pros from little small holder schemes to business magnates to farmers as a way reflecting over the all encompassing community out of destitution. In any case, it was close to the summary closure of World War II with the introduction and implementation of the Marshall plan, the thought had a noteworthy impact.

Presently the usage of the coinage micro financing has its basic establishments typically in the seventies when connections, for example, the then established Grameen Bank of third world Bangladesh giving the support of concept developer Mohammad Yunus, spearheaded the evolution and entrenchment of the business concepts of microfinancing were established. Another significant spearheader here is Akhtar Hameed Khan. Circa this period the further engrainment of microfinance exercises carried somewhat varied advancements into this space. Many innovative undertakings began investigating diverse roads with respect to the advances to the underserved people. The key moving factor behind the concept of microfinancing can be traced back to the 1970s where the enterprises manned by people, demonstrated extreme reliability to repay back tranches of advancements serving as a green light that it's possible to give funds to desperate people through market-based undertakings without much disappointment. A significant market

pioneer in the institutional personality of ShoreBank was essential in the system progression. This was convened then in Chicago in 1974.

Meanwhile a write-up on the evolution of monetary schemes at the Ivy league school, Yale propounded by a student named Timothy Guinnane who had been doing an academic write up on Friedrich Wilhelm Raiffeisen's propoundment of town bank improvement in Germany which started in 1864 and constantly 1901. The bank had successfully accomplished the disbursement of loans to 2 million provincial farmers. In doing this the legendary Timothy Guinnane propounded that it was progressive that a scheme like microcredit could sail through the two criteria concerning social orders reward moral and the probability to give monetary help to poor people.

Another significant proponent to this cause, The Caisse Populaire movement further entrenched by stalwarts Alphonse and Dorimène Desjardins who resident in the Canadian province of Quebec, could not overemphasize the retrogressive state of poverty and concluded over the two criteria. Significantly over the period 1900 to 1906 when they convened and proved the first 'Caisse', they issued a directive controlling them in the Quebec environs, where they personally invested significantly private with much confidence and statistical certainty with regards to the microcrediting.

The World Bank currently appraises that upwards of 16 million people are rightfully catered to by approximately a whopping 7000 microfinance associations all throughout the globe. Subject matter experts in the CGAP league infer that around 500 million families are direct beneficiaries of little advances given the green light for more microcredit ventures to partake in the niche. At a gathering summit in Washington DC, where microcredit units convened, a target of a 100 million of the world's most unfortunate people who up to this point would purchase credit from the leading pioneers and major gargantuan financial houses was set.

To give credence to the burgeoning industry, the year 2005 was christened, the International Year of Microcredit. This was done by The Economic and Social Council of the United Nations in a bid to throw more light and eventually more investment with the aim of bridging the poor-rich gap around the globe.

After this exceeding success the financial aspects stalwart Mohammad Yunus and the pioneering institution of Grameen Bank were duly recognized and immortalised by the Nobel Prize of 2006 for their contributions. The official write up by nobelprize.org states:

"The Committee on the Norwegian Nobel Prize" conceded the Nobel Peace Prize for 2006, apportioned into two comparable measures, to Muhammad Yunus and Grameen Bank for their enormous resolve to make monetary and social improvement from the lower echelons of society. Enduring congruity can not be cultivated aside from if huge masses clusters find habits by which to emerge from ground breaking destitution. Micro-credit is a significant tool to bridge the divide. Real improvement would have to emanate from underneath to drive greater goal for ruling by government and human rights. The stalwart Muhammad Yunus is depicted as being a pioneer who has unravelled the elucidation of dreams into rational action to help teaming numbers of people, especially in third world countries with Bangladesh being a highlight. Credit to the vulnerable and marginalised in society who essentially haven asset related security had radiated an impression of being an unfathomable idea. From inconspicuous conception spanning three decades, Yunus as an issue of first significance through Grameen Bank, framed the concept of micro-crediting into a great panacea in the fight against destitution. Grameen Bank has also housed all the brilliant conception and models of the various foundations in the field of micro-credit that around the globe.

It is conceptualised and underlining that all homo sapiens have the desire to flourish and continue and that there in lies the potential. Across over social orders and human

progressions, Yunus and Grameen Bank have exhibited that even the most unfortunate of the poor can work to understand their own one of a kind development.

Micro-credit has wound up becoming a basic liberating power in social settings where women, explicitly, need to fight against harsh social and monetary conditions. Financial improvement and political larger part rule government can't achieve their most extreme limit aside from if the female bit of mankind takes an enthusiasm on a proportional equalization with the male.

Yunus' whole deal vision is to discard poverty on the planet. That vision can't be recognized by strategies for micro-credit alone. Regardless, Muhammad Yunus and Grameen Bank have exhibited that in the procedure with undertakings to achieve it, micro-credit must have a significant impact."

2.3 The Micro Finance Industry in Ghana

The microfinance concept, is anything but a nascent one in Ghana and other sub-saharan countries. (Ikechukwu, 2012). By and large, scores of people have vested funds and taken little credits under social affairs inside the setting of personal development to start organizations or cultivating attempts. Anecdotal reports suggests that the essential Credit Association in Africa was developed in Northern extents of Ghana by Canadian Catholic Evangelists in the year 1955 (Asiama and Osei, 2007).

An endearing money conservation concept, Susu, serving as a significant microfinance strategy, is thought to have been conceptualised in Nigeria before crossing borders to Ghana mid nineties. This was clearly elucidated by Littlefield et al (2003), as referred to in (Brefo, 2009). Microfinancing has without doubt transitioned over four

(4) particular segments . These segments are depicted underneath by the Ministry of Finance - Ghana.

Segment One

This segment was distinguished by the course of action of finance credit schemes by the sovereign from the fifties when it was highly anticipated that the non-attendance of money was significantly a deterrent to the end of destitution. This segment was not productive and demonstrated ineffectual in light of the rule that "penniless people require a collection of money related organizations not just credits". In like manner, the disappointment of this stage to offer reliability to the next correlative help, for example, funds, capacities preparing, etc rendered this stage inadequate.

2.3.1 Segment Two

The second segment included the game plan of micro-crediting chiefly through NGOs who served as middle men to channel funds to the poor during the 1970s. Amid this period, manageability and monetary self - sufficiency were up 'til now not contemplated objective. This stage unnecessarily depended upon outside guide without thinking about its revival for capability and suitability.

2.3.2 Segment Three

In the 1990s the formalization of Microfinance Institutions (MFIs) began. This is the segment within which the conceptualisation of the MFIs as a business commenced. The stage concentrated on the verification and enshrinement of the concept as well as the sovereign's formalization.

2.3.3 Segment Four

This segment was pursued to the mid-1990s when MFIs saw commercialization and thus picked up noticeable quality. MFIs were along these lines mainstreamed into the money

related division and are at present seen as a sub-part of the budgetary area, involving most unique monetary institutions which use a particular budgetary procedure to go to poor people.

2.4 Related Literature

The precise examination of writing attracts allow particularly by picking up learning through prompt and roundabout discernment or experience. The winding-up of the modernistic Microfinance Institution has been widely attributed over different possible failings. Meanwhile further investigations down to the minutest of details regarding microfinance institution (MFI) disappointments is missing (Siwale and Ritchie, 2011).

Anecdotal spanning a number of practicing countries suggests that the demise of MFIs are as unbelievable as their triumphs. In Nigeria, the ever expanding rate at which microfinance and mid-sectionbanks (MFBs) were winding-up, made the Central Bank of Nigeria resulted in the amazing apathy of the regulator towards their demise. This resulted in significant constraints to National Association of Microfinance Banks (NAMB), the chapter belonging to the Lagos State, resulting in the birth of an Intervention Fund in 2010 investing MFBs monetary necessities (Vanguard, 2010).

In Zimbabwe, in 2014, the Zimbabwe Association of Microfinance Institutions (ZAMFI) undertook an endearing campaign admonishing the Zimbabwean sovereign in fighting against store taking microfinance institutions. By February of that year, a whopping 147 MFIs were enrolled by the Reserve Bank of Zimbabwe (RBZ), the country's national bank. Significantly no institution was approved to take stores due to variations from the norm in the system, as tricky MFIs kept on deceiving individuals when all is said in done. It further prompted the demise of the Microfinance Act in August 2014 to coordinate the activities of MFIs (MicroCapital, 2014; The Standard, 2014).

In Zambia however, the promulgation of Rural Initiatives and Development Enterprises (PRIDE Zambia or PZ), a once bustling and vibrant Zambian MFI significantly declined in 2009 while trying to finish up as an income driven MFI (Siwale and Ritchie, 2011). Morocco, Nicaragua and even India have all observed money related crisis leading to massive winding-up of MFIs (Wichterich, 2012; CGAP, 2013)

2.5 Management of MFIs in Crisis

Foundational banking emergencies is a result of a loss of trust in a generous bit of the banking framework, sufficiently genuine to create severe unwanted consequences for the genuine economy thereby affecting the installments framework, credit streams and decimation of asset esteems (Hoelscher, n. d.). Methodological imperfections, normal fakes in the executives, unregulated development, activities in burgeoning markets outside of the microcredit net, slack doling out of funds to unsuspectingly unworthy clients and frail risk control frameworks have been referred to among others as the conceivable reasons for banking wind-ups (Hoelscher, n. d.; Mariana, 2015).

Crisis in the microfinance terrain have agonisingly turned into a stream of stress and worry to the partners of MFIs. In any case, emergencies the board in MFIs has ended up being fruitful in a few nations. A case in point was the Moroccan Microfinance debacle which started in 2007 (CGAP, 2013).

A league named the Consultative Group to Assist the Poorest (CGAP) report revealed that the burgeoning microfinance segment in Morocco was for 10 years, thought about as a promising industry. The sector took a favorable position of exceptionally high-ranking institutions bolstered by subject matter experts and international investors.

The Moroccan debacle was, as in the report, the result of a sharp advancement of their cumulative loan portfolio, which stood at a whopping recognisable ration of USD733 million to 1.35 million in assets over the period spanning from four years from 2003. In this regard, it metamorphosed into the grandest scheme in the whole of the Middle East and North Africa. Competition within the industry also culminated in significant borrowing on the part of the general populace. A general estimate of 40% was assigned as the percentage of customers who collected facilities in a few MFIs, which inadvertently resulted in the steep amelioration of the general credit risk to 13.7% in 2009.

The Central Bank of Morocco, at the initial stage of the debacle, the Bank AlMaghrib (BAM), the Ministry of Finance and other significant organisations and fund groups resolved to assemble funds to restore the sanity and certainty about the market. BAM in other to resolve the crisis implemented an immediate strategy of regular engagements with the MFIs to enhance their supervisory roles. BAM and the Ministry of Finance determined the criteria for honoring of credit requests to customers of MFIs. Also as an aspect on contingencies to mitigate the crisis, ARDI, a subsidiary MFI upheld by the sovereign Enterprise Crédit Agricole was borne by the Central Bank to entrench the structures of small MFIs by assisting to ensure the board framework. The Government in this regard deserve plaudits due to their speedy amendment and enhancement of regulatory machinery and sophisticated policy directives.

With the resolve to greatly expand the liquidity status of the MFIs, the sovereign, in February 2013, submitted other policy measures which allowed non-legislative MFIs (NGOs) to hold concessions in microcredit organizations.

Despite these significant administrative arrangements, the MFIs as well made very significant strides. They took a shot at improving their own frameworks by engaging

committed recuperation groups, taking legitimate actions against recalcitrant clients and the creation of an information platform for customer boycotts and assets.

Despite the fact that, recuperation was delicate, the other resolutions went a long way to guarantee the going concern of MFIs in this country. The Moroccan strategy provided very useful tips in the regulatory environment of MFIs.

2.6 Survival Analysis

Survival investigation as of late has increased more unmistakable quality. Truly, survival investigation was utilized in the therapeutic environment just as in designing, where the time length until an occasion is broke down, for instance the time until death or machine disappointment (See Kalbfleisch and Prentice, 2002; Collett, 2003; Cox and Oakes, 1984)

Measurable models from survival investigation are being proposed in monetary hazard the executives as elective devices to demonstrate interior hazard parameters, as indicated by advancement upgrades requested by the Basel II Accord. This is altogether because of the reason that survival procedures can do consistent checking of hazard after some eras in a financially liquid related institution (Louzada-Neto, 2006; Malik and Thomas, 2009; Thomas, 2010; Bonini and Caivano, 2013).

As an option in contrast to calculated relapse, Narain (1992) first presented utilizing survival examination in the credit hazard setting.

2.7 Survival Models

Survival investigation is usually portrayed as a great deal of systems for detailing algorithms of data where the result indicator is determined as the period till demise occurrence being occasion of prime interest. The identifier could be the passing, the occasion of a sickness,

union, discrete, etc. The opportunity to occasion or period of success can be over varying time ranges. A case in point is the occasion of intrigue is a on the chance of cardiac stoppage, the period till survival can depicted in years until an individual develops a cardiac stoppage.

In the depiction of survival ranges, the points of study are ordinarily pre-ordained given a time range with accentuation on the span or intrigue. A possible question could be asked as to Why not use direct relapse to demonstrate the spanned period as a limit of a great deal of pointer factors? It can be said that, span of observations are conventionally positive in numbering; regular direct relapse will not specifically achieve the aim unless the depictions are first changed in a way that empties this impediment. Second, and even more fundamentally, standard straight relapse can't effectively deal with the blue penciling of perceptions.

Observations are viewed as controlled when the information about their survival time is divided; the most consistently experienced shape is right blue penciling. Expert study points are zoned into in an examination spanning 20 weeks. A study point who does not experience the occasion of enthusiasm for the span of the examination is said to be effectively blue-penciled. The time to observation of intrigue for this study point is seen as in any occasion as over the span of the inspect. A significant depiction of right controlling is the span over which data points leave examination before the completion of point of intrigue recognition span. The study point's survival time is said to be edited since we understand that the occasion of intrigue did not happen while this individual was under determining of the time till the study point completes the item of intrigue in addressing an information that does not pertain. Controlling in a situation which is hypothetical and does not given any information is commonly required in order to avoid predisposition in a survival analysis.

Not in the slightest degree like typical relapse models, survival strategies successfully intertwine information from both blue-penciled and uncensored observations in surveying fundamental points in the study point's analysis. The depiction of the concept of 'variable' in survival investigation is made out of two segments: Firstly, the opportunity to occasion and the other is the occasion status, confirming whether the item of conveyance which is of prime importance occurred or not. In this instance with confidence one can conclude that they have the means to review two criteria points of conveyance that are liable to a spanning frame. The time till the item of intrigue as well as the opportunities for exposure are quite underlining in depiction of the span to crystalisation of the item of intrigue. This depiction of the span to occurrence of the item of conveyance affords, for as a matter of course, the likelihood of suffering the item of conveyance. The activities of succeeding the item of conveyance gives the potential that the occasion will occur, per time unit, given that an individual has suffered up to the predefined time. While these are normally of direct conveyance, various diverse measures of conveyance (e.g., center survival) may as such be assessed from knowing either the peril or survival work. It is all around of enthusiasm for survival concentrates to delineate the relationship of a factor of intrigue (for example treatment) to the opportunity to an occasion, inside seeing a couple covariates, for example, age, sexual introduction, race, etc. A number of models are available to look at the relationship of a ton of pointer factors with the survival time. Systems join parametric, nonparametric and semiparametric approaches.

Parametric procedures accept that the essential appropriation of the survival times seeks after surely known likelihood conveyances. Understood ones consolidate the exponential, Weibull, and lognormal appropriations. The depiction of the conveyance of the survival times and the change in their dissemination as a limit of markers is of intrigue. Display parameters in these settings are regularly evaluated using a reasonable adjustment of most outrageous likelihood. A nonparametric means of depicting with some assurance of the survival work, the Kaplan Meier technique is extensively used to gauge and graph the

probability of the item of conveyance as a part of time. It might be used to get univariate illuminating bits of knowledge for survival information, including the center survival time, and consider the survival experience for no less than two gatherings of subjects. To test for as a rule differentiates between assessed survival curves of two or then again more social affairs of subjects, for example, folks versus females, or treated versus untreated (control) get-togethers, a couple of tests are open, including the log-rank test. This can be pushed as a sort of chi-square test, a comprehensively used test eventually, and really is a procedure for differentiating the Kaplan-Meier twists assessed for each social affair of subjects.

A common relapse demonstrate for the examination of survival information is the Cox corresponding dangers relapse display. It licenses testing for differences in survival times of no less than two social occasions of intrigue while allowing to adjust for covariates of intrigue. The Cox relapse display is a semiparametric show, making less suppositions than customary parametric systems anyway a bigger number of presumptions than those nonparametric strategies depicted already. In particular, and interestingly with parametric models, it makes no suppositions about the condition of the supposed benchmark peril work.

The Cox relapse display gives profitable and simple to unravel information for the relationship of the peril's ability to markers. While a nonlinear association between the activity of identify chance of going outside the expected result and the markers is expected, the proportion or ratio of the item of conveyance being crystalised differentiating any two discernments is, as a general rule, unfaltering after some time in the setting where the pointer factors don't vary after some time. This supposition is known as the relative dangers presumption and checking if this suspicion is met is a basic bit of a Cox relapse examination. Significantly the most standard way for depicting the span till is executed in incalculable programming bundles, including SAS, STATA, SPSS, and JMP and R.

Chapter 3

Methodology

3.1 Introduction

This chapter lays much emphasis on the empirical models, the estimation techniques, the data, and the data collection method.

3.2 Survival Analysis Setup

- 1) Subjects are pursued until the moment that an occasion crystallises (disappointment) or we lose them from the example (edited observations).
- 2) We will be lay emphasis on to what degree they stay in the example (survival).
- 3) We are likewise inspired by their chance of disappointment (risk proportions).

3.3 Survival Function $S_x(t)$

Give (x) a chance to denote an actual existence matured x, where $x \geq 0$. The future lifetime of (x) can be demonstrated by a constant arbitrary variable T_x or a discrete irregular variable K_x . The conveyance of things to come lifetime is given by

$$F_x(t) = P[T_x \leq t] \quad (3.1)$$

That is the likelihood that (x) does not get by past age $x+t$. The supplement of the dispersion work is the survival work

$$S_x(t) = 1 - F_x(t) = P[T_x > t] \quad (3.2)$$

As indicated by the International Actuarial documentations, the proportionate survival and mortality documentations are given by

$$\begin{aligned} {}_{[t]}p_x &= P[T_x > t] = S_x(t) \\ {}_{[t]}q_x &= P[T_x \leq t] = 1 - S_x(t) = F_x(t) \end{aligned} \quad (3.3)$$

3.4 Hazard Function $h_x(t)$

The capacity of time to survival t gives the restrictive rate of disappointment. It is characterized as the probability of disappointment amid a little time interim, assuming that the individual has made due to the beginning of the interim, or as the farthest point of the likelihood that a person bombs in a short interim, $t + \delta t$, gave that the individual has made due to time.

Risk rate is the probability that the span will finish after time t , gave that it has kept going until time t :

$$h_x(t) = \frac{f_x(t)}{S_x(t)}$$

where $f_x(t)$ is the likelihood thickness capacity and $S_x(t)$ is survival work.

3.5 Non-Parametric Model

A nonparametric estimator of the survival work, the Kaplan Meier technique is comprehensively used to gauge and outline survival probabilities as a segment of time. It might be used to get univariate illuminating bits of knowledge for survival information.

Table 3.1: Non-Parametric model Table

Time	Number at risk	Events	Survival	Standard Error	Lower 95% CI	Upper 95% CI
------	-------------------	--------	----------	-------------------	-----------------	-----------------

3.6 Semi-Parametric model

3.6.1 Cox Proportional Model

Survival examination procedures can moreover be extended to evaluate a couple of hazard factors at the same time like different direct and numerous strategic relapse investigation as portrayed in the modules talking about Confounding, Effect re-development, Correlation, and Multivariable Methods. A champion with regards to the machinations of resolving the depiction of the span till the item of conveyance being studied is Cox corresponding dangers relapse, that is depicted relate a couple of hazard parts or exposures, considered at the same time, to survival time. In a Cox relative dangers relapse show, the proportion of effect is the peril rate, which is the danger of disappointment (the hazard or likelihood of enduring the occasion of intrigue), given that the part has made due up to an express time. The chance must lie occupying the span of 0 to 1. In any case, the danger addresses the ordinary number of occasions per one unit of time. Along these lines, the risk in a social affair can outperform 1. For example, if the peril is 0.2 at time t and the time units are months, at that point everything considered, 0.2 occasions are ordinary per individual in danger consistently. Another elucidation depends on the reciprocal of the danger. For example, $1/0.2 = 5$, which is the ordinary sans occasion time (5 months) per individual in danger.

By and large, we are keen on looking at gatherings with respect to their dangers, and we use a peril proportion, which is for all intents and purposes proportionate to a chances proportion in the setting of various strategic relapse investigation. The risk proportion can be assessed from the information we organize to lead the log-rank test. Specifically, the danger proportion is the proportion of the total number of saw to expected occasions in two free correlation gatherings:

$$HR = \frac{\sum O_{Exp,t} / \sum E_{Exp,t}}{\sum O_{Unexp,t} / \sum E_{Unexp,t}}$$

(3.4)

In a couple of examinations, the refinement between the uncovered when appeared differently in relation to the unexposed bunches are clear. In different examinations, it isn't. The ending scenario however, either assembling may be displayed in the upper section and the elucidation of the danger proportion evolves as the danger of occasion, social affair in the upper section when diverged from the danger of occasion in the get-together in the denominator. The Cox corresponding dangers relapse model can be composed pursuant:

$$[h(t) = h_0(t) \times \exp(b_1X_1 + b_2X_2 + \dots + b_pX_p)]$$

where $h(t)$, depicted as the ordinary danger at time t , $h_0(t)$ is the standard peril addresses the chance of crystalisation when most of the highlight pointers (or autonomous factors) X_1, X_2, X_p are identical to zero. Notice that the foreseen danger (i.e., $h(t)$), or the rate of enduring the occasion of enthusiasm for the accompanying moment, is the aftereffect of the standard peril ($h_0(t)$) and the exponential limit of the straight blend of the indicators. As such, the indicators have a multiplicative or relative effect on the foreseen hazard.

Mull over a basic model with one indicator, X_1 . The Cox corresponding perils show is:

$$[h(t) = h_0(t) \times \exp(b_1X_1)]$$

Expect the item of conveyance to dissect 2 individuals as far as their ordinary perils, and the first has $X_1 = a$ and the second has $X_1 = b$. The ordinary risks are $h(t) = h_0(t)\exp(b_1a)$ and $h(t) = h_0(t)\exp(b_1b)$, respectively.

The peril proportion is the proportion of these two anticipated risks: $h_0(t)exp(b_{1a})/h_0(t)exp(b_{1b}) = exp(b_{1(a-b)})$ which does not depend upon time, t. In this way the risk is relative over time.

Now and then the model is imparted in a startling way, relating the relative peril, which is the proportion of the danger at time t to the pattern risk, to the hazard factors:

$$\left[\frac{h(t)}{h_0(t)}\right] = exp(b_1x_1 + b_2x_2 + \dots + b_px_p)$$

We can take the regular logarithm (ln) of each side of the Cox corresponding dangers relapse show, to create the accompanying which relates the log of the relative risk to a straight capacity of the indicators. Notice that the correct hand side of the condition resembles the more natural direct mix of the indicators or hazard factors (as found in the various straight relapse show).

$$[ln\left\{\frac{h(t)}{h_0(t)}\right\}] = b_1X_1 + b_2X_2 + \dots + b_px_p$$

The intrigue lies in the relationship between all of the hazard elements or indicators ($X_1, X_2, \dots, X_p$) and the result. The affiliations are assessed by the relapse coefficients ($b_1, b_2, \dots, b_p$). The system for assessing the relapse coefficients in a Cox corresponding risks relapse demonstrate is past the degree of this substance and is depicted in Cox and Oakes. Here we revolve around elucidation. The assessed coefficients in the Cox relative dangers relapse demonstrate, b_1 , for example, address the alteration in the ordinary log of the risk proportion in regard to a one unit change in X_1 , holding each and every other indicator reliable.

The antilog of an expected relapse coefficient, $exp(b_i)$, produces a risk proportion. If an indicator is dichotomous (e.g., X_1 is a pointer of overwhelming cardiovascular ailment or male sex) at that point $exp(b_1)$ is the peril proportion looking at the danger of occasion for individuals with $X_1 = 1$ (e.g., inescapable cardiovascular malady or male sex) to individuals with $X_1 = 0$ (e.g., free of cardiovascular ailment or female sex).

If the danger proportion for an indicator is close to 1, that indicator does not impact survival. If the peril proportion is under 1, the indicator is cautious (i.e., related with improved survival) and in case the danger proportion is more noticeable than 1, the indicator is related with expanded hazard (or diminished survival).

Trial of theory are used to survey whether there are quantifiably noteworthy relationship among indicators and time to occasion. The points of reference that seek after speak to these tests and their interpretation.

The Cox relative dangers demonstrate is known as a semi-parametric model, in light of the fact that there are no suppositions about the condition of the standard risk work. There are nevertheless, different suppositions as noted above (i.e., freedom, changes in indicators make corresponding changes in the risk paying little regard to time, and a straight relationship between the basic logarithm of the relative peril and the indicators). In literature there are other relapse depictions used in diagnosing the time till the item of conveyance that accept unequivocal circulations for the span till the item of conveyance, for example, the exponential, Weibull, Gompertz and log-typical distributions^{1,8}. The exponential relapse survival display, for example, accept that the risk work is reliable. Different circulations expect that the risk is expanding after some time, diminishing as time goes on, or expanding at first and after that diminishing.

3.6.2 Test of Cox danger proportionality (Schoenfeld test)

The Schoenfeld Residuals Test is utilized to test the autonomy among residuals and time and subsequently is utilized to test the corresponding Hazard supposition in Cox Model.

One of key suppositions in the Cox Proportional Hazard demonstrate is that of relative perils. As indicated by corresponding risk condition, the covariates are multiplicatively identified with the danger for example in a relapse type setting the survival disseminations

ought to have peril works that are corresponding after some time. In basic words danger for any individual is a fixed extent of peril for some other individual.

The Schoenfeld Residuals Test is undifferentiated from testing whether the incline of scaled residuals on time is zero or not. On the off chance that the slant isn't zero, at that point the relative peril supposition has been disregarded. In this test, there is discrete remaining for every person for each covariate, and the covariate esteem for people that fizzled less its normal esteem is characterized as Schoenfeld residuals. On the off chance that the plot of Schoenfeld residuals against time demonstrates a non-arbitrary example, the PH supposition has been abused. The residuals can be relapsed against time to additionally test autonomy among residuals and time.

3.7 Probability of Defaults

Much the same as chances in straightforward strategic relapse, the general equation just is

$$\text{Probability of Defaults} = 1 + \frac{\text{Hazard Ratio}}{\text{Hazard Ratio}}$$

Chapter 4

Analysis

4.1 Introduction

This chapter produces the results and discussion of the results generated by the analysis.

4.2 Data Supply and Design

Based on the objective of this study, Kaplan-Meier non-parametric analysis, Cox

Proportional Hazard model in modeling the probability of default in Non-Banking Financial Institutions in Ghana.

We employed a data on defaults in Non-Banking Financial Institutions (Microfinance Institutions) from XDS Credit Bureau (authorized by the Bank of Ghana) in modeling the probability of default. The modeling process was aided by MS EXCEL and R software.

4.3 Variables Description

The variables considered in the study are as follows;

- a) Survival time (TIME) ranging from 0 to 120 months, time of default, refersto the survival time of a particular account. Survival time is the time from when the account was opened to the date of default. The period is in months.
- b) Gender of customers (GENDER) indicates the sex of customers. Thus male (1)Figure 4.1: Summary of Statistics of Data

AmountOverdue	MonthsInArrears	Gender	Age
Min. : 0.0	Min. : 0.000	Min. :1.000	Min. :19.0
1st Qu.: 0.0	1st Qu.: 0.000	1st Qu.:1.000	1st Qu.:36.0
Median : 0.0	Median : 0.000	Median :1.000	Median :41.0
Mean : 477.7	Mean : 8.364	Mean :1.392	Mean :43.2
3rd Qu.: 0.0	3rd Qu.: 5.000	3rd Qu.:2.000	3rd Qu.:50.0
Max. :100000.0	Max. :98.000	Max. :2.000	Max. :87.0

and female (2).

- c) Amount Overdue (AMOUNTOVERDUE) specifies any liability that should havebeen paid but that for some reason has not.
- d) Months In Arrears (MONTHSINARREARS) specifies the amount of the arrears inthe months accrued from the date on which the first missed payment was due.
- e) Age of customer (AGE) stands for the age of the customer.

4.4 Statistics of Data

In the study, Figure 4.1 shows the minimum, median, quartiles, mean and maximum of time, event and age of individual, gender of individual, amount overdue by individual and months in arrears by individual in Non-Banking Financial Companies in Ghana.

4.5 Kaplan-Meier Model

Figure 4.2 displays a statistical synopsis using the Kaplan-Meier survival analysis. It can be viewed that at time Zero (0), three (3) individuals defaulted in Non-Banking Financial Institutions. Hence Non-Banking Financial Institutions had a rate of survival of 1.000 at time 0. Survival rate of Non-Banking Financial Institutions decreased once an event occurs.

Figure 4.3 also demonstrates that from time 0 to 120, Non-Banking Financial Institutions have a reducing survival rate or probability.



Figure 4.2: Summary of Survival probability using Kaplan-Meier
Call: survfit(formula = Surv(time, event) ~ 1)

time	n.risk	n.event	survival	std.err	lower 95% CI	upper 95% CI
0	19996	3	1.000	8.66e-05	1.000	1.000
1	19977	16	0.999	2.18e-04	0.999	0.999
2	19865	3	0.999	2.35e-04	0.998	0.999
3	19787	69	0.995	4.80e-04	0.994	0.996
4	19442	60	0.992	6.21e-04	0.991	0.994
5	19231	17	0.991	6.56e-04	0.990	0.993
6	19114	978	0.941	1.70e-03	0.937	0.944
7	14698	45	0.938	1.75e-03	0.934	0.941
8	14367	26	0.936	1.77e-03	0.933	0.940
9	14242	25	0.935	1.80e-03	0.931	0.938
10	14143	81	0.929	1.89e-03	0.925	0.933
11	13827	114	0.922	2.00e-03	0.918	0.925
12	13372	2471	0.751	3.50e-03	0.744	0.758
13	6757	49	0.746	3.56e-03	0.739	0.753
14	6534	56	0.739	3.63e-03	0.732	0.747
15	6339	315	0.703	4.00e-03	0.695	0.711
16	5440	1	0.703	4.00e-03	0.695	0.710
17	5388	77	0.692	4.10e-03	0.684	0.701
18	5155	515	0.623	4.69e-03	0.614	0.633
19	3535	49	0.615	4.78e-03	0.605	0.624
20	3439	18	0.611	4.82e-03	0.602	0.621
23	3387	41	0.604	4.90e-03	0.595	0.614
24	3225	247	0.558	5.33e-03	0.547	0.568
25	2374	5	0.557	5.35e-03	0.546	0.567
28	2362	3	0.556	5.36e-03	0.545	0.566
30	2356	1	0.556	5.36e-03	0.545	0.566
31	2352	4	0.555	5.37e-03	0.544	0.565
34	2344	1	0.554	5.37e-03	0.544	0.565
35	2333	40	0.545	5.49e-03	0.534	0.556
36	2094	224	0.487	6.13e-03	0.475	0.499
37	805	22	0.473	6.59e-03	0.461	0.486
39	579	1	0.473	6.62e-03	0.460	0.486
44	572	1	0.472	6.66e-03	0.459	0.485
46	567	3	0.469	6.78e-03	0.456	0.483
48	556	3	0.467	6.90e-03	0.453	0.480
49	499	1	0.466	6.95e-03	0.452	0.480
52	456	21	0.444	8.05e-03	0.429	0.460
60	406	6	0.438	8.37e-03	0.422	0.454
84	282	76	0.320	1.31e-02	0.295	0.346
85	99	14	0.275	1.59e-02	0.245	0.307
92	59	1	0.270	1.63e-02	0.240	0.304
95	58	1	0.265	1.66e-02	0.235	0.300
120	17	6	0.172	3.26e-02	0.118	0.249

4.6 Cox Proportional Hazard Model

From Figure 4.4, the section labelled “z” documents the Wald statistic value. It shows the proportions of each regression coefficient to its standard error ($z = \text{coef}/\text{se}(\text{coef})$). The wald statistic determines coefficient of a given factor is statistically significantly different from

0. From the output above, we can conclude that the variables amount overdue, months in arrears, age and gender have highly statistically significant coefficients.

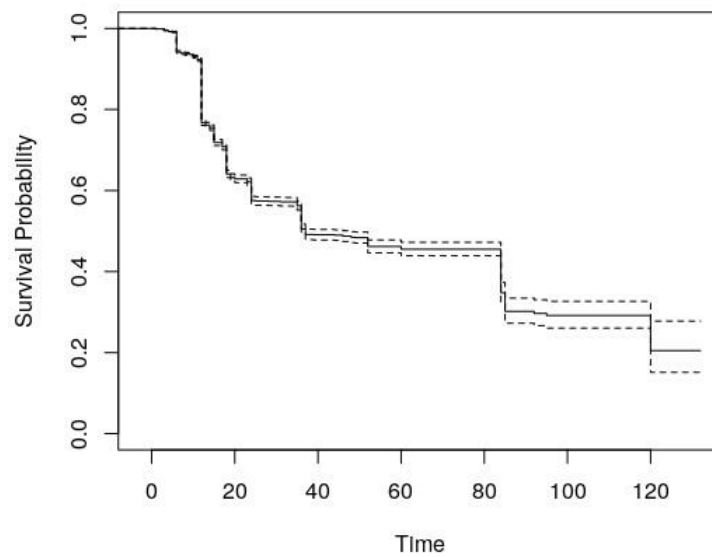
The results in this case also provide p-values for three other tests (the likelihood-ratio test, Wald test, and score logrank statistics) for overall significance of the model. These three tests are asymptotically equivalent. For large N, they will give similar results. For small N, they may differ. The Likelihood ratio test has better behavior for small sample sizes, so it is generally preferred.

4.6.1 Regression Coefficients

The regression coefficients in the Cox model results is the (coef). A positive sign means that the hazard (risk of default) is higher, and thus the default is worse. The variable gender is encoded as a numeric value. 1: MALE, 2: FEMALE.

As stated in <http://www.sthda.com/english/wiki/cox-proportional-hazards-model>, the R summary for the Cox model gives the hazard ratio (HR) for the second group relative to the first group, that is, FEMALE vs MALE. The coefficient for Gender = 4.016e-01 indicates that females have higher risk of defaulting than males, in this data. Also, the coefficient of Age, Months in arrears and Amount overdue are positive indicating higher risk of defaulting. Thus, older age, higher months in arrears and higher amount overdue in are associated with poorer survival (default).

Figure 4.3: Plot of survival probability using Kaplan-Meier



4.6.2 Hazard Ratios

Hazard ratios in the Cox model results is the exponentiated coefficients ($\exp(\text{coef})$). The summary output also gives upper and lower 95% confidence intervals for the hazard ratio ($\exp(\text{coef})$). These give the effect size of covariates. For example, being FEMALE (Gender=2) increases the hazard by a factor of 49%. Being female is associated with poorer defaulting. Also, Age, Months in arrears and Amount overdue have a hazard ratio of 0.4%, 4.2% and 0% respectively. Hence these three covariates are associated with worse defaulting.

Figure 4.4: Summary of Cox Proportional Model

```

Call:
coxph(formula = Surv(time, event) ~ Age + Gender + MonthsInArrears +
      AmountOverdue, data = mydata)

n= 20000, number of events= 5710

              coef exp(coef)  se(coef)      z Pr(>|z|)
Age           3.542e-03  1.004e+00  1.281e-03   2.765   0.0057 **
Gender         4.016e-01  1.494e+00  2.773e-02  14.483  <2e-16 ***
MonthsInArrears 4.084e-02  1.042e+00  4.915e-04  83.094  <2e-16 ***
AmountOverdue   2.537e-05  1.000e+00  1.596e-06  15.899  <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

              exp(coef) exp(-coef) lower .95 upper .95
Age                1.004      0.9965      1.001      1.006
Gender              1.494      0.6693      1.415      1.578
MonthsInArrears     1.042      0.9600      1.041      1.043
AmountOverdue        1.000      1.0000      1.000      1.000

Concordance= 0.858 (se = 0.003 )
Rsquare= 0.265 (max possible= 0.994 )
Likelihood ratio test= 6159 on 4 df, p=<2e-16
Wald test               = 7256 on 4 df, p=<2e-16
Score (logrank) test = 9991 on 4 df, p=<2e-16

```

4.6.3 Test of Proportional Hazard Assumption

A comprehensive way to test for the the proportional hazards (PH) assumption can be done using statistical tests and similarly graphical depictions using scaled Schoenfeld residuals. For each covariate, the test function matches the corresponding set of scaled Schoenfeld residuals with time, in order to assure that the residuals and time are mutually exclusive. The test summarilly also serves as a global test for the model as a whole.

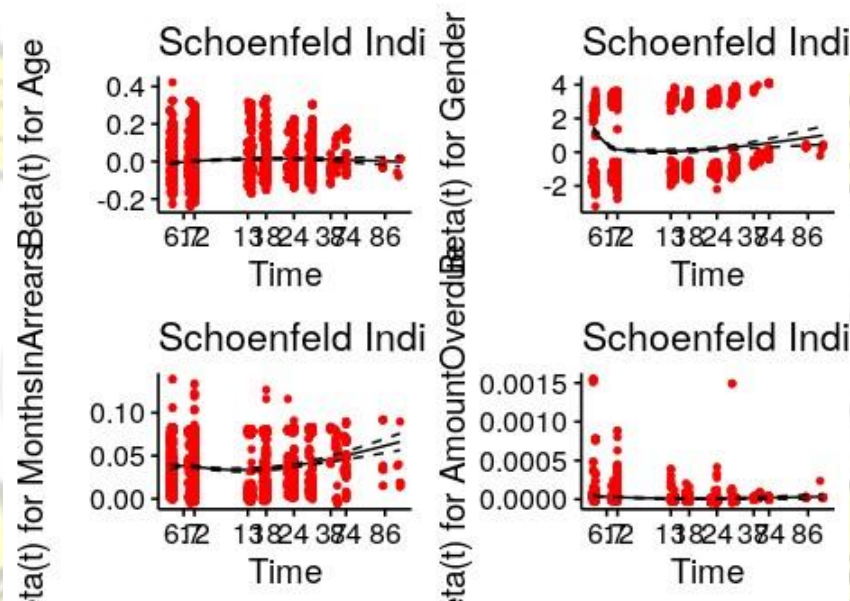
The resultants above demonstrate statistical significance for each of the covariates, the global test as well demonstrates statistical significance. Following from this we can safely conclude for proportional hazards.

However, this can be demonstrated by providing a graphical depiction which depicts for each covariate, graphs of the scaled Schoenfeld residuals compared to the transformed time.

Figure 4.5: Test of Proportional Hazard Assumption

	rho	chisq	p
Age	0.0687	28.06	1.18e-07
Gender	-0.0780	33.78	6.18e-09
MonthsInArrears	0.0385	5.19	2.27e-02
AmountOverdue	-0.0947	29.22	6.46e-08
GLOBAL	NA	116.64	2.79e-24

Figure 4.6: Graphs of the scaled Schoenfeld residuals
Global Schoenfeld Test p: 2.787e-24



The diagram above also shows a thick line as a smoothing spline fit to the plot, with the dashed lines representing a +/- 2-standard-error band around the fit. Also, there is no pattern with time. Hence, the assumption of proportional hazards is supported by the chosen covariates.

4.7 Determining Probability of Defaults

Figure 4.7: Probability of Defaults (omitted some entries)

[1]	0.4823051	0.4782527	0.4903224	0.4749190	0.4741093	0.4716812	0.4757288	0.4789691	0.4644054
[10]	0.4652132	0.4741093	0.4838328	0.4700632	0.4708722	0.4830220	0.4716812	0.4886996	0.4838328
[19]	0.4838328	0.4741093	0.4716812	0.4708722	0.4708722	0.4822112	0.4814005	0.4773487	0.4797795
[28]	0.4692545	0.4838328	0.4838328	0.4684459	0.4692545	0.4644054	0.4692545	0.4708722	0.9023226
[37]	0.5202301	0.5202301	0.5202301	0.5106135	0.5106135	0.5106135	0.5106135	0.5106135	0.5106135
[46]	0.5042527	0.5042527	0.5041209	0.5041209	0.5041209	0.5024975	0.5024975	0.5307887	0.5307887
[55]	0.5307887	0.5307887	0.5307887	0.5211575	0.5211575	0.5016858	0.5016858	0.5747004	0.5747004
[64]	0.5562246	0.5562246	0.8985386	0.8985386	0.5000623	0.5000623	0.5013237	0.5000623	0.5000623
[73]	0.5000623	0.5000623	0.5013237	0.4992505	0.5032167	0.4960036	0.4960036	0.4960036	0.4960036
[82]	0.8970489	0.8970489	0.5088418	0.5088418	0.5088418	0.4974281	0.4974281	0.4974281	0.4974281
[91]	0.4960036	0.4960036	0.4960036	0.4960036	0.4960036	0.4960036	0.4960036	0.4951919	0.4951919
[100]	0.4951919	0.4951919	0.4951919	0.4951919	0.4951919	0.4951919	0.4951919	0.7075700	0.8967486
[109]	0.8967486	0.6167857	0.5226621	0.5061856	0.5061856	0.4951919	0.4951919	0.4951919	0.4951919
[118]	0.4951919	0.4951919	0.4951919	0.4953551	0.4955559	0.4961834	0.4951919	0.4951919	0.4951919
[127]	0.4951919	0.4951919	0.5140150	0.4951919	0.4951919	0.4951919	0.4951919	0.4951919	0.4951919
[136]	0.4951919	0.4951919	0.4951919	0.4951919	0.4951919	0.4951919	0.4951919	0.4951919	0.4943802
[145]	0.4943802	0.4943802	0.4943802	0.4943802	0.4943802	0.4943802	0.4943802	0.4943802	0.4943802
[154]	0.4943802	0.4943802	0.4943802	0.4943802	0.4943802	0.4943802	0.4943802	0.4943802	0.4943802
[163]	0.4943802	0.4943802	0.4935686	0.5593643	0.5593643	0.8961458	0.8961458	0.8961458	0.8961458
[172]	0.8961458	0.5866855	0.5866855	0.5866855	0.4935686	0.4935686	0.4935686	0.4935686	0.4935686
[181]	0.4935686	0.4935686	0.4935686	0.4935686	0.8961458	0.5123661	0.5123661	0.4935686	0.4935686
[190]	0.4935686	0.4935686	0.4935686	0.4935686	0.4935686	0.4935686	0.4935686	0.4935686	0.4935686
[199]	0.4935686	0.4935686	0.5675425	0.5675425	0.5675425	0.5489998	0.5489998	0.8958432	0.8958432
[208]	0.4927570	0.4927570	0.4927570	0.4927570	0.4927570	0.4919454	0.4919454	0.4919454	0.4919454
[217]	0.8955398	0.8955398	0.6307018	0.6307018	0.4919454	0.4919454	0.4919454	0.4919454	0.4919454
[226]	0.4919454	0.4919454	0.4919454	0.4919454	0.4943674	0.4919454	0.8955398	0.8955398	0.6472542
[235]	0.6472542	0.6210928	0.6210928	0.4919454	0.4919454	0.4919454	0.4919454	0.4919454	0.4919454
[244]	0.4919454	0.4919454	0.4939658	0.4939658	0.4919454	0.8955398	0.8955398	0.5404573	0.5404573
[253]	0.5404573	0.5295111	0.5295111	0.5107434	0.5107434	0.4919454	0.4919454	0.4919454	0.4919454
[262]	0.4919454	0.4919454	0.4919454	0.4919454	0.4919454	0.4919454	0.4919454	0.4919454	0.8955398
[271]	0.8955398	0.5942076	0.5942076	0.5942076	0.4919454	0.4919454	0.4919454	0.4919454	0.4919454
[280]	0.4919454	0.4919454	0.4919454	0.4919454	0.4919454	0.4919454	0.4919454	0.4919454	0.4919454
[289]	0.8952357	0.8952357	0.5005332	0.5005332	0.4911339	0.4911339	0.4911339	0.4911339	0.4911339
[298]	0.4911339	0.4911339	0.4911339	0.8952357	0.8952357	0.4911339	0.4911339	0.4911339	0.4911339
[307]	0.4911339	0.4911339	0.4911339	0.4911339	0.4911339	0.4911339	0.4911339	0.4911339	0.4911339
[316]	0.4911339	0.4911339	0.4911339	0.6911780	0.4911339	0.5050899	0.4911339	0.4911339	0.4911339
[325]	0.5194054	0.5194054	0.5194054	0.5006210	0.5006210	0.4911339	0.4911339	0.4911339	0.4911339
[334]	0.4912280	0.4912280	0.4912280	0.8830693	0.8830693	0.8791304	0.8791304	0.8750777	0.8750777
[343]	0.8443486	0.8443486	0.8342074	0.8342074	0.8289415	0.8235437	0.8123483	0.8065491	0.7945445

Chapter 5

Conclusion

5.1 Introduction

This chapter summarises the major findings of the research, conclusions and recommendations for the future study.

5.2 Summary of Findings

- a) The variables amount overdue, months in arrears, age and gender have highly statistically significant coefficients.
- b) Females have higher risk of defaulting than males. Also, the coefficient of Age, Months in arrears and Amount overdue are positive indicating higher risk of defaulting. Thus, older age, higher months in arrears and higher amount overdue in are associated with poorer survival (default).
- c) The Cox Proportional Hazard Model for Non-Banking Financial Institutions (Microfinance Institutions) in Ghana is.

$$[H(t) = H_0(t) \times \exp(3.542e-03X_{Age} + 4.016e-01X_{Gender} + 2.537e-05X_{AmountOverdue} + 4.084e-02X_{MonthsInArrears})]$$

5.3 Recommendation

The study conducted was limited to Cox Proportional Hazard Model (semi-parametric). Further studies could be done in modeling the probability of default for Non-Banking Financial Institutions (Microfinance Institutions).

References

- Addo, C. K. (2014). Overtrading versus lack of qualified staff as cause of failure of microfinance institutions in Ghana: A conceptual investigation. *Research Journal of Finance*, 2(11). An explanatory note on the Basel II IRB Risk Weight Functions- July 2005 - Basel Committee on Banking Supervision. Page 3- Bank For International Settlements.
- Asiama, J. P., amp; Osei, V. (2007). Microfinance in Ghana: an overview. Retrieved from <http://www.economicswbinstitute.org/essays/microfinanceghana.htm>
- Berger, A. N., amp; Udell, G. F. (2006). A more complete conceptual framework for SME finance. *Journal of Banking amp; Finance*, 30(11), 2945-2966.
- Bonini, S., amp; Caivano, G. (2013). The survival analysis approach in basel ii credit risk management: modeling danger rates in the loss given default parameter. *The Journal of Credit Risk*, 9(1), 101.
- Brefo, S. A. (2009). Sustainability of microfinance institutions in Ghana: A case study of Opportunity International Savings and Loans Limited (Doctoral dissertation).
- Buvinić, M., amp; Gupta, G. R. (1997). Female-headed households and female maintained families: are they worth targeting to reduce poverty in developing countries? *Economic development and cultural change*, 45(2), 259-280.
- Byström, H. N. (2007). Back to the future: Futures margins in a future credit default swap index futures market. *Journal of Futures Markets: Futures, Options, and Other Derivative Products*, 27(1), 85-104.

CGAP. (2013). What lessons can we learn from the Moroccan microfinance crisis? Retrieved from <http://www.cgap.org/publications/lessons-learned-moroccancrisis>

Collett, B. R., Olan, J. L., and Myers, K. M. (2003). Ten-year review of rating scales. V: scales assessing attention-deficit/hyperactivity disorder. *Journal of the American Academy of Child and Adolescent Psychiatry*, 42(9), 1015-1037.

Cox, D. R., and Oakes, D. (1984). *Analysis of Survival Data*.

Floyd, D., and McManus, J. (2005). The role of SMEs in improving the competitive position of the European Union. *European Business Review*, 17(2), 144-150.

Ghana Statistical Service. (2012). 2010 Population and Housing Census: Summary report of final results. Retrieved from http://www.statsghana.gov.gh/docfiles/2010phc/Census2010_Summary_report_of_final_results.pdf

GPRS II (2010-2013): Volume II costing and financing of policies and strategies. IMF. Washington D.C.

Hoelscher, D. S. (n. d.). *Managing Systemic Banking Crises*. Retrieved from <http://web.worldbank.org/archive/website01049/WEB/IMAGES/HHOELSCH.PDF>

Ikechukwu, A. (2012). A Microfinance Banking in Nigeria: Problems and Prospects. *International Journal of Finance and Accounting*, 1(5), 106-111. Retrieved June 17, 2015

Is Microfinance an Effective Strategy to Reach the Millennium Development Goals?

(Authors : Elizabeth Littlefield, Syed Hashemi, Murdoch, Jonathan) Volume 24 , Focus Note(01/01/2003)

Kalbfleisch, J. D., amp; Prentice, R. L. (2002). Relative risk (Cox) regression models. The Statistical Analysis of Failure Time Data. Hoboken, NJ: John Wiley amp; Sons, Inc, 95-147.

Kiraka, R., Kobia, M., amp; Katwalo, A. M. (2013). Micro, small and medium enterprise growth and innovation in Kenya: A case study on the Women Enterprise Fund. Investment Climate and Business Environment Research Fund, 1-104.

Louzada-Neto, F. (2006). Lifetime modeling for credit scoring: A new alternative to traditional modeling via survival analysis. Tecnologia de Crédito (Serasa), 56, 8-22.

Malik, M., amp; Thomas, L. C. (2010). Modelling credit risk of portfolio of consumer loans. Journal of the Operational Research Society, 61(3), 411-420.

Mariana, P. (2015). Microfinance crisis: results from several surveys. In C. Alambik (Ed.), Mini-conference // Microfinance (pp. 68-71). Convergences.

MicroCapital. (2014). Zimbabwe Association of Microfinance Institutions (ZAMFI) Warns Against Illegal Deposit-taking by Microfinance Institutions (MFIs). Retrieved August 24, 2015, from <http://www.microcapital.org/microcapitalbrief-zimbabweassociation-of-microfinance-institutions-zamfi-warns-against-illegal-deposit-taking-by-microfinance-institutions-mfis-2>

Ministry of Finance - Ghana. (n.d.). General Background on Global Microfinance. Trends. Retrieved May 11, 2015, from <http://www.mofep.gov.gh/?q=divisions/microfinance>

Proctor (2003). Essentials of Marketing Research. Published by Financial Times Prentice Hall, 2003

Siwale, J., amp; Ritchie, J. (2011). Failure by design: the rise and fall of a microfinance institution in Zambia—a case of pride Zambia.

The Standard. (2014). Zimbabwe regulates microfinance business. Retrieved from <http://www.thestandard.co.zw/2013/09/08/zimbabwe-regulates-microfinance-business>

Vanguard. (2010). Liquidity is the blood of micro-finance banks. Retrieved from <http://www.vanguardngr.com>

Wichterich, C. (2012). The Other Financial Crisis: Growth and crash of the microfinance sector in India. *Palgrave Macmillan Journals*, 55(3), 406–412.

