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THE EFFECT OF MORAL HAZARD ON THE CREDIT RISK IN THE MICROFINANCE SECTOR; A THEORETICAL APPROACH

BY

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DECLARATION

I hereby declare that this thesis is a presentation of my original research work, in partial fulfillment for the requirement for an Mphil degree. Contributions of others are referenced appropriately with due regards to the literature and acknowledgment of research work and articles of relevant authors. This project was done at the University of Ghana, Legon under the supervision of Dr. Perpetual Andam Boiquaye and Dr. Godwin Debrah.

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DEDICATION

I dedicate this work to my parents and loved ones.

Abstract

Credit risk is a major concern in the banking and finance sector and has been one of the reasons for credit market imperfections across the globe. Moral hazard in credit markets, causes a major impact and affects the determination of interest rates in the banking sector. This study set out to ascertain the probability of defaults of unsecured assets and secured assets. The study calculates the probability of occurrence of the behavior of borrowers and find moral hazard effects on individual credit risk system. Essentially, the study sought to find how microfinance institutions are affected when customers default on their payments. The study assessed the risk associated with microfinance business when the asset follows the Ornstein- Uhlenbeck process. Due to the fact that risks cannot be assessed using numerical data because we are dealing with human behaviors, we assumed that they invest their money in secured and unsecured assets. The study found that the impact of credit default was lesser with secured assets than it was with the unsecured assets and therefore recommend that microfinance institutions give credits with collateral more than the ones without collateral.

Contents

1. Introduction

This chapter talks about the main idea behind the study and how the work is structured. This chapter incorporates the background of study, statement of the problem, objectives of the study, research questions, significance of the study and how the study is organized.

1.1 Background of study

Microfinance can be defined as the provision of savings accounts, loans, insurance, money transfers, and other banking facilities to clients who lack access to mainstream financial services, typically due to poverty and small business owners, many of whom are in the developing world according to Hassan (2002). Microfinance is intended to provide monetary services to people who are traditionally exempted from conventional financial networks due to their weak, erratic, and volatile income.

The emanation of Microfinance is said to be dated back to the nineteen seventy's (1970s) when institutions like Bangladesh's Grameen Bank started the modern microfinance industry with the founder of microfinance, Mohammad Yunus. Mohammad Yunus, a professor of economics who was awarded the Noble Prize for his contributions in 2006. The Akhtar Hameed Khan is another leader in the field. . A new wave of microfinance projects at that period brought several new technologies into the field. Many innovative firms have begun integrating with loans to marginalized individuals. The main motive for microfinance, which dates back to the 1970s, is that the schemes would demonstrate that people can be relied on to repay their loans and that disadvantaged people will provide financial services to market-based businesses without subsidies. Today the World Bank reports that some 7000 microfinance institutions are serving more than 16 million people around the world. Experts from the Consultative Group for Assistance to the Poor (CGAP) claim that some five hundred million families benefit from these small loans that

make new businesses possible (Malathi & Vijayarani, 2012.)

Microfinance is viewed as one of the biggest advancement programs on the planet, both in monetary terms and as far as the number of needy individuals focused on. Promoters hailed the arrangement of 'micro' financial services administrations to poor people, especially little loans, as a powerful apparatus for neediness lightening and development (Robinson,2001; Yunus,1999).

Historically, the goal of microfinance was to alleviate poverty and therefore consisted of a lot of NGO's but in today's world, most of the nonprofit microfinance institutions are evolving into institutions pursuing profit to achieve greater efficiency, sustainability, and market power. The average global rate of interest paid on microloans is about 35%. The cost of borrowing seems high but less costly compared to other available alternatives like the informal local money lenders.

Microfinance institutions(MFI's) in Ghana usually borrow from banks at a specified interest rate to be able to operate. Since most of these institutions are in for-profits, they in turn add a percentage to the interest rates and charge customers for it. This is the main cause of higher interest rate charging among our local MFI's. Recently in Ghana, the central bank revoked the licenses of 300 microfinance and 39 microcredit or money lending firms. According to the statements released by the central bank, 192 of the microfinance firms, a further 155 are insolvent and ceased operations well before the regulator took action. The revocation of these institutions' licenses is intended to remove insolvent and inactive institutions that do not have fair prospects for recovery and have refused depositors access to their deposits, thereby posing a danger to the financial system stability (Bank of Ghana, 2019).

Microfinance institutions face a lot of moral hazard issues due to the nature of the services they render. Moral hazard is related to credit markets of which microfinance is not excluded. Moral hazard is the idea that people have opportunities to change their actions when others bear their risk of poor decision. There are two forms of moral hazard in microfinance. They are the ex-ante and ex-post moral hazard. Ex-ante moral hazard is related to imperceptible actions or attempts made by lenders after the loan has been distributed but before the project returns are made.

These actions affect the probability of a return being made successful. Usually, ex-ante moral hazard refers to clients who switch from a secure project to a risky project due to credit contract opportunities (Gine et al., 2010). Ex-post moral hazard occurs when the borrower decides to strategically default until project returns are achieved.

Due to the rise of moral hazard, there has been an equal rise in effective credit risk management; this is to reduce adverse selection as much as possible. Personal credit default is typically due to the investment or management failure of creditors, which causes them to lose their creditworthiness, and also where the borrower does not comply with the loan agreement or lack of willingness to pay. Individuals do borrow money and instead of investing them into lucrative ventures, they tend to spend it anyhow. This renders an individual incapable of paying back in time or even forever. Some individuals use borrowed money for investment alright but not exactly what they stipulated with the lender. Usually, these investments are highly risky and in as much they have higher returns when successful, the chance of losing everything when they fail is certain. Once there is a failure, there is an automatic loss of repayment power. The last group of individuals is the ones that do not repay the money borrowed whether or not they make returns on their personal investment.

Since microfinance institutions are more lenders, the concept of moral hazard and individual credit risk is very much needed. Consequently, this research aims to assess the effects of moral hazards on individual credit risks.

1.2 Statement of the problem

The credit market of which the microfinance institutions can be classified often assist individuals and businesses with loans to operate with in which they are expected to payback over a duration with interest. The loans are usually invested in a risky or riskless venture. Customers may choose the risky ones which is associated with high returns and great loss when it fails. This therefore

lead to tendency of credit default which further causes moral hazard to increase. High interest rate may also cause moral hazard to increase (Chen, et al., 2005). Credit default adversely affects the Microfinace institutions and the economy as a whole in the long run. In Ghana, most of these institutions had their licenses revoked by the Central Bank. When interest rates are reduced, most of these debtors will be able to repay their loans on time. This study however wants to measure the effect moral hazard has when customers default their payment.

1.3 Objectives of the study

1. To obtain a measure for the probability of defaults for unsecured assets and secured assets.
2. To ascertain the impact of borrowers behavior after loan acquisition.
3. To find the relationship between moral hazard and individual credit risk system.

1.4 Research questions

1. How can the probability of defaults of unsecured assets and secured assets be measured?
2. How can the probability of occurrence of the behavior of borrowers be calculated?
3. How to calculate the effect of moral hazard on individual credit risk mechanisms?

1.5 Research relevance

The result of this study will help microfinance institutions calculate the effect moral hazard has on individual credit risk, calculate the probability of occurrence of behavior of customers and also know the probability of defaults of unsecured and secured assets. The purpose of this study is to use Ornstein- Uhlenbeck process backed with certain assumptions to prove that moral hazard

affects credit risk management. Moreover, this research will fill the gaps in existing knowledge about microfinance and credit risk management and will create a platform for more research work

1.6 Organization of study

The analysis is composed of four parts. The first chapter, introduction, is devoted to study context, problem statement, study purpose, study meaning and study organization. Chapter Two deals with literature reviews of the study's related principles , theories and empirical proof. Chapter three deals with the approach adopted for conducting the research and the main work and the final chapter draws conclusions on the research.

2. Literature review

2.1 Introduction

This chapter reviews literature relevant to the study. It first presents the overview of microfinance, credit risk in the microfinance sector, the black scholes model, interest rate and moral hazard.

2.2 Overview of microfinance

Microfinance and microcredit are used interchangeably on the regular, but there is a distinction between the two. Microcredit's history is deeper than microfinance and microcredit is a specialized branch of microfinance. 'Micro' emerged from the Greek word 'mikros' the word, signifying 'close to nothing' or 'little', and 'credit' emerged from the Latin word 'credere,' signifying 'trust'. 'Microcredit' is accordingly a blend of confidence between two parties in a particular loaning plan (borrower and moneylender). Given the harsh essentials and demonstrations of the formal budgetary division, microcredit consistently suggests giving little advances to helpless people with practically no guarantee to get something accomplishing for themselves. Different financial plans all over bear similarity to microcredit, however, Bangladesh's experience has made the method notable around the globe. There are matches in Ghana, for example, between the 'Susus' in Ghana,' Chit Fund' in India,' Tandas' in Mexico,' Arisan' in Indonesia,' Cheetu' in Sri Lanka,' Hodgepodges' in West Africa, and 'Pasanku' in Bolivia run over an extended period (CGAP, 2006).

Microfinance covers a more conspicuous range than microcredit. Even though microcredit is restricted to credit administrations, miniature protection, stores, repayments, and other cash products. So, Ledgerwood (1998) discusses the uncommon features of microfinance, which are budgetary intermediation and intermediation of culture. Qudrat-I Elahi & Rahman (2006) refers

to social intermediation to find out and lift the voice of the disadvantaged to cope with whatever problems they have. Microfinance and micro-credit concepts ought to be utilized appropriately with their ranges. Jain & Moore (2003) propose the use of microcredit instead of microfinance, perceiving that most Microfinance Institutions (MFIs) have not yet settled a huge deposit activation system. In either event, their contention in the current environment can be alluded to, since most MFIs effectively offer financial organizations equivalent to those in the organization banking framework. In the same period, all MFIs in Bangladesh lend, take deposits, and have other money related administrations to its clients. As per Mia (2016), commercial banks, non-bank money related offices, and credit offices, which offer an expansive scope of services, have joined the microfinance market. In either situation, rather than 'microcredit', we need to utilize the word 'microfinance'. Although MFIs additionally developed to incorporate an expansive assortment of products and enterprises, their unique intention was to help the powerless and hindered in the public eye by offering them the capacity to partake in certain areas. Ventures and this target stay a basic aspect of their activities.

Leatherman et al. (2012) suggest that change is associated with the exemplary thought driving microfinance, a move in the financial sector that revolves around needy individuals, that most formal money related establishments don't consider. Notwithstanding, microfinance plans don't believe poor people to be people that are casualties that should be upheld by good cause (Nasrin, Baskaran & Rasiah, 2017). Instead, microfinance projects see the vulnerable as standard citizens with a characteristic alternative to get resources from the riches of our world (Hickel, 2015). Microfinance assumes a connection between the poor and the financial sector because the poor can not receive loans from banks without collateral. The Muhammad Yunus microfinance solution allows loans to be obtained as a form of 'money-related guarantee' through a 'peer monitoring system,' something that cannot be found with the traditional banking system. The Muhammad Yunus microfinance solution allows loans to be obtained as a form of 'money-related guarantee' through a 'peer monitoring system,' something that is missing from the traditional banking system. This has therefore allowed granting loans to the needy very flexible by microfinance.

Microfinance, among other things, enables the poor to generate income, make resources, and reduce their helplessness in the financial crisis. Besides, one of microfinance's greatest involvement is its devotion to engaging women, a fundamental social change in male-centered social orders designed to improve well-being and achieve the Sustainable Development Goals (SDGs) (Loewe & Rippin, 2015; Pitt, Khandker & Cartwright, 2006; Pronyk, Hargreaves & Morduch, 2007; Weber & Ahmad, 2014).

Furthermore, microfinance gained overall prevalence before the end of the 20th century, especially after early research by financial specialists considered it as a method of helping the penniless, yet additionally a strategy for developing monetary turn of events. (Hashemi, Schuler & Riley, 1996; Morduch, 2000; Pitt & Khandker, 1998; Schuler & Hashemi, 1994). Duvendack et al. (2011), kept an eye regarding the matter of lacking methodologies in microfinance evaluations. Yet, the utilization of Randomized Control and Trial (RCT) is one of the current, advanced, and exact approaches to quantify the impact of microfinance. By utilizing information and the RCT approach, Karlan & Zinman (2009) found that the prosperity of the poor is boosted when they approach adaptable credit offices. Besides, another exploration they completed in the Philippine microfinance part (Karlan & Zinman 2011) found that microcredit prompted improved cultural relations, viable danger supporting, and a more adaptable admittance to advances.

In a later exploration did by Banerjee, Dufflo, Glennerster & Kinnan (2015), in the wake of summing up the eventual outcomes of six separate RCT microfinance tests in India, it was discovered that the microfinance impact was unassumingly idealistic yet not progressive. Despite these RCT assessment reports, Khandker & Samad (2014) played out the flow thorough examination to date, which remembers the abundance of 3,000 family units in 87 towns and a period of 20 years in Bangladesh. They repeated that microfinance has in truth continued helping the poor by growing family government help in numerous ways. These components stretch out from extended individual spending, family asset assortment, women reinforcing, extended work availability, among others. Sufficient confirmation based work supports the case that advances conceded by microfi-

nance are planned to enhance gender equality (Laha & Kuri, 2014; Nilakantan, Datta, Sinha, & Datta, 2013; Rehman, Moazzam, & Ansari, 2015, Weber & Ahmad, 2014), and in male-centric cultural orders speaks to a significant social change. Besides, Weber & Ahmad (2014) discovered that women in higher credit cycles tend to feel more empowered in Pakistan as against the ones who are new to the loaning cycle.

In light of these essential preferences, the Grameen-put together microfinance programs have centered concerning mitigating neediness and urging people to be independent. This has been reflected by developed countries, for instance, the United States, Canada, Germany, and a couple of other European nations. Nonetheless, Bateman & Chang (2012) contend that microfinance is an obstacle to achieving self-supporting financial targets. Instead of facilitating neediness, the high financing costs charged on credits by Microfinance Institutions will in general conflict with the essential destinations of microfinance. Therefore, a few people default on the credit facility since they cannot keep up with the high cost of borrowing. This thus goes to influence the other group members, since they should bear an additional expense of this defaulting person. In the direst outcome imaginable, they won't be granted access to the credit facility again. Issues in microfinance extended in the year 2007, when Compartamos, a Mexican microfinance institution, charged an unprecedented 195 percent rate for initial public offering (IPO) and interest rates. (Bateman & Chang, 2012).

Professor Muhammad Yunus called this shameful advantage boosting MFIs 'new credit sharks' abusing needy individuals (Mitra, 2009). Somewhere in the range of 2005 and 2014, there was a steady interest rate in the microfinance area in Bangladesh (22% to 26%). The high-interest rate charged by MFIs is because of the notable expense of activities, for example, underwriting costs. Theoretically, an MFI that looks to advance the underlying thought of microfinance could give credit offices to the poor at sensible rates and thus put in measures to amplify the utilization of their assets to diminish working costs (Mia & Ben Soltane, 2016). Similarly, the microfinance aspect faces monetary problems in specific nations where consumers are enormously falsely obliged

and default rates have increased. In any case, Ashta, Khan & Otto (2015) did research that demonstrated that there was a frail connection between microfinance and suicide occurrences yet rather indicated a high relationship between suicide incidents and banking division. Moh'd Al-Azzam (2016) and Sinclair (2012) have focused on corruption in microfinance. During the mid-1970s, microfinance began in Bangladesh, amid monetary strife caused by the consolidated challenges of being born as another nation. Bangladesh has had a monetary situation in which economic transactions have been restricted and destitute individuals have been prevented. After Bangladesh got free in 1971, the nation rose out of the war of freedom with Pakistan, which had many effects on the economy which made the level of poverty rise, especially in rural areas. The issue was additionally aggravated by the incredible starvation of 1974 when a great many Bangladeshis kicked the bucket in 1973–1974 because of the powerlessness of the recently settled government to give adequate help to over 80% of the populace living beneath the poverty line (Hossain, 2018). Coups in 1975 further destabilized the financial sector. In the period 1971–1975, monetary development of about 2% every year denied policymakers the capacity to help the poor. To meet its advancement costs, Bangladesh needed to rely upon remote help from the USA, Japan, the Soviet Union, and India (Mia, 2019).

Nonetheless, and, in the end, nation territories remain commonly isolated from help. Genuine starvations, political aggravation, and catastrophic events set up for the foundation of microfinance as an instrument for advancement during the 1970s. The Grameen Bank microfinance model was made after genuine investigation and testing by US-arranged Bangladeshi financial expert Muhammad Yunus. Stressed by the budgetary decline and the heavy presence of the marginalized sections of society, Muhammad Yunus was persuaded to investigate such a failure while working with the University of Chittagong. Yunus took a couple of understudies with him to the near to the town of Jobra in the Chittagong region to investigate various roads in regards to new systems to help the destitute. He found that by far most of the poor were caught in an unending circle of procuring and repayment ensuing to working with them since they had no budgetary resources for their free endeavors. Convinced by local people's aptitudes, enthusiasm,

and troublesome work, he understood those people expected admittance to sensible credit terms and conditions (Levin, 2012). So Yunus set up Grameen Bank, as opposed to offering noble cause, to offer hope to poor people. A minimal expenditure related blessing, which created trust in their lives, infers their business and the assurance of an age freed from destitution. No one had given such cash related administrations before Yunus. Accordingly, he engaged vulnerable ladies occupants to break out of the example of obligation. Yunus has won numerous nearby and worldwide honors due to his fantasy about giving money-related services to the penniless and testing the customary financial system.

Grameen Bank (GB) was officially settled in 1983 with the usage of the Grameen Bank Ordinance as an independent bank administered with the council following a lot of game plans with watchful financial specialists and managing reluctant government legislators and overseers. From the outset, the plan of Yunus' The Grameen Bank used a community lending model in which five individuals collectively form a group and a typical branch consists of seven or eight groups (Morduch, 1999a). The first two individuals get loans for any random group, followed by the accompanying two and over the long run the last individual, generally speaking for a one year or 50week period. Should any group member default, each other group member will be turned down any form of credit. The branch set up in the normal MFI contains a field supervisor and different field authorities who spread the zone from 15 to 22 towns by making primer visits to the towns to get settled with the lifestyle and necessities of expected customers (Morduch, 1999a). Microfinance improvement got balance during the 1980s as equivalent sorts of MFIs were set up from one side of the country to the other (Ahmed, 2009), which turned out to be firmly through 'broadening' as the structures and rules of different components of their parent affiliation were echoed by new branches (Zaman, 2004). Notwithstanding the way that the Grameen Bank model in Bangladesh's driving microfinance system, the methodology hasn't proceeded as in the past. Reformist overhauls have been noted consistently, as analysis from field delegates, topographical zone, and social norms have exceptionally influenced the model. Some MFIs have modified the main importance of microfinance to fulfill their organizational philosophy (Khan & Ashta, 2013)

and have better choices for network closure, leading to a wide variety of credit improvements and the delivery of monetary services. Employees, for example, got analysis that different helpless ladies are untalented and need an entrepreneurial upgrade; subsequently, MFIs introduced training and financial literacy programs for them.

Notwithstanding giving loans to entrepreneurs, the MFIs understood the people in the catastrophe inclined areas would require calamity loans should any unexpected occurrence happen (Matin & Taher 2001). MFIs have begun offering loans to people in catastrophe inclined to provide food for the repercussions of a catastrophic event with adaptable installment terms. Grameen Bank's working model has moreover been reviewed from an essential perspective to adjust to different kinds of risks (Khan & Ashta, 2013). Taking everything into account, because of the developing free-rider worries among network individuals, the gathering based loaning approach has offered an approach to singular credits. Feeble social ties have additionally incited the near powerlessness of group lending (Lehnar, 2009), group loans are accompanied with high operational expenses and a moderately high advance portion pace, fines that put off incredible credit hazard carriers (Giné & Karlan, 2014), and primary defaults and lower repayment rates. On account of these, after 2002, GB ignored joint obligation courses of action which different MFIs in the money related segment replicated (Hisaki, 2006). Singular credits increased quick acknowledgment in Bangladesh and that added to the fast development of the microfinance segment. Lehnar (2009) forecasts a further development of the division's interest for singular advances because many individuals were mentioning it. Although ladies are the basic point of convergence of the microfinance system, credit administrations have been expanded to consolidate men as well. The number of ladies that profit by microfinance outperform men.

The financing sources in a like manner accepted a significant function in the extension of MFI's credit exercises during the development stage. After the Palli Karma-Sahayak Foundation (PKSF) was framed, the sector developed quickly. The establishment is the main association set up in 1990 to help MFI financing activities. The financing of microfinance activities has been upgraded

by the aggregate funding of universally settled associations including the World Bank, the United Nations, the Ford Foundation, Oxfam, the Aga Khan Foundation, and other public and worldwide private benefactors. In any case, the productive financially stable MFIs, especially immense and driving MFIs, for instance, BRAC, ASA, and Grameen Bank would not recognize additional gifts (Zaman, 2004). Consequently, most global contributor help was coordinated with helping new MFIs. Furthermore, the advancement of the area during this improvement period was upheld by the helpless people's a lot of recorded and creative demonstrations of conquering misfortune (Ledgerwood, 1998). Policymakers have gone to microfinance as a huge financing instrument to diminish poverty. Furthermore, the absence of effective composed control and regulatory oversight fuelled the headway of microfinance in Bangladesh from 1986 to 1995 (Conroy & MacGuire, 2000).

Also, this season of advancement can be seen as a 'scaling up' process, as microfinance has been standardized as a key source of cash-related assistance for the poor. (Zaman, 2004) examines three essential issues that shed light on its snappy mid-1990s turn of events: activity; work rousing powers; and practical learning. The key MFIs firmly adhered to their public conviction against pessimism that microfinance could be an effective and sincere way of coping with the vulnerable sponsors. This vision pulled in a different workforce, which enlivened the improvement of the zone close by selecting, progressive new development and favorable circumstances, both monetary and non-financial. The MFIs moreover drove successful learning-by-doing basically to organize their activities towards the prerequisites of destitute individuals and the business. Besides, the accomplishments of MFIs were further enhanced by bunch surveys, structured and easygoing system evaluations, and understudy reviews. Since the mid-1990s, the advancement of microfinance worldwide in East Asia, Latin America, the Caribbean, and African countries has been due to the success of Bangladesh. It was after this period that microfinance increased overall acknowledgment, principally through commitments from Bangladesh, ending up at ground zero in the 2005 UN explanation as the 'Time of Microcredit'. The advancement step was based on different progressions, including the formalization of MFI organization procedures, decentralization of the

chief's activities, branch self-sufficiency, improvement of initiative abilities, execution of the executives' data, and control frameworks (generally in managerial undertakings) and representative.

Dynamically, the area began placing assets into human resource development, progressive exercises computerization, and reliance reduction. In essence, Bangladeshi MFIs have begun to grow numerous branches throughout Asia, Africa, and the Americas in different regions. Advancing innovation likewise checks developed microfinance markets. In this manner, GB revived the current microfinance stage to Grameen-II during that period, which offers complete item investment funds, updated credit arrangements, and versatility in credit settlements. Grameen-II immediately got recognition, for its unquestionable and by and large invited money-related items. An unmistakable discussion can be found in Rutherford (2006) and Dowla & Barua (2006) about Grameen-II and its distinctive financial aspects. The asset transfer framework was launched in 2002 as recommended by field workers to reach the needy in Bangladesh (Mair & Marti, 2009).

The main objective of knowing such a system is to fulfill the needs of poor and vulnerable women, as they are constrained by socio-social and strict expectations to stay at home (Meyer, 2002; Roy, Ara, Das, & Quisumbing, 2015). In Bangladesh and a dream for the oppressed, such an asset transfer program by MFIs is to a large extent efficient (Krishna, Poghosyan, & Das, 2012; Raza, Das, & Misha, 2012; Roy et al.2015). In any instance, over the years, MFI investment fund services have also improved slowly, from obligatory to adaptable retirement plans with numerous attractive features. In addition, driving MFIs have begun to provide grants, grants, and instructive developments to fulfill the intergenerational needs and reactions of the microfinance customer base to versatility in Bangladesh (Cumming, Dong, Hou, & Sen,2017). Grameen Bank, for example, has created advanced education advances (through Grameen Kalyan) for the children of its customers at flexible rates. Green Microfinance (GM), Microfinance Plus (MP), and Micro Health Insurance (MHI) are other major innovations in microfinance that were designed to attract their new customers during the growth process. Due to non-asset accessibility and donor emphasis on sustainability issues, these technologies were promoted during the development

process but not scaled up during that period (Goldmark, 2006). During the development time frame, these instruments subsequently acquired ubiquity when MFIs produced some degree of financial advancement (Biosca, Lenton, Mosley, 2014b; Lanao-Flores, Serres, 2009; Viswanath, 2015). The MHI program began to cover the well-being-related budgetary costs of the poor to support the well-being status of poor people by making small and ordinary payments to clients as an advantage that significantly diminishes their poverty (Mosley, 2003). It was initiated by the GB in 1996 when the Grameen Kalyan was set up to present welfare administrations to the poor. GB's MHI administration officially began in 1997 and was expected to operate both as a back-up plan and as a specialist organization. (Ahmed, Islam, Quashem, & Ahmed, 2005). Building Resources Across Communities (BRAC) In 2001, with money-related and specialized assistance from the International Labor Organization (ILO), the 'Micro Health Insurance Initiative for Poor Rural Women in Bangladesh' (BRAC-MHIB)' was formally initiated. According to Werner (2009), the top three MHI providers of GB, BRAC and the Society for Social Services (SSS) had 115,000 policyholders and 560,000 people covered by the scheme, and this trend affected and expanded country-wide micro-insurance operations (Matin, Imam, & Ahmed, 2005).

The effective development of MFIs and the financial practicality of their activities have delivered business banks excited for giving microfinance administrations in Bangladesh. Besides, state banks including Rajshahi Krishi Unnayan Bank and Bangladesh Krishi Bank and different business banks, for example, BASIC Bank, Ansar VDP, National Bank, and Trust Fund, little and medium-sized endeavors have likewise started to advance enterprise among poor people (Mia, 2016). In 1998, CGAP invited business banks to make microfinance benefits and named them 'new parts in the field of microfinance' (Isern & Porteous, 2005). Nevertheless, microfinance has stayed a restricted proportion of the activities of business banks and still perceives little scope ventures as their top targets (Mia, 2016). On the one side, Bangladesh's general demographic populace (checking moneylenders, savers, miniature protection guarantors, and non-budgetary beneficiaries) and banks (tallying current advances with MFIs), which arrived at its top in 2011 after a decrease in 2007, began to decay subsequently. Again, the total number of customers for

every division declined gradually from 2006 to 2012 and remained moderately stable from 2013 to 2015. The decrease in the number of customers per branch is generally a result of the snappy even advancement in the crowded geographical segment. Another prominent drenching state is multiple borrowing (in any case called 'cross membership'). Numerous borrowing suggests that people or family units enroll on several microfinance plans. Precisely when a borrower receives loans from more than one MFI, they are implied as 'individual multiple borrowing' and if more than one individual from a similar family unit obtains loans from the same or another MFI, they are referred to as multiple household borrowings (Faruqee & Khalily, 2011).

2.3 Loan risk in the microfinance sector

Credit risk can be considered as a risk of default if a debtor fails to satisfy its loan contract and is of natural interest to bank practitioners as well as regulators. The credit risk issue may also become a crisis if some of the risks land back on banks. To some extent, the Asian financial crisis was also triggered in 1997 by the same issue. Microfinance offers financial services to low-income customers, mostly excluded from conservative banking services, intending to boost entrepreneurship, and increasing revenue-generating projects (Ledgerwood, 1999). MFIs prefer to concentrate on this market segment because poor customers are too risky, as many loan providers are reluctant to lend to such highly risky groups (Hulme & Mosley,1996). Many lending techniques have been recommended for overcoming this form of risk. Among these, group lending practice is the most effective way to address the issue of the lack of collateral that group lenders are expected to have.

Besides, on each effective repayment, some MFIs grant additionally bigger advances to increase reimbursement rates and limit defaulters' rights to prospective loans (Galema, 2011). MFIs diversify their activities in addition to these policies and do not depend solely In addition to these measures, MFIs diversify their activities and do not focus exclusively on issuing credit to the

underprivileged. They transitioned to investment and security utilities. Like many financial institutions, when the subprime crisis uncovered the risks of furnishing higher-risk borrowers with a growing variety of higher risk loans, MFIs are not safe from the financial crisis. Undeniably, financial crises have drained suppliers of capital and increased micro-entrepreneurs' over-indebtedness. Many of them struggled or swarmed into financial distress as a consequence (Servin et al.,2012). Risk management thus appears to be a critical step for them to ensure financial security while achieving their social objectives by recognizing the facets and events that influence the default rate of payment for MFIs. We are therefore trying to categorize the MFIs' credit risk determinants in this study.

In general, we consider two distinct types of determinants; the features of MFIs (non-systematic) and the differences between countries in economic and institutional terms. Initially, researchers are likely to minimize risk to improve repayment rates by looking at the effectiveness of MFIs in terms of methods. Morduch (1999) indicates that community lending decreases risk by reducing adverse selection and moral hazards. Certainly, collective loan contracts effectively bind the borrower's co-signors to loans, thereby alleviating issues caused by lender-borrower knowledge irregularities. Co-signers are advised to take and exclude risky borrowers from involvement on a mutual basis, this would promote redemption rates even in the utter lack of collateral. Likewise, Islam (1995) found that lenders had lower rates than traditional lenders using peer-monitoring systems and had the same interest rate. The rate of refund is higher than expected. However, at the cost of performance, risk reduction is achieved, indicating that community lending leads MFIs to adjudicate between risk and performance. In practice, however, community loans have some flaws, such as lowering the risk of contamination when one of the vendors has been unable to make reimbursements. (Armendariz de Aghion & Morduch, 2000).

Armendariz de Aghion & Morduch (2000) outlined a range of significant activities that achieve high redemption rates without the need for collateral and the use of low-income community lending contracts. These frameworks typically contain non-refinancing risks, routine repayment

plans, collateral replacements, and the provision of non-financial services. Crabb and Keller (2006) evaluated the key risk factors of loan portfolios, including institutional size and macro-economic factors, in a sample of 37 MFIs between 2001-2003. They noticed that the community lending approach often used by MFIs minimizes the danger of the loan portfolio. However, while higher credit to women is believed to consistently increase portfolio risk, it is also believed that female community lending mitigates this risk. As such, in a Nicaraguan study of MFIs, Saravia-Matus, and Saravia-Matus (2015) provided substantial evidence indicating that female repayment performance is better than that of males. An analysis of 350 MFIs in 70 countries, as analyzed by D'Espallier et al (2011), reported findings that more female borrowers were correlated with lower portfolio risk ceteris paribus, lower write-offs, and lower credit-loss provisions. Within a selected group of MFIs from Vietnam, East Asia, and the Pacific, Ayayi (2012) analyzed credit risk determinants.

While liquidity had a positive impact on MFIs' credit risk, it had a negative impact on the size of their overall lending and operational inefficiencies, according to the findings. The idea is that the microfinance industry is subject to tight cross-border regulation and global expenditure in resources by foreign capital suppliers (Mersland et al., 2011). This area of research builds on the work of La Porta et al. (1998), which found that legal mechanisms and borrower rights foster credit markets. For example, Djankov et al.(2007) found evidence that the ratio of private credit to GDP is positively associated with the quality of law enforcement, creditor rights, and knowledge exchange. Brown et al.(2016) found that lower credit costs are associated with exchanging knowledge in transition countries and that this association is greater in countries with weak legal systems. Among some of the authors focusing on MFIs, Gonzalez (2007) investigated whether shifts in per capita GDP have a major effect on the portfolio risk of MFIs (30-day and 90-day portfolio risk, default lending rate, and write-off ratio). The author has analyzed a sample of six hundred and thirty-nine MFIs observed in eighty-eight countries over the period 1999 to 2006. He found no evidence of a relationship between the quality of MFI assets and development. The exception was a 30-day portfolio risk, where there was a statistically significant relationship.

These tests suggest that microfinance portfolios are extremely susceptible to economic shocks. Taking annual data from 325 MFIs operating in 66 developing economies between 1998 and 2006, Krauss and Walter (2009) looked at systemic microfinance threat. No risk mitigation to foreign capital markets has been reported in the MFIs analyzed. Once subjected to the Gross domestic product, these MFIs show very strong correlations, suggesting that MFIs are not isolated from their respective domestic economies. Consequently, Galema (2011) examined the effect of creditor protection, data sharing, and law enforcement on the risk-taking of MFIs. The study revealed that contract enforcement times are negatively associated with the risk taken by MFIs, while in countries with strong creditor rights, contract enforcement days minimize the risk taken by MFIs. The analysis revealed that contract compliance periods are negatively correlated with the risk taken by MFIs, while in countries with good creditor rights, contract enforcement days minimize the risk taken by MFIs.

Microfinance initiatives have been shown to contribute substantially to poverty reduction. Microfinance can be adopted as a development strategy by helping disadvantaged startups to continue in business, coaching them on how and when to handle the resources they have, decreasing risk, and developing their business output. Microcredit initiatives make it easier for small businesses to get started and creates livelihood opportunities for the impoverished, thereby facilitating economic and social development implementation. MFIs have proved to be a truly profitable and successful business in addition to their social mission performance, and have not reported a well-known achievement in achieving remarkable repayment rates from some third-world programs. To be self-sustaining, the MFI must be self-sufficient, capable of paying all its current expenses, and also benefit from the services rendered.

To become permanent and optimize their longevity, high-interest rates, significantly higher than market rates, have to be applied to MFIs. This can be at the expense of social objectives, as poor people can be excluded at high-interest rates, especially those located in remote areas. One of the most frequently debated dilemmas among microfinance academicians and policymakers is the

dual goal of servicing poor borrowers with relatively small loans and achieving self-sustainability. Identifying best practices, improving the effectiveness of their portfolio risk management, and applying correct pricing policies are critical for the stability of MFIs to meet such a challenge, allowing for a more balanced focus on sustainability and accessibility. The ongoing instability in the stock market related to the U.S. subprime mortgage lending crisis offers an indication of the dangers of providing higher-risk borrowers a growing variety of higher-risk loans. The gradual increase in the availability of micro-credit capital, the rise of competitiveness in the micro-credit sectors, its over-indebtedness of micro-creditors, and the ongoing financial meltdown are rising the threat of credit, leading to an increasing need to measure the risk of micro-finance borrowers failing. It is more important than ever to develop successful MFI credit risk management tools to boost social and economic resiliency in a more localized environment. Yaron and Benjamin, 2002, traced the history of control of credit risk within microfinance institutions.

Essentially, this was split into two parts. The first one was a summary of the imperfection of the credit markets which, according to economic theory, are cited as the key obstacles preventing formal financial markets from crediting poor borrowers. Several banking institutions endeavored to provide financial services to the poor in remote regions by implementing substantial subsidized credit schemes between the 1950s and 1970s in order to provide cheaper financing. Their purpose was to provide traditional farm producers with subsidized loans for below-market interest rates, allowing them to boost agricultural investment, thus boosting general economic growth and increasing food security (Yaron and Benjamin, 2002). However, in most cases, these initiatives have faltered, resulting in violence and extortion, as well as a breakdown. Morduch (1999) discusses the study of Adams Graham and von Pischke, who argue that in the 1950s, an affordable loan was a keystone for many developing nations as an attempt to alleviate poverty, All of these endeavors, however, were a failure, with repayment rates of less than 50%. Poor rural households are discouraged from being served by conventional banking networks by numerous barriers. The theoretical construct that seeks to understand collateral liability explains why that's the case.

The bank explained that Yunus (1994a), addressed mainstream bankers about the causes of disadvantaged people's financial marginalization:'Banks need collateral. No collateral can be provided by the poor. Banking is an industry. It is unable to indulge in love for the weak'(Ibtissem, 2013). As a strategy that reduces both the problems of screening and compliance, collateral is widely used. Empirical research by Machauer & Weber (1998) and empirical evidence and studies recorded by Ibtissem, 2013, promote the presence of the screening function of collateral. Collateral debt can be used as a method to expose the hidden details of the lender ex-ante. It could also be used to improve credit. The repayment will be the collateral if the loan could not (unplanned default) or did not (selective default) reimburse the borrower. Vulnerable entrepreneurs, however,has almost no physical and consistent resources as a reliable source of income that a bank may guarantee as collateral. High transaction costs especially for small loans are also key obstacles that keep poor rural households from being served by the conventional banking system. At present, in certain bureaucratic systems, the system of lending a loan is found, leading to extra transaction costs. Regardless of the size of the loan, these transaction expenses include a large fixed-cost component.

The cost of making multiple small cash loans to a large number of borrowers is also way greater than the lower transaction costs of lending larger loans to a few customers. Bad clients are more prone to apply for small loans, resulting in higher transaction costs for the lender. Giné et al.(2010) asserted that, along with small transaction amounts, moral hazard and adverse selection limits the banks' ability to lend to impoverished consumers. The decline of traditional commercial banking, as well as the exclusion of poor borrowers, raises the question of how to improve things for the poor. Credit operations have encountered major difficulties in addressing three of them, according to Hulme & Mosley (1996): ways to ensure that a significant number of low-income borrowers are able to obtain loans; in the absence of written records and business plans, how to create a method for screening bad borrowers, both in terms of character and ventures; and how to provide an incentive to repay borrower debtors. In particular, creative lending institutions have been generated by the low payback margins of agricultural national banks providing subsidized

loans to subsistence farmers; microfinance institutions have been generated by the failure of formal banks in the rural sector. This entire organization has become an increasingly prevalent weapon of making small, uncollateralized loans to poor consumers that can alleviate poverty.

In addition, its exceptionally high rate of repayment was what drew attention to MFIs. Several frameworks are being introduced by microfinance institutions to address screening and compliance challenges, reduce default risk, and higher rates of repayment. Microfinance has been a successful way to alleviate poverty, as per Armendariz and Morduch (2005) and Giné et al. (2010), because the form of this type of organization and the manner it operates is suited for resolving awareness issues. To understand the effectiveness of microfinance in providing the poor with credit, a vast variety of theoretical works use the idea of principal/agent to demonstrate that the problems of asymmetric knowledge in the credit market are solved by microfinance agreements lending to mutual groups. They allow the creditor to avoid adverse selection thus help to sustain high rates of repayment. The existing research and theoretical models on innovative variables that contribute to high payback rates in microcredit programs are described by Kono & Takahashi (2010). They use basic models to show that various aspects of microcredit, such as group lending, are resolving asymmetric knowledge difficulties in the credit market.

A significant part of MFI, does not issue community loans, but only individual loans. Many community lending professionals are now moving increasingly towards individual lending. This makes it possible to construct a very urgent matter: how MFIs handle their credit risk as they are not connected to the joint liability lending system and offer only individual loans. In their theoretical study, Armendariz & Morduch (2000) emphasized several key strategies that enable MFIs to retain high repayment from risky borrowers without the need for collateral and the use of collective loan contracts. These operations include the use of non-refinancing risks, routine repayment schedules, collateral replacements, and the provision of non-financial services.

This paper would like to know the effects moral hazard has on individual credit from the theoretical level risk by using the Ornstein-Uhlenbeck Process and probability.

2.4 Black Scholes Model

The Black-Scholes-Merton (BSM) model is a numerical model for the evaluation of an option contract. Model assessments, in particular, the difference after a certain period in the financial instruments. It is believed that these strategies (e.g. stocks or future) will have a normal dispersion value. The condition infers the expense of a call alternative by utilizing this supposition and figuring in other huge factors. The model assumes that a geometric Brownian motion with consistent float and unpredictability follows the cost of vigorously exchanged properties. The model incorporates the constant value volatility of the stock, the term estimate of the capital, the strike value of the option, and the potential for the end of the option to be added to the investment opportunity. Frequently referred to as Black-Scholes-Merton, it was the key option pricing model that was regularly used. It is utilized to quantify the theoretical estimation of options utilizing current stock costs, anticipated profits, strike cost of the option, loan fees anticipated, expiry period, and instability anticipated.

The Black-Scholes model has some undermining assumptions which are stated below:

- The option is European and can only be exercised at expiration.
- No dividends are paid out during the life of the option.
- Markets are efficient (i.e., market movements cannot be predicted).
- There are no transaction costs in buying the option.
- The risk-free rate and volatility of the underlying are known and constant.
- The returns on the underlying asset are normally distributed.

The Brownian Motion

Many researchers from time immemorial have used different approaches such as theories and some type of data which have proven ineffective or not enough since not only numerical data is

not enough to prove this but theories and experiments must be considered also. Theories and experiments must be considered since the concept of Brownian motion cannot be fully understood. The Brownian motion was originally introduced to describe the movement of particles in fluids discovered in 1827 by Robert brown observing the movement of pollen particles in water after completing this experiment several times he concluded that the particles are alive but the origin of the particles remained unexplained. In 1900, Louis Bachelier was the first to give a theory of Brownian motion in his Ph.D. thesis "The theory of speculation".

Later in 1905, Albert Einstein utilized a probabilistic model to adequately clarify the Brownian motion. As he would see it, he expressed that "kinetic energy of liquids was correct, the particles of water moved at random". In this manner, a little molecule would get an irregular number of effects of arbitrary quality and from arbitrary headings in any brief time frame. This arbitrary siege by the molecules of the liquid would make an adequately little molecule move precisely exactly how Robert Brown portrayed it to be. What makes Brownian motion so unique and singular?

- In spite of the fact that it is continuous everywhere, Brownian motion is nowhere differentiable.
- It is self-similar; i.e., every small piece of a trajectory Brownian motion, if extended, looks like the whole trajectory, like fractals
- Finally, Brownian motion reaches any and every real value, no matter how big or negative.
- Once Brownian's motion hits 0 or any particular value, it will hit it again infinitely often and then again in the long term periodically.

Brownian motion's mathematical theory was applied in ways far beyond the flu-id movement of particles. Even if they can say what the global economy is leaning towards on a minute-by-minute basis, it is very difficult for them to identify buyers, sellers, and how demand and supply impact price fluctuations. Stock market analysts have been faced with the same problem until recently. There are several fascinating hypotheses on how the actions of different firms make prices move,

but there are several fascinating hypotheses on how the actions of different firms make prices move. Nonetheless, stock markets, exchange rates, commodity markets, and mortgage markets are all expected to obey the Brownian movement, where assets are continuously shifting over very short periods, and random quantities are called the situation, namely the change in the state of assets. More precisely, the mathematical models used to model Brownian motion are the fundamental instruments on which all financial asset and commodity pricing measures are based.

The goal of this project is to use the geometric Brownian motion supported by the assumptions to show that individual activities have indeed influenced credit risk management. A continuous-time stochastic method in which the logarithm of different quantities or characteristics follows a Brownian motion based on the assumptions is also known as the Wiener process or the exponential Brownian motion. These assumptions can be categorized into two projects (Project A and Project B), where Project A is categorized as a high-risk and high-yield investment, while Project B is considered a low-risk and low-yield investment. These loans will presumably be issued to be invested in Project B. In making hypotheses for the different cases in which a person chooses to pay or not on time, failed investments, high-interest rates, and a person running away, conditional probabilities, probability density functions, and projected returns were not left out. Secured and unsecured assets were taken into account after these hypotheses were made, just in case, a person failed to repay their loans.

Ornstein-Uhlenbeck Process

The Ornstein-Uhlenbeck process in mathematics is a stochastic approach with applications in financial mathematics and physical sciences. As a model for the velocity of a massive Brownian particle under the influence of friction, its original application in physics was. It is named after George Eugene Uhlenbeck and Leonard Ornstein. The Ornstein-Uhlenbeck process is a Gaussian process, a Markov process, and is temporarily homogeneous. This is the only non-trivial method that fulfills these three conditions to allow for linear transformation of the variables of space and time. Over time, the approach seems to be drifting towards its mean function: this process is

called mean-reverting.

2.5 Interest Rates

It is known as the proportion of the amount loaned, It is defined as the proportion of the amount lent, usually expressed as an annual percentage, which the customer pays as security for a loan. A lender will charge the rate at which its money is borrowed or the level at which banks pay its savers to hold money in an account. This rate for one year is the annual interest rate. Other interest rates are available over various times, such as a month or a day, but are typically annualized. Ever since the advent of civilization, interest rates have been around. They can be traced back to 3,000 BC. It did not take long for individuals to understand that interest rates were a critical component of the equation of borrowing and lending. Lenders couldn't make money from their services without interest rates, and there would be no incentives for taking all of the risks. They may or may not be paid back, but the transaction will not make money. That would make seeking lenders difficult for borrowers.

Interest rates gave some skin to borrowers in the game and made lenders more appealing in the process. Over the years, these rates have changed a lot. Even in the very early days, seeing concentrations of 20 percent or higher was not unusual. Interest rates that are high today are going to cause a crisis. When it comes to setting interest rates, it is done by central banks of various countries or their governments. This has been so for the past two centuries. For instance, from 1954 to 2008, the Federal Reserve federal funds rate in the United States varied between about 0.25 percent and 19 percent, while from 1989 to 2009 the Bank of England base rate varied between 0.5 percent and 15 percent, and in the 1920s Germany experienced rates close to 90 percent down to about 2 percent in the 2000s. Zimbabwe's Central Bank raised borrowing interest rates to 800 percent to counter rocketing stagflation in 2007 (Stewart Douglas, October 3, 2007). In the late 1970s and early 1980s, core interest rates were much high than recorded,

higher than the previous US spikes since 1800, than British spikes since 1700, or than Dutch spikes since 1600.

Interest rate goals are a crucial monetary system and are taken into account when addressing variables such as investment, inflation, and unemployment. Generally speaking, central banks tend to lower interest rates if they want to increase investment and consumption in the economy of the country. As a macro-economic policy, however, a low-interest rate can be risky and could lead to the creation of an economic bubble in which large amounts of capital are injected into the real estate and stock markets. In developed economies, interest-rate adjustments are therefore made to keep inflation within the scope of economic activity healthy or to cap the interest rate at the same time as economic growth to preserve economic momentum.

2.6 Moral Hazard

In insurance literature, "moral hazard" originated. Economists recognize its modern use in economics to explain the loss-increasing actions of insurance firms. In reality, as Pauly argued, the question of "moral hazard" in insurance has nothing to do with morality but can be examined with orthodox economic tools (Pauly, 1968). Moral hazard arises when there is data asymmetry, a condition in which more information is available to a participant in a transaction than to another, and one participant is isolated from the risk's negative consequences (Krugman, 2009). In the case of the financial meltdown, a moral hazard comes to an end if a financial company learns that a lender of last resort (government) is secured and, as a result, invests in riskier assets because it expects everyone else to bear losses (Stiglitz, 2010). The lack of criminal prosecution of organizations or persons for criminal activity was one unusual feature of moral risk during the 2008 financial meltdown. Instead, its "punishment" was borne at the detriment of their shareholders employing financial fines, paid out by corporations (Ferguson, 2012).

Economic experts have used the definition of moral hazard to examine a wide variety of public

policy situations, from unemployment benefits, corporate bailouts to natural resource policy (Hale 2009). Time quoted the Federal Reserve as saying, for example, Ben Bernanke, the President of the United States, when addressing the handling of the Global Financial Crisis: All the measures produced moral hazard, sending a twisted message that no matter how badly they screw up, "too big to fail" financial firms would not be rescued, enabling Wall Street traders to begin to risk again (Grunwald, 2009). Some critics were a little more cautious but expressed concern about this economic term's theoretical patterns: the theory of moral hazard is commonly used and deeply rooted in reality. Economics, with little regard given to the core ethical and moral ideas implied by the use of that specific term (Dembe & Boden, 2000), and one thing that should be explicit about the phrase 'moral hazard' is that the language is based on a subjective notion. This suggests that there is a moral hazard, a moral problem, linked to over-insurance (or over-insurance) (Hale, 2009).

Moral hazards normally arise whenever a team or individual is given a chance in a transaction to understand that, if things are not working out, another party or individual is liable for adverse consequences. In the course of the transaction, there might be a disservice to the second party in To get the transaction to take place, and even after the transaction has taken place. There are many ways to mitigate the moral hazard, like rewards, mitigation mechanisms for unethical behavior, and frequent monitoring. Inconsistent or asymmetrical data is at the core of the moral hazard. More information on the situation or intentions is available to the risk-taking party in the transaction than to the party suffering any consequences. Typically, A party with additional knowledge has more incentive and is more likely to behave adversely to profit from a transaction. After the transaction has been completed, the value of asymmetric data remains. In different types of circumstances and different arenas, a moral hazard exists. In the financial sector, bailouts may be one motivator.

Credit institutions usually make their huge yield on loans that are considered risky. When they have hopes of some form of government assistance in the event of failures on loans, they are

much more inclined to make such loans. The securitization of mortgages can result in moral hazard. Mortgage originators will pool the loans and then sell to investors parts of this mortgage pool, moving the risk of default on to someone else. In such a case, the buyer or purchasing agency profits from being vigilant in tracking the loan originators and checking the quality of the loans. Moral hazard has arisen in the health insurance sector where the insured party or person acts in such a way that increments in premiums are to the benefit of the insurer. There is an opportunity for people who do not have to pay for medical care to pursue more costly and even riskier care that they would not otherwise need. In general, health insurance providers establish a company and deductibles for these reasons, requiring people to pay for at least a portion of the care they receive. Such a deductible sum scheme and usage is an incentive for the insured to minimize the service and stop filing claims.

The moral danger arises in one of the most basic forms when workers shy away from duty at their workplaces. The employee has a clear opportunity to do the least amount of work for the same amount of money. The employer profits from eliminating this moral hazard. Incentives can be provided by the employer to enable workers to achieve an above-average workload. For example, giving incentives (that might be cash or company shares) to complete several tasks or to produce more may help to keep workers away from undesirable activity in the direction of desirable behavior. Employers will need to have long-term incentives intended to enable workers to be active and loyal. Moral Hazard wins if borrowers who can reimburse are not ready to reimburse. This is additionally valid for those who are happy to-reimburse however not ready to-reimburse due to, among different reasons, banks' ethically shaky conduct. Moral hazard likewise perseveres in a circumstance where borrowers are capable to exploit credit strategy irregularity and failure of the moneylenders or where borrowers' are in capacity to-reimburse loans suffer badly because of the imperfect policy system of the lender.

In a productive credit market, lenders are needed to guarantee that borrower's character, capacity, collateral, capital, and business conditions (famously named a five C's of credit) are all together

and there is no prejudicial utilization of credit standard. Among these, the initial two Cs - that is character and capacity- establish the premise prerequisites for giving advances to the candidate (Gitman, 2000). While character alludes to moral commitment identifying with monetary and authoritative commitments, for example, giving genuine data to the bank regarding credit value, capacity alludes to borrower's budgetary capacity to reimburse loans as and when it falls due. The way banks require accurate and solid data to search contemptible or dreadful borrowers from the pool of advanced candidates is not denied. As banks do, creditors learn about their monetary position, their ability to operate a company, and their ability to repay loans. Since credit markets are particularly blemished in developed nations (Kane 1975; Srinivasan 1994), non-straightforward and are tormented by information asymmetry (Srinivasan 1994; Gopal 1993), the ideal customer profiles (ICP's) are not in a situation to evoke genuine data about character, capacity, and money related states of the borrowers. Regardless of whether they try, they can't get all fundamental information since no component can inspire all appropriate data in a blemished economic situation.

Just the genuineness of the borrowers can fill in as a self-screening instrument which guarantees the development of reliable borrowers. It is also true that imperfect credit market conditions and lenders inefficiency allows the dishonest or borrowers who are incapable of credit have access to the loan regime and developing countries are infested with such credit unworthy borrowers who tend to get away with credit money or to become a willful defaulter. The lenders in advanced nations know about this circumstance and to secure their advantage, they accept current just as fixed assets of the borrowers as collateral against the loans they gave. The bank's first line of guard at the point where a loan goes bad is to seize and auction collateral to get the loans back. On the off chance that the borrowers can overstate the cost of the collateralized resources, get their cash back since the market estimation of the collateral will be lower than their expected worth. This means that collateral by itself does not guarantee the lender's commitment against the default of the loan. If there should arise an occurrence of industrial loans, the issue is more intense since the fixed resources of the firm are taken as collateral.

The exploitative borrowers will in general exaggerate the development cost of the firm and give these as collateral. Since the genuine estimation of the guarantee is far lower than the expressed value, moneylenders can't recuperate their credits by selling these in the market. Not just this, by falling back on over-invoicing (which means exaggerating the genuine market estimation) of the imported machinery, the borrowers can divert an enormous lump of money from the company's account to its private account. On the off chance that the exaggerated estimation of the collateral exceeds the advantages of loans default loans instead of the cost of not paying back the loans, creditors will be encouraged to disregard the obligation to loan repayment and become wilful default. Indeed, deceptive borrowers need to benefit more obligation and give less value which raises obligation value proportion (that is low value and high obligation) to procure more fixed resources which give greater chance to credit redirection. Sinkey & Greenwalt (1991) locate that a high proportion of obligation value is related to the higher risk of credit default. The ICPs may fall back on legal disputes to recoup advances from these obligation defaulters. With the recovery of loans from evaders, Koford & Tschoegl (1999) found that the judiciary was gentle and ineffective.

Also, the recovery of loans by legal action is not cost-effective. There are transparent costs to be paid by legal litigation, such as legal and court charges, and tacit costs, such as insolvent costs of business administration. If the borrowers know that the loans' rewards are greater than the expense of the loans. They are not going to be able to pay back the loans and default. They will not repay the loans. This does not mean the only culprits who try to decamp with loan cash are fraudulent borrowers. The ICPs can be equally responsible to increase the debt-burden beyond the repayment capacity of the honest borrowers who are willing to repay loans. If their credit policy is defective, the repayment ability of the borrower would be eroded and they will not expect repayment of the loan to occur in time. For example, a high interest that attracts bad borrowers tends to be charged by the ICPS (Stiglitz& Weiss 1981). The willingness of the borrower to accept the high-interest rate itself indicates the presence of a moral danger. Honest borrowers are mindful that they will be incapacitated to repay loans at higher interest rates that

increase the debt burden and refrain from borrowing as such. Yet morally bankrupt investors will be doing the reverse and defaulting. Since the industrial credit market in developing countries is highly inelastic, borrowers have little alternative but to rely on ICPs that operate as oligopolists and charge high-interest rates that increase the debt burden and the risk of default on loans. A high-interest rate in Bangladesh is a probable cause of default on loans, Hoque (1999) finds. This shows that the interest rate strategy that can not be justified morally is a loan loss formula.

3. Main work

3.1 Introduction

This chapter describes the approach employed in undertaking this study. It captures some key notations, assumptions, discusses the consumer loan rate and the credit risk of moral hazard consequences, and, centered on this, discusses the transition of the ethical risk of individual credit to credit risk and the response of credit risk to moral hazard.

Individuals usually do go for personal loans to cater for their financial needs or for investment purposes. But once any of the ways to repay loans fail, there is an automatic credit default. This is because these individuals lose their repayment power.

It seeks to find expected returns if two projects are undertaken: Project A and Project B. The study considers Project A to be a riskier venture with Project B being the less risky one. Risky investments are characterized by high returns and less risky assets are also characterized by less returns. Microfinance institutions tend to find themselves in a game theory setting as referred by economists in issuing loans to clients. In as much as the institutions try hard to make background check of customers and know their level of credibility they still stand a high risk of misinformation. This therefore put the clients in a dominant position. There are several instances where individuals borrow from the microfinance institutions stipulating clearly in the contract they are using the money for a less risky investment and then end up using it for something with the high level of risk. This usually do put the microfinance institutions at a disadvantaged point especially when investments fail for their clients. Also when relatively high interest is charged on loans, the probability of credit default also increases. Hence there exist a positive relationship between high interest rates and personal credit default(Calem & Mester,1995).

From these, we denote the expected return on investing in Project A as $x\delta_A$ and the expected return on investment in Project B is α which is distributed randomly on $[0, x\delta_B]$, with $F(\alpha|x)$

as the function of conditional distribution and $f(\alpha|x)$ as the function of conditional density.

Assumptions of investment

- The consumer loan default emerges if the investment fails.
- The game between micro finance institutions and people is dominant since banks are not aware of the high risk associated with Project A.
- If the rate of interest on the loan is substantial enough, the probability of default on personal credit increases with increasing interest rates.

3.2 Individual Credit Default

Unsecured Assets

Default of loans occur when there is a failure in investments as loans are usually taken to undertake projects expected to earn returns. Therefore when these expectations are not met either through mismanagement of funds or investing in a risky venture, credit default occurs. There are two types of assets to invest in: Project A and Project B.

Project A is considered a highly risky investments associated with relatively high returns. Risky assets are considered as such because there exist a significant amount of market instability. Examples are equity, real estate and currencies. Whereas, Project B is considered a less risky investment associated with fairly low returns. The certainty generally comes from a supreme amount of confidence in the insurer of the asset. This can also be termed as risk-free or risk-less assets. An example is the treasury securities.

For risky assets we know that credit default happens because investment is associated with high

returns. Instances like this lead to moral hazard often. Individuals do take this initiative just because they know the risk is borne by others and not themselves. A situation where a micro insurance is granted on a loan taken, borrowers may tend to invest in a risky asset because of the knowledge of insurance protection if the investment fails. Risk lovers are the ones who usually venture into projects like this. Let Project A be a very risky asset. Let the expected benefits of investing in Project A be V then according to Merton(1974),when moral hazard occurs then, $V = x\delta_A$, which follows an Ornstein-Uhlenbeck (OU) process of the form,

$$dV_t = \theta(\psi - V_t)dt + \sigma dB_t \tag{3.2.1}$$

We compute the expectation of Project A's success below;
Remove the diffusion term

$$dV_t = \theta(\psi - V_t)dt$$

Using the integrating factor;

$$e^{\int \theta dt} = e^{\theta t}$$

expanding equation (3.2.1) and using the integrating factor we obtain,

$$dV_t = \theta\psi dt - \theta V_t dt + \sigma dB_t$$

$$dV_t + \theta V_t dt = \theta\psi dt + \sigma dB_t$$

$$e^{\theta t}dV_t + \theta e^{\theta t}V_t dt = \theta\psi e^{\theta t}dt + e^{\theta t}\sigma dB_t$$

$$d\left(e^{\theta t}V_t\right) = \theta\psi e^{\theta t}dt + e^{\theta t}\sigma dB_t$$

$$\int_0^t d\left(e^{\theta s}V_s\right) = \int_0^t \theta\psi e^{\theta s}ds + \int_0^t e^{\theta s}\sigma dB_s$$

$$V_t e^{\theta t} - V_0 e^{-\theta(0)} = \theta\left[\frac{e^{\theta t} - e^{-\theta(0)}}{\theta}\right] + \int_0^t e^{\theta s}\sigma dB_s$$

$$V_t e^{\theta t} - V_0 = \psi\left[e^{\theta t} - 1\right] + \int_0^t e^{\theta s}\sigma dB_s$$

$$V_t e^{\theta t} - V_0 = \psi\left[e^{\theta t} - 1\right] + \sigma\int_0^t e^{\theta s}dB_s.$$

We know that $\int_0^t e^{\theta s}dB_s$ is an it$\hat{o}$ integral

$$\Rightarrow E\left[\int_0^t e^{\theta s}dB_s\right] = 0$$

Calculating for its variance,

$$\text{Variance} = E[\int_0^t e^{\theta s}dB_s]^2 - \left(E[\int_0^t e^{\theta s}dB_s]\right)^2$$

$$E\left[\int_0^t e^{\theta s} dB_s\right]^2 = E\left[\int_0^t e^{2\theta s} ds\right]$$

$$E\left[\int_0^t e^{\theta s} dB_s\right]^2 = E\left[\frac{1}{2\theta}\left(e^{2\theta t} - e^{2\theta(0)}\right)\right]$$

$$E\left[\int_0^t e^{\theta s} dB_s\right]^2 = E\left[\frac{1}{2\theta}\left(e^{2\theta t} - 1\right)\right]$$

but we know that the expectation of a constant is a constant, therefore

$$E\left[\int_0^t e^{\theta s} dB_s\right]^2 = \frac{1}{2\theta}\left(e^{2\theta t} - 1\right)$$

$$\Rightarrow \left(E\left[\int_0^t e^{\theta s} dB_s\right]\right)^2 = 0$$

The variance can therefore be computed as, $\frac{1}{2\theta}\left(e^{2\theta t} - 1\right)$. Let ε denotes the distribution of the $it\hat{o}$ integral, then, $\varepsilon \sim N(0, \frac{1}{2\theta}\left(e^{2\theta t} - 1\right))$

Since $\varepsilon \sim N(0, \frac{1}{2\theta}\left(e^{2\theta t} - 1\right))$ and $B_t \sim N(0, \sqrt{t})$ then we have

$$\varepsilon \times B_t = \frac{1}{2\theta}\left(e^{2\theta t} - 1\right))\sqrt{t} = \varepsilon\sqrt{t}$$

therefore,

$$V_t e^{\theta t} - V_0 = \psi(e^{\theta t} - 1) + \sigma\varepsilon\sqrt{t}$$

$$V_t = Ve^{-\theta t} + \psi\left(1 - e^{-\theta t}\right) + e^{-\theta t}\sigma\varepsilon\sqrt{t} \tag{3.2.2}$$

where, V_t is expected benefit to be earned from project A at t time and $V_0 = V$, is the estimated return of undertaking project A.

Now, if we have,

$$1 - P_A = P_r\{V_t < D_t | V_0 = V\} \tag{3.2.3}$$

where D_t is the sum of the principal and interest to be paid at the time of payment denoted by t. Then from equation (3.2.3), $V_t < D_t$ and we know V_t from equation (3.2.2) then it implies that

$$Ve^{-\theta t} + \psi\left(1 - e^{-\theta t}\right) + e^{-\theta t}\sigma\varepsilon\sqrt{t} < D_t$$

making ε the subject we get,

$$e^{-\theta t}\sigma\varepsilon\sqrt{t} < D_t - \psi\left(1 - e^{-\theta t}\right) - Ve^{-\theta t}$$

$$\varepsilon < \frac{D_t - \psi\left(1 - e^{-\theta t}\right) - Ve^{-\theta t}}{e^{-\theta t}\sigma\sqrt{t}}$$

$$\frac{D_t - \psi\left(1 - e^{-\theta t}\right) - Ve^{-\theta t}}{e^{-\theta t}\sigma\sqrt{t}} > \varepsilon$$

therefore,

$$1 - P_A = Pr\left[\frac{D_t - \psi\left(1 - e^{-\theta t}\right) - Ve^{-\theta t}}{e^{-\theta t}\sigma\sqrt{t}} > \varepsilon\right] \tag{3.2.4}$$

ψ represents the risk free rate for $\varepsilon \sim N(0, \frac{1}{2\theta}\left(e^{2\theta t} - 1\right))$. When the variance is very low, we can say it has a high precision whereas high variance indicates low precision.

The likelihood of Project A being a success under the normal distribution assumption is:

$$P_A = 1 - \Phi\left[\frac{D_t - \psi\left(1 - e^{-\theta t}\right) - Ve^{-\theta t}}{e^{-\theta t}\sigma\sqrt{t}}\right] \tag{3.2.5}$$

Where $\Phi(.)$indicates standard normal distribution cumulative probability function. From our first assumption, if project A fails, the consumer credit default risk can be estimated using the method below;

$$P_D = \Phi\left[\frac{D_t - \psi\left(1 - e^{-\theta t}\right) - Ve^{-\theta t}}{e^{-\theta t}\sigma\sqrt{t}}\right] \tag{3.2.6}$$

P_D is the probability of consumer credit default.

3.3 Secured Assets

The term secured asset can also be termed as encumbered asset. This refers to anything that serves as some form of security for the repayment of the debt due to the microfinance institutions (Vig, 2013). If debtors do not repay the debt to the microfinance institution, the relevant asset is then sold by the microfinance institution to cater for the debt. Customers usually pay back their loans when the project they embarked on becomes successful. Here, we denote project A being a success by, $M + V_t > D_t$

$$P_A = Pr\left\{k = V_t + M - D_t > 0\right\} \tag{3.3.1}$$

When the collateral debtors give as a pledge is assessed(M), the default likelihood feature of consumer loans is;

$$w = f(k),\ where \quad k = V_t + M - D_t,\ \text{and} \quad w \in [0,1] \tag{3.3.2}$$

w is the default likelihood if an individual mortgage is invested in Project A, then f(k) is a declining function of k as shown in Figure 1.

Evaluating the Loss Aversion component, which refers to people's propensity to prefer to avoid loss to benefit equal gains: where $k \geq 0$,the degree of people's propensity to decrease its credit-worthiness caused by k increases a unit lower than the degree of people's propensity to increase the possibility of default caused by k decreasing the unit (Li et al.,2014).

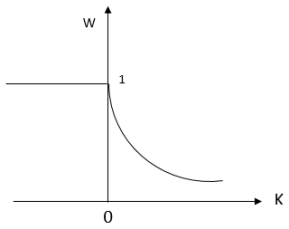

Figure 1: Personal mortgage default probability graph

When $k \geq 0$, $f(k)$ is a concave function which is called $g(k)$ and $k \geq 0$, according to the first assumption made earlier, credit default is inevitable once investment fails so $f(k) = 1$

$$f(k) = \begin{cases} g(k), & k > 0 \\ 1, & k \leq 0 \end{cases} \tag{3.3.3}$$

Equation (3.3.3) specifies the default likelihood function investment of a personal mortgage loan in Project A and can represented graphically below.

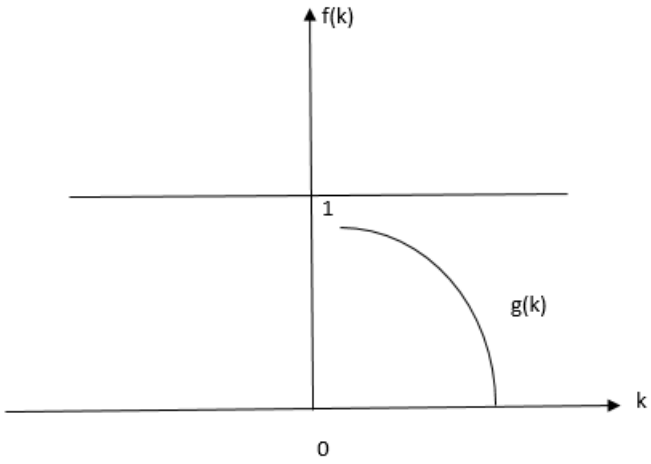

Figure 2: Default Probability Graph

3.4 Behaviour Of Debtors After Loan Acquisition

Moral risk occurs when there is the tendency for an entity to increase its exposure to risk because the full cost of the risk is borne by others. Also, moral hazard can arise when governments decide to bail out large companies. These bailouts send a message to large corporate executives that any economic costs resulting from participating in overly risky business practices (to maximize their profits) will be borne by someone other than themselves. Instances like this may cause microfinance institutions to give out loans to customers without doing a proper background check. Also customers of these microfinance institutions who may have already acquired their loans before the government bailout may decide not to return it leading to a rise personal moral hazard.

Let x_B represent the amount borrowed at rate, i and invested in operational project B. Since the expected return on investing in Project B is α which is distributed randomly on $[0, x\delta_B]$, with $F(\alpha|x)$ as the conditional distribution function and $f(\alpha|x)$ representing the conditional density function, therefore the expected return when Project B is successful is,

$$V_B(x_B) = \int_{x_B(1+i)}^{\mu} [\alpha - x_B(i+1)]\, f(\alpha|x_B) d\alpha \tag{3.4.1}$$

where $\mu = x_B \delta_B$ is the upper limit of investment fund returns x_B in project B.

Using integration by parts to solve equation (3.4.1),

$$\int u dv = uv - \int v du$$

let

$$dv = f(\alpha|x_B) d\alpha$$

to get v, we integrate dv

$$v = \int_{x_B(1+i)}^{\theta} f(\alpha|x_B) d\alpha$$

$$v = F(\alpha|x_B)$$

also let

$$u = \alpha - x_B(1+i)$$

$$du = d\alpha$$

Substituting the limits into the equation we get,

$$V_B(x_B) = [\mu - x_B(1+i)]F(\mu|x_B) - [[x_B(1+i) - x_B(1+i)]F(x_B(1+i)|x_B)] - \int_{x_B(1+i)}^{\mu} F(\alpha|x_B)d\alpha$$

$$V_B(x_B) = [\mu - x_B(1+i)]F(\mu|x_B) - [[x_B(1+i) - x_B(1+i)]F(x_B(1+i)|x_B)] - \int_{x_B(1+i)}^{\mu} F(\alpha|x_B)d\alpha$$

$$V_B(x_B) = [\mu - x_B(1+i)]F(\mu|x_B) - \int_{x_B(1+i)}^{\mu} F(\alpha|x_B)d\alpha$$

$$V_B(x_B) = [\mu - (i+1)x_B]F(\mu|x_B) - \int_{x_B(1+i)}^{\mu} F(\alpha|x_B)d\alpha \tag{3.4.2}$$

The rational individual will move funds from Project B to Project A when the estimated returns of Project A is way greater than that of Project B, leading to moral hazard in personal credit. This happens if an individual invests in a more risky project other than was intended. When the project fails, the individual loses their repayment power.

Personal credit will have a moral hazard if the following equation holds. From the nature of distribution function, $F(\mu|x_B) = 1$. Therefore, equation (3.4.2) can be written below by substituting $F(\mu|x_B) = 1$,

$$V_B(x_B) = [\mu - (i+1)x_B] - \int_{x_B(1+i)}^{\mu} F(\alpha|x_B)d\alpha \tag{3.4.3}$$

If an individual borrows x_B from a microfinance company for Project B and then invests them

in Project A, the expected return of Project A will be given by,

$$V_A(x_B) = P_A\left[x_B\delta_A - x_B(1+i)\right] \tag{3.4.4}$$

Equating equation 3.4.3 and 3.4.4 we get;

$$\begin{aligned}
P_A\left[x_B\delta_A - x_B(1+i)\right] &= \mu - (i+1)x_B - \int_{x_B(1+i)}^{\mu} F(\alpha|x_B)d\alpha \\
P_A x_B\delta_A &= \mu + P_A x_B(1+i) - (i+1)x_B - \int_{x_B(1+i)}^{\mu} F(\alpha|x_B)d\alpha \\
\delta_A &= \frac{\mu + P_A x_B(1+i) - (i+1)x_B - \int_{x_B(1+i)}^{\mu} F(\alpha|x_B)d\alpha}{P_A x_B} \\
\delta_A &= \frac{\mu - x_B(1+i)(1-P_A) - \int_{x_B(1+i)}^{\mu} F(\alpha|x_B)d\alpha}{P_A x_B} \\
\delta_A &\leq \frac{\gamma\left[\mu - x_B(1+i)(1-P_A) - \int_{x_B(1+i)}^{\mu} F(\alpha|x_B)d\alpha\right]}{P_A x_B}.
\end{aligned} \tag{3.4.5}$$

where, $\gamma \geq 1$.

When the margin at which Project A is expected to yield is better than Project B when all are successful, it depends on the level at which a person wants to bear risk. For a risk lover, as long as the estimated return of Project A exceeds that of Project B if both are good, Project A will be preferable for a risk lover.

$\gamma \geq 1$ denotes the individual risk appetite factor while for a risk lover, personal moral hazard will occur when $\gamma \geq$1 and for a risk adverse person moral hazard will only occur when γ is large enough.

Let;

$$\frac{\gamma\left[\mu - x_B(1+i)(1-P_A) - \int_{x_B(1+i)}^{\mu} F(\alpha|x_B)d\alpha\right]}{P_A x_B} = \eta(i) \tag{3.4.6}$$

Then the likelihood of the incidence of moral hazard by personal credit is;

$$P_M = 1 - H\left(\eta(i)\right) \tag{3.4.7}$$

where $H(,)$ is the distribution function of δ_A.

$$\frac{\gamma\left[\mu - x_B(1+i)(1-P_A) - [F(\mu|x_B) - F(x_B(1+i)|x_B)]\right.}{P_A x_B} = \eta(i)$$

Differentiating equation (3.4.6) with respect to i;

$$\frac{\partial\eta(i)}{\partial i} = \frac{\gamma}{P_A x_B}\left[\frac{\partial}{\partial i}[\mu - x_B(1+i)(1-P_A) - (F(\mu|x_B) - F(x_B(1+i)|x_B))]\right]$$

$$\frac{\partial\eta(i)}{\partial i} = \frac{\gamma}{P_A x_B}\left[[0 - x_B(1-P_A) - (0 - F(x_B(1+i)|x_B)(x_B))]\right]$$

$$\frac{\partial\eta(i)}{\partial i} = \frac{\gamma}{P_A x_B}\left[-x_B(1-P_A) + F(x_B(1+i)|x_B)(x_B)\right]$$

$$\frac{\partial\eta(i)}{\partial i} = \frac{\gamma}{P_A x_B}\left[F(x_B(1+i)|x_B)(x_B) - x_B(1-P_A)\right]$$

$$\frac{\partial\eta(i)}{\partial i} = \frac{\gamma\left[F(x_B(1+i)|x_B)(x_B) - (1-P_A)\right]}{P_A} \tag{3.4.8}$$

$F\left(x_B(1+i)|x_B\right)$ is the likelihood of B running project to fail and the likelihood of B project failure should be lower than that of A . Which can be written mathematically as; $F\left(x_B(1+i)|x_B\right) < 1 - P_A$.

$$1 - P_A > F\left(x_B(1+i)|x_B\right) \tag{3.4.9}$$

$$\text{So} \quad \frac{\partial \eta(i)}{\partial i} < 0$$

When the lending rate i, increases, $\eta(i)$ decreases monotonically indicating a negative relationship. From equation (3.4.7) P_M increases monotonically according to the character of distribution function.

If there is an ethical danger in purchaser credit, the risk in moral hazard from consumer credit rises monotonically with lending rates on bank loans rising.

Credit Risk for Individuals

At the point when one obtains cash from a microfinance institution at the rate of interest i, the possibility that the institution faces a consumer credit default becomes;

$$P_D = P_M(1 - P_A) + (1 - P_M)F\left(x(1+i)|x\right) \tag{3.4.10}$$

$P_M(1 - P_A)$ implies the risk of Project A failing in the event of a moral hazard to consumer loan; $(1 - P_M)F\left(x(1+i)|x\right)$ indicates the risk that if moral hazard does not exist to consumer loans, Project B will fail.

P_D does not generally increase monotonically alongside the likelihood of increased moral hazard of consumer loans, however it relies upon the probability of Project A being a good investment that is (P_A) and Project B. Particularly when the likelihood of a buyer's credit being a moral

hazard is 0, the default level of consumer credit is equal to Project B.

Link between loan rates and personal credit default probability(P_D)

Assuming P_D represents a continuous i function,and knowing that the interest rate of lending,i reaches an initial value of i_0 when $i = i_0$, P_M is minimum which implies $i = i_0$, $P_M \approx 0$. Hence, $P_D \approx F(x(1+i)|x)$.

From the distribution function features, a sufficiently small positive semi-neighborhood of i_0 exists.

$\theta_\epsilon = [i_0, i_0 + \epsilon]$ where ϵ is a fairly small positive number

if $i \in \theta_\epsilon$, default likelihood rises along with the increase in i, then

$$\left.\frac{dP_D}{di}\right|_{i=i_0} > 0 \tag{3.4.11}$$

where $i \in [i_0, i_0 + \epsilon)$

From equation (3.4.10), differentiating these composite functions with respect to i where $P_M = 1 - H(\eta(i)(i))$:

$$\frac{dP_D}{di} = \frac{dP_M}{di}(1 - P_A) - \frac{dP_M}{di}F\left(x(1+i)|x\right) - (1 - P_M)f\left(x(1+i)|x\right) \cdot x|x$$

By rearranging and factorization,

$$\frac{dP_D}{di} = (1 - P_A)\frac{dP_M}{di} - F\left(x(1+i)|x\right)\frac{dP_M}{di} - (1 - P_M)xf\left(x(1+i)|x\right)$$

$$\frac{dP_D}{di} = \left[1 - P_A - F\left(x(1+i)|x\right)\right]\frac{dP_M}{di} - (1 - P_M)xf\left(x(1+i)|x\right) \tag{3.4.12}$$

If $(1 - P_A) \in [0, 1]$ for $i = \hat{\mathsf{i}} \notin \theta_\epsilon$, then $1 - P_A = F\left(x(1+\hat{\mathsf{i}})|x\right)$ so according to equation (3.4.12), $\frac{dP_D}{di} = -(1 - P_M)xf\left(x(1+\mathsf{i})|x\right)$ which implies $1 - P_A = F\left(x(1+\hat{\mathsf{i}})|x\right) = 0$

$$\left.\frac{dP_D}{di}\right|_{i=\hat{\mathrm{i}}} < 0 \tag{3.4.13}$$

Then from the third assumption,

$$\left.\frac{dP_D}{di}\right|_{i=\bar{i}} > 0 \tag{3.4.14}$$

Therefore, there is $i \in \left(\hat{i}, \bar{i}\right)$ making,

$$\left.\frac{dP_D}{di}\right|_{i=\underline{i}} = 0$$

So, P_D reaches a minimum when $i = \underline{i} \in \left(\hat{i}, \bar{i}\right)$

Clearly, we can tell from the lending interest rate i_0 that minimizes the probability P_D of moral hazard of customer credit varies from the loaning financing cost(i) that limits the default likelihood.

Per equation (3.4.11), (3.4.12) and (3.4.13), the default likelihood of consumer credit P_D increases monotonically at i_0, but P_D at first ascents monotonically, at that point falls monotonically and rises once more, along with the expansion in the loaning rate i. The interest rate on loans, $\bar{i}$ makes the likelihood of the purchaser credit default hit the minimum while $\underline{\mathrm{i}}$ makes the likelihood of the consumer credit default hit its limit. Therefore $\bar{i}$ lies within $(i_0, \underline{i})$. Simply put, along with the loaning rate i, the default likelihood of consumer credit increases first, at that point hit the greatest $i = \bar{i}$ then decrease, to a base at $i = \underline{i}$,

In the event that moral hazard of consumer credit happens, the loan financing cost $\underline{i}$ that permits

the customer credit to hit a minimum is more noteworthy than the loan rate $\bar{i}$ that makes the buyer credit $\bar{i}$ hit the limit. This indicates: where there is an ethical peril to individual credit, with lower financing costs on bank loans, the likelihood of consumer credit default P_D will not reduce monotonically and decreased lending rates will not inherently minimize the likelihood of consumer credit default. This shows that lending rates can not be lowered to monitor the default risk of consumer loans.

When the likelihood of consumer credit default and loan rate i rise together, then i is a loan rate that rises with the likelihood of personal credit default; something else, if the likelihood of individual credit default increments for lower credit rates $(i \in (\bar{i}, \underline{i}))$, we then say i is a loan rate that decreases with the likelihood of personal loan default.

It can be said from the first conclusion that, the ascent in bank loan rates, the risk of moral hazard of individual loans P_M increments monotonically, yet the default likelihood of consumer credit P_D does not rise monotonically. Therefore we draw the accompanying significant conclusions:

Moral risk is neither non-monotonic nor non-linear because of the relationship between the default probability and the probability of buyer credit. In addition, there is an exogenous credit rate i, which allows for the maximum and minimum probability of individual credit default.

As the risk of moral hazard of consumer credit grows monotonically, personal credit default rates first reach their height and then reach their minimum. Furthermore, according to equations (3.4.5) and (3.4.7), the smaller the distance between $P_A\delta_A$ and P_B, the greater the $\eta(i)$, the less likely the moral hazard of personal credit $P_M = 1 - \Phi(\eta(i)))$ is.

The process for moving the moral hazard of personal loans to credit risk is therefore as follows:

1. If the probability of moral hazard of the individual credit risk is 0, then the likelihood of consumer credit default is equal to Project B's probability of failure.

2. If Project A 's estimated return is marginally greater than Project B's return upper bound, then the likelihood of consumer credit's moral hazard is low. If the moral hazard in consumer credit arises, the default likelihood of consumer credit will show a monotonous rise in patterns along with a rise in the loan interest rate.

3. If Project A 's estimated return is much greater than Project B 's return upper limit, then the likelihood of consumer credit's moral hazard is high. And the personal credit default rate will initially diminish, then increase, along with higher interest rates for lending.

The Moral Hazard Effect

The probability of Project B failing is denoted by, $\lambda = F\left(x(1+i)|x\right)$. According to equation (3.4.7),

$$\begin{aligned} P_D &= P_M(1-P_A) + (1-P_M)\lambda \\ P_D &= P_M - P_A P_M + \lambda - \lambda P_M \\ P_D &= P_M\left(1 - P_A - \lambda\right) + \lambda \\ P_D - \lambda &= P_M\left(1 - P_A - \lambda\right) \\ P_M &= \frac{P_D - \lambda}{(1-P_A) - \lambda} \end{aligned} \tag{3.4.15}$$

If λ and $1 - P_A$ are all unchanged, the default charge of consumer credit $P_D \in [\lambda, 1 - P_A]$ moves in the same direction as the likelihood of moral hazard of consumer credit P_M and the default rate P_D.

Holding the default rate of consumer credit P_D constant, the likelihood of Project A failing that is $1 - P_A$ will increase; or $1 - P_A$ will remain unchanged, while λ will decrease the likelihood of moral hazard of consumer credit P_M.

The interval $[\lambda, 1 - P_A]$ is called consumer credit default rate restriction interval. Apparently, from one viewpoint, the bigger the stretch, the less likely the moral hazard of customer credit is,

on the other, when the default rate limit span is defined, in light of the fact that the chance of moral hazard of consumer credit moves a similar way with the default rate, people with higher credit hazard default rate P_D dropping into the right half of the interval $[\lambda, 1 - P_A]$ as the asset deteriorates further will increase the likelihood of moral hazard thereof.

4. Conclusion

Using the Ornstein-Uhlenbeck process, after careful study, evidence and scrutiny of the relationship between moral hazards and credit risks, we found that credit loans and interest rates on loans influence the individual's actions in repaying the loans. In fact, individuals prefer to trade in the investments of their choice after loans are granted. Depending on profit margins, these investments may either be risky or non-risky. The stochastic approach has been used to calculate the risk factors and possible losses in an investment. In addition, steps are in place to ensure the payment of loans in order to reduce losses for microfinance institutions. These measures are in the form of secured and unsecured assets depending on the type of loan the individual opts for or the time frame within which the loans must be repaid. We recommend that microfinance institutions should do more secured assets since it's impact is less.

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