EFFECTS OF MICROCREDIT ACCESS, UTILIZATION AND REPAYMENT ON CATFISH PRODUCTION ENTERPRISES IN BENUE STATE, NIGERIA

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A DISSERTATION SUBMITTED TO THE POSTGRADUATE SCHOOL, MICHAEL OKPARA UNIVERSITY OF AGRICULTURE, UMUDIKE, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DOCTOR OF PHILOSOPHY (AGRIBUSINESS INVESTMENT AND FINANCE) IN THE DEPARTMENT OF AGRIBUSINESS AND MANAGEMENT

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DECLARATION

This Dissertation is the original work approved and supervised by the Supervisory Committee and carried out by me: **OGIDI, ARMSTRONG EMMANUEL (MOUAU/PG/Ph.D./ABM/15/5353)** in partial fulfillment of the requirements for the award of Doctor of Philosophy Degree in Agribusiness Investment and Finance in the Department of Agribusiness and Management.

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CERTIFICATION

We certify that this Dissertation titled: "**Effects of Microcredit Access, Utilization and Repayment on Catfish Production Enterprises in Benue State, Nigeria.**" Written by **OGIDI, ARMSTRONG EMMANUEL** has been examined and found acceptable for the award of Doctor of Philosophy Degree in Agribusiness Investment and Finance in the Department of Agribusiness and Management.

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DEDICATION

This thesis is dedicated to the Almighty God who has been my backbone from the inception of this work to its end, and to my beloved wife and son, Mrs. Rose Ihotu Ogidi and Cedric Owoichogbe Ogidi for their time and support.

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ABSTRACT

The broad objective of this study was to examine the effects of microcredit access, utilization and repayment on catfish production enterprises in Benue State, Nigeria. Multistage sampling technique was used in selecting respondents for the study. Thus, a total sample size of 300 catfish production enterprises was selected for this study. The study used descriptive statistics to examine and analyze objectives one, two, three and eight, respectively. Objectives four to seven utilized inferential statistics. The statistical techniques adopted were: frequency distributions, means and percentages to examine variables, multiple regression, logit regression, Structural Equation Modeling (SEM), stochastic frontier, analysis of variance (ANOVA), and likert scale. The study disclosed that, of the total sum of ₦ 39,189,185 microcredit accessed by catfish production enterprises; a huge sum of ₦ 28,582,422 was utilized in catfish production business. However, the utilization index for accessed microcredit was 0.73; this translates into 73% of utilized microcredit in the study area. In the case of microcredit repayment, a vast sum of ₦ 37,054,472 was repaid by catfish production enterprises. This implies that 94% of the total sum of ₦ 39,189,185 microcredit accessed by catfish production enterprises was repaid. SEM was used to test the relationship among the constructs; for the whole model, the statistical result shows that Chi-square value of 222, 091.25 was significant at 1%. Standard estimation of the full model of the three paths indicates significance for both Content Specific Factors and Social Factors respectively. Economic Factors however, was not significant even at 5% but was at 10% which is a bit far off for this study. The study concludes that, the coefficients agreed with the *a priori* expectation, which states that, a unit increase in microcredit access, utilization and repayment leads to a corresponding increase in catfish output in the study area. The Multiple coefficient of determination (R^2) value is 0.960, which indicated that there is a very strong and significant relationship between the indicators. The results indicate that the calculated value of F-test at 1% level showed significant value of 10.45. Based on the findings of this study, catfish production enterprises should engage the office of the Director of Fisheries under the Benue State Ministry of Agriculture to enquire about skills in writing a feasibility study for their enterprises in order to access more microcredit from Bank of Industry (BOI) and Bank of Agriculture (BOA). The credit made available by sources of microcredit such as BOI, BOA, cooperatives, etc, to catfish production enterprise need to be increased so that the enterprise could make greater impact on fish production and economic growth of the Nation. Government should fund more microcredit institutions so that their interest rate would be reduced for catfish production enterprises to obtain credit with ease.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Microcredit is a loan granted to micro-enterprises, such as peasant farmers, artisans, fishermen, youths, women, senior citizens and non-salaried workers in the formal and informal sectors; the loans are usually unsecured, but typically granted on the basis of the applicant's character and the combined cash flow of the business and household (Central Bank of Nigeria (CBN), 2012). Microcredit is very essential to catfish production enterprises and farmers, who are mostly unable to meet the collateral requirements of formal financial institutions (UNIDO, 2010).

In the wake of a looming global food crisis, Nigeria is not isolated; more emphasis is now being placed on increased domestic supplies (Emokaro and Ekunwe, 2009). Catfish is the most commonly cultivated species of fish because of its superior market value (FAO, 2012). According to the Aquaculture and Inland Fisheries Project (AIFP) of the National Special Program for Food Security (NSPFS), Benue State has the highest number of catfish farms compared to other Northern States in Nigeria (Benue State Ministry of Agriculture, 2018; FAO, 2007a; FAO, 2007b). In agreement, the Director of Fisheries, Ministry of Agriculture, Benue State, confirmed that the State has more than 300 catfish farmers (Benue State Ministry of Agriculture, 2018). In order to boost fish production in Benue State, the Federal Government made available inputs such as juveniles and 50 percent subsidized standard fish feeds of 15 kilogrammes at ₦12, 500 to fish production enterprises in 2013 after the 2012 flood (Abah, 2014). In 2016 catfish farmers benefited from the provision of collapsible tanks (tarpaulin tanks) and in June, 2017, the Federal Ministry of Agriculture, through the Department of Fisheries distributed about 400, 000 fingerlings which were stocked at Akata in Katsina-Ala Local Government Area of Benue State (Benue State Ministry of Agriculture, 2018). The condition of catfish production in Benue State is influenced by microcredit access, utilization and repayment.

Access to microcredit is pertinent for transforming a developing country like Nigeria (Norton, Alwang and William, 2010). Access to microcredit by agribusiness managers leads to increased productivity and income (Tijani, 2011). However, microcredit availability is influenced by determinants of microcredit access such as sources of microcredit, amount of microcredit obtained by the catfish production enterprise and rationing in rural credit markets.

Microcredit sources such as Bank of Agriculture (BOA), Bank of Industry (BOI), commercial banks, microfinance or community banks, cooperative societies, private money lenders, family and friends and owner savings are necessary for high performance of catfish production business. Catfish producers can obtain loans from such microcredit sources close to them. In Benue State, fish cooperatives are trying to formally register themselves in order to source microcredit from BOA and BOI (Benue State Ministry of Agriculture, 2018). Furthermore, taking a look at available credit sources in both the formal and informal credit sector, it has been discovered that though, credit is important for sustainable agricultural development, there still exists a gap between its demand and supply as induced by certain constraints (Adebayo and Adeola, 2008). According to the Director of Fisheries, only crop producers enjoy source of credit such as anchor borrowers' scheme. An anchor borrower scheme will soon be in the pipeline for fish producers to access microcredit in Benue State (Benue State Ministry of Agriculture, 2018). However, the amount or level of microcredit accessed determines the depth of investment within the catfish production enterprise.

The amount accessed for catfish production is one of the major factors influencing rapid economic development. Amount of microcredit invested also has the capacity to transmit the benefits of growth more rapidly and more equitably, through the informal sector (UNIDO, 2010). Access to investment funds through microcredit is critical to lifting small scale farmers above the subsistence level and enable the catfish producer cushion his/her business against risks. Access to microcredit and amount invested is more of a supply-side issue related to the potential lender's choice of the maximum credit limit (Diagne, 1999). However, the amount or level of investment as a result of accessibility to microcredit is affected by certain variables such as rationing in credit markets (Weber and Musshroff, 2012).

Microcredit utilization ensures that catfish production business employs inputs such as labour, land, fingerlings and standard feeds judiciously. Microcredit aids catfish producers to plough in more investment fund which is likely to bring in high returns. The need for microcredit is relevant for catfish production, income and wealth generation (Afolabi, 2010; Mbam, 2017). Technical and allocative efficiencies of catfish production business depend largely on the judicious utilization of microcredit obtained. Microcredit enables catfish producers to purchase the inputs they need to increase their productivity, as well as finance a range of activities, thereby, adding value to catfish output (Nosiru, 2010). Resources are scarce and catfish production requires the judicious or efficient utilization of resources to avoid wastage and loss (Awoniyi and Omonona, 2006). However, profit needs to be realized through proper utilization of microcredit accessed in order for the catfish producer to pay back borrowed credit. This is feasible, especially for mangers with the experience and access to microcredit. Repayment of microcredit by catfish farmers is more compared to crop farmers in Benue State due to the incidence of threats such as floods, herdsmen challenges, and crop loss (Benue State Ministry of Agriculture, 2018).

In the case of repayment of microcredit loans, banks do not lend to poor groups due to fear of non-repayment and increase in their non-performing assets (Kohansal and Mansoori, 2009; Weber, Mubhoff and Petrick, 2014). Lenders can evaluate whether or not direct financing of producers or indirect financing of their suppliers or buyers, is most appropriate (Coon, Campion and Wenner, 2010). Various factors influence the repayment performance of borrowers in rural markets such as farming experience, income of borrower, loan size, value of collateral offered as security, interest rate, total application costs and number of installments to repay loan (Kohansal and Mansoori, 2009). However, the classification of factors affecting repayment schedules is divided into three broad categories, namely: social factors; economic factors; and contract-specific factors. These factors and other constraints determine continuity in the catfish production business.

Constraints are vital forces that catfish producers must take notice of in order to remain in business. The constraints are usually inherent in the environment where the catfish business is operated. Examples of constraints include but are not limited to the following: high interest rates, bureaucratic bottlenecks, late approval, guarantor, collateral, no banks in the locality, defaulting in payment, lack of awareness, sentiments, and inadequate credit.

It is against this backdrop that this study set out to examine the effects of microcredit access, utilization and repayment on catfish production in Benue State.

1.2 STATEMENT OF THE PROBLEM

According to the Fisheries Department of Benue State Ministry of Agriculture (2018), the problems faced by catfish producers includes, absence of banks in the locality, high interest rate, bureaucratic bottlenecks, late approval of loan request, amount of credit given is too small, collateral request by lenders, negotiating produce before production, sentiments, delay in loan repayment and lack of awareness regarding microcredit policies and accessibilities. With the various programmes (such as Bank of Industry (BOI), Bank of Agriculture (BOA), CBN Anchor Programmes, etc.) channeled towards reducing microcredit challenges, small scale producers are still faced with issues such as inability to access formal credit (Abdelateif and Sayed, 2015).

Inability to access formal credit remains one of the most restrictive problems facing small scale producers (Abdelateif and Bauer, 2013). This has forced small scale producers to sometimes seek capital from relatives, friends and money lenders which are ineffective in providing capital needs especially in agricultural investment. Similarly, the private money lenders are interested more in earning high interest or taking hold of the debtor’s property rather than financing people in need. Therefore, microcredit institutions that offered formal credit to the poor provide hope for the farmers in terms of loan amount and interest rate charged (Alufohai, 2006). Thompson & Mafimisebi (2014) reported that over 87% of farmers did not have any access to credit among the catfish aquaculture in Nigeria. This is not too far from the assertions by, Olaoye, Ogunremi, Ojebiyi, Ojelade, Shopade and Opele (2017) that the lack of group formation among fish producers affected the access to credit and information by owners.

Fish producers are yet to form cooperatives that would champion the affairs of members; however, formation of fish associations that would reduce inability to access microcredit is in progress (Benue State Ministry of Agriculture, 2018). Fish farmers in Benue State faced challenges of producing fish in commercial quantity. This became difficult when, the Growth Enhancement Support Scheme (GESC) introduced by the Goodluck Jonathan administration favoured mostly crop farmers by providing for example, seeds and fertilizers at subsidized rates; in the process fish farmers were neglected in the State (Benue State Ministry of Agriculture, 2018). In Benue State, the anchor borrowers’ scheme favours crop production enterprises except fish producers; this reduced the probability of catfish production businesses gaining access to microcredit (Abah, 2014). Individual borrowers who owned catfish production businesses were not able to access microcredit of more than ₦250, 000 from BOA and BOI; highly educated catfish farmers who could write good feasibility proposals for their production businesses were able to access a million Naira (Benue State Ministry of Agriculture, 2018). Without collateral, BOA and BOI send in their experts to verify claims made on paper by the prospective catfish production business; qualified applicants are then granted credit for their businesses.

Government has tried to enhance the availability of microcredit with the provision of BOI, BOA and various community or microfinance banks within the Country. Government also gives support to catfish farmers to form co-operative societies in order to improve their financial base, but despite these efforts, at both Federal and State levels, microcredit access and utilization are still not feasible (Sampou, 2006). Even with this impressive zeal of Government, catfish production enterprises continue to experience capital inadequacy due to high rate of loan default (Edet, Atairet, Nkeme and Udoh, 2014). In order to solve the problem of financial constraint, the problem of high default risk associated with farmers, which made the financial institutes reluctant to extend loan, has to be solved (Gebeyehu and Assefa, 2004). Default in repayment of microcredit could be linked to loan diversion into other activities not associated with the enterprise in question.

Some catfish producers engage in loan diversion for other purposes leading to poor utilization of borrowed microcredit (Benue State Ministry of Agriculture, 2018). This increases the suspicion by formal financial institutions as regards agricultural producers. Support from informal borrowers is vital, however, they charge very high interest rates within a very short period of time; studies (Afolabi, 2010; Adegbite, 2009; Oni, Oladele and Oyewole, 2005), indicate that small holder loan schemes in Nigeria have high rate of loan default. Some studies, (Oboh and Kushwaha, 2009; Alade, Ajayi, Enendu and Idowu, 2003) credited it to fund diversion, poor marketing opportunities, low pricing of products, low yield and negative attitude of farmers towards government owned credit, interest rate problem, inadequate loan volume, loan diversion as well as unprofitable interest rate (Edet *et al.* 2014). These studies, however are flawed because they concentrate on the catfish farmers' socio-economic features in association with his/her part-time fish production business.

Much work has not been done as regards the economic and demographic profiles of catfish production enterprises. However, many research has been carried out as regards socio-economic features of catfish farmers in Benue State and Nigeria (Folayan and Folayan, 2017; Akarue and Aregbor, 2015) as a whole. Studies such as Sampou (2006), highlighted the problems of microcredit acquisition and utilization among small-scale fish farmers neglecting the repayment aspect. From observation, this study found out that little works on microcredit access, utilization and repayment in Benue State in particular exists. This review brings out the gap in Literature which this study tried to examine.

1.3 RESEARCH QUESTIONS

In line with the above problem statement, the following research questions were considered.

i. What is the demographic and economic profile of catfish production enterprises in Benue State?

ii. How important are the sources and amount of microcredit accessed by catfish production enterprises?

iii. What is the level of microcredit utilization and repayment by catfish production enterprises?

iv. How important are the determinants of microcredit access, utilization and repayment by catfish production enterprises?

v. What are the effects of microcredit access, utilization and repayment on output of catfish production enterprises?

vi. What is the efficiency of catfish production enterprise in Benue State?

vii. What are the differences in microcredit access, utilization and repayment by catfish production enterprises?

viii. What are the constraints to microcredit access, utilization and repayment by catfish production enterprises in Benue State?

1.4 OBJECTIVES OF THE STUDY

The broad objective of this study was to examine the effects of microcredit access, utilization and repayment on catfish production enterprises in Benue State, Nigeria. The specific objectives were to:

i. describe the demographic and economic profile of catfish production enterprises in Benue State;
ii. examine the sources and amount of microcredit accessed by catfish production enterprises;
iii. analyze the level of microcredit utilization and repayment by catfish production enterprises;
iv. analyze the determinants of microcredit access, utilization and repayment by catfish production enterprises;
v. determine the effect of microcredit access, utilization and repayment on output of catfish production enterprises;
vi. analyze the efficiency of catfish production enterprise in Benue State;
vii. determine the differences in microcredit access, utilization and repayment by catfish production enterprises; and
viii. identify constraints to microcredit access, utilization and repayment by catfish production enterprises in Benue State

1.5 HYPOTHESES OF THE STUDY

$H0_1$: Determinants of microcredit access, utilization and repayment do not have significant effect on catfish production enterprises;

$H0_2$: Microcredit access, utilization and repayment do not have significant effect on output of catfish production enterprises

$H0_3$: Inefficiency effects are absent from catfish production enterprises in Benue State

$H0_4$: Microcredit access, utilization and repayment by catfish production enterprises are not significantly different

1.6 JUSTIFICATION OF THE STUDY

Little study has been undertaken to examine the effects of microcredit access, utilization and repayment on catfish production in Benue State. Catfish production enterprises are characterized by low investment outlay and therefore are unable to repay loan or credit extended to them (Abdelateif and Bauer, 2013). Expansion and sustainability of their enterprises depend to a large extent on microcredit access, utilization and repayment, given good management. In order to survive, the catfish production enterprise needs to obtain credit from microcredit finance institution. Some agricultural microcredit lending institutions that have a firmer or stronger presence at the rural areas of Benue State are: BOA, BOI, Nigeria Agricultural Co-operative and Rural Development Bank (NACRDB), private American non-profit organization (PFD), co-operative societies and Local Bam. Benue State is blessed with a loamy-clay soil that is very suitable for catfish production. The ability of the soil to retain water is very vital for entrepreneurs who want to engage in earthen pond and other forms of catfish farming in the study area. Moreso, the State is number one when it comes to fish farming in Northern Nigeria (FAO, 2007a; FAO, 2007b). It is from the foregoing backdrop that this study is justified and will be useful in numerous ways.

The findings of this study would provide useful information on the effect of microcredit access, utilization and repayment on the catfish production enterprises and their level of operation to meet productivity and income. This study will be beneficial to entrepreneurs intending to invest in catfish production in the study area. The study will help managers of catfish enterprises to reduce diversion of funds to the minimum.

Entrepreneurs wishing to go into catfish production business will be guided by the study to take decisions as regards available microcredit for catfish production in the study area. Thus, the entrepreneur will have knowledge of microcredit sources, access, utilization and repayment, thereby, reducing shocks from the environment that could discourage continuity in the business.

The outcomes of this study will proactively spur government policy makers to formulate realistic investment policies that are likely to enhance catfish production in Benue State, Nigeria. Awareness of the effect of microcredit access, utilization and repayment on catfish production business is pertinent in the academics. Finally, the study would further contribute to the body of knowledge, fill the gap in the existing literature and be a useful source of information for future research regarding this subject matter, in the study area most especially.

1.7 SCOPE AND DELIMITATIONS OF THE STUDY

This study gives priority to the production of cultured catfish. This aspect involves growing up fingerlings until they reach the maturity stage of harvest taking into consideration the investment role played by the entrepreneur. Primary data of catfish production for the year 2017 was relied upon. The study covered catfish producers who specialize in concrete, earthen, tarpaulin and fiber or plastic systems of catfish production in Benue State. The study highlighted three microcredit activities (i.e., access, utilization and repayment) which where the main focus of credit activities for this study.

The study was limited to only microcredit and not microfinance as a subject matter. In the case of microcredit, borrowed funds from lenders (i.e., Bank of Agriculture (BOA), Bank of Industry (BOI), commercial banks, microfinance or community banks, cooperative societies, private money lenders, family and friends and owner savings) were mirrored upon. In this regard, microcredit is a subset of microfinance. Microfinance which this study does not take congnisance of, is a universal set that includes microcredit activities, insurance, capital instruments such as stocks, shares, debentures, bonds, etc.

It is important to state here that, this study cannot be generalized for Nigeria as a whole because determinants of factors responsible for microcredit activities such as access, utilization and repayment of borrowed loans in Benue State, might be different compared to other States in the country.

This study is also limited to the examination of the catfish enterprise as a business entity. Thus, issues surrounding the socio-economic activities of the catfish farmer/manager and their entire household were not of interest.

CHAPTER 2

REVIEW OF RELATED LITERATURE

2.1 CONCEPTUAL FRAMEWORK

Conceptualization for this study takes into consideration, the concept of microcredit and concept of production efficiency. The concepts may be divided into constructs/dimensions to throw more light on the subject matter.

2.1.1 Concept of microcredit

Microcredit is defined as any credit facility and ancillary services, extended to both peasant farmers and poor non-farmers (rural populace), aimed at not only boosting agricultural production, but also at improving the standard of living of the rural populace, as well as, stimulating rural sector economic growth and development (Tijani, 2008). Access to microcredit (formal and or informal) is often confused with participation in microcredit (formal and or informal) programmes, as the two concepts are often used interchangeably in many studies. A household is said to have access to a particular source of microcredit if it is able to borrow from that source, although for a variety of reasons it may choose not to. The extent of access to microcredit is measured by the maximum amount a household can borrow (its credit limit). If this amount is positive, the household is said to have access to microcredit. A household is said to be participating if it is borrowing from a source of microcredit. A household is credit constrained when it lacks access to credit or cannot borrow as much as it wants (Diagne and Zeller, 2001).

A farmer who benefits from a loan offered by a credit agency may be found to be more productive, however, in some cases this may not be. Loans lead to higher productivity since it is plausible that farmers with more ambition and ability are likelier to seek out loans.

The concept of microcredit has been around for quite some time. Brandt, Epifanova, and Klepikova (2012) claim that documentation of loans being made out to the poor have been cited in Europe since the 18th century. They highlight several examples. For one, Jonathan Swift created a fund to provide “poor industrious tradesmen” money “in small sums of five, and ten pounds, to be repaid weekly, at two or four shillings, without interest” (Brandt, Epifanova and Klepikova, 2012:1). Another was the Irish Reproductive Loan Fund Institution that began in 1822 to assist the poor by providing them with small loans under 10 Euros in modern terms. In addition, 19th century German credit cooperatives highlight another example of historical microfinance. These cooperatives acted as the modern microcredit self-help group in which the whole cooperative was provided a loan, and they were communally responsible for its repayment (Brandt *et al.*, 2012). Lastly, Wolcott (2009) also discusses an early example of microfinance in which very small loans were made to people in need without the requirement of collateral in colonial India. Indeed, microcredit is not a new trend.

It was in the 70s that microcredit became a “modern” phenomenon. The modern concept of microcredit is often championed by Muhammad Yunus, a native Bangladeshi educated in the United States who later became a professor at Chittagong University in Bangladesh. In 1974, the beginnings of the now famous Grameen Bank occurred when Yunus lent a small amount of money from his own pocket to a crafts woman he trusted to repay him. Since then, Grameen Bank has garnered a lot of international attention, winning Yunus a Nobel Peace Prize in 2006 (Yunus, 2003).

Grameen and the many institutions that have modeled its system claim to not only be a powerful source for alleviating poverty, but many Micro Finance Institutions (MFIs) also claim to empower women, even in traditionally patriarchal societies such as Bangladesh. These institutions assert that they are providing individuals with useful capital at interest rates that are not exorbitant, unlike the informal lenders within these developing nations. The poor tend to have limited access to services from formal financial institutions in less developed countries due to, for example (i) the lack of physical collateral; (ii) the cumbersome procedure to start transactions with formal banks, which would discourage those without education from approaching the banks; and (iii) lack of supply of credit in the rural areas related to urban biased banking networks and credit allocations (Imai and Azam, 2010).

There seems to be a lack of access to microcredit for poor individuals in developing nations, and microfinance claims to be assisting in reversing this problem. It is also important to note that microfinance began by giving only microcredit to individuals. Since then, the financial toolbox of microfinance institutions has expanded. A 2012 systematic review, funded by UK's Department for International Development (DFID), analyzed these expansions by not only studying microcredit, but micro-savings and micro-leasing (Stewart *et al.,* 2012). In addition to these microfinance instruments, some institutions also provide micro-insurance and non-financial programs that assist in social development such as business and financial literacy training (Duvendack *et al.,* 2011).

More generally, actual loan uptake would be an accurate measure of credit only if credit limits were universally binding i.e. if everyone's loan uptake were equivalent to her credit limit (Hazarika and Alwang, 2003). Hence, credit limit – the maximum amount that may be borrowed which is often considered to be a better measure of credit access; unlike credit programme participation or actual loan uptake which are related to demand for credit, reflecting mainly supply side factors such as the availability of credit programmes and financial resources of the lenders, is a true measure of an exogenous credit constraint (Diagne and Zeller, 2001).

Concept of microcredit for this study is divided into four separate constructs. The constructs are as follows: microcredit sources, microcredit access, microcredit utilization and microcredit repayment. This is to throw more light on the key words in the topic and to give the reader a clear view of what to expect in chapter four.

a) Concept of microcredit sources

In respect to this study, concepts of microcredit sources are explained below:

(i) Concept of private money lender

A private money lender is a non-organizational individual that lend money guided by a deed of trust, for the reason of financing a project. Private money lenders are more liberal than formal (hard) money lenders (Bigger Pockets, 2017). Private money lenders are in business to be paid above average rates of return on their money. This makes it difficult for catfish producers to pay private money lenders on time or at all without legal battle. The money lender can demand for collateral same as a commercial bank in case of a default in re-payment. There exist some private money lenders in Benue State that offer microcredit to catfish producers on the basis of relationship between both parties.

(ii) Concept of family and friends loan

This is a loan accord whereby family and friends concur to borrow money to a catfish producer. This agreement may or may not involve any formal contract (Business Loans, 2017). It is pertinent that the catfish producer treat family and friends with respect. The catfish producer ought to explain the business vision, strategy and own investment so far. This will show confidence and how the catfish producer plans to profit from the microcredit to be offered.

(iii) Concept of commercial banks

Commercial banks are monetary organizations that grant various financial services, which includes accepting money deposits and granting loans (Investopedia, 2017). Commercial banks loan out customers' deposits to businesses and individuals who are in need of credit. However, these loans have interest rates that are more than the rates banks pay to their depositors. Catfish farmers find it very difficult to obtain microcredit from commercial banks in Benue State, Nigeria.

(iv) Concept of bank of agriculture

Bank of Agriculture (BOA) is a special type of bank that borrows money to farmers for longer durations of time and demand less interest than other categories of banks (Ogunojemite, 2017). BOA is a special credit bank created in accord with the stipulations of law to support agricultural improvement within a community. Their functions include granting of loans for longer durations with lower interests. Various tasks are carried out by the BOA. According to the Central Bank of Nigeria (CBN), Federal Ministries of Agriculture and Finance, such tasks include credit task and developmental task. The essential products and services carried out by the BOA are as follows: Credit Services, Micro Loans Scheme, SME/Agribusiness Loans Scheme, On-Lending Loan Scheme, Bank of Agriculture Rural Business Initiative (BoARBI) and Mobile Banking Services.

(v) Concept of cooperatives

Cooperatives are deliberate organizations formed by persons for mutual assistance and its objectives are achieved through self help and collective effort (Ogidi, 2017).

It's a perquisite that cooperatives should be registered with the Government. The minimum requirement should not be less than ten persons. Capital is raised from members which is also referred to as the share capital. Cooperatives could be one of the following: farmer/agricultural cooperatives, consumer cooperatives, community cooperatives, worker cooperatives, housing cooperatives, credit unions, civil society, second and third tier cooperatives, etc.

(vi) Contract farming

Contract farming is a contractual agreement between a farmer and a prospective buyer. With this type of arrangement, a buyer involves smallholder farmers or producers who in turn supply their output after the former had aided in the provision of some basic inputs. The buyer organizes the supply chain from the top, including collection and processing services, and provides critical inputs, specifications, training, and credit to its suppliers. The farmer provides assured volumes of catfish of specified quality, on specified dates, at agreed-upon prices (Karamchamdi, Kubzansky and Frandano, 2009).

The company or large buyer often agrees to support the farmer through, e.g., supplying inputs, assisting with land preparation, providing production advice and transporting produce to its premises. The term "contract farming" is sometimes used synonymously with out-grower scheme, most commonly in Eastern and Southern Africa (Shabu, Gyuse and Abawua, 2011). The out-grower microcredit programme is designed to strengthen the capacity of small holder farmers to produce a sustainable supply of high quality catfish.

(vii) Owner's Fund

Owner's fund is money borrowed the owner or C.E.O. of the catfish business and also referred to as capital in the case of sole proprietor, partnership, limited liability partnership etc (Aggarwal, 2015). Owner's funds involve the profits accrued from the catfish enterprise that are reinvested in the catfish enterprise referred to as retained earnings, ploughing back of profits or self financing.

b). Concept of microcredit access

Microcredit is accessed through various sources such as private money lenders, family and friends, commercial banks, Bank of Industry (BOI), Bank of Agriculture (BOA), cooperatives, contract farming and savings of the entrepreneur which have their peculiar processes or procedures. These sources can also be grouped into formal and informal financial institutions (Sampou, 2006).

Other major informal financial institutions such as: catfish production cooperatives, catfish marketing cooperatives, fish producers' cooperatives, play a major role in catfish production enterprises. These informal credit institutions have microcredit access processes which includes member guarantor, credit given to members only and collect as you turn in the rotation (Nweze, 2001). Obstacles trail these processes in the sense that, in the rotation, cooperative members are expected to contribute a certain amount of money periodically; which can be daily, weekly or monthly until the turn of such a member is reached. Members are often required to contribute the said amount until the specified period is reached; the farmer is expected to use a member of the association as a guarantor before credit access can be allowed (Sampou, 2006). Sometimes these informal cooperative give out loans to members only. In the formal process of acquiring microcredit, some banks like the NACB require that the farmer must deposit 10% of the needed credit (NACRDB, 2000). According to Nweze (1995), most small fish enterprises cannot comply with this procedure (Nweze, 1995). However, some institutions like BOI and BOA do not require any deposit or collateral for microcredit access, although formal process and procedures must be followed. In Nigeria, formal financial institutions such as commercial banks have complicated and rigid procedures and processes in issuing forms for accessing loans (Chidebelu, 1983). This leads to delay in microcredit access for catfish production enterprises.

The catfish production enterprise is faced with certain attributes from the business environment and from the production system itself. These attributes combine together to make microcredit inaccessible to catfish production enterprises from formal sources of credit. This results to the exposure of catfish enterprises to informal sources of credit; which increases the chances of exploitation by such informal credit institutions at the slighted opportunity (Sampou, 2006; Okorouen, 1986). Management can be irrational when it comes to utilization of accessed credit; even the owner of the enterprise is not spared from this problem. Logically, management makes effort to reduce unethical tendencies and ensure high utilization of the microcredit acquired (FAO, 2000).

c). Concept of microcredit utilization

In spite of the apparent function played by catfish production enterprises in the Nigerian economy, there are array of challenges hindering their performance in the Country (Sampou, 2006). The combined effect of the catfish production enterprise outlook as regards, threats from the business environment, traditional system of production and lack of adequate use of resources worsen utilization of accessed microcredit. Problems faced by catfish production enterprises hinder full utilization of accessed microcredit. Some of these problems are as follows: farm capital, farmers union, diversion of microcredit by management, agricultural institutions, natural resource input and credit institutions (Olayide *et al.*, 1980). Challenges such as increased cost of catfish inputs brought about by inflationary trend in the economy;

high cost of investible funds and deregulation of interest rates, have to a large degree decreased the rate of utilization of accessed microcredit; as such fish farmers were not able to cope with production activities (CBN, 1994).

d) Concept of microcredit repayment

It is pertinent to investigate the microcredit repayment issues of catfish production enterprises. Kohansal and Mansoori (2009) identify factors influencing repayment of microcredit and found that loan size, value of collateral offered as security have significant positive impact on repayment performance of borrowers while interest rate, total application costs and number of installments to repay loan impact it negatively. Various factors affect repayment performance of borrowers in the rural credit markets. We have classified these factors into three broad categories, namely (Weber *et al.*, 2014): (1) Social factors; (2) Economic factors; and (3) Contract-specific factors.

While the most common social factors affecting repayment rate among borrower enterprises are age of the enterprise, diversion of loan, incidence of diseases and pests, farm size, monopoly power created by informal lenders in markets, use of modern machinery and equipments. Economic factors include interest rate on loan, income of the catfish enterprise, loan size, value of the collateral offered as security, total application costs, net profit, market price fluctuations, market value of catfish, fluctuations in commodity prices, amount spent on hiring equipment (Weber *et al.*, 2014; Kohansal and Mansoori, 2009). Contract-specific factors include various terms and conditions specific to a particular loan contract like lender's supervision on utilization of loan, number of repayment installments, down-payment of loan, length of waiting time for receiving the loaned amount from lender, length of repayment period.

2.1.2 Concept of production efficiency

Measure of efficiency works are imbedded in production analysis and resources utilization coefficient studies (Koopmans, 1951 and Debreu, 1951). The argument of Farrell (2005) implied that the firm's efficiency can be calculated from innovation method of efficiency frontier estimation. Technical efficiency degree measure of a production unit permits increase in production if there is increase in production without consuming, at the same time, more resources, or reduce the use of at least one input by conserving at the last time, the same level of production (Briec, Comes and Kersten, 2006).

Allocative efficiency places in relation the inputs utilizations by the current prices in the market (Rodriguez-Alves, Tovar and Trujillo, 2007). If the firm maximizes its profits or minimizes its costs at a given level of production, then allocative efficiency is necessary. Comparing the minimum cost of outputs quantity production at the cost incurred effectively by the firm, optimum inputs combination and allocative efficiency is obtained.

Efficiency Estimation Methods: classification of the frontier estimation methods can be according to the estimation technique used to obtain it. Frontier form permits us to differentiate amongst the parametric and nonparametric approaches, according to classification. Explicit parameters such as Cobb-Douglass, Constant Elasticity of Substitution (CES), Translog, etc, are present in functions such as parametric approaches (Nuama, 2006). Estimation of the production or the cost frontiers parameters is permitted by many econometrical techniques and non econometrical ones. Nonparametric frontiers do not impose pre-established form to the frontier (Murillo-Zamorano, 2004). If inefficiency of the producer is explained by some random elements which is not associated with the producer, we say the frontier has a stochastic nature (Kumbakar and Lovell, 2000).

Fare, Grosskopf and Kokkelenberg (1989) and Fare, Grosskopf and Lovell (1994) introduced the concept of variable input utilization rate. The variable input utilization rate is simply the ratio of observed input usage to the optimal input usage, which is defined as the level of variable input usage required to operate at full capacity utilization. The problem with determining maximum output levels is how to efficiently utilize the resource stocks. If an assessment of catfish output is based only on existing resource input combinations, estimates of catfish outputs from production enterprises may be highly profitable. In contrast, catfish production must be made conditional on desired resource levels and possibly various determinant factors (Adedeji and Okocha, 2012). The issue which needs to be addressed is whether or not management desires to know the maximum potential harvest when resource levels do not constrain production.

Catfish farming may range from 'backyard' subsistence ponds to large-scale industrial enterprises. Farming systems can be expressed in terms of input levels as follows (Carballo *et al.*, 2008): *(i) Extensive System:* In extensive fish farming, economic and labor inputs are usually low. Natural food production plays a very important role, and the system's productivity is relatively low. *(ii) Semi-intensive System:* Semi-intensive fish farming requires a moderate level of inputs and fish production is increased by the use of labour and/or supplementary feeding. This means higher labor and feed costs, but higher fish yields usually more than compensate for this. *(iii) Intensive*

System: Intensive fish farming involves a high level of inputs and stocking the ponds with as many fish as possible. The fish are fed supplementary feed, while natural food production plays a minor role. In this system, difficult management problems can arise caused by high fish stocking densities (increased susceptibility to diseases and dissolved oxygen shortage). The high production costs force one to fetch a high market price in order to make the fish farm economically feasible.

Judicious use of inputs is pertinent for a successful catfish production. According to Masser, Woods and Clary (2004), producers new to catfish business are advised to: (1) gain knowledge - gather all the information you can before you make your investment, (2) plan - lay a firm groundwork for financing, production and marketing before the business begins, (3) start small - limit your investment of time and money to minimize the risk for yourself and your farm, (4) grow with success - expand the operation as you have the earnings to pay for it.

For years it has been believed that the optimal stocking density for larval catfish was 100 per square meter; harvesting about 35-40 fingerlings/m^2 after 5 weeks, was normal with each fingerling weighing 2-3 gram each (De Graaf, Galemoni and Banzoussi, 1995). Developments in Kenya (Campell, Obuya and Spoo, 1995) have changed this picture, with higher stocking densities and more fingerlings per square meter being harvested. Stocking densities as high as 250 larvae/m^2 with an average production of 85 fingerlings/m^2 were obtained before in Nigeria (De Graaf *et al.* 1995). In South Africa nursery ponds are repeatedly stocked at a rate of 2,000 fry/m^2 and about 500-800 fingerlings are harvested per square meter. However, these ponds are stocked with 10 day old fry (20-30 mm) and so this cannot be directly compared with the stocking of hatchlings (De Graaf and Janssen, 1996); the stocking rate depends upon the market size desired and varies from 2 to 10 fingerlings per-square-meter, which corresponds to a market size of approximately 500 and 200g, respectively after a six month rearing period.

Artificial formulated diets are generally composed of a mixture of vegetable and animal feedstuffs (usually agricultural and mill by-products) supplemented with vitamins and minerals. It is not possible to give standard formulation for a balanced diet for catfish since the composition of artificial diets will depend upon the availability and prices of locally available feedstuffs which in turn vary considerably between countries. Least cost formulation methods are used within the feed manufacturing (De Graaf and Janssen, 1996). Commercially prepared catfish feeds, available in bulk and in bags, should contain 26 to 36 percent crude protein plus all essential vitamins and minerals (Masser, Woods and Clary, 2004).

The high labor cost involved in removing pond mud poses serious constraints to catfish production. Large quantities of fry of the required age/size are usually produced in open ponds, concrete tanks, or net enclosures. The latter technique utilizes pond space more efficiently but requires more labor and equipment. In extensive fish farming, economic and labor inputs are usually low (Carballo *et al.*, 2008). Investment of protected ponds, price of labor, the availability of skilled and reliable management are usually high for intensive farms (De Graaf *et al.*, 1995). Labor cost consists of both family and hired labor. An adult male farmer is expected to work for 8 hours daily, an adult female is 2/3 man-day and a child less than 15 years works 1/3 man-day. The cost of labor is estimated with the number of hours daily. The coefficient of the variable is expected to have a negative sign.

Catfish farming ponds range in size from a few dozen square-meters (m^2) to several hectares (ha). Small ponds are normally used for spawning and baby catfish production, while larger ponds are used for the grow-out period. Production ponds larger than 10 ha become difficult to manage and are not very popular with most producers (Carballo *et al.,* 2008). Small ponds are those that are up to 1000m^2, while medium sized ponds measure between 1001m^2 to 3000 m^2 (Panayotou, Wattanutchariya, Isvilanonda and Tokrisna, 1982).

2.2 THEORETICAL FRAMEWORK

Several theories relevant to the study were explored. Two major theories pertinent to the study are theories of microcredit and production.

2.2.1 Theory of microcredit

Jonathan Swift inspired loan funds of the 18th and 19th centuries (Hollis and Sweetman, 1997). In the mid 19th century, Lysander Spooner wrote about the importance of microcredit for enterprises as a way to reduce poverty (Spooner, 1846).

According to Spooner, Friedrich Wilhelm Raiffeisen founded the first microcredit cooperative that support farmers in Germany (Raiffeisenverband, 2011). While using the Camilla Model, Akhtar Hameed Khan distributed microcredit in East Pakistan in the 1950s through community initiatives (Bateman, 2010). Organizations in Bangladesh, most especially the Grameen Bank initiated the origins of microcredit. Thus, founded in 1983 by Muhammad Yunus, the Grameen Bank is generally considered the first microcredit organiztion (Bateman, 2010). Latin America experienced the effect of microcredit when it was introduced in Bolivia in 1986 with the establishment of Promocion y Desarollo de la Microempresa (PRODEM) later known as BancoSol (Armendariz, 2005). Microcredit helped to reduce poverty and ushered in economic development through many organizations in developing countries (Bateman, 2010). It is widely used in developing countries and popular for its potential as a poverty alleviation tool (Coons and Paprocki, 2008).

Microcredit is the expansion of small loans to poor borrowers, who do not have the collateral, fixed income stream and proven credit culture. Microcredit is part of microfinance which renders various services especially to the less privileged. The loan officers found it very difficult to grant microloans to villagers and community member because of default in payment (Bateman, 2010). Bank workers decided that it was necessary to built trust before introducing their loan scheme (Hassan, 2002). The microcredit loan itself is structured typically from a few dollars to less than two hundred dollars. The high interest charged by microcredit loans could not be settled by Government social policy; this situation led to the shutdown of markets (Crabb, 2008; Elahi and Danopoulos, 2004; Tsai, 2004).

Some challenges such as access to microcredit was caused by lack of collateral by poor household businesses. No benchmark was in place to guide how financial organizations could profit from bearing the costs risks of giving out loans to the poor in the community (Brau and Woller, 2004). Microcredit loans offered to groups instead of individuals brought investment capital to the entrepreneur instead of the entrepreneur applying for loan. This practice removes bottlenecks such as specific social and structure hurdles that renders orthodox forms of financial backing ineffective (Navajas, Schreiner, Meyer, Gonzalez-vega and Rodriguez-meza, 2000). Lending to groups influence the behavior of the less privileged shifting economic motivation through the provision of microcredit and social development resources intended to control behaviors. Dignity and self-esteem is restored to the less privileged entrepreneurs when lending to groups. This is essential for the fact that the poor entrepreneurs can have control over the future of their lives and household (Crabb, 2008).

2.2.2 Credit theories of money

Credit theories of money (also called debt theories of money) are theories concerning the relationship between credit and money. Proponents of these theories, such as Mitchell-Innes (1913), sometimes emphasize that money and credit/debt are the same thing, seen from different points of view (Mitchell-Innes, 1913). Proponents assert that the essential nature of money is credit (debt), at least in eras where money is not backed by a commodity such as gold. Two common strands of thought within these theories are the idea that money originated as a unit of account for debt, and the position that money creation involves the simultaneous creation of debt. Some proponents of credit theories of money argue that money is best understood as debt even in systems often understood as using commodity money. Others hold that money equates to credit only in a system based on fiat money, where they argue that all forms of money including cash can be considered as forms of credit money.

The first formal *Credit theory of money* arose in the 19th century. Anthropologist David Graeber has argued that for most of human history, money has been widely understood to represent debt, though he concedes that even prior to the modern era, there have been several periods where rival theories like Metallism have held sway.

According to Schumpeter (1995), the first known advocate of a credit theory of money was Plato. Schumpeter (1995) describes Metallism as the other of "two fundamental theories of money", saying the first known advocate of metallism was

Aristotle (Schumpeter, 1995). The earliest modern thinker to formulate a credit theory of money was Henry Dunning Macleod, with his work in the 19th century, most especially with his *The Theory of Credit* (1889). Macleod's work was expanded on by Mitchell-Innes (1913) in his papers *What is Money?* (1913) and *The Credit Theory of Money* (1914) (CES, 2004), where he argued against the then conventional view of money arising as a means to improve the practice of barter. In this alternative view, commerce and taxation created obligations between parties which were forms of credit and debt. Devices such as tally sticks were used to record these obligations and these then became negotiable instruments which could function as money. As Innes puts it in his 1914 article (Mitchell-Innes, 1914):

> *"The Credit Theory is this: that a sale and purchase is the exchange of a commodity for credit. From this main theory springs the sub-theory that the value of credit or money does not depend on the value of any metal or metals, but on the right which the creditor acquires to "payment," that is to say, to satisfaction for the credit, and on the obligation of the debtor to "pay" his debt and conversely on the right of the debtor to release himself from his debt by the tender of an equivalent debt owed by the creditor, and the obligation of the creditor to accept this tender in satisfaction of his credit".*

Mitchell-Innes (1913) goes on to note that a major problem in getting the public to understand the extent to which monetary systems are debt based is the challenge in persuading them that "things are not the way they seem" (Wray, 2004). A Quantity Theory of Credit was proposed in 1992 by Richard Werner, whereby credit creation is disaggregated into credit for GDP and non-GDP (financial circulation). The approach is tested empirically in a general-to-specific econometric time series model and found to be superior to alternative and traditional theories. Werner found that bank credit creation for GDP transactions Granger-causes nominal GDP growth, while credit creation for financial transactions explains asset prices and banking crises.

The 2005 book *New Paradigm in Macroeconomics* (Palgrave Macmillan) by Richard Werner presents a comprehensive and empirically tested credit theory of money, including the Quantity Theory of Credit, and policy proposals as to how to avoid the 'recurring banking crises' and how to stimulate economies after severe banking crises (making use of Werner's policy concept of *quantitative easing*, which he proposed in Japan in 1994, and which is defined in true 'credit theory of money' spirit as an expansion in credit creation for GDP transactions). Werner's historical analysis presents a historical overview of credit money, tracing it back to ancient Mesopotamia (Werner, 2005).

In his 2011 book *Debt: The First 5000 Years*, the anthropologist David Graeber asserted that the best available evidence suggests the original monetary systems were debt based, and that most subsequent systems have been too. Exceptions where the relationship between money and debt was less clear occurred during periods where money has been backed by bullion, as happens with a gold standard. Graeber echoes earlier theorists such as Innes by saying that during these eras population perception was that money derived its value from the precious metals of which the coins were made, but that even in these periods money is more accurately understood as debt. Graeber states that the three main functions of money are to act as: a medium of exchange; a unit of account; and a store of value. Graeber writes that since Adam Smith's time, economists have tended to emphasise money as a *medium of exchange*. For Graeber, when money first appeared its primary purpose was to act as a *unit of* *account*, to denominate debt. He writes that coins were originally created as tokens which represented a unit of account rather than being an amount of precious metal which could be bartered (Graeber, 2011).

Economics commentator Philip Coggan holds that the world's current monetary system became debt based after President Nixon suspended the link between money and gold in 1971. He writes that "Modern money is debt and debt is money". Since the 1971 *Nixon Shock*, debt creation and the creation of money increasingly took place at once. This simultaneous creation of money and debt occurs as a feature of Fractional reserve banking. After a commercial bank approves a loan, it is able to create the corresponding amount of money, which is then acquired by the borrower along with a similar amount of debt. Coggan goes on to say that debtors often prefer debt based monetary systems such as Fiat money over commodity based systems like the gold standard, because the former tend to allow much higher volumes of money to circulate in the economy, and tend to be more expansive. This makes their debts easier to repay. Coggan refers to Bryan's 19th century Cross of Gold speech as one of the first great attempts to weaken the link between gold and money; he says the former US presidential candidate was trying to expand the monetary base in the interests of indebted farmers, who at the time were often being forced into bankruptcy. However Coggan also says that the excessive debt which can be built up under a debt based monetary system can end up hurting all sections of society, including debtors (Coggan, 2011).

In a 2012 paper, economic theorist Perry Mehrling notes that what is commonly regarded as money can often be viewed as debt. He posits a hierarchy of assets with gold at the top, then currency, then deposits and then securities. The lower down the hierarchy, the easier it is to view the asset as reflecting someone else's debt (Mehrling, 2012). A later 2012 paper from Claudio Borio of the BIS made the counter-intuitive case that it is loans that give rise to deposits, rather than the other way round (Borio, 2012).

In a book published in June 2013, Martin (2013) argued that credit based theories of money are correct, citing earlier work by Macleod: "currency represents transferable debt, and nothing else". Martin writes that it's difficult for people to grasp the nature of money, because money is such a central part of society, and alludes to the Chinese proverb that "If you want to know what water is like, don't ask the fish" (Martin, 2014; Birrell, 2013).

2.2.3 Theory of production

Theory of production can be termed as the economic procedure of transforming inputs into outputs. Goods and services are created when resources are used (Courbois and Temple, 1975). The main vital forms of production are household, public and market production. Catfish production, catfish smoking, catfish sorting and catfish packaging are all examples of production. Production can be viewed as a process which takes place through time and space; emphasis is placed on the rate of output per period of time (Genesca and Grifell, 1992). Production processes are usually three, quantity, form and distribution. Production process is the act of making output in the forms of goods and services that have worth and can provide value to the lives of individuals (Craig and Harris, 1973).

Human needs are satisfied when economic well-being is formed in a production process. Improving quality price ratio and increasing incomes are the two characteristics of an increasing economic well-being. Having an edge in the area of product competiveness leads to lower product prices; this implies losses in incomes, which the entrepreneur is likely to recoup from sales growth. Consumption and production are the central activities in an economy.

The stakeholders of production are people, groups and organizations. In the case of groups, three stakeholders involved are, producers, customers and suppliers. Production inputs namely, raw materials, labour, capital and land are referred to as factors of production.

Numerical representation of the production process is referred to as production model which depends on inputs and outputs. Two major methods are utilized when it comes to production function concept. Macroeconomic formulae are mathematically based and arithmetical models are employed in microeconomic situations (Hulten, 2009). Production performance is well understood when it comes to formulating the objective function of either to maximize profit or minimize cost of inputs used in production.

2.3 EMPIRICAL REVIEW

2.3.1 Social, economic and demographic profile of catfish production

This study by Folayan and Folayan (2017), examined the Socio-economic characteristics of catfish farmers, estimated the cost and returns, and determined the profitability and ascertaining the factors that affect catfish production in Akure North Local Government, Ondo State, Nigeria. Purposive sampling technique was used to select the Local Government area based on the intensity of Catfish farmers. Primary data were collected with the use of structured questionnaires to interview one hundred and ten (110) Catfish Farmers in the area. Only 100 questionnaires were valid for analysis. Data were collected on respondents' socio-economic variables such as age, household size, educational level, fish farming experience, cost of feed, stock size, farm area, quantities and unit prices of output and input items were obtained for the determination of Net Income. Data collected was analyzed by using percentage, frequency, statistics and Gross margin analysis. The result showed that majority (75%) of the respondents were male, 77% had formal education, while 68% of the respondents stocked between 501 to 1000 units of fingerlings. The result of profitability analysis shows that an average profit of N8766.40 (an equivalent of 53.24 US dollar) could be realized per month and the enterprise could be adjudged as profitable. It was recommended that fish farmers be advised to form association that would enhance expansion of operation, while the government should encourage catfish production via discouragement of catfish importation into the country as well as extending credit facilities to credit worthy catfish association.

The study on the socio-economic analysis of Fish farmers in Uvwie south Local Government area of Delta State, Nigeria, carried out by Akarue and Aregbor (2015) described the socio-economic characteristics of catfish farmers. A two multistage random sampling technique was used to draw samples of 90 farmers for the study as follows: Stage one involved the purposively selecting Ekpan fish farm settlement from the three in the study areas. The next stage was the random selection of 100 fish catfish farmers for the study. Data for the study were collected from primary sources using a set of structured questionnaire, a total of 87 questionnaires were returned and found useful for the analysis. The data obtained were analysed using descriptive statistics, gross margin, and multiple regressions. The result showed that majority of farmers accounting for 50.57 percent were male while majority of the respondents representing 40percent had secondary school education. The result also showed that

83.91 percent of them had spent between 1 and 5 years in fish farming. The profitability analysis showed a gross margin per farmer N 43,106,380.00 naira with BCR =1.75, ESR=0.11, POR=0.75 and GR=0.57. In determining the factors affecting fish farming, education and labour were significant at 5% while pond size and farm size were significant at 1% High cost of transport, lack of finance, price fluctuation, high cost of storage etc were major problems encountered by the farmers. These problems if addressed will go a long way to improve fish farming.

2.3.2 Sources and amount of microcredit access in fish production

The study of Olaoye, Ogunremi, Ojebiyi, Ojelade, Shopade and Opele (2017). investigated the sources of credit used by fish farmers in their production activities vis-à-vis the profitability of fish farming in Eriwe fish farm estate, Ijebu-Ode, Ogun State, Nigeria. This was done through the random sampling of 80 out of 150 fish farmers and 10 out of 74 fish farmers' groups in Eriwe fish farm estate. Data were collected with pre-validated interview guide and analysed using inferential statistics, budgetary analysis and Chi-square analytical technique. The findings revealed that the fish farmers had mean age of 47.08±9.07 years, and a mean household size of 7 persons; 71.25% of the respondents were married, while 55.0% of them had secondary education. The fish farmers sourced production credit mainly from personal savings, asusu, ajo, loans from friends and Ijebu-Ode Development Initiative on Poverty Reduction (IDIPR). The mean fish farming experience, number of ponds operated, culture periods, and distance to fish farms were 6.56±2.49 years, 3 ponds, 6.15±0.39 months, and 3.34±1.30km respectively. Also, majority operated on leased/rented lands (91.25%), sourced fish seeds from known hatcheries (90.0%), and used weighing scales for selling fishes (100.0%).

The study also deduced that the gross margin and net farm incomes were N605,287.50 and N503,611.58 respectively. The benefit-cost ratio and return on investment were 1.32 and 0.32 respectively. Significant associations were found between the profitability level of fish farming and credit sources such as personal savings ($\chi2= 18.05$, $p = 0.011$), esusu ($\chi2= 11.63$, $p = 0.020$), ajo ($\chi2 = 29.92$, $p = 0.004$), and IDIPR ($\chi2 = 68.76$, $p = 0.001$). It was therefore concluded that fish farming is a profitable business in Eriwe fish farm estate and recommended among other things that unemployed youths should venture into fish farming as a means of wealth creation and employment generation.

Omitoyin and Sanda (2013) examined sources and uses of microcredit in poverty alleviation among fish farmers in Osun State, Nigeria. A two stage random technique was used to select 135 respondents from the three Osun state Agricultural Development Programme (ADPs) zones. Structured questionnaire was used to collect data on demographic characteristics, microcredit sources and use, occupational, income and fish production data. Data was analysed using descriptive statistics, FGT and logit model. The result showed that both formal and informal microcredit sources were used in the area studied with high interest rate militating against the adequate use of some of the microcredit sources. From the study, poverty alleviation through microcredit use will increase efficiency through the use of modern effective and efficient technology leading to greater production. According to the studies, the policies aimed at making microcredit readily available should be focused on to alleviate poverty among fish farmers.

2.3.3 Microcredit utilization and repayment in catfish production

The study by Sampou (2006), highlighted the problems of micro-credit acquisition and utilization among small-scale fish farmers. The specific objective were to: Identify the micro-credit needs of small scale fish farmers, Identify the major sources of micro-credit among fish farmers, determine the terms of microcredit acquisition among the farmers, identify the ways of micro-credit utilization among the farmers, identify the major constrain in micro-credit acquisition among the fish farmer and determine strategies for enhancing micro-credit acquisition and utilization among small scale fish farmers in Bayelse state. Six research questions and two null hypotheses were formulated to guide the study. A total of 280 respondents comprising small scale fish farmers and ten respondents from the major financial lending institutions were adopted. The data was obtained using 69 item structured questionnaire. The data were analyzed with mean and t- test. The findings of the study revealed that small scale fish farmers use the relatively small credit obtained to meet their needs. They obtain loan mainly from Nigerian Agricultural Corporative and Rural Development Bank (NACRDB). Fish farmers find it extremely difficult to achieve optimum progress and high performance due to the problems they encountered in obtaining the credit. Finally, fish farmers still felt that the credit should transform them from small-scale to middle or large scale of production by increasing their credit.

2.3.4 Determinants of loan repayment in fish production

The study by Edet, Atairet, Nkeme and Udoh (2014) estimated the loan repayment index and examined the determinants of loan repayment from a sample of 80 rural women fish traders obtained through a multi-stage sampling in four selected markets in Akwa Ibom State, Nigeria. Data were collected in May, 2013 and analyzed using descriptive and inferential statistics. Findings revealed that informal sources of loan were popular among the fish traders. The result of the probit analysis revealed that educational level, interest rate charged, spouse income, marketing experience, personal income of traders, non fish marketing income and household size were the major determinants of loan repayment in the study area. The reasons for loan default in order of importance were; family commitment, untimely loan disbursement, high interest rate charged as well as unforeseen circumstances. The study further revealed that only 63 percent of the total loan accessed by respondents was repaid. The paper recommended the evolution of a more proactive loan monitoring procedure by lenders such as verification of the loan worthiness and previous loan repayment history of borrowers before granting loans, encouraging the patronage of formal credit sources, pursuing policies that would reduce household sizes as well as the setting - up of loan delinquent court to prosecute defaulters as the way out.

2.3.5 Efficiency in catfish production

The study which was conducted in Anambra State, Nigeria by Ugwumba (2010), examined the efficiency of resource use and determinants of catfish production output. Data were obtained from 204 catfish farmers selected by means of multistage random sampling technique. It utilized descriptive and parametric statistics in data analysis. Results indicated that farmer’s age, cost of feed, stock size and farm size were significant determinants of catfish production output. Returns to scale value of 1.06 showed that the farms were operating at increasing returns to scale. Resource use efficiency values were 12.78, 1.12, 0.15, 4.70 and 14.47 for stock size, feed, labour and fuel respectively. This implies over utilization of labour input and under utilization of the other ones. Policy must be directed towards measures that would ensure the availability of the under utilized inputs and at cheaper rates.

The study of Tsue, Lawal and Ayuba (2012), examined profit efficiency among catfish farmers in Benue State of Nigeria, using a stochastic profit frontier approach. A multi-stage sampling technique was used to collect data from 143 catfish farmers through a well structured questionnaire. The estimated elasticity parameters of variables with respect to gross profit of catfish farmers revealed the significance of all the independent variables included in the stochastic profit function. However, the number of ponds (-0.02), cost of feed (-0.30), cost of fingerlings (-0.11) and cost of hired labour (-0.004) had an inverse relationship with the profit of farmers with cost of feed being the most important variable decreasing the profit of farmers in the study area. The negative elasticity of number of ponds with respect to farmers' profit was likely due to under-utilization of ponds capacity.

The result further indicated that the kilogramme of catfish produced (elasticity of 1.43) was the most important variable determining profit in catfish farming in the study area. Analysis of profit efficiency revealed a varied (23-99%) profit efficiency of the farmers with a mean value of 0.84. This implies that the farmers were able to obtain a little above 80 percent of their potential profit from a unit mix of inputs. This means that about 16 percent of the profit is lost due to inefficiency of management. Thus, in the short run there is scope for increasing profit from catfish production by 16 percent by adopting the technology and the techniques used by the 'best practiced' catfish farmers. Analysis of the factors influencing profit efficiency revealed that while age of famers, farming experience and duration of culture positively influenced profit efficiency, years of education, off-catfish-farm income, and training negatively influenced profit efficiency. The policy implication of these findings is that profit inefficiency in catfish production can be reduced significantly overtime as the farmers get more experienced and a more conducive environment is created, to encourage more aged farmers to be involved in catfish production in a bid to alleviate poverty and food insecurity in the state and the country at large.

The study by Kareem, Dipeolu, Aromolaran and Akegbejo (2008) investigated the costs and returns analysis of the respondents and the stochastic frontiers production analysis was applied to estimate the technical, allocative efficiency and economic efficiency among the fish farmers using concrete and earthen pond systems. A total of 100 fish farmers were selected using a Multi Stage Sampling technique. The first stage involved broken of a sample frame of 220 into sub- group or strata in order to get adequate representation of the four Agric Zones. Secondly, the simple random Sampling was then used from each stratum or sub group among the list of fish farmers in each stratum. Only 85 were used for meaningful analysis.

The results of the returns to Naira invested shows that earthen pond system yielded N8.0 while concrete pond system yielded N6.5. The results of economic efficiency also revealed an average of 76% in concrete pond system while earthen pond system made as high as 84% economic efficiency level. The results of the analysis of the mean technical efficiency for both systems revealed that concrete pond system with 88% while earthen pond system was 89%. Similarly, the allocative efficiency results revealed that concrete pond system was 79 percent while earthen pond had 85%. Stochastic frontier production function models revealed that pond area, quantity of lime used, and number of labour used were found to be the significant factors that contributed to the technical efficiency of concrete pond system while pond, quantity of feed and labour are the significant factors in earthen pond system. The results therefore concluded that only years of experience is the significant factor in concrete pond system in the inefficiency sources model. On the basis of the findings, the study suggested that government of Nigeria should provide a conducive environment for the establishment of both concrete and earthen pond system;, encourages more citizenry, mostly youth to set up both pond systems in a bid to alleviate poverty status and un-employment rate in the State and the country at large.

The study which was conducted in Anambra State, Nigeria, by Ugwumba and Chukwuji, (2010), assessed the profitability of catfish farming without neglecting constraints that could retard profitability. It utilized non-parametric statistics, enterprise budgeting and the profit function model in data analysis. Data were obtained from 204 farmers selected via multistage random sampling technique. Results indicated mean gross margin of N734,850.39, mean net farm income of N712, 659.89 and net return on investment of 0.61, implying that catfish farming is profitable in the study area. Furthermore, cost of catfish feeds and production unit negatively and significantly influenced profit, while output price exerted a positive and significant influence on profit. Profitability could be increased by tailoring policies towards the setting up of commercial pelleted and floating catfish feed mill and modern hatcheries in the State, the provision of adequate infrastructure, cheap and available credit facilities and expansion of extension services. These would go a long way to solving the most serious constraints to catfish production in the study area - high cost of feeds, lack of quality fingerlings and inadequate capital.

The study by Oyakhilomen, Murtala, Abraham and Kwagyang (2016) examined the gender perspective of the technical efficiency of catfish farming in Alimosho Local Government Area of Lagos State. Primary data elicited from a sample size of 70 catfish farmers (38 male and 32 female catfish farmers) were employed in the study. Analysis of the data was done using descriptive statistics and stochastic frontier production function. The maximum likelihood estimates of the stochastic frontier production function revealed that the mean technical efficiency of the male catfish farmers (86%) was higher than that of the female catfish famers (20%) and this implies that the male and female catfish farmers have the scope of improving their efficiency by 14% and 80%, respectively, through the use of farming practices used by the most efficient male and female catfish farmers. The factors that were significant in influencing the technical efficiency of the female catfish farmers were farming experience and credit while in the case of the male catfish farmers, farming experience significantly influenced their technical efficiency. In the light of the low technical efficiency of the female catfish farmers relative to the male catfish farmers, it was recommended that gender equality in fishery training, extension delivery, distribution of resources and access to supportive services should be encouraged in a bid to improve the technical efficiency of the catfish farmers especially that of the female catfish farmers.

2.3.6 Constraints to microcredit access by fishermen

The objective of the study by Nyang'aya and Onyango (2016) identified factors that impact on the access to financing by artisanal fishermen in Lake Victoria. A total of 314 artisanal fishermen were interviewed from landing beaches along Lake Victoria. A 5 point Likert scale was used to assess the awareness of the respondents on access to financing. Consequently a factorial analysis was used to order the factors that influence the access to financing. The order of factors that had an impact on access to credit finance were found to be: saving regulations (F1), group characteristics(F2), socio economic characteristics of fishermen(F3), gender issues(F4), household expenditures(F5) and marital status(F6). The results can be used in financial interventions since they show that the fishermen are aware of their preference in accessing finance.

2.4 ANALYTICAL FRAMEWORK

Analytical framework necessary for data analysis were carefully selected and explained to achieve the studies specific objectives. The following analytical framework were highlighted, Cobb-Douglas production function, stochastic production function, stochastic profit function, logit model, probit model, tobit model, ordered probit model, multinomial probit model and structural equation modeling.

2.4.1 Stochastic production frontier (SPF) analysis and efficiency

The frontier function approach is a method to measure productive inefficiency of individual producers**.** Inefficiency is measured by the deviation from the frontier, which represent a best-practiced technology among all observed firms. Coelli (1995a) presents two reasons to estimate frontier functions. First, the frontier function is consistent with theoretical representation of production activities, which is derived from an optimization process. For example, the production function consists of a series of outputs attainable, given different combinations of inputs, while cost and profit functions are represented by frontiers derived from optimization. Second, the estimation of frontier function provides a tool for measuring the efficiency level of each firm within a given sample.

The SPF allows for the sensitivity of data to random shocks by including a conventional random error term in the estimation of the production frontier such that only deviation caused by controllable decisions are attributed to inefficiency

(Jaforullah and Premachandra, 2003). Inefficiency is assumed to be part of the error term consisting of two parts – a random error term, which is normally distributed $N\ (0, \sigma_u^2)$ and represent random shocks and statistical errors, and the inefficiency term which is one-sided (non-negative). The inefficiency error term has a half normal distribution. The SPF is expressed as:

$$Y_i = f(X_i, \beta)e^{v-u} \quad \ldots (2.1)$$

In logarithm terms the SPF is expressed as

$$lnY_i = lnf(X_i, \beta) + V_i - U_i \quad \ldots (2.2)$$

Where, Y_i is the output vector, X_i is the input vector, β is an unknown parameter vector, V_i is the random error term assumed to be $N\ (0, \sigma^2)$, U_i is the inefficiency term independently distributed from V_i.

There is disagreement among econometricians as to the distribution of U_i (Jaforullah and Premachandra, 2003). This function has been successfully used by Ajibefun and Daramola (2003); Hassan and Ahmad (2005); Abdulai (2006); Goni, Mohammed and Baba (2007), Al-hassan (2008); Lambarraa, Serra and Gil (2008); Ugwumba (2010); Omonona, Egbetokun and Akanbi (2010), and Vincent, Langat and Ngeno (2010). Previous studies have used several distributions including single parameter half-normal distribution, exponential and truncated normal distributions and two parameter gamma distribution (Bravo-Ureta and Reiger, 1990).

For the technical efficiency of firm i at time t, U_{it}, is transformed as $TE_{it} = \exp(-U_i)$, which now represents technical efficiency index. The technical efficiency of the ith firm, defined by $TE_i = \exp(-U_i)$, has a technical inefficiency effect, U_i, which is unobservable. Even if the true value of the parameter vector, β, in the stochastic frontier model was known, only the difference, $\varepsilon = V_i - U_i$, could be observed. The best predictor for U_i is the conditional expectation given the value of $V_i - U_i$. This result was first recognized and applied in the stochastic frontier model by Jondrow, Lovell, Materov and Schmidt (1982), who derived the result as follows:

$$E\left[\frac{U_i}{\varepsilon_i}\right] = \frac{\sigma\lambda}{1+\lambda^2}\left[\left(\frac{\emptyset Z}{1-\emptyset Z}\right) - Z\right] \quad \ldots (2.3)$$

Where, $z = \frac{\varepsilon_i \lambda}{\sigma}$, $\emptyset$ is read from the normal distribution table

An operational predictor of U_i involves replacing the unknown parameters with the Maximum Likelihood estimates. Jondrow *et al.* (1982) suggested that the technical efficiency of the i^th^ firm should be predicted using $E\left[\frac{U_i}{\varepsilon_i}\right]$. The rationale for this prediction is that $1 - U_i$ is a first order approximation to the equation:

$$\exp(-U_i) = 1 - U_i + U_i^2/2 - U_i^3/6+ \quad \ldots (2.4)$$

After estimating the U_is, firm specific technical efficiency (TE) is then calculated using the formula:

$$TE = \exp(-U_i) = e^{-ui} \quad \ldots (2.5)$$

The SPF requires the specification of a functional form. Most efficiency studies have used the Cobb-Douglas production function on the basis of its simplicity (in terms of analysis and interpretation).

i) Interpretation and testing of the stochastic production frontier

An important aspect of the stochastic production frontier is whether or not one needs to estimate a stochastic frontier to obtain estimates of technical efficiency. That is, could estimates of technical efficiency be obtained using the deterministic full frontier or the statistical frontier in, which there are no random errors in production? Alternatively is the average response function the appropriate characterization of the technology (i.e., are all firms operating efficiently?). This may be assessed by testing whether or not the parameter

$$\gamma = \frac{\sigma_u^2}{(\sigma_v^2 + \sigma_u^2)} \quad \text{… (2.6)}$$

equals one in value. The initial test for determining whether or not there are technical inefficiency effects in the model or that the traditional average response function, without the technical inefficient effect, is an appropriate specification is a test of the null vs. the alternative: H_0:$\gamma = 0$, or H_1:$\gamma > 0$. If H0 is true, the conventional average response function, without technical inefficiency effects, is the appropriate specification. If the alternative is true, then, the SPF is the appropriate specification. If γ is greater than 0, but less than 1.0, the SPF specification is the appropriate specification for technical inefficiency. If γ = 1.0, however, the deterministic or statistical frontier model is the appropriate specification.

The test to determining whether or not the stochastic production frontier is the appropriate specification is actually a one-sided likelihood ratio test (Coelli, 1995b). The likelihood ratio test simply requires estimating the production model under both the null and alternative hypothesis and obtaining the corresponding values of the likelihood function (Battese and Corra, 1977; Coelli *et al.*, 1998). Where: L is the value of the likelihood function under each hypothesis. Coelli (1995a) demonstrated that the generalized likelihood-ratio statistic has an asymptotic distribution which is a mixture of chi-square distributions. Coelli then demonstrates that the critical value for a test of size α (e.g., 0.05) is equal to the chi-squared valued corresponding to 2 α. The critical values for the one-sided likelihood ratio test are also available in the statistical table of Kodde and Palm (1986).

ii) Measuring farm-level technical (*TE*) and allocative (*AE*) efficiencies

Estimating a stochastic production frontier provides the basis for measuring farm-level technical (*TE*) and allocative (*AE*) efficiencies. Then, a second step analysis

(Bravo-Ureta and Pinheiro, 1993; Lingard, Castillo and Jayasuriya, 1983) is performed where separate two-limit tobit equations for *TE* and *AE* are estimated as a function of various attributes of the farms/farmers in the sample.

Overtime, Farrell's approach has undergone changes. This study is focused on the refined model extended by Kopp and Diewert (1982) and later customized by Bravo-Ureta and Rieger (1990). We presume that the deterministic production frontier is given by the equation

$$Y_j = g(X_{ij}, \beta) \quad \ldots (2.7)$$

Where:

Yj is the output of the *j*th farm, Xij is the *i*th input used by farm *j*, and β is a vector of unknown parameters. To simplify the exposition, the subscript *j* is dropped in what follows. From equation (2.8), it is possible to derive the technically efficient input quantities (Xit) for any given level of output $\bar{Y}$, by solving simultaneously the following equations:

$$\bar{Y} = g(X_i, \beta) \quad \ldots (2.8)$$

$$X_1/X_i = K_i \quad \ldots (2.9)$$

Where:

K_i is the ratio of the observed level of inputs $X1$ and Xi at output $\bar{Y}$.

Next, assume that the production frontier in equation (2.10) is self-dual (e.g., Cobb-Douglas) and that the corresponding cost frontier can be expressed as:

$$C = h(P, Y; \alpha) \quad \ldots (2.10)$$

Where:

C is the minimum cost to produce output *Y*, *P* is a vector of input prices, and α is a vector of parameters. Applying Shephard's lemma, the system of minimum cost input demand equations can be obtained by differentiating the cost frontier with respect to each input price. This demand equation for the *i*th input (*Xdi*) is equal to

$$\frac{\delta C}{\delta P_i} = X_{di} = f(P, Y; \phi) \quad \ldots (2.11)$$

Where:

ϕ is a vector of parameters. From the input demand equations we can obtain the economically efficient input quantities, *Xie*, by substituting the firm's input prices *P* and output quantity *Y* into equation (2.11).

Thus far, we have solved for the input bundles *Xi*, *Xit*, and *Xie*. It is now possible to calculate the cost of the actual or observed (*COB*) input bundle as *Xi* · *Pi*, while the cost of the technically (*CTE*) associated with the firm's observed output are given by *Xit* · *Pi*. These cost measure is the basis for calculating *TE*:

$$TE = \sum_i X_{it} \,.\, P_i \,/\, \sum_i X_i \,.\, P_i = CTE/COB \quad \ldots (2.12)$$

$$EE = \sum_i X_{ie} \,.\, P_i \,/\, \sum_i X_i \,.\, P_i = CEE/COB \quad \ldots (2.13)$$

As already mentioned, in the Farrell (1957) methodology, *EE* is equal to the product of *TE* and *AE*; hence, equations (2.12) and (2.13) are used to calculate *AE* as:

$$AE = EE/TE = \sum_i X_{ie} \,.\, P_i \,/\, \sum_i X_{it} \,.\, P_i = CEE/CTE \quad \ldots (2.14)$$

iii) Stochastic profit function and efficiency

Functional form of the stochastic profit frontier is estimated by testing the adequacy of Cobb Douglas in the less restrictive translog. Profit function model used in determining profit efficiency for catfish production can be explained as follows (Sunday *et al.*, 2012):

$$\pi = \frac{\pi}{\rho} = f(q_i, Z)exp\ (V_i - U_i) \qquad \text{... (2.15)}$$

Where, π = normalized profit of i^th^ catfish producer, q_i= vector of variable inputs, Z = vector of fixed inputs, ρ = output price, $exp\ (V_i - U_i)$= composite error term

The stochastic error term consists of two independent elements "V" and "U". The element V account for random variations in profit attributed to factors outside the catfish producer's control. A one sided component U ≤ 0 reflects economic efficiency relatives to the frontier. Thus, when U = 0, it implies that farm profit lies on the efficiency frontier (i.e. 100% profit efficiency) and when U < 0, it implies that the farm profit lies below the efficiency frontier. Both V and U are assumed to be independently and normally distributed with zero means and constant variances. Thus, economic efficiency of an individual farmer is derived in terms of the ratio of the observed profit to the corresponding frontier profit given the price of variable inputs and the level of fixed factors of production of farmers.

The profit efficiency is expressed as the ratio of predicted actual profit to the predicted maximum profit for a best-practiced catfish farmer. Profit efficiency in this study is defined as profit gain from operating on the profit frontier, taking into consideration farm-specific prices and factors. And, considering a farm that maximizes profit subject to perfectly competitive input and output markets and a singular output technology that is quasi - concave in the (n x 1) vector of variable inputs, an d the (m x 1) vector of fixed factors. The actual normalized profit function which is assumed to be well behaved can be derived as follows; Farm profit is measured in terms of Gross Margin (GM) which equals the difference between the Total Revenue (TR) and Total Variable Cost (TVC). That is:

GM (π) = ∑(TR-TVC) =∑(PyQ - WiXi) .... (2.16)

To normalize the profit function, gross margin (π) is divided on both sides of the equation (2.16) by Py which is the market price of the output.

Where, TR = Total revenue (Naira/ ha), TVC = Total variable cost (Naira/ ha), Py = Unit price of output (Naira/ Kg), Xi= Variable input quantity, Z = Price of fixed inputs (Naira), Pi= W/Py which represents normalized price of input Xi (Naira) and f(Xi, Z) represents production function.

Coelli (1996) model specify the stochastic frontier function with behaviour inefficiency components. It also estimates all parameters together in one step maximum likelihood estimation. The explicit Cobb-Douglas functional form for the catfish producers in the study area, is therefore, specified as follows:

$$ln\pi = \beta_0 + \beta_1 InX_1 + \beta_2 InX_2 + \beta_3 InX_3 + \beta_4 InX_4 + (V_i - U_i) \quad \text{... (2.17)}$$

Where, π = restricted normalized profit computed for j^{th} farm which is defined as gross revenue less variable costs divided by farm specific catfish output price Py, ln = Natural log, X_1=fingerlings, X_2=standard feeds, X_3=labour, X_4=pond size, β_{js}= parameters of linear tems; j=0,1…4 are parameters to be estimated.

2.4.2 Logit model

For statistics, logit model is a regression model whereby, the dependent variable (DV) is categorical (Freedman, 2009). Logistic regression takes into cognizance binary dependent variables. It takes only two values that are usually depicted as win or lose, black or white, real or fake, pass or fail, etc.

The logit model measures the association among categorical dependent variable and one or more independent variables by assessing probabilities through a logistic function (Freedman, 2009). Logistic model is a special phase of the generalized linear model and analogous to linear regression. The two features of logistic regression are that the conditional distribution of y | x is a Bernoulli distribution rather than a Gaussian distribution, in this case, the dependent variable is binary. Predicted values are restricted to 0,1 via logistic distribution function. Logistic model becomes an alternative to Fisher's 1936 approach (James, Witten, Hastie and Tibshirani, 2013).

The logistic regression can be understood simply as finding the β parameters that best fit:

$$y = \begin{cases} 1 & \beta_0 + \beta_1 x + \varepsilon > 0 \\ 0 & else \end{cases} \quad \ldots (2.18)$$

Where:

ε is an error distributed by the standard logistic distribution. The associated latent variable is

$$y' = \beta_0 + \beta_1 x + \varepsilon \quad \ldots (2.19)$$

The error term ε is not observed, and so the y' is also an unobservable, hence termed "latent".

One of the advantages of fusing the logistic function is its ability to estimate inputs with negative, positive or infinity, but the output values always range between zero and one (Hosmer and Lemeshow, 2000). The logistic function $\sigma(t)$ is defined as follows:

$$\sigma(t) = \frac{e^t}{e^t + 1} = \frac{1}{1 + e^{-t}} \quad \ldots (2.20)$$

$$t = \beta_0 + \beta_1 x \quad \ldots (2.21)$$

The logistic regression is represented as:

$$F(x) = \frac{1}{1+e^{-(\beta_0+\beta_1 x)}} \qquad \dots (2.22)$$

$F(x)$ represents the probability of the dependent variable having "access to microcredit" or "non-access to microcredit" (Freedman, 2009).

We can now define the inverse of the logistic function, g, the logit (log odds):

$$g(F(x)) = ln\left(\frac{F(x)}{1-F(x)}\right) = \beta_0 + \beta_1 x, \qquad \dots (2.23)$$

and equivalently, after exponentiating both sides:

$$\frac{F(x)}{1-F(x)} = e^{(\beta_0+\beta_1 x)}, \qquad \dots (2.24)$$

Where: g = the logit function, $g(F(x))$ = illustrates that the logit (i.e., log-odds or natural logarithm of the odds), ln = denotes the natural logarithm, $F(x)$ = is the probability that the dependent variable equals a case, given some linear combination of the predictors, The formula for $F(x)$ = illustrates that the probability of the dependent variable equaling a case is equal to the value of the logistic function of the linear regression expression, β_0 = is the intercept from the linear regression equation (the value of the criterion when the predictor is equal to zero), $\beta_1 x$ = is the regression coefficient multiplied by some value of the predictor, e = denotes the exponential function. Odds of the dependent variable is as follows (Hosmer, David and Lemeshow, 2000):

$$odds = e^{\beta_0+\beta_1 x} \qquad \dots (2.25)$$

For a continuous independent variable the odds ratio can be defined as:

$$OR = \frac{odds(x+1)}{odds(x)} = \frac{\left(\frac{F(x+1)}{1-F(x+1)}\right)}{\left(\frac{F(x)}{1-F(x)}\right)} = \frac{e^{\beta_0+\beta_1(x+1)}}{e^{\beta_0+\beta_1 x}} = e^{\beta_1} \quad \ldots (2.26)$$

This exponential relationship provides an interpretation for β_1: The odds multiply by e^{β_1}

2.4.3 Structural equation modeling (SEM)

Structural Equation Modeling (SEM) or path analysis is a very powerful multivariate technique. It is a specialized version of other analysis methods and enables researchers in measurement of direct and indirect effects. However, structural equation modeling is a multivariate technique incorporating measured variables and latent constructs, and explicitly specifies measurement error (Ogidi, Abah, Ezeorah, Okewu and Odiba, 2012). A model (diagram) allows for specification of relationships between variables.

SEM is a comprehensive statistical approach to testing hypotheses about relations among observed and latent variables (Hoyle, 1995). It is a methodology for representing, estimating, and testing a theoretical network of (mostly) linear relations between variables (Rigdon, 1998). It tests hypothesized patterns of directional and non-directional relationships among a set of observed (measured) and unobserved (latent) variables (MacCallum and Austin, 2000). According to (Kline, 1998), the two goals in SEM are: 1) to understand the patterns of correlation/covariance among a set of variables; and 2) to explain as much of their variance as possible with the model specified. The purpose of the model, in the most common form of SEM, is to account for variation and covariation of the measured variables (MVs). Path analysis (e.g., regression) tests models and relationships among MVs. Confirmatory factor analysis tests models of relationships between latent variables (LVs or common factors) and

MVs which are indicators of common factors. Latent growth curve models (LGM) estimate initial level (intercept), rate of change (slope), structural slopes, and variance. Special cases of SEM are regression, canonical correlation, confirmatory factor analysis, and repeated measures analysis of variance (Kline, 1998).

2.4.4 Multiple regression

Linear regression is a linear approach to modelling the relationship between a scalar response (or dependent variable) and one or more explanatory variables (or independent variables). The case of one explanatory variable is called simple linear regression. For more than one explanatory variable, the process is called multiple linear regression (Freedman, 2009). This term is distinct from multivariate linear regression, where multiple correlated dependent variables are predicted, rather than a single scalar variable (Rencher and Christensen, 2012). Linear regression was the first type of regression analysis to be studied rigorously, and to be used extensively in practical applications (Yan, 2009). This is because models which depend linearly on their unknown parameters are easier to fit than models which are non-linearly related to their parameters and because the statistical properties of the resulting estimators are easier to determine. Ordinary least squares (OLS) is the simplest and thus most common estimator. It is conceptually simple and computationally straightforward. OLS estimates are commonly used to analyze both experimental and observational data. The OLS method minimizes the sum of squared residuals, and leads to a closed-form expression for the estimated value of the unknown parameter β.

2.4.5 Analysis of variance (ANOVA)

Analysis of variance (ANOVA) is a collection of statistical models and their associated estimation procedures (such as the "variation" among and between groups) used to analyze the differences among group means in a sample. ANOVA was developed by statistician and evolutionary biologist Ronald Fisher. In the ANOVA setting, the observed variance in a particular variable is partitioned into components attributable to different sources of variation. In its simplest form, ANOVA provides a statistical test of whether the population means of several groups are equal, and therefore generalizes the *t*-test to more than two groups. ANOVA is useful for comparing (testing) three or more group means for statistical significance. It is conceptually similar to multiple two-sample t-tests, but is more conservative (results in less type I error) (Diez, Barr and Cetinkaya-Rundel, 2017). and is therefore suited to a wide range of practical problems.

The ANOVA model for the study is represented below:

$$V = \sum_{i=1} \frac{(X-x)^2}{n} \qquad \ldots (2.27)$$

Where: X = the value of the individual variable items, x = the means of the series, n = the total number of variable items, V=variance

The F-coefficient or the variance or F-calculated ratio used in this study is depicted below: $F = \frac{Greater\ variance}{Smaller\ variance}$ … (2.28)

As such, the value of F will always be greater than unity (1).

The calculations of ANOVA can be characterized as computing a number of means and variances, dividing two variances and comparing the ratio to a handbook value to determine statistical significance. Calculating a treatment effect is then trivial, "the effect of any treatment is estimated by taking the difference between the mean of the observations which receive the treatment and the general mean" (Cochran, Cox and Gertrude, 1992).

The ANOVA F-test is known to be nearly optimal in the sense of minimizing false negative errors for a fixed rate of false positive errors (i.e. maximizing power for a fixed significance level). For example, to test the hypothesis that various medical treatments have exactly the same effect, the F-test's p-values closely approximate the permutation test's p-values: The approximation is particularly close when the design is balanced (Hinkelmann and Kempthorne, 2008). Such permutation tests characterize tests with maximum power against all alternative hypotheses, as observed by Rosenbaum. The ANOVA F–test (of the null-hypothesis that all treatments have exactly the same effect) is recommended as a practical test, because of its robustness against many alternative distributions (Moore and McCabe, 2003).

2.4.6 Likert scale and principal component analysis (PCA)

Likert Scale (Pornel, 2009 and Likert, 1932) has been an important tool in measuring constructs like attitude, images, opinions (Wu, 2007), motivation, leadership style, etc. The use of Likert Scale had spread from the field of psychology to various fields such as education, management, leadership, medicine, and agriculture. This study utilized a 4 point Likert like scale; a value of 2.5 was used to select critical items. Principal Component Analysis (PCA) is necessary to explore the underlying constraints (12 items) influencing catfish production enterprises in the study area.

2.5 SUMMARY OF LITERATURE

The study considered the concept of microcredit which was sub-categorized into four namely, concept of microcredit sources, concept of microcredit access, concept of microcredit utilization and concept of microcredit repayment. In order to throw more light on microcredit sources as it relates to catfish production in the study area, concepts of Bank of Agriculture (BOA), Bank of Industry (BOI), commercial banks, microfinance or community banks, cooperative societies, private money lenders, family and friends and owner savings were examined. Concept of production efficiency focused on the technical (Rodriguez-Alves, Tovar and Trujillo, 2007), allocative and profit efficiencies as it relates to catfish production using the available microcredit accessed in the study area. Efficiency also has to do with the judicious use of microcredit accessed via inputs for successful catfish production (Masser, Woods and Clary, 2004). The two major theories explored by this study are the theory of microcredit (Raiffeisenverband, 2011), credit theories of money (Mitchell-Innes, 1913) and production theory (Hulten, 2009).

Review of related literature showed that little effort has been done as regards the economic and demographic profiles of catfish production enterprises. Instead, lots of work have been carried out on the socio-economic features of catfish farmers in Benue State and Nigeria (Folayan and Folayan, 2017; Akarue and Aregbor, 2015) as a whole. Literature has many works as regards microcredit access and utilization as compared to microcredit repayment. An example is the work of Sampou (2006), who highlighted the problems of micro-credit acquisition and utilization among small-scale fish farmers. Studies such as the one carried out by Edet, Atairet, Nkeme and Udoh (2014) estimated the loan repayment index and examined the determinants of loan repayment among fish business women in Akwa Ibom State, Nigeria. However, the study found out that little works on the determinants of loan utilization in fish production exists compared to that of determinants of loan repayment.

Technical efficiency estimates (Ugwumba, 2010), is necessary in examining efficiency of resource use and determinants of catfish production output. Allocative efficiency investigates the costs and returns analysis (Kareem, Dipeolu, Aromolaran and Akegbejo, 2008) of the catfish enterprises. Profit efficiency (Ugwumba and Chukwuji, 2010), among catfish farmers in Benue State of Nigeria, was examined using a stochastic profit frontier approach (Tsue, Lawal and Ayuba, 2012). However, technical, allocative and profit efficiencies of catfish production has many works attributed to it in Nigeria.

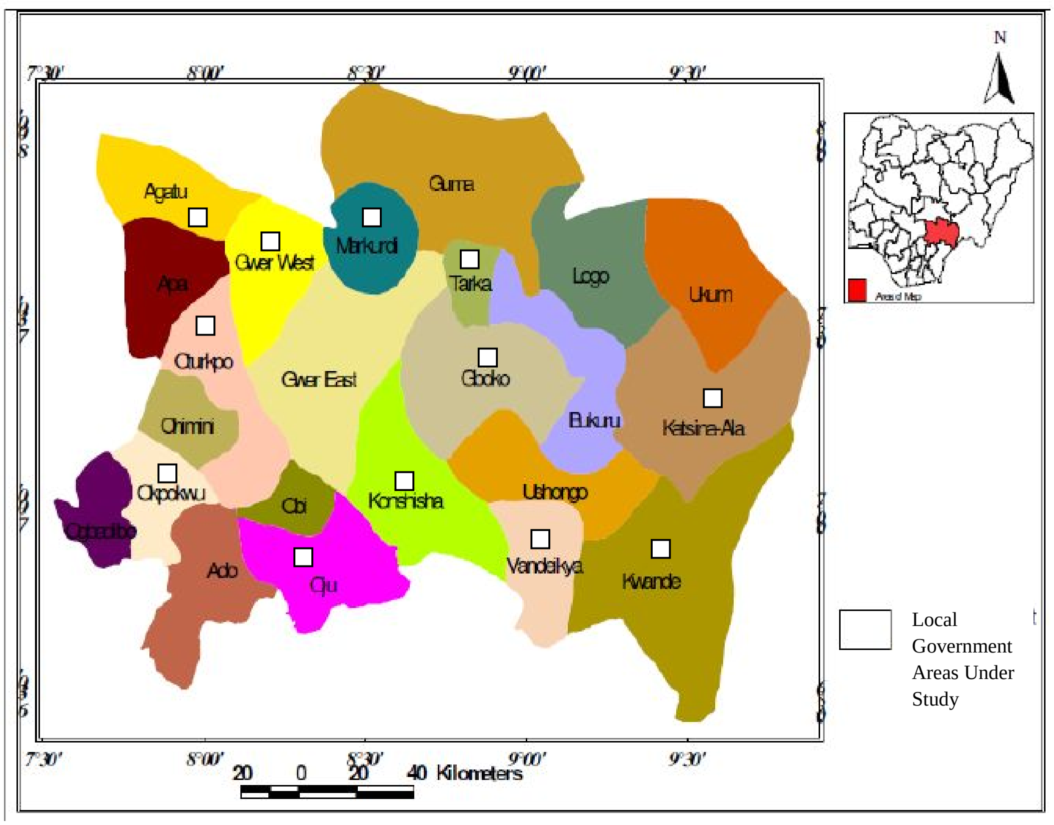
Studies like the one carried out by Asadi, Kalantari and Choobchian (2013) formulated a structural model to analyze the effects of ecological, social, and economic factors on sustainable agricultural development in Qazvin Province of Iran. As at the time of this study, little or no work has been carried out as regards using SEM to analyze the effects of the determinants of microcredit repayment on catfish production. Majority of studies such as Nyang'aya and Onyango (2016) identified factors that impact on the access to financing by artisanal fishermen in Lake Victoria. From observation, there are not much works on the constraints or factors that impact on catfish production enterprises. This review brings out the gap in literature which this study tried to examine.

CHAPTER 3

METHODOLOGY

3.1 THE STUDY AREA

Benue State is located in the North Central region of Nigeria. Benue State lies between latitudes 6°25'N and 8°8'N and longitudes 7°47'E and 10°E' (Ade, 2014). It has a total land-area of about 33, 955 square kilometers with a population of 5,741,815 (National Population Commission (NPC), 2017), and an average population density of 99 persons per square kilometer. The State is blessed with a loamy-clay soil that is very suitable for catfish production. Figure 3.1, shows the map of Benue State, indicating Local Government Areas (L.G.As) under study.



Source: Adapted from, Ade, M.A. (2014) Application of Geographic Information Systems in Land Suitability Rating for Lowland Rice Production in Benue State

Figure 3.1: Geographical Map of Benue State

Benue is a rich agricultural region and grows crops such as; sweet potatoes, cassava, soya bean, guinea corn, flax, yams, sesame, rice, and groundnuts, Palm Tree. Benue State is blessed with a loamy-clay soil that is very suitable for earthen catfish production. The catfish production systems predominant in the study area include: earthen pond, concrete pond, plastic, tarpaulin and fiber systems.

Some agricultural microcredit lending institutions, parastatals and agencies that have a firmer or stronger presence in Benue State are: BOA, BOI, Nigeria Agricultural Co-operative and Rural Development Bank (NACRDB), private American non-profit organization (PFD), co-operative societies, Local Bam, Federal University of Agriculture, Makurdi, Benue State Agriculture and Rural Development Authority (BNARDA), Benue State Tractor Hiring Agency (BENTHA), Akperan Orshi College of Agriculture, Yandev (AOCAY), Agricultural Training Centre, Mbatie, Agricultural Vocational Centre, Otobi, Livestock Investment and Breeding, Raav, Fadama III, IFAD Rice and Cassava Value Chain Development Programme, Benue Swine/Crop Integrated Improvement Project, Bill gate Foundation Synergos, German International Cooperation (GIZ) and SASAKAWA Africa Association (SAA).

The State has low population density areas such as Guma, Gwer East, Ohimini, Katsina-Ala, Apa, Logo and Agatu, each with less than seventy persons per km^2, while Vandeikya, Okpokwu, Ogbadibo, Obi and Gboko have densities ranging from 140 persons to 200 persons per km^2. Zone A is made up of Katsina Ala, Konshisha, Kwande, Logo, Ukum, Ushongo, Vandeikya. Zone B comprises of Buruku, Gboko, Guma, Gwer, Gwer-West, and Makurdi LGAs. Lastly, Zone C comprises of, Agatu, Apa, Obi, Oju, Ogbadibo, Okpokwu, Otukpo LGAs.

3.2 POPULATION OF THE STUDY

The population of catfish production enterprises in Benue State consists of various production systems. However, the population is not known, but it is finite and includes, concrete, earthen, tarpaulin and fiber or plastic systems of catfish production systems. Obviously, gathering data from every individual in this population would be nearly impossible and prohibitively expensive. It would be more practical to collect data from a subset or sample of the population.

3.3 SAMPLE SIZE DETERMINATION

Multistage sampling technique was used in selecting respondents for the study. Using stratified sampling method in **stage one**, Benue State was divided into three agricultural Zones. In **stage two**, purposive sampling was used to select four Local Government Areas from each Zone – i.e. the most prolific catfish producing L.G.As (Benue State Ministry of Agriculture, 2018). Twelve (12) L.G.As were chosen from the three Zones in the State. Kwande, Vandeikya, Konshisha and Katsina-Ala L.G.As are representative of Zone A. Under Zone B, Gboko, Gwer West, Tarka and Makurdi L.G.As were chosen. Lastly, Otukpo, Okpokwu, Oju and Agatu L.G.As are representing Zone C. For **stage three**, purposive sampling was also used in selecting 5 of the most prolific catfish producing communities from each of the 12 L.G.As. In **stage four**, 5 catfish production enterprises were selected via simple random sampling from each of the communities. This implies that 25 catfish production enterprises from each of the L.G.As were chosen. Thus, a total sample size of 300 catfish production enterprises was selected for this study.

3.4 METHOD OF DATA COLLECTION

Primary data was used via the administration of questionnaire in the study area.

3.5 METHOD OF DATA ANALYSIS

Data collected was analyzed with the use of descriptive tools (tables, frequencies, means and chats) as well as inferential statistics (probit and OLS models). The study used descriptive statistics to examine and analyze **objectives one, two** and **three** respectively. The statistical techniques adopted were: frequencies, means and chats to examine variables. The **fourth objective** was divided into three different categories which utilized multiple regression, logit regression and SEM. With respect to the **fifth objective**, multiple regression technique was used. In this case, multiple regression analysis was employed to make tentative predictions concerning the outcome variables. **Objective six** made use of stochastic frontier to determine technical, allocative and profit efficiencies for catfish production enterprises. The **Seventh objective** adopted analysis of variance (ANOVA), to detect if there are differences among variable means. The **eighth objective** used Likert scale, CPA, mean score and ranking to identify the constraints affecting microcredit access, utilization and repayment.

3.6 MODEL SPECIFICATION

3.6.1 Objective one – descriptive statistics via averages

The first objective made use of averages to describe the demographic and economic profile of catfish production enterprises. The demographic and economic distribution of catfish enterprises used summary of the mean value of items for description. One of the most common ways to describe a single variable is with averages.

$$X_i = \left(\frac{n_i}{N}\right) \qquad \dots (3.1)$$

Where:

X_i = mean value of the i^{th} variable in question

n_i= value of the ith variable in question (e.g. years of operation, number of microcredit sources, pond type or system, nature of input supplier, nature of buyers, bank account for enterprise, funds from any microcredit sources last season, amount of microcredit intended to borrow, amount of microcredit borrowed to enterprise, interest charges, amount owed currently, interest rate payment scheduled, existence of microfinance organization which offers loans to catfish production business)

N = total sample under study

3.6.2 Objective two – averages and microcredit access index

The second objective also made use of averages to describe the sources and amount of microcredit accessed for the catfish production enterprises.

$$X_j = \left(\frac{n_j}{N}\right) \qquad \dots (3.2)$$

Where:

X_j = mean value of the jth source of microcredit

n_j= value of the jth source of microcredit (e.g. Formal source of microcredit such as BOI, BOA, commercial banks, microfinance banks and community banks [FORMAL], family and friends [FAF], cooperatives [COS], private money lenders [PRIV] and owner's equity funding [OEF])

N = total amount of microcredit accessed by sample size

Microcredit Access Index was used to compute the benchmark for low and adequate microcredit accessed (Bassey *et al.* 2014). The total amount of microcredit accessed, was divided by the total amount of microcredit requested by the catfish production enterprises multiplied by 100. A microcredit access index < 50% is termed as low microcredit accessibility while, a microcredit access index ≥ 50% is regarded as adequate microcredit accessibility.

$$Index_{microcredi\ access} = \frac{microcredit\ accessed}{microcredit\ requested} \text{ x } 100 \qquad \dots (3.3)$$

3.6.3 Objective three – microcredit utilization and repayment index

Microcredit Utilization Index: To compute the utilization index, the total amount of microcredit utilized, was divided by the total amount of microcredit accessed by the catfish production enterprises multiplied by 100 (Bassey *et al.* 2014 and Adegbite, 2009).

$$Index_{microcredi\ utilization} = \frac{microcredit\ utilized}{microcredit\ accessed} \text{ x } 100 \qquad \ldots (3.4)$$

Microcredit Repayment Index: The format for calculating the microcredit repayment index is similar to that of the utilization index earlier mentioned (Bassey *et al.* 2014 and Adegbite, 2009). The total amount of microcredit repayment was divided by the total amount of microcredit accessed by the catfish production enterprise multiplied by 100.

$$Index_{microcredi\ repayment} = \frac{microcredit\ repayed}{microcredit\ accessed} \text{ x } 100 \qquad \ldots (3.5)$$

3.6.4 Objective four – multiple regression, logit regression and SEM

(a) Multiple regression

Multiple regression was applied for the analysis of microcredit access determinants as regards catfish production enterprises in Benue State. This takes care of the (a) part of the fourth objective. The implicit form of the model is shown below:

$$Y = f(X_1, X_2, X_3, X_4, e) \qquad \ldots (3.6)$$

Where,
Y = Amount of microcredit accessed in Naira
$X_1, X_2, \ldots X_4$= determinants of microcredit access variables
e = error term

The explicit form is as follows:

‘$MACES = b_0 + b_1 LENDCAP + b_2 \text{FAVSOCREL} + b_3 \text{INTRATE} + b_4 \text{LENWAIT} + e$ … (3.7)

Where,

MACES = Amount of microcredit accessed in Naira

LENDCAP = Borrowing capacity of borrower (less than ₦250, 000 = low, equal to or greater than ₦250, 000 = high)

FAVSOCREL = Favours due to social relations between catfish enterprise and borrower (less than ₦250, 000 = low, equal to or greater than ₦250, 000 = high)

INTRATE = Interest rate on loan (percentage)

LENWAIT = Length of waiting to receive loan from lender (days)

e = error term

a priori expectations are $b_1, b_2 > 0$ and $b_2, b_4 < 0$

(b) Logit regression model

Microcredit utilization rate was assessed using logit model. This study utilized logistic regression model to empirically determine the presence or absence of high or low utilization of microcredit as influenced by certain determinants in the study area.

$$L_i = \left(\frac{PY_i}{1-PY_i}\right) = \beta_0 + \beta_1 DL + \beta_2 PS + \beta_3 ME + \beta_4 PF + \beta_5 SL + e_i \quad \text{… (3.8)}$$

Where,

Li = Logit or log of odds ratio

PYi = High utilization rate of microcredit in Naira

1 - PYi = Low utilization rate of microcredit in Naira

$\beta_1, \beta_2 \dots \beta_5$ = Coefficients to be estimated

e_i = error term

DIV=Diversion of loan (Naira)

POSI=Pond size (m^2)

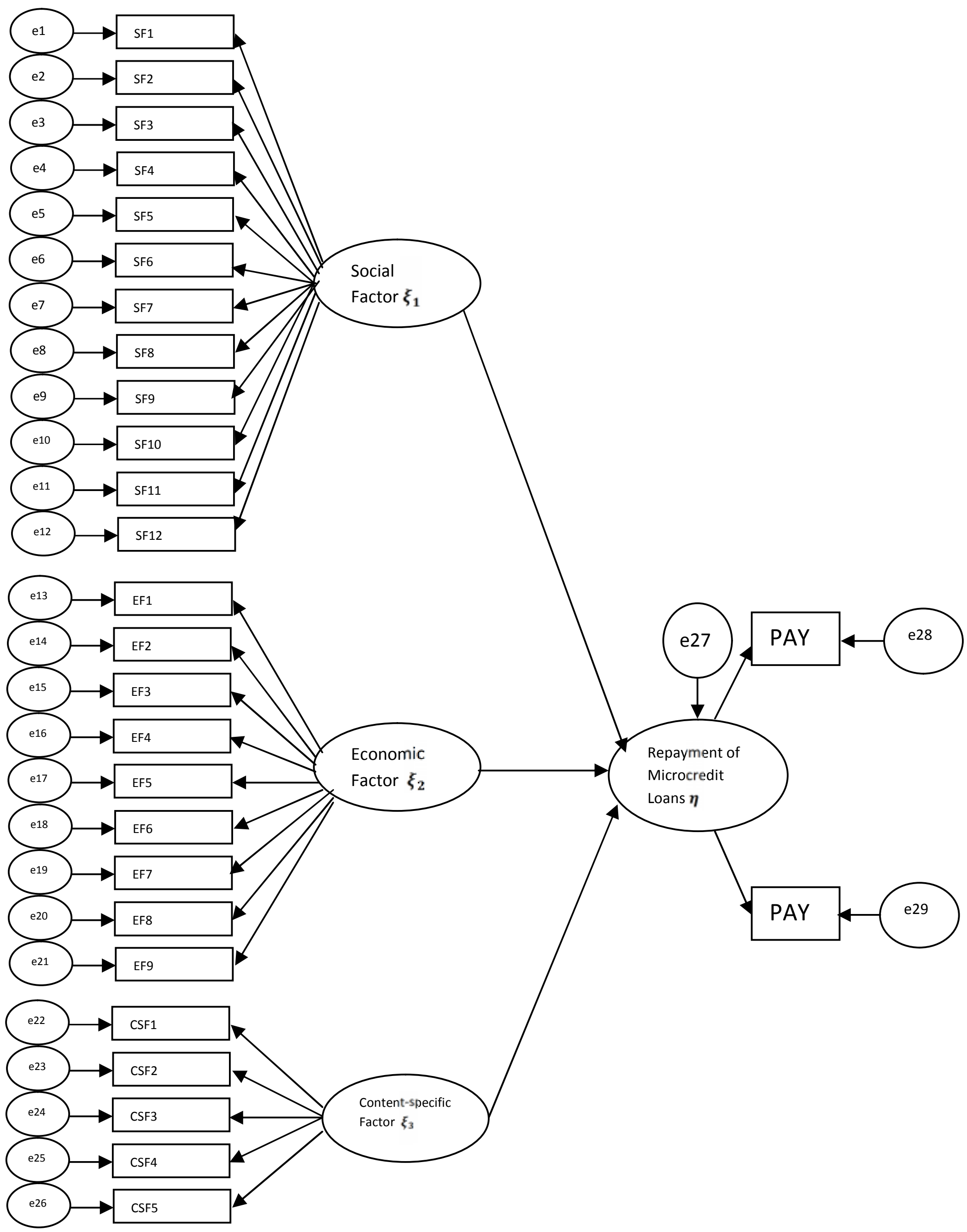
MACES= Microcredit access (Naira)

LSUP=Lender’s supervision on utilization of loan (Dummy: low=0, high=1)

a priori expectations are β_2, β_3, $\beta_4 > 0$ and $\beta_1 < 0$

(c) Structural equation modeling (SEM)

The structural model helped to determine factors affecting repayment of microcredit loans by catfish production enterprises in the study area. The SEM model for this study is represented below.



Source: The study

Figure 3.2: SEM Model of Factors Affecting Repayment of Microcredit Loans by Catfish Production Enterprises

Where,

SF1=Age of the enterprise; *a priori* expectation is positive

SF2=Mortality rate of fish; *a priori* expectation is negative

SF3=Farm size; *a priori* expectation is positive

SF4=Employee size; *a priori* expectation is positive

SF5=Diversion of loan; *a priori* expectation is negative

SF6=Incidence of diseases and pests; *a priori* expectation is negative;

SF7=Pond size; *a priori* expectation is positive

SF8=Monopoly power created by informal lenders; *a priori* expectation is negative

SF9=Use of modern machinery and equipments; *a priori* expectation is positive

SF10=Social relations of management to the borrower; *a priori* expectation is positive

SF11=Experience of management; *a priori* expectation is positive

SF12=Educational qualification of management; *a priori* expectation is positive

EF1=Interest rate on loan; *a priori* expectation is negative

EF2=Income of the catfish enterprise; *a priori* expectation is positive

EF3=Loan size; *a priori* expectation is positive

EF4=Net profit; *a priori* expectation is positive

EF5=Fluctuations in commodity prices; *a priori* expectation is negative

EF6=Market value of catfish; *a priori* expectation is positive

EF7=Market price fluctuations; *a priori* expectation is negative

EF8=Exchange rate of Naira to Dollar; *a priori* expectation is positive

EF9=Asset base of catfish enterprise; *a priori* expectation is positive

CSF1=Lender's supervision on utilization of loan; *a priori* expectation is positive

CSF2=Number of repayment installments; *a priori* expectation is positive

CSF3=Down-payment of loan; *a priori* expectation is positive

CSF4=Length of waiting to receive loan from lender; *a priori* expectation is positive

CSF5=Length of repayment period; *a priori* expectation is positive

PAY1=Payment is in accordance with the lender's terms; *a priori* expectation is positive

PAY2= Repayment does not affect profit of the catfish production business; *a priori* expectation is positive

e=error term

Linear Structural Relationships was used to calculate the effect of various factors on repayment of microcredit loans. The computer software of SmartPLS 3 was used to specify fit and evaluate structural equation model. A model for repayment of microcredit loans (Figure 3.2) was formulated as a cause/effect chain to work out structural analysis. As the qualitative variables of this model was measured through various items in the form of Likert type scale, by adding up these items, a quantitative set of data for each of the variables was obtained and the structural analysis calculated. This model consists of two parts: the measurement model and the structural equation model. The structural model specifies how latent variables (ξ_1, ξ_2, ξ_3 and η) depend upon or are indicated by the observed variables. It describes the measurement properties (reliabilities and validities) of the observed variables, and is defined by the following equations:

Structural equation

$$\eta = \gamma_{11}\xi_1 + \gamma_{12}\xi_2 + \gamma_{13}\xi_3 + \zeta_1 \quad \text{… (3.9)}$$

Measurement equations

$$y = \lambda\eta + \varepsilon \quad \text{… (3.10)}$$

$$x = \lambda\xi + \delta \quad \text{… (3.11)}$$

Where,

η = $m \times 1$ random vector of latent dependent (endogenous) variables;

γ = $m \times n$ matrix of coefficients of the ξ variables;

ξ = $n \times 1$ random vector of latent independent exogenous) variables;

ζ = $m \times 1$ vector of equation errors (random disturbances) in the structural relationship between η and ξ;

λ= $p \times m$ matrix of coefficients of the regression (loading) of y on η or, is a q x n matrix of coefficients of the regression (loading) of x on ξ;

δ = $q \times 1$ vector of measurement errors in x;

$\varepsilon = p \times 1$ vector of measurement errors in y.

To examine the reliability of the latent variables, composite reliability value for each latent variable will be calculated. To do this, the information on indicator loadings and error variances calculated by SmartPLS 3 was used and by applying the following formula, the composite reliability of various latent variables was calculated (Diamantopoulos and Siguaus, 2000).

$$P_c = (\Sigma\lambda)^2/[(\Sigma\lambda)^2 + \Sigma(\theta)] \quad \ldots (3.12)$$

Where,

P_c = Composite reliability;

λ = Indicator loadings;

θ = Indicator error variance (ie. variances of the δ_s or ε_s); and

Σ = Summation over the indicators of the latent variables.

3.6.5 Objective five – multiple linear regression

Multiple linear regression was used to determine the effect of microcredit access, utilization and repayment on output of catfish production enterprises in Benue State. The implicit form of the model is shown below:

$$Y = f(X_1, X_2, X_3, e) \quad \ldots (3.13)$$

Where,

Y = Catfish output in kg

X_1, X_2, X_3 = determinants of microcredit access, utilization and repayment variables

e = error term

The explicit form for this aspect is as follows:

$$CATOUTPUT = b_0 + b_1 MACES + b_2 \text{UTILIZED} + b_3 \text{REPAY} + e \quad \ldots (3.14)$$

Where,

CATOUTPUT= Catfish output (kg)

MACES = Microcredit access (Naira)

UTILIZED = Microcredit utilization (Naira)

REPAY = Microcredit repayment (Naira)

e = error term

a priori expectations are $b_1, b_2, b_3 > 0$

3.6.6 Objective six – stochastic frontier models

Stochastic frontier models were used to compute the technical, allocative and profit efficiencies of catfish production business in Benue State. Thus, the sixth objective was divided into three parts namely: technical, allocative and profit efficiencies.

a) Technical efficiency specification

A single stochastic production frontier equation was applied to the analysis of catfish production enterprises in Benue State as specified below:

$$LogY_i = \beta_0 + \sum_{j=1}^{4} \beta_j \, LogX_{ij} + (V_i - U_i) \quad \dots (3.15)$$

$$lnY = \beta_0 + \beta_1 lnFING + \beta_2 lnFEED + \beta_3 lnLABO + \beta_4 lnPOSI + (V_i - U_i) \quad \dots (3.16)$$

Where,

Log or ln = natural logarithm

i = sample of catfish enterprises

j = number of inputs and farm-specific variables

β_js = parameters of linear terms; j = 0, 1... 4 are parameters to be estimated

ln = Log of estimated values of inputs, output and error term

v_is = statistical errors and random shocks such as faulty equipments, low quality fingerlings, errors in measurement, etc, are assumed to be independent and identically distributed N (0, σ^2) random variables.

u_is = error term measuring the level of inefficiency in production; are assumed to be independent and identically distributed non-negative truncations of the N (μ, σ^2) distribution.

Y = catfish output (kg)

$FING$ = fingerlings used in catfish production (kg)

$FEED$ = quantity of standard feeds used (kg)

$LABO$ = labor requirements (man-days)

$POSI$ = pond size of catfish enterprise (m^2)

a priori expectations are $\beta_1, \beta_2, \beta_3, \beta_4 > 0$

b) Allocative efficiency specification

$$lnC_i = \beta_0 + \beta_1 lnVFING + \beta_2 lnVFEED + \beta_3 lnVLABO + \beta_4 lnVPOSI + (V_i - U_i) \quad \ldots (3.17)$$

Where,

ln = natural logarithm;

i = sample of catfish enterprises

C_i = revenue from sales in Naira (output price of the x output of the it catfish farm in kilogram kg).

β_js = parameters of linear terms; j = 0, 1... 4 are parameters to be estimated

ln = Log of estimated values of inputs, output and error term

v_is = statistical errors and random shocks such as cost of faulty equipments, cost and low quality fingerlings, errors in measurement, etc, are assumed to be independent and identically distributed N (0, σ^2) random variables u_is = error term measuring the level of inefficiency in production; are assumed to be independent and identically distributed non-negative truncations of the N (μ, σ^2) distribution.

$VFING$ = value of fingerlings used in catfish production (₦)

$VFEED$ = value of quantity of standard feeds used (₦)

$VLABO$ = value of labor requirements (₦)

$VPOSI$ = value of pond size of catfish enterprise (₦) – this fixed variable items are depreciated using the sum of years digit method in order to spread the cost of the assets over their useful life, be it earthen, concrete, tarpaulin and fiber or plastic systems of pond used.

a priori expectations are $\beta_1, \beta_2, \beta_3, \beta_4 < 0$

The technical and allocative inefficiency model

The inefficiency model for the study is shown below;

$$U_i = \delta_0 + \sum_{j=1}^{6} \delta_j \, LogZ_{ji} \quad \ldots (3.18)$$

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \cdots + \delta_6 Z_6 \quad \ldots (3.19)$$

Where,

U_i = inefficiency effect

Z_{ji}= Explanatory variables for the technical inefficiency effects for the i^{th} farmer,

δ_js = parameters of environment of business variables

Z_1 = Interest rate – INT – (%)

Z_2 = Number of microcredit sources – NMS – (number)

Z_3 = Collateral – COLL – (₦)

Z_4 = Guarantor – GURA – (number)

Z_5 = Default in payment – DPAY – (₦)

Z_6 = Sentiments – SENT – (yes, no)

a priori expectations are δ_2, $\delta_6 > 0$ and δ_1, δ_3, δ_4, $\delta_5 < 0$

c) Profit efficiency estimation using stochastic frontier

In other to determine the profitability of catfish production, the functional form of the stochastic profit frontier was determined by testing the adequacy of the Cobb – Douglas (highly restrictive) by fitting in the less restrictive translog. According to Sunday *et al.*, (2012), the profit function model for the profit efficiency analysis was given as follows:

$$\pi = \frac{\pi}{\rho} = f(q_i, Z) exp\ (V_i - U_i) \quad \text{... (3.20)}$$

Where,

π = normalized profit of i^{th} catfish enterprise

q_i= vector of variable inputs

Z = vector of fixed inputs

ρ = output price

$exp\ (V_i - U_i)$ = composite error term

The profit efficiency is expressed as the ratio of predicted actual profit to the predicted maximum profit for a best-practiced catfish farmer. Profit efficiency in this study is defined as profit gain from operating on the profit frontier, taking into consideration farm-specific prices and factors. The actual normalized profit function which is assumed to be well behaved can be derived as follows; Farm profit is measured in term of Gross Margin (GM) which equals the difference between the Total Revenue (TR) and Total Variable Cost (TVC). That is:

$$GM (\pi) = \sum(TR-TVC) = \sum(PyQ - WiXi) \quad \text{.... (3.21)}$$

To normalize the profit function, gross margin (π) is divided on both sides of the equation (3.22) by Py which is the market price of the output.

Where,

TR = Total revenue (Naira/ ha)

TVC = Total variable cost (Naira/ ha)

Py = Unit price of output (Naira/ Kg)

Xi= Variable input quantity

Z = Price of fixed inputs (Naira) – this fixed variable items are depreciated using the sum of years digit method in order to spread the cost of the assets over their useful life, be it earthen, concrete, tarpaulin and fiber or plastic systems of pond used.

Pi= W/Py which represents normalized price of input Xi (Naira) and

f(Xi, Z) represents production function.

For this study, Coelli (1996) model was used to specify the stochastic frontier function with behaviour inefficiency components and to estimate all parameters together in one step maximum likelihood estimation. The explicit Cobb-Douglas functional form for the catfish producers in the study area, is therefore, specified as follows:

$$ln\pi = \beta_0 + \beta_1 lnCFING + \beta_2 lnCFEED + \beta_3 lnCLABO + \beta_4 lnCPOSI + (V_i - U_i) \quad \text{... (3.22)}$$

Where,

π = restricted normalized profit computed for j^{th} farm which is defined as gross revenue less variable costs divided by farm specific catfish output price Py;

ln = Natural log

β_js = parameters of linear terms; j = 0, 1... 4 are parameters to be estimated

v_is = statistical errors and random shocks assumed to be independent and identically distributed N (0, σ^2) random variables u_is = error term measuring the level of inefficiency in profit.

$VFING$ = value of fingerlings used in catfish production (₦)

$VFEED$ = value of quantity of standard feeds used (₦)

$VLABO$ = value of labor requirements (₦)

$VPOSI$ = value of pond size of catfish enterprise (₦) – this fixed variable items are depreciated using the sum of years digit method in order to spread the cost of the assets over their useful life, be it earthen, concrete, tarpaulin and fiber or plastic systems of pond used.

a priori expectations are $\beta_1,\beta_2,\beta_3,\beta_4,\beta_5 < 0$

The profit inefficiency model

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \cdots + \delta_9 Z_9 + \theta \quad \text{... (3.23)}$$

Where;

Ui= Inefficiency effects

θ= Truncated random variable.

δ0 and δ1-n are scalar parameters to be estimated.

Z_1 = Interest rate – INT – (%)

Z_2 = Number of microcredit sources – NMS – (number)

Z_3 = Collateral – COLL – (₦)

Z_4 = Guarantor – GURA – (number)

Z_5 = Default in payment – DPAY – (₦)

Z_6 = Sentiments – SENT – (yes, no)

a priori expectations are δ_2, $\delta_6 > 0$ and δ_1, δ_3, δ_4, $\delta_5 < 0$

These inefficiency variables are included in the model to indicate their possible influence on the profit efficiencies of the catfish enterprises (determinant of profit efficiency). Profit loss is defined as the amount that has been lost due to inefficiency in production given prices and fixed factor endowments and is calculated by multiplying maximum profit by (1-Pe). Maximum profit per hectare was computed by dividing the actual profit per hectare of individual farms by its efficiency score.

PL = maximum profit (1-PE)

Where,

PL = profit loss

PE = profit efficiency

3.6.7 Objective seven – analysis of variance (ANOVA)

Consider catfish production enterprises from the study area whose means we want to compare. Let $n_i, i = 1, 2, \ldots, I$ be the sample size of catfish production enterprise "I". For the microcredit data, $I = 3$, representing microcredit access, utilization and repayment at the particular locus of interest. The F – coefficient or the variance ratio refers to the ratio which the greater variance bears to the smaller variance. This ratio was used to compare if the average or means of microcredit access, utilization and repayment are significantly different or not. In order words, this ratio is

$$F = \frac{S_B^2}{S_W^2} \quad \text{... (3.24)}$$

and

$$S_B^2 = \frac{n_r \sum(\bar{X}_c - \bar{\bar{X}}_c)^2}{K-1} \quad \text{… (3.25)}$$

$$S_W^2 = \frac{(X_{rc} - \bar{X}_c)^2}{N-K} \quad \text{… (3.26)}$$

Where;

F = coefficient or the variance ratio

S_B^2 = sum of squares of deviation for variance between samples

S_B^2 = sum of squares of deviation for variance within samples

n_r = number of rows or number of observations in each sample

$\bar{X}_c$ = mean of each column

$\bar{\bar{X}}_c$ = grand mean

K = number of columns (i.e., microcredit access, utilization and repayment)

X_{rc} = value of each observation in a sample, where r=row, c=column

N = total number of respondents

The study examined if the mean scores of microcredit access, utilization and repayment are the same. Null hypothesis specify that the mean score of microcredit access, utilization and repayment are the same in the study area.

$$H_0: \mu_1 = \mu_2 = \mu_3 \quad \ldots (3.27)$$

3.6.8 Objective eight – Likert scale and principal component analysis (PCA)

Likert scale and Principal Component Analysis (PCA) were used to examine the constraints to microcredit access, utilization and repayment by catfish production enterprises in Benue State. The Like Scale was coded as follows: SD=strongly disagree, D=disagree, A=agree, SA=strongly agree. Constraints that affect microcredit accessibility, utilization and repayment are as follows: absence of banks in the locality, high interest rate, bureaucratic bottlenecks, late approval, guarantor, amount given is too small, collateral, negotiating your produce before production, sentiments, delay in approval of loan, delay in payment and lack of awareness. The Cut-off point of the Likert scale used in this study is 2.5.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 DEMOGRAPHIC AND ECONOMIC PROFILE OF CATFISH PRODUCTION ENTERPRISES

Descriptive statistics of demographic and economic profile of catfish production enterprises is presented in Table 4.1.

Table 4.1: Demographic and Economic Profile of Catfish Prod. Enterprises (n=300)

Demographic and economic profile	Obs	Mean	Std. Dev.	Min	Max
MACES (₦)	300	130630.6	52989.61	35000	324000
AMIB (₦)	300	236882.9	67232.26	35000	470000
DEBT (₦)	300	7115.709	12397.31	0	59616
PAYS (option)	300	3.156667	0.6378178	2	4
EXIMC (dummy)	300	0.7666667	0.42365	0	1
YOOP (yrs)	300	5.606667	2.605363	2	13
NMS (dummy)	300	2.846667	0.8238637	2	4
PSYS (option)	300	2.493333	0.8239449	1	5
ACCT (dummy)	300	1.053333	0.2250728	1	2
INT (%)	300	6.456667	5.0926	0	20

Source*:* Field Survey, 2018

The mean microcredit access (MACES) for the study area was ₦130, 630.60 which is less than the average credit of ₦170, 173.40 accessed by catfish production enterprises in a study by Mgbedu and Achike (2017); however, Edet, Atairet, Nkeme and Udoh (2014) had a higher average of accessed credit of ₦1, 838, 709 in Akwa Ibom State. The average amount of microcredit, catfish production enterprises intended to borrow (AMIB) was ₦236, 882.90. The mean default rate in the repayment of microcredit loans (DEBT) stood at ₦7, 115.709, which corroborates the stand of the Ministry of Agriculture, Makurdi (2018) that fish production enterprises repay borrowed credit more often than crop production enterprises, because they are less susceptible to environmental forces compared to crop. The average mean of 2.49 for PSYS (pond system) indicates that most catfish enterprises in the study area are engaged in earthen system of catfish production.

The existence of microcredit organizations which offer loans to catfish production businesses (EXIMC) on the average was 0.77; this indicates that out of every 10 respondents, 8 agreed to the existence of a microcredit source. On the average, years of operating (YOOP) catfish production enterprises indicate 5.6 years. The average payment schedule (PAYS) was at 3.16 indicating that repayment was mostly done on monthly basis. Most of the catfish production enterprises owned bank accounts as the average ACCT was 1.05. Interest charged on microcredit loans on the average was 6.45%.

4.2 SOURCES AND AMOUNT OF MICROCREDIT ACCESSED

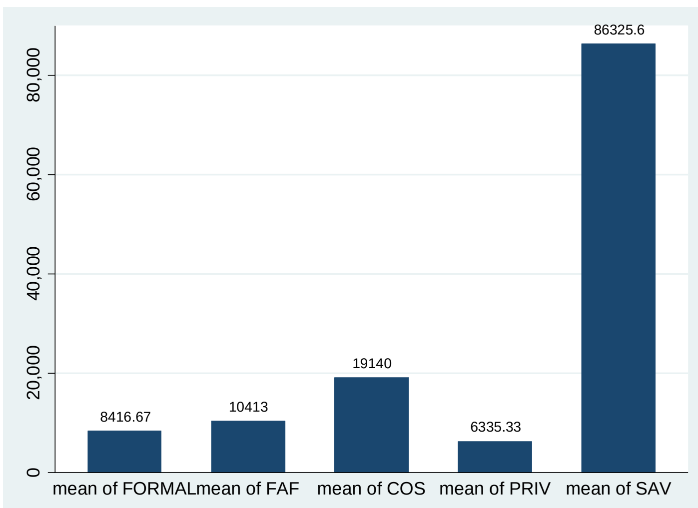
Table 4.2 reveals that a total of ₦ 39,189,185 of microcredit was accessed by catfish production enterprises. This far outweighs the ₦ 7,355,036 by Edet *et al.* (2014) as accessed credit by fish traders. Microcredit obtained from owner's equity funding (OEF) was highest with a total value of ₦ 25,897,685. The second highest microcredit lender was cooperatives (COS) with a total value of ₦ 5,742,000. Thirdly, family and friends (FAF) contributed a total of ₦ 3,123,900. The fourth ranking microcredit lender was from formal financial institutions (FORMAL) such as Bank of Industry (BOI), Bank of Agriculture (BOA), microfinance and community banks with a total value of ₦ 2,525,000. The fifth ranking microcredit lender was private money lenders (PRIV) with a total value of ₦ 1,900,600.

Table 4.2: Sources and Amount of Microcredit Accessed (n=300)

Sources of microcredit	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Total**
FORMAL (₦)	300	8416.667	11431.48	0	50000	2,525,000
FAF (₦)	300	10413	9081.07	0	39000	3,123,900
COS (₦)	300	19140	14368.781	0	100000	5,742,000
PRIV (₦)	300	6335.333	5019.322	0	20000	1,900,600
OEF (₦)	300	86325.62	45596.81	20000	250045	25,897,685
Total						**39,189,185**

Source*:* Field Survey, 2018

The mean amount from microcredit sources tells us the average value in Naira of credit obtained from lenders. Microcredit obtained from owner's equity funding (OEF) topped the chart below (see Figure 4.1) with a mean value of ₦ 86,326.62.



Source*:* Field Survey (2018) Computation from STATA Version 14.2 for Windows

Figure 4.1: Sources and Mean Values of Microcredit Accessed in Naira

The second highest microcredit lender was cooperatives (COS) with a mean value of ₦ 19,140. Thirdly, family and friends (FAF) contributed an average of ₦ 10,413. The fourth ranking microcredit lender was from formal financial institutions (FORMAL) such as Bank of Industry (BOI), Bank of Agriculture (BOA), microfinance and community banks with a mean value of ₦ 8,416.67. The fifth ranking microcredit lender was private money lenders (PRIV) with a mean value of ₦ 6, 335.33.

4.2.1 Microcredit access index

The overall microcredit access index is represented in Table 4.3.

Table 4.3: Microcredit Access Index

Microcredit activities	Total
AMID (₦)	70,064,870
MACES (₦)	39,189,185

Note: AMID = amount of microcredit catfish production enterprises intended to borrow; MACES = amount of microcredit accessed; Microcredit Access Index = $\frac{MACES}{AMID}$ x 100 = $\frac{39{,}189{,}185}{70{,}064{,}870}$ x 100 = 0.5593 x 100 ≈ 56%

Source*:* Field Survey, 2018

The microcredit access index was 0.56 as indicated in the Table above. More than half of the microcredit requested was met, indicating that 56% of microcredit applied for was accessed by catfish enterprises. Thus, the study area has an adequate microcredit access index.

4.3 LEVEL OF MICROCREDIT UTILIZATION AND REPAYMENT

Table 4.4 disclosed that, from the total sum of ₦ 39,189,185 microcredit accessed (MACES) by catfish production enterprises, a huge sum of ₦ 28,582,422 was utilized in catfish production business. Microcredit was used in the purchase of inputs such as standard feeds, fingerlings, labour, etc.

Table 4.4: Level of Microcredit Utilization and Repayment

Microcredit activities	Obs	Mean	Std. Dev.	Min	Max	Total
MACES (₦)	300	130630.6	52989.61	35000	324000	39,189,185
UTILIZED (₦)	300	95274.74	33863.77	28100	259200	28,582,422
REPAY (₦)	300	7115.709	12397.31	0	59616	37,054,472

Source*:* Field Survey, 2018

In the case of microcredit repayment, a vast sum of ₦ 37,054,472 was repaid by catfish production enterprises. This implies that 94% of the total sum of ₦ 39,189,185 microcredit accessed (MACES) by catfish production enterprises was repaid. This is as a result of less environmental hindrance to catfish production business in the year 2017 (Ministry of Agriculture, Makurdi, 2018).

4.3.1 Microcredit utilization and repayment index

The microcredit utilization index in the study area however, was 0.73; this translates into 73% of utilized microcredit in the study area (see Table 4.5).

Table 4.5: Microcredit Utilization and Repayment Index

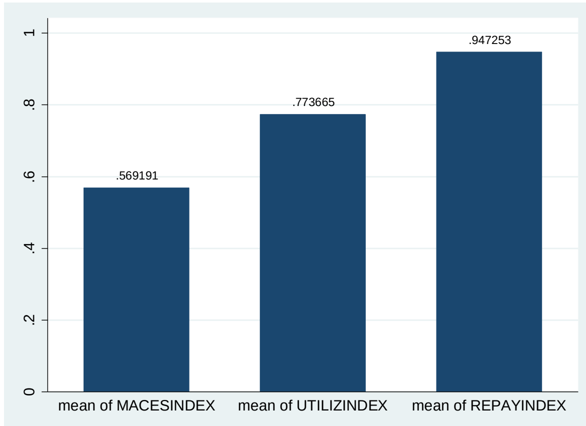
Microcredit activities	Total
MACES (₦)	39,189,185
UTILIZED (₦)	28,582,422
REPAY (₦)	37,054,472

Note: MACES = amount of microcredit accessed; UTILIZED = amount of accessed microcredit utilized; REPAY = amount of accessed microcredit refunded; Microcredit Utilization Index = $\frac{UTILIZED}{MACES}$ x 100 = $\frac{28,582,422}{39,189,185}$ x 100= 0.7293 x 100≈ 73%; Microcredit Repayment Index = $\frac{REPAY}{MACES}$ x 100 = $\frac{37,054,472}{39,189,185}$ x 100= 0.9446 x 100≈ 94%

Source*:* Field Survey, 2018

However, the very high repayment index of 0.94 for this study, is above the repayment index (0.63) recorded by Edet *et al.* (2014). Both of these studies oppose Ajayi, Enendu and Idowu (2009); Alade (2003) and Ojo (1985) that small holders loan schemes in Nigeria is characterized by high rate of default.

The average microcredit index values indicate that 57%, 77% and 95% respectively were achieved for microcredit access, microcredit utilization and microcredit repayment respectively (see Figure 4.2). These values are close to the actual microcredit index values for access, utilization and repayment earlier mentioned.



Source*:* Field Survey (2018) Computation from STATA Version 14.2 for Windows

Figure 4.2: Average Microcredit Access, Utilization and Repayment Index

The mean value indicate that on average, each catfish production enterprise had ability of accessing microcredit at a 57% rate. The average microcredit utilization rate for each catfish production enterprise was at a value of 77%. This indicates that only 26% of the average microcredit accessed was diverted towards non catfish production activities. The average microcredit repayment index per catfish production enterprises was the largest with a value of 95%; indicating that catfish producers are very disciplined and do not breach the trust or contracts with borrowers.

4.4 DETERMINANTS OF MICROCREDIT ACCESS, UTILIZATION AND REPAYMENT

4.4.1 Determinants of microcredit access via multiple regression model

Table 4.6 shows that R^2 value of 0.05 indicate that 5% of the variation of microcredit acquired is explained by the variables included in the model. From findings, favours due to social relations between the catfish enterprise and lender (FAVSOCREL) is the only independent variable that was significant at 1% but negative.

Table 4.6: Determinants of Microcredit Access using Multiple Regression (n=300)

		Coef.	**Std. Err.**	**z**	**p > | z |**
Constant	β_0	154743.100	11644.720	13.29**	0.000
LENDCAP (₦)	β_1	8259.23100	7568.585	1.09	0.218
FAVSOCREL (₦)	β_2	-33345.960	9099.375	-3.66**	0.000
INTRATE (%)	β_3	-583.069	596.376	-0.98	0.329
LENWAIT (days)	β_4	5139.505	6268.459	0.82	0.413
F (4, 295)		4.02*			
Prob > F		0.0034			
R^2		0.0517			
Adj R^2		0.0388			
Root MSE		51950			

Note: * and ** indicate that the parameter is significant at the 5% and 1%, respectively; dependent variable = MACES (Amount of microcredit accessed in Naira); LENDCAP = Lending capacity of lender; FAVSOCREL = Favours due to social relations between catfish enterprise and lender; INTRATE = Interest rate on loan; LENWAIT = Length of waiting to receive loan from lender

Source*:* Field Survey (2018) Computation from STATA Version 14.2 for Windows

This entail that the more interactions and social relations management has with the lender, the less loan favours the enterprise is likely to obtain from credit source(s). This is contrary to *a priori* expectations that increase in social relations of management to the lender results to a corresponding increase in the amount of microcredit accessed by the catfish production enterprises. This could be as a result of insensitivity of lenders to social and personal relationships when it comes to parting away with limited cash; the tight economic recession experienced in 2017 made it necessary for credit sources to do away with sentiments.

Test of hypothesis: Significant P value for the regression model is shown in Table 4.6. However, the P value of the overall F-test is significant; the regression model predicts the response variable better than the mean of the response. The F-test value is 4.02, which is greater than the F-tabulated value indicating significant relationship between MACES and independent variables (LENDCAP, FAVSOCREL, INTRATE and LENWAIT) of the model. Thus, the null hypothesis was rejected and the alternative hypothesis accepted, which states that, *"determinants of microcredit access have significant effect on catfish production enterprises"*.

4.4.2 Determinants of microcredit utilization via logit model

Logit model was used to estimate the determinants of microcredit utilization rate in Table 4.7; which show that an increase in pond size (POSI) factor was statistically positive and significant at a value of 5%. For the POSI factor, the likely utilization rate of microcredit loan (i.e. odds ratio of high against low utilization) is increased by a factor of 0.00122, other factors remaining constant.

Table 4.7: Determinants of Microcredit Utilization using Logit Model (n=300)

		Coef.	Std. Err.	z	p > | z |
logit model					
Constant	β_0	-3.919	0.604	-6.49**	0.000
POSI (m^2)	β_1	0.00122	0.000420	2.91*	0.004
MACES (₦)	β_2	0.0000205	0.00000345	5.97**	0.000
DIV (₦)	β_3	-0.0368	0.263	-0.14	0.889
LSUP (dummy)	β_4	0.335	0.604	-6.48**	0.000
parameters					
Log Likelihood	LLF	-173.3625			
LR test of the one sided error	LR	60.10**			
Prob > Chi^2		0.000			
Pseudo R^2		0.1377			

Note: * and ** indicate that the parameter is significant at 5% and 1%, respectively

Source*:* Field Survey (2018) Computation from STATA Version 14.2 for Windows

The variable, MACES (microcredit access) is positive and significant at a value of 1%. The coefficient (or parameter estimate) for the variable MACES is 0.0000205.

This means that for a one-unit increase in MACES (in other words, going from high to low), we expect a 0.0000205 increase in the log-odds of the dependent variable utilization rate of microcredit (i.e. holding all other independent variables constant).

Diversion of loan (DIV) variable showed a negative and insignificant value. DIV contributed very little to microcredit utilization rate. For every one-unit increase in amount of microcredit loan diverted, we expect a 0.0368 increase in the log-odds of microcredit utilization rate, holding all other independent variables constant.

The lender's supervision (LSUP) indicates a positive and significant value at 1%. More so, for every one-unit increase in LSUP (so, for every additional effort made by the borrower to investigate and monitor the activities of the catfish production enterprise), we expect a 0.335 increase in the log-odds of microcredit utilization rate, holding all other independent variables constant.

Test of hypothesis: The LR chi^2 also referred to as LR test of the one sided error, is the likelihood ratio (LR) chi-square test. The likelihood chi-square test statistic is 60.10 which is significant at a 1% level for the logit model on Table 4.7. The Prob > chi^2 is the probability of obtaining the chi-square statistic given that the null hypothesis is true. This is, of course, the p-value, which is compared to critical value of 0.05 or 0.01 to determine if the overall model is statistically significant. In this case, the model is statistically significant because the p-value is less than 0.000. Thus, the null hypothesis was rejected and the alternative accepted which states that, "*determinants of microcredit utilization have significant effect on catfish production enterprises*".

4.4.3 Determinants of microcredit repayment via SEM

The study used Structural Equation Modeling (SEM) for purposes of analyzing the determinants of microcredit repayment such as social, economic and contract specific factors. Objective of the general analysis is to reject or accept the null hypothesis of a set of specific paths. The estimation technique used for this SEM analysis is Ordinary Least Squares (OLS).

In addition, by conducting SEM analysis, the researcher was able to model observed and latent variables. SEM was used as a confirmatory technique in testing several *a priori* expectations and the entire complex theoretical model in one analysis. Analysis was carried out with the aid of SmartPLS version 3.2.7 software for Windows.

(i) Collinearity statistics

The condition index (CI) values above 30 indicate critical levels of collinearity. The CI < 30 indicated that the variables would not present collinearity problems if they stayed together (Gujarati, 2003). Variance inflation factors (VIF) is used to measure collinearity.

Multicollinearity occurs when two or more predictors in the model are correlated and provide redundant information about the response. Multicollinearity was measured by variance inflation factors (VIF) and tolerance (Gómez, Pérez, Martín and García, 2016). VIF is the reciprocal of the tolerance value. Multicollinearity is a problem that occurs with regression analysis when there is a high correlation of at least one independent variable with a combination of the other independent variables. In multiple regression, the variance inflation factor (VIF) is used as an indicator of multicollinearity. Computationally, it is defined as the reciprocal of tolerance: 1 / (1 -

R2). A small VIF value indicates low correlation among variables under ideal conditions, VIF < 3. If VIF value exceeds 4.0, or by tolerance less than 0.2 then, there is a problem with multicollinearity (Hair, Hult, Ringle and Sarstedt, 2017). For this study, the maximum level of VIF < 5 is acceptable, as indicated by (Ringle,Wende and Becker, 2015). This study's VIF correlation values of the independent variables and the dependent variable is represented in Table 4.8.

Table 4.8: Collinearity Statistics showing Variance Inflation Factors (VIF)

	Repayment of Microcredit Loans
Content Specific Factors	2.552
Economic Factors	1.767
Social Factors	2.219

Source*:* Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

From the Table above, the correlation value between content specific factors and repayment of microcredit loans is 2.552. The association between economic factors and repayment of microcredit loans gave a correlation value of 1.767. Lastly, correlation between social factors and repayment of microcredit loans indicate a value of 2.219. However, this indicates low correlation among variables and highlight an ideal condition because, VIF < 3; therefore our data does not have any problem with multicollinearity as indicated by Hair *et al.* (2017).

(ii) Measurement model

Before proceeding to the structural model in SEM, the validity and reliability of the constructs must be analyzed. This was examined before model fit from the operational model of determinants of microcredit repayment by catfish production enterprises was analyzed.

(a) Validity test

Heterotrait-monotrait (HTMT) ratio of correlations: The heterotrait-monotrait ratio of correlations (HTMT) is a new method for assessing discriminant validity in partial least squares structural equation modeling, which is one of the key building blocks of model evaluation. Discriminant validity is demonstrated by the square root of the Average Variance Extracted (AVE) being greater than any of the inter-construct correlations. If discriminant validity is not established, researchers cannot be certain that the results confirming hypothesized structural paths are real, or whether they are merely the result of statistical discrepancies. The HTMT criterion clearly outperforms classic approaches to discriminant validity assessment such as Fornell-Larcker criterion and (partial) cross-loadings, which are largely unable to detect a lack of discriminant validity.

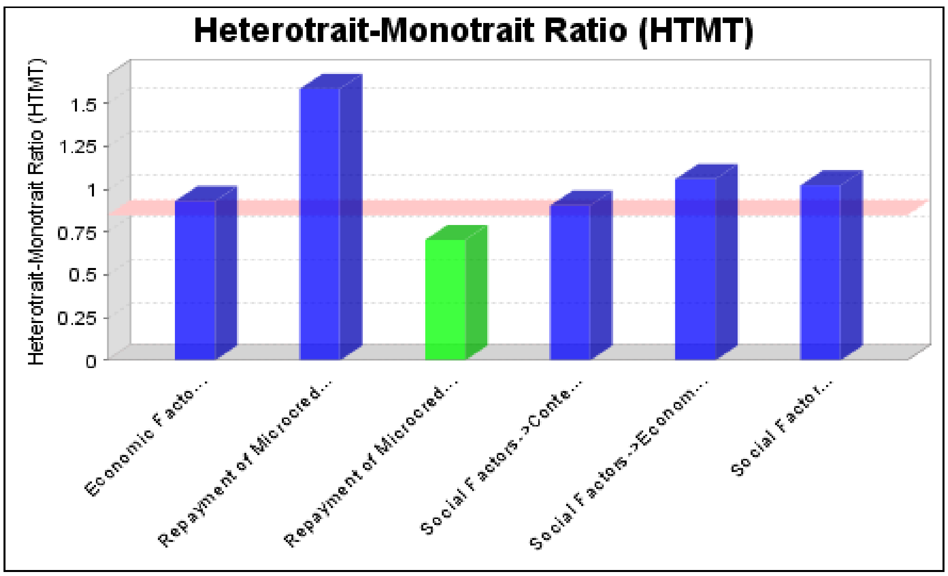
The discriminant validity assessment has the goal to ensure that a reflective construct has the strongest relationships with its own indicators (e.g., in comparison with than any other construct) in the PLS path model (Hair *et al.*, 2017). However, HTMT criterion computation differs from the equation given by Henseler, Ringle and Sarstedt (2015). Discriminant validity assessment has become a generally accepted prerequisite for analyzing relationships between latent variables. The HTMT values for latent variables in this study are indicated in Table 4.9 below.

Table 4.9: Heterotrait-monotrait (HTMT) ratio of correlations

	Content Specific Factors	Economic Factors	Repayment of Microcredit	Social Factors
Content Specific Factors				
Economic Factors	0.932			
Repayment of Microcredit	1.590	0.706		
Social Factors	0.907	1.062	1.024	

Source*:* Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

The paired relationship values (HTMT ratio of correlations) for latent variables in respect of the study indicates that, economic and content specific factors has HTMT value of 0.93, repayment of microcredit and content specific factors has HTMT value of 1.59, social and content specific factors has HTMT value of 0.91, repayment of microcredit and economic factors has HTMT value of 0.71, social and economic factors has HTMT value of 1.06, and lastly social and repayment of microcredit factors has HTMT value of 1.02 (see Figure 4.3).



Source: Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

Figure 4.3: Heterotrait-Monotrait Ratio (HTMT)

If the HTMT value is below 0.90, discriminant validity has been established between two reflective constructs. Figure 4.3 above indicates the 0.9 benchmark. The only paired association which indicates discriminant validity is the combinations of repayment of microcredit and economic factors. HTMT is a common approach to gain insights into discriminant validity and very useful only if you chose to compare traits that are not too far away from one another, otherwise the results become trivial. A more sophisticated approach would be the analysis of nomological networks not just by means of manifest correlations (like Pearson's r) but by latent structural equation models.

Average variance extracted (AVE): Convergent validity was carried out through factor loadings. The result of Table 4.10 highlighted the amount of variance explained by four factors (i.e., Content Specific Factors (CSF) = 38.4%, Economic Factors (EF) = 22.3%, Social Factors (SF) = 56.3% and Repayment of Microcredit Loans (RML) = 65.4%).

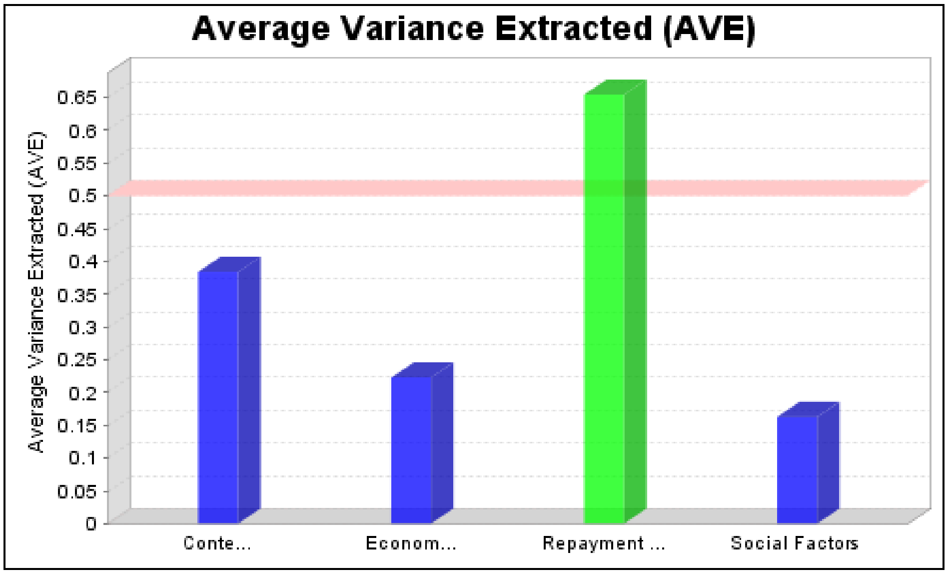
Table 4.10: Construct Validity and Reliability

	Content Specific Factors	Economic Factors	Social Factors	Repayment of Microcredit Loans
AVE	0.384	0.223	0.163	0.654
Cronbach's Alpha	-0.700	0.104	-0.062	0.492
rho_A	0.671	0.629	0.517	0.566
Composite Reliability	0.049	0.365	0.340	0.789

Note: AVE = Average Variance Expected

Source*:* Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

Values of Average Variance Extracted (AVE) shown above indicate the affiliation of the items to a factor. The Figure below indicates AVE loadings for economic, social, content-specific and repayment factors, highlighting the benchmark value of 0.5 and above for convergent validity.



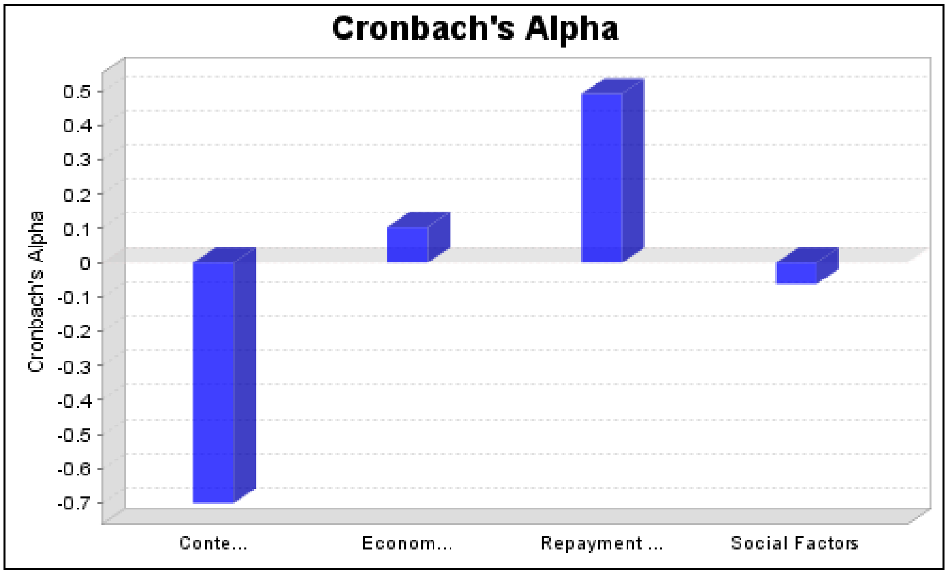
Source*:* Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

Figure 4.4: Average Variance Extracted (AVE)

Figure 4.4 indicates that only repayment of microcredit had the highest variance explained (0.654). This value surpasses the threshold value of 0.5 as highlighted by the Figure above. The amount of variance explained by content specific factor (0.384), economic factor (0.223) and social factor (0.163) does not meet the 0.5 value; indicating poor affiliation of the variables in those items.

(b) Reliability coefficient test

Cronbach's alpha: The reliability coefficient was tested using Cronbach's alpha (α) analysis. The construct reliability test for the four factors was analyzed varied from -0.700 to 0.492, indicating a mixed poor to medium reliability factors. The reliability Cronbach's alpha of the determinants of Repayment of Microcredit Loans (RML) was substantial because its Cronbach's Alpha value was 0.492 on Table 4.10. Constructs showing poor reliability are Content Specific Factors (CSF) with -0.700, Economic Factors (EF) with 0.104 and Social Factors (SF) with -0.062 respectively (see Figure 4.5).

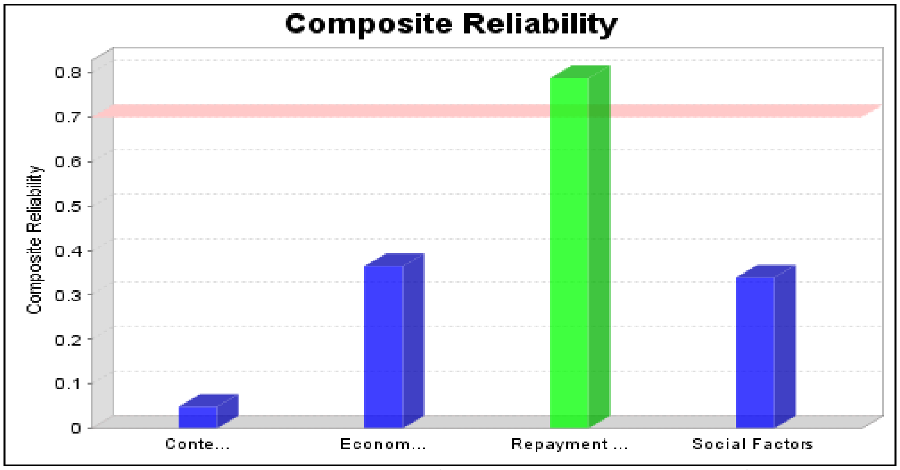


Source*:* Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

Figure 4.5: Cronbach's Alpha

Cronbach's alpha is a common measure of internal consistency of constructs. By common rule of thumb, 0.60 or higher is adequate reliability for exploratory purposes. Here Cronbach's alpha is below 0.60, a sign that the indicators for the "Predictors" construct and for the "Dependents" construct do not cohere well. This implies the constructs are multi-dimensional rather than unidimensional.

Composite reliability: Composite reliability is a somewhat more lenient convergent validity criterion often favored by PLS researchers. It uses the same cutoff point (0.7) as for Cronbach's Alpha. For this study, the reliability measure shows good reliability for the "Repayment of Microcredit" construct but poor reliability for "social, economic and content specific" constructs (Table 4.9). By common rule of thumb, 0.60 or higher is adequate reliability for exploratory purposes (see Figure 4.6).



Source: Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

Figure 4.6: Composite Reliability

(c) Factor loadings

To determine the minimum loading necessary to include an item in its respective constructs, Hair, Hult, Ringle and Sarstedt (2017) suggested that variables with loading greater than 0.30 are adequate. Not a single factor had been dropped out under this circumstance which means the factor analysis ran on an ultimate success.

The greater the loading of an item for a group, the stronger the affinity and affiliation of that item to the specific factor it belongs to. For this study, each of the three dimensions of microcredit repayment determinants (social, economic and content specific factors) and repayment factor were homogeneously loaded to the different factors. Each of the items that loaded into four different factors are significantly related to the study.

Measurement loadings are the standardized path weights connecting the factors to the indicator variables. As data are standardized automatically in SmartPLS, the loadings vary from 0 to 1 (see Table 4.11).

Table 4.11: Factor Loadings

	Content Specific Factors	Economic Factors	Social Factors	Repayment of Microcredit Loans
CSF1	0.474			
CSF2	0.691			
CSF3	0.903			
CSF4	0.698			
CSF5	0.625			
EF1		0.430		
EF2		0.566		
EF3		0.953		
EF4		0.424		
EF5		0.477		
EF6		0.808		
EF7		0.472		
EF8		0.636		
EF9		0.493		
SF1			0.330	
SF10			0.761	
SF11			0.553	
SF12			0.619	
SF2			0.361	
SF3			0.375	
SF4			0.422	
SF5			0.529	
SF6			0.505	
SF7			0.667	
SF8			0.328	
SF9			0.422	
PAY1				0.900
PAY2				0.706

Source*:* Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

The loadings should be significant. In general, the larger the loadings, the stronger and more reliable the measurement model. Indicator reliability may be interpreted as the square of the measurement loading: thus, $0.708^2 = 0.50$ reliability (Hair *et al.*, 2014). Outer model loadings appear in the graphical model (above). They may be considered a form of item reliability coefficients for reflective models: the closer the loadings are to 1.0, the more reliable that latent variable. By convention, for a well-fitting reflective model, path loadings should be above 0.70 (Henseler, Ringle and Sarstedt, 2012).

(d) Model fit measures

SRMR: The standardized root mean square residual (SRMR) based on transforming both the sample covariance matrix and the predicted covariance matrix into correlation matrices on Table 4.12, indicate a value of 0.0275 is the difference between the observed correlation and the model implied correlation matrix.

Table 4.12: Fit Measures

Fit Measures	Saturated Model	Estimated Model
SRMR	0.0275	0.0275
d _ULS	30.593	30.593
d_G	1,956.81	1,958.29
NFI	0.007	0.007
Chi^2	222.25	222.25
RMS_theta	0.352	0.000

Source*:* Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

Thus, it allows assessing the average magnitude of the discrepancies between observed and expected correlations as an absolute measure of (model) fit criterion. Our value is less than 0.10 which is considered as a good fit (Hu and Bentler, 1998). Henseler, Dijkstra, Sarstedt, Ringle, Diamantopoulos, Straub, Ketchen, Hair, Hult and Calantone (2014) introduced the SRMR as a goodness of fit measure for PLS-SEM that can be used to avoid model misspecification.

d_ULS and d_G: For the exact fit measures of d_ULS and d_G, inference statistics for an assessment was analyzed via bootstrap procedure as described in Dijkstra and Henseler (2015) and Yuan and Hayashi, (2003) to create confidence intervals for the d_ULS, d_G, and SRMR criteria. From our analysis, the difference between the correlation matrix implied by our model is significant, which indicates that model fit has not been established.

NFI: The normed fit index (NFI) by Bentler and Bonett (1980). It computes the Chi^2 value of the proposed model and compares it against a meaningful benchmark. The NFI value in Table 4.12 is 0.007 which is below 0.9 value for an acceptable fit.

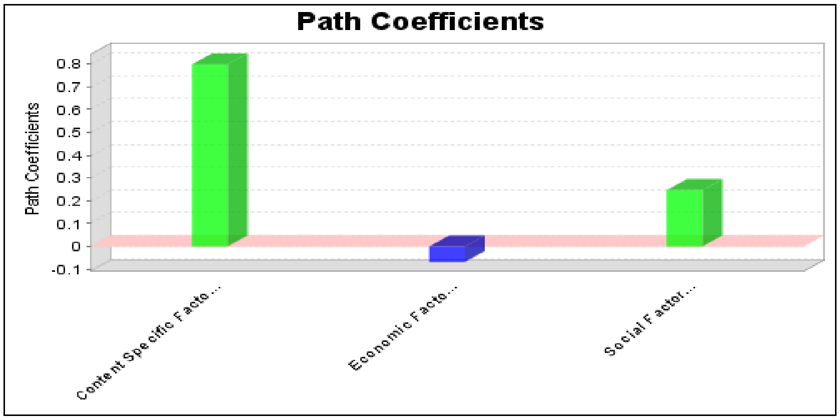
Chi^2: Assuming a multinormal distribution, the Chi^2 value of the PLS path model for this study is 222.25 which is significant. However, future research must clearly define how to determine the degrees of freedom of composite model, common factor models, and mixed models when using PLS.

RMS_theta: This is the root mean squared residual covariance matrix of the outer model residuals (Lohmöller, 1989). The RMS_theta value of 0.352 indicates a fitting model; values below 0.12 indicate well-fitting model (Henseler *et al.*, 2014).

(e) Path coefficients

A path coefficient is interpreted as follows: If the predictors change by one standard deviation the dependents changes by standard deviations (with b being the path coefficient). The path coefficient is interpreted like a standardized regression coefficient.

The sample mean in bootstrapping is the average coefficient over all bootstrapping runs. It indicates whether there exists some bias between original sample coefficient and sampling distribution. If the bias is large it is better to use bias-corrected confidence intervals for assessing the significance of the relationship. However path coefficient is the indicator for the relationship and effect size for the level of the effect. In PLS regression model there is only one path, from the construct for the predictors to that for the dependents. SmartPLS output is shown in the Figure 4.7.



Source: Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

Figure 4.7: Path Coefficients

Table 4.13 below shows the path coefficients effect. Association between the predictors and dependent variables in terms of effect and magnitude can be deduced from the Table.

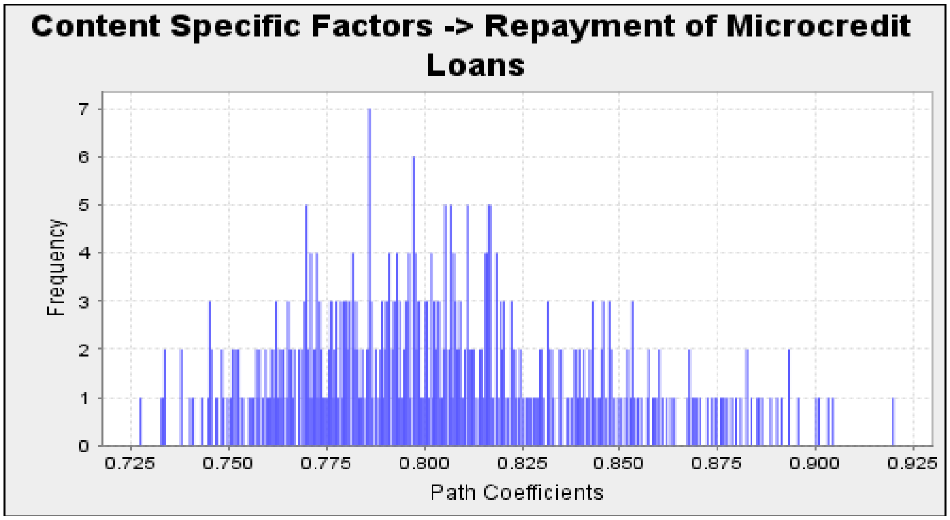
Table 4.13: Path Coefficients Effect

	Original Sample (O) [ESTIMATES]	Sample Mean (M)	Standard Deviation (STDEV) [SE]	t-Statistics (|O/STDEV|)	P Values
Content Specific Factors -> Repayment of Microcredit Loans	0.799	0.804	0.036	22.042	0.000**
Economic Factors -> Repayment of Microcredit Loans	-0.068	-0.066	0.032	2.091	0.037*
Social Factors -> Repayment of Microcredit Loans	0.247	0.244	0.031	7.945	0.000**

Note: * and ** indicate that the parameter is significant at 10% and 1%, respectively

Source: Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

Permutation test for content specific and repayment factors: In Table 4.13, the path from Content Specific Factors to Repayment of Microcredit Loans has a coefficient of positive 0.799. Permutation algorithm output process for Content Specific Factors to Repayment of Microcredit Loans is illustrated in histogram of the permutation sample results for any given path coefficient (see Figure 4.8).

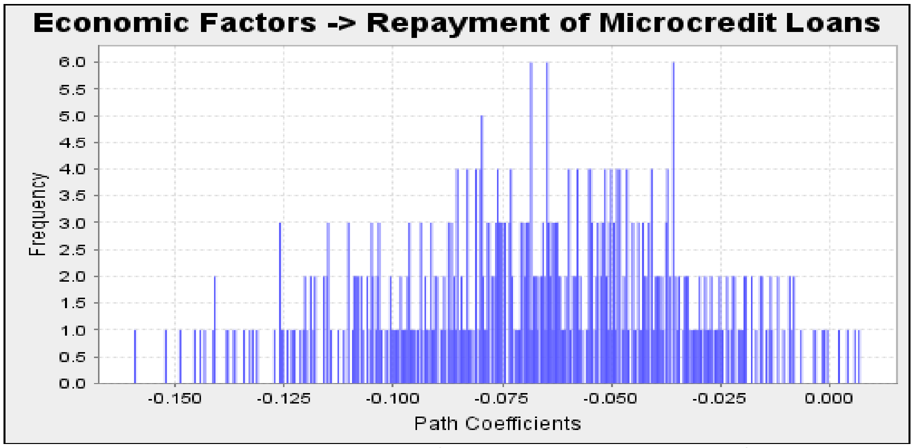


Source: Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

Figure 4.8: Permutation Algorithm for Content Specific Factors and Repayment

Permutation-based significance test results for the SmartPLS model comparing the Content Specific Factors to Repayment of Microcredit Loans are shown in Figure 4.8. The permutation test results confirm significant difference between Content Specific Factors and Repayment of Microcredit Loans for the structural (inner) model, as the "permutation p-value" in the far right column is above the 0.05 cutoff (see Table 4.13).

Permutation test for economic and repayment factors: The path from Economic Factors to Repayment of Microcredit Loans has a coefficient of negative 0.068 (see Table 4.13). The histogram permutation algorithm output process for Economic Factors to Repayment of Microcredit Loans is indicated below (see Figure 4.9).

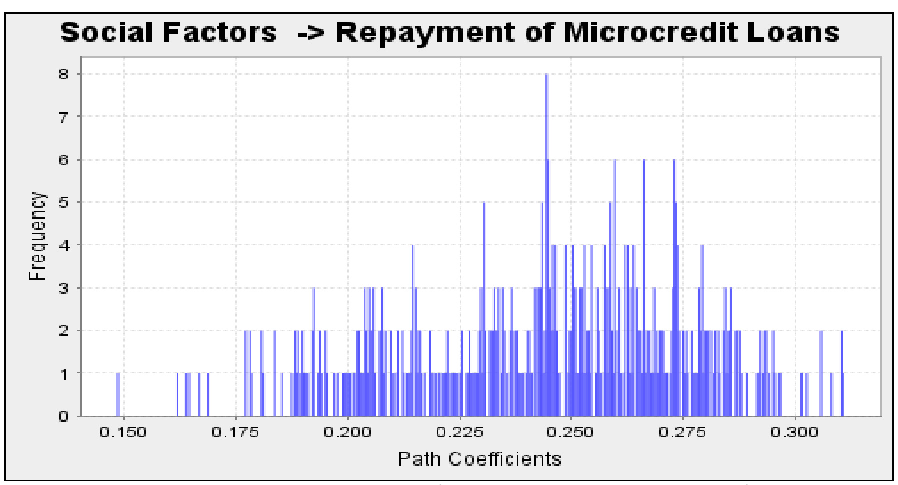


Source: Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

Figure 4.9: Permutation Algorithm for Economic Factors and Repayment

The permutation test results confirm insignificant difference between Economic Factors and Repayment of Microcredit Loans for the structural (inner) model, as the "permutation p-value" is below the 0.05 cutoff (see Table 4.13).

Permutation test for social and repayment factors: The path from Social Factors to Repayment of Microcredit Loans has a coefficient of positive 0.247 (see Table 4.13). Frequency of occurrence of the permutation algorithm output process for Social Factors to Repayment of Microcredit Loans is illustrated in histogram below (see Figure 4.8).



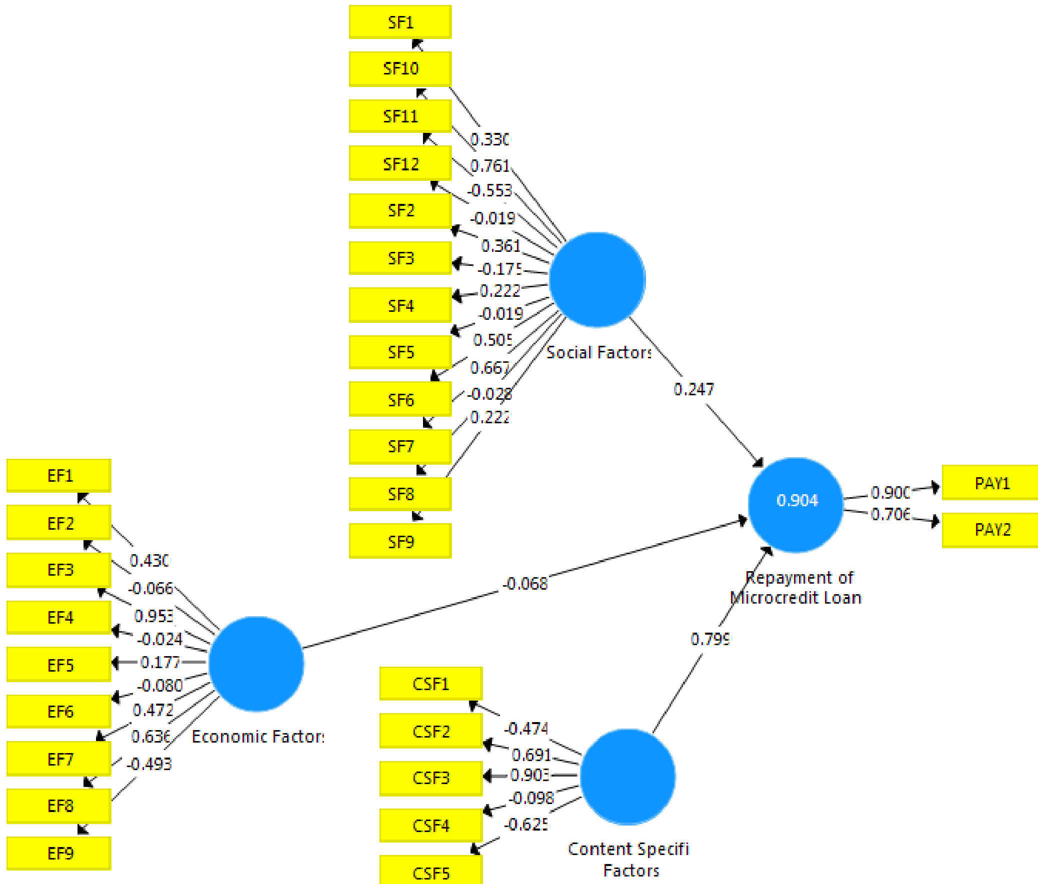
Source: Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

Figure 4.10: Permutation Algorithm for Social Factors and Repayment

The permutation test results confirm significant difference between Social Factors and Repayment of Microcredit Loans for the structural (inner) model, as the "permutation p-value" is above the 0.05 cutoff (see Table 4.13).

Path coefficients are always standardized path coefficients. Given standardization, path weights, therefore, vary from -1 to +1. Weights closest to absolute 1 reflect the strongest paths. Weights closest to 0 reflect the weakest paths. In Table 4.13, the path weight of 0.799 shows Content Specific Factors have a positive effect on Repayment of Microcredit Loans. Economic Factors, at -0.068, has a negative effect. Social Factors have a positive effect on Repayment of Microcredit Loans. Since standardized data are involved, it can also be said based on these path coefficients that the absolute magnitude of the Content Specific Factors effect on Repayment of Microcredit Loans is approximately three times that of Social Factors and eleven times that of Economic Factors.

The model view of the SmartPLS 3 software and the standardized path coefficients placed on the corresponding paths in the graphical model is shown in Figure 4.11. The R-square values are shown inside the ellipses for endogenous latent variable (Repayment of Microcredit Loan). This is the most common effect size measure in path models, carrying an interpretation similar to that in multiple regression. In this case, only Repayment of Microcredit Loan is an endogenous variable (one with incoming arrows). For the endogenous variable Repayment of Microcredit Loan, the R-square value is 0.904, meaning that about 90% of the variance in Repayment of Microcredit Loan is explained by the model (that is, jointly by Content Specific, Economic and Social Factors). Thus, the objective of variance analysis is explained with the high R^2 obtained in our result.



Source: Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

Figure 4.11: Path Coefficients

The regression results of the path analysis: The regression analysis results retained most of the model variable items relationships because of their significant values. However, ten variable item relationships were insignificant (i.e., CSF4,<--Content Specific Factors, EF2 <-- Economic Factors, EF4 <-- Economic Factors, EF5 <-- Economic Factors, EF6 <-- Economic Factors, SF1 <-- Social Factors, SF3 <-- Social Factors, SF4 <-- Social Factors, SF5 <-- Social Factors and SF8 <-- Social Factors) indicating that t-values are non-significant ($p > 0.05$). The R-squared value of the variables in the model is equal to 0.904. R-squared adjusted for the model is equal to

0.903. This indicates that 90% of the variation of microcredit repayment is explained by the variables included in the model as earlier mentioned (see Table 4.14).

Table 4.14: Regression Results

	Estimates	SE	t-Statistics	P Values
CSF1 <- Content Specific Factors	-0.474	0.044	10.678	0.000**
CSF2 <- Content Specific Factors	0.691	0.037	18.547	0.000**
CSF3 <- Content Specific Factors	0.903	0.011	83.632	0.000**
CSF4 <- Content Specific Factors	-0.098	0.082	1.197	0.232
CSF5 <- Content Specific Factors	-0.625	0.051	12.207	0.000**
EF1 <- Economic Factors	0.43	0.133	3.234	0.001*
EF2 <- Economic Factors	-0.066	0.1	0.666	0.506
EF3 <- Economic Factors	0.953	0.022	43.442	0.000**
EF4 <- Economic Factors	-0.024	0.14	0.169	0.866
EF5 <- Economic Factors	0.177	0.15	1.18	0.239
EF6 <- Economic Factors	-0.08	0.095	0.851	0.395
EF7 <- Economic Factors	0.472	0.133	3.552	0.000**
EF8 <- Economic Factors	0.636	0.073	8.724	0.000**
EF9 <- Economic Factors	-0.493	0.108	4.565	0.000**
SF1 <- Social Factors	0.33	0.158	2.088	0.037
SF10 <- Social Factors	0.761	0.065	11.686	0.000**
SF11 <- Social Factors	-0.553	0.084	6.596	0.000**
SF12 <- Social Factors	-0.019	0.193	0.097	0.922
SF2 <- Social Factors	0.361	0.133	2.707	0.007*
SF3 <- Social Factors	-0.175	0.179	0.977	0.329
SF4 <- Social Factors	0.222	0.113	1.958	0.051
SF5 <- Social Factors	-0.019	0.155	0.122	0.903
SF6 <- Social Factors	0.505	0.148	3.404	0.001*
SF7 <- Social Factors	0.667	0.06	11.087	0.000**
SF8 <- Social Factors	-0.028	0.155	0.179	0.858
SF9 <- Social Factors	0.222	0.084	2.651	0.008*
PAY1 <- Repayment of Microcredit Loans	0.9	0.017	53.568	0.000**
PAY2 <- Repayment of Microcredit Loans	0.706	0.055	12.867	0.000**
Parameters				
R^2	0.904			
R^2 Adjusted	0.903			
Chi^2	222,091.25			0.000**

Note: * and ** indicate that the parameter is significant at 5% and 1%, respectively

Source: Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

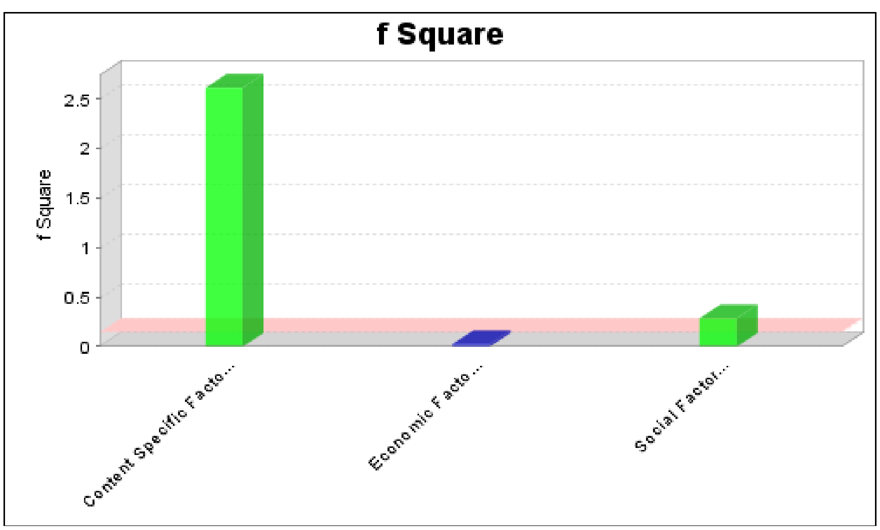
F square: The f^2 value measure the strength of each predictor variable in explaining endogenous variables. According to Henseler *et al.* (2009), f^2 values of 0.02, 0.15, and 0.35 for the significant independent variables represent weak, moderate and substantial effects, respectively. From Table 4.15, the predictors' f^2 values in predicting their strengths on Repayment of Microcredit Loans are shown.

Table 4.15: f Square

	Repayment of Microcredit Loans
Content Specific Factors	2.615
Economic Factors	0.027
Social Factors	0.288

Source*:* Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

From our results, the f^2 value (2.615) for Content Specific Factors indicates very high substantial effects on Repayment of Microcredit Loans. Economic Factors' f^2 values (0.027) imply a weak relationship effect with Repayment of Microcredit Loans. A moderate significant relationship in terms of f^2 value (0.288) is indicated by Social Factors and Repayment of Microcredit Loans. The histogram representation and weak cutoff point for the f^2 value is indicated in Figure 4.12.



Source*:* Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

Figure 4.12: f Square

Test of hypothesis: The SEM was examined to test the relationship among the constructs. For the whole model, the statistical result shows that Chi-square value of 222, 091.25, is significant at 1% (see Table 4.14). Standard estimation of the full model of the three paths indicates significance for both Content Specific Factors and Social Factors respectively (Figure 4.13). Economic Factors however, was not significant even at 5% but was at 10% which is a bit far off for this study (see Table 4.13).

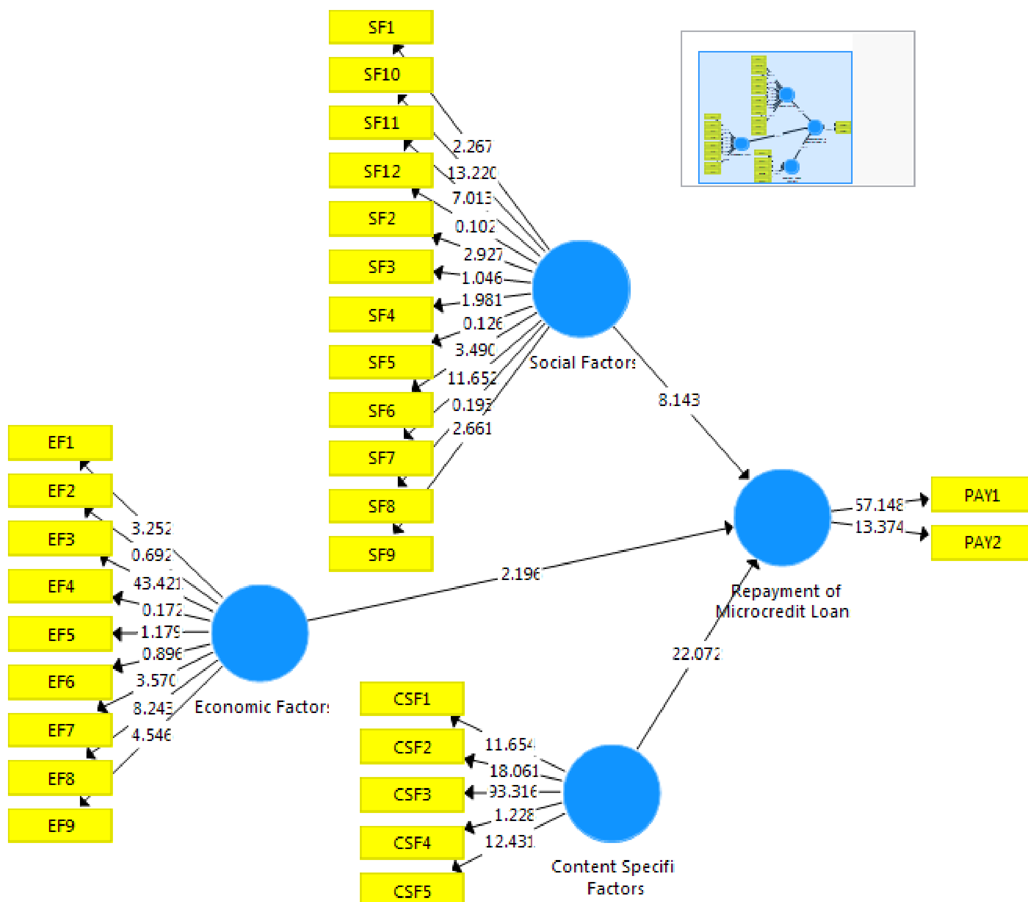


Figure 4.13: T Statistic Values

Source*:* Field Survey (2018) Computation from SmartPLS Version 3.2.7 for Windows

Content Specific Factors and Social Factors improve repayment of microcredit by catfish production enterprises in Benue State compared to Economic Factors which contributes little to repayment of borrowed loans. Thus, the null hypothesis was rejected and the alternative hypothesis accepted, which states that, *"determinants of microcredit repayment have significant effect on catfish production enterprises"*.

4.5 MICROCREDIT VARIABLES' EFFECT ON CATFISH OUTPUT

Multiple linear regression was used to estimate the coefficients of the linear equation, involving microcredit independent variables (i.e., microcredit access, utilization and repayment) that best predict the value of catfish output. Microcredit access, utilization and repayment variables' value of the coefficient (Beta) in the regression equation were significantly different from zero at 5%, 1% and 10% respectively. Table 4.16 shows that microcredit access (MACES) has more effect on catfish output in the study area with its 1.028 Beta coefficient estimate.

Table 4.16: Microcredit Effects on Catfish Output (n=300)

		Coef.	**Std. Err.**	**Z**	**p > | z |**
Output model					
Constant	β_0	1.008	0.473	2.13*	0.034
MACES	β_1	1.028	0.379	2.71**	0.007
UTILIZED	β_2	0.561	0.105	5.33***	0.000
REPAY	β_3	0.767	0.364	2.10*	0.036
F		10.45***			0.000
R^2		0.958			
Adjusted R^2		0.866			
Root MSE		0.25017			

Note: Dependent Variable: CATOUTPUT= Catfish output (kg), *, ** and *** indicate that the parameter is significant at 10%, 5% and 1% respectively

Source: Field Survey (2018) Computation from STATA Version 14.2 for Windows

This is followed by microcredit repayment (REPAY) with coefficient value of 0.767 while, microcredit utilization (UTILIZED) was last with an effect of 0.561 on catfish output in the study area. These three independent variables have positive signs as expected. The coefficients agreed with the *a priori* expectation, which states that, a unit increase in MACES, REPAY or UTILIZED leads to a corresponding increase in catfish output in the study area. The Multiple coefficient of determination (R^2) value is 0.960, which indicated that there is a very strong and significant relationship between the indicators. The results indicate that the calculated value of F-test at 1% level showed significant value of 10.45.

4.6 EFFICIENCY OF CATFISH PRODUCTION ENTERPRISES IN BENUE STATE

The study employed technical efficiency score of 300 catfish production enterprises in Benue State. Using Translog Normal Half-Normal and Translog Normal Exponential Stochastic Frontier Models (i.e., TNHNSFM and TNESFM), the study examined variations in efficiency among the enterprises. The inefficiency model, however did not show any significant values in respect of the six variable items for technical, allocative and profit efficiencies.

4.6.1 Technical efficiency

The results on Table 4.17 shows maximum likelihood stochastic frontier (translog function). The output determinants of catfish production enterprises in Benue State**,** which indicated that all the technical efficiency determinants, that is, fingerlings, standardized feeds, labour and pond size are in tandem with *a priori* expectations. Quantity of fingerlings (FING) used by catfish production enterprises in Benue State showed positive and significant values at 1%. A unit increase in FING leads to a corresponding increase in the quantity of catfish output by 0.522 units. This is in tandem with *a priori* expectations that a unit increase in fingerlings leads to a resultant output in catfish output. Studies such as Mohammed, Gluide, Shettima and Umoru (2014); Onoja and Achike (2011) and Ugwumba (2010) also reported the same significant and positive relationship between fingerlings and catfish output.

Table 4.17: Stochastic Production Frontier Translog Model and Inefficiency (n=300)

		Model 1				**Model 2**			
		Normal/Half-normal Model				**Normal/Exponential Model**			
		Coef.	Std. Err.	z	p > | z |	Coef.	Std. Err.	z	p > | z |
Frontier model									
Constant	β_0	1.370	0.223	6.15*	0.000	1.309	0.219	5.96*	0.000
FING (kg/m^2)	β_1	0.522	0.056	9.29*	0.000	0.532	0.057	9.39*	0.000
FEED (kg/m^2)	β_2	0.074	0.062	1.20	0.231	0.071	0.062	1.15	0.250
LABO (man days/m^2)	β_3	0.021	0.098	0.22	0.830	0.025	0.097	0.26	0.798
POSI (m^2)	β_4	0.288	0.048	5.94*	0.000	0.286	0.049	5.88*	0.000
Inefficiency model									
Constant	δ_0	-3.517	0.761	-4.62*	0.000	-5.113	1.255	-4.07*	0.000
INT (%)	δ_1	-0.001	0.309	-0.00	0.996	0.041	0.505	0.08	0.935
NMS (number)	δ_2	0.809	1.122	0.72	0.471	1.301	1.809	0.72	0.472
COLL (₦)	δ_3	0.636	1.018	0.62	0.532	0.894	1.435	0.62	0.535
GURA (number)	δ_4	0.186	0.440	0.42	0.673	0.309	0.673	0.46	0.646
DPAY (₦)	δ_5	0.004	0.380	0.01	0.991	0.002	0.597	0.00	0.997
SENT (dummy)	δ_6	-0.495	0.502	-0.99	0.324	-0.854	0.944	-0.91	0.365
Variance parameters									
Sigma-squared	σ^2	0.165	0.021	7.850*		0.178	0.019	7.016*	
Gamma	γ	0.746	0.263	9.495*		0.745	0.262	2.018*	
Log Likelihood	LLF	193.09				185.370			
LR test of the one sided error	LR	50.737*				50.561*			

Note: * indicate that the parameter is significant at 1%
Source*:* Field Survey (2018) Computation from STATA Version 14.2 for Windows

The variable, POSI (pond size) is positive and significant at a value of 1%. The coefficient (or parameter estimate) for the variable POSI is 0.288. This means that for a one-unit increase in POSI, we expect a 0.288 increase in catfish yield. This is in tandem with *a priori* expectations that a unit increase in pond size leads to a resultant output in catfish output. This result corroborates the study of Itam, Etuk and Ukpong, (2014) which also recorded positive significant values for pond size.

Elasticity of production and return to scale: Estimated coefficient for the specified stochastic frontier indicates the elasticities of the independent variables. The Return to Scale (RTS) from the Frontier model and the inefficiency model indicates a value of

0.905 obtained from the catfish production enterprise. This was largely influenced by inefficiency effects. The RTS shows that the catfish production enterprises were producing at stage 2 of the production function also referred to as the decreasing returns to scale stage or rational stage. This shows that fingerlings, standard feeds, labor and pond size are operating in stage 2, i.e., they are increasing at a decreasing rate and are operating in the rational stage of production. This study's result is in tandem with the findings of Ogundari, Ojo and Brummer (2005) in a study of aquaculture in Oyo State with RTS of 0.841. This current study's RTS (0.9797) is also in accordance with the RTS (0.664) of Emokaro and Ekunwe (2009).

Parameter estimates: The Maximum Likelihood estimate (MLS) results showing parameters of translog stochastic production frontier model of catfish production enterprises is represented in Table 4.19. Sigma squared (σ^2) and gamma (γ) represent the variance parameters of the stochastic frontier. The variance parameter known as sigma squared (σ^2) indicate that 17% of the variation in catfish yield among the production enterprises was attributed to differences in technical efficiencies of catfish production enterprises. To investigate the presence of technical inefficiency on the relationship between business environment and catfish production, the study discussed the estimated gamma (γ) (see Table 4.17). The variance parameter, gamma (γ), is statistically significant and greater than zero, which suggests the relevance of technical inefficiency in explaining output variability among catfish production enterprises. Estimated coefficients help to understand the determinants of sample catfish production enterprises' technical inefficiency.

From the analysis, the study obtained 0.746 of γ, which was found to be significant at 1% and indicates the amount of variation in output resulting from the technical inefficiencies of the enterprises. This shows that inefficiency effects are significant amongst the catfish production enterprises. Hence, this means that 75% of the variation in the output of catfish production enterprises was due to technical inefficiency. This is expected for catfish production enterprises where inefficiency data noise is unavoidable.

Elasticity of production and return to scale: Estimated coefficient for the specified stochastic frontier indicates the elasticities of the independent variables. The Return to Scale (RTS) from the Frontier model and the inefficiency model indicates a value of 0.905 obtained from the catfish production enterprise. This was largely influenced by inefficiency effects. The RTS shows that the catfish production enterprises were producing at stage 2 of the production function also referred to as the decreasing returns to scale stage or rational stage. This shows that fingerlings, standard feeds, labor and pond size are operating in stage 2, i.e., they are increasing at a decreasing rate and are operating in the rational stage of production. This study's result is in tandem with the findings of Ogundari, Ojo and Brummer (2005) in a study of aquaculture in Oyo State with RTS of 0.841. This current study's RTS (0.9797) is also in accordance with the RTS (0.664) of Emokaro and Ekunwe (2009).

Technical efficiency estimates: The specific technical efficiencies range for the catfish production enterprises was between 0.06 and 0.60 with a mean of 0.37. Most of the catfish production enterprises had efficiency between 30% and 40% while few had efficiency greater than 10% and an impressive number had technical efficiency of 40% and above. To confirm this observation further, the technical efficiency estimated for catfish production enterprises in Benue State was examined (see Table 4.18). Nonetheless, this finding's technical efficiency is lower than that obtained in Ojo, Fagbenro and Fapohunda (2006) with an average Technical Efficiency of 0.83

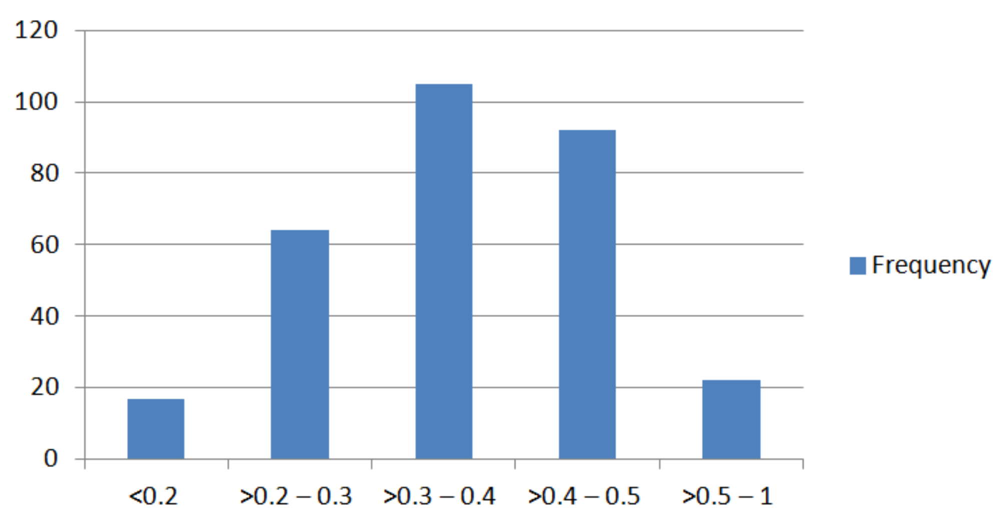
and Kareem, Dipeolu, Aromolaran and Akegbejo (2008) with an average Technical Efficiency of 0.88.

Table 4.18: Technical Efficiency Distribution among Catfish Enterprises

Efficiency range	**Frequency**	**Percentage**
<0.2	17	05.66
>0.2 – 0.3	64	21.34
>0.3 – 0.4	105	35.00
>0.4 – 0.5	92	30.66
>0.5 – 1	22	07.34
Total	300	100.00
Mean	0.37	
Minimum	0.06	
maximum	0.60	

Source: Field Survey (2018) Computation from STATA Version 14.2 for Windows

Technical efficiency distribution scores among catfish enterprises were simplified using a diagram. However, Figure 4.14 depicts a graphical representation of the technical efficiency estimates for catfish production in the study area.



Source: Field Survey (2018) Computation from Microsoft Excel, 2007 Version

Figure 4.14: Technical Efficiency Estimates

Features of the most technical efficient catfish production enterprise: The most technical efficient catfish production enterprise for this study had a Technical

Efficiency of 0.604 which indicates that only 40% of the catfish output is forgone due to inefficiency from environmental influence in the production process. The catfish enterprise had access to ₦35, 000 of borrowed microcredit from only owner's equity fund at an interest rate of zero percent.

The output yield of 543kg was actualized from 1.2kg of catfish fingerlings. The enterprise used 45kg of standard feed and 120 man-days of labour in the production process. The enterprise utilized ₦30, 450 while ₦4, 550 was diverted; however, the entire borrowed microcredit of ₦35, 000 was repaid.

Test of hypothesis: The null hypothesis tested implies that technical inefficiency effects from catfish production enterprises in Benue Stat are absent. Therefore, H_0: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$ (also, H_0: $\gamma < 0$); when this restriction was imposed on the Frontier model, the value of the Logarithm of the Likelihood Function (LLF) reduced to 193.09. This provides Likelihood Ratio (LLR) test statistic of 50.737 (see Table 4.19), which is larger than the critical value of 12.483. Thus, we reject the null hypothesis and accept the alternative hypothesis which states that, *"inefficiency effects are present among catfish production enterprises in Benue"*.

4.6.2 Allocative efficiency

The estimated stochastic cost frontier model is represented in Table 4.19 below with sigma squared (σ^2) value (0.175) statistically significant (7.016) which explains the correctness of the specified distribution of assumption of the composite error term. Meanwhile, gamma (γ) value (0.731) represents the amount of variation in the total cost of production resulting from the allocative efficiencies of the enterprises. This implies that 73% of the variation in the total cost of production for catfish enterprises was due to allocative efficiency. However, the parameters of σ^2 and γ were significantly different from zero at 1%. This indicates a good fit and correctness of the distribution form assumed for the composite error term. The positive signs of the variable inputs go against the *a priori* expectations that a unit increase in the cost of the independent variables leads to a resultant decrease in the cost of catfish production.

Table 4.19: Stochastic Cost Frontier Translog Model and Inefficiency (n=300)

		Model 1 Normal/Half-normal Model				**Model 2 Normal/Exponential Model**			
		Coef.	Std. Err.	z	p > | z |	Coef.	Std. Err.	z	p > | z |
Frontier model									
Constant	β_0	1.469	0.427	3.44**	0.001	1.395	0.427	3.27**	0.001
VFING (kg/m^2)	β_1	0.540	0.057	9.52***	0.000	0.547	0.058	9.46***	0.000
VFEED (kg/m^2)	β_2	0.050	0.063	0.80	0.423	0.047	0.063	0.75	0.454
VLABO (man days/m^2)	β_3	0.017	0.099	0.17	0.864	0.021	0.098	0.21	0.830
VPOSI (m^2)	β_4	0.262	0.050	5.26***	0.000	0.261	0.050	5.18***	0.000
Inefficiency model									
Constant	δ_0	-3.926	1.168	-3.36**	0.001	-5.693	2.196	-2.59*	0.010
INT (%)	δ_1	0.030	0.367	0.08	0.936	0.126	0.646	0.20	0.845
NMS (number)	δ_2	0.983	1.367	0.72	0.472	1.624	2.490	0.65	0.514
COLL (₦)	δ_3	0.687	1.110	0.62	0.536	0.952	1.535	0.62	0.535
GURA (number)	δ_4	0.224	0.511	0.44	0.661	0.381	0.848	0.45	0.653
DPAY (₦)	δ_5	0.064	0.439	0.15	0.884	0.065	0.701	0.09	0.926
SENT (dummy)	δ_6	-0.451	0.652	-0.69	0.49	-0.833	1.292	-0.64	0.519
Variance parameters									
Sigma-squared	σ^2	0.175	0.025	7.016***		0.186	0.023	8.149**	
Gamma	γ	0.731	0.362	2.02***		0.731	0.405	1.802**	
Log Likelihood	LLF	181.570				164.690			
LR test of the one sided error	LR	50.196***				50.192***			

Note: *, ** and *** indicate that the parameter is significant at 10%, 5% and 1% respectfully

Source*:* Field Survey (2018) Computation from STATA Version 14.2 for Windows

The coefficient estimates of the monetary value of fingerlings (VFING) and pond size (VPOSI) were positive and statistically significant at 1% level of probability. Price value of VFING was found to be positive and significant at 1%. This suggests that a unit increase in the amount spent on VFING will result in a corresponding increase of 0.540 cost of catfish produced in the study area.

VPOSI was found to be positive and significant at 1% level also. The positive sign indicates that an increase in the price value of VPOSI will lead to cost rise of 0.262 in catfish production. This is not in accordance with the *a priori* expectations that a unit increase in the costs of VFING and VPOSI, independently, leads to a resultant decrease in the cost of catfish production.

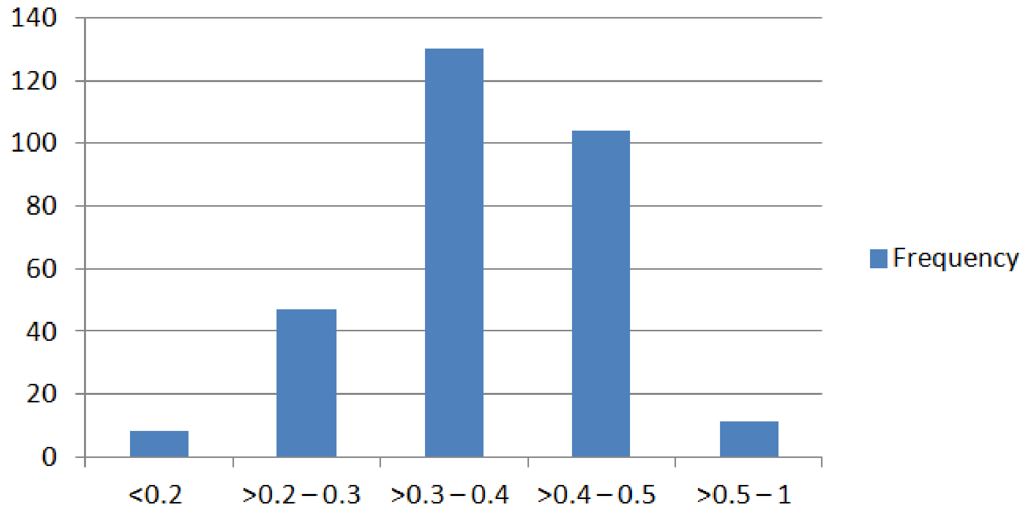
Frequency distribution of economic efficiency scores of catfish farmer: From the study, about 96.34% of the catfish enterprises had allocative efficiency scores between the range of up to 0.5, while 3.66% of the catfish enterprises were able to achieve allocative efficiency scores of above 0.50. The best catfish enterprise demonstrated an allocative efficiency of 0.75 while the worst catfish enterprise had an allocative efficiency of 0.02 (see Table 4.22).

Table 4.20: Allocative Efficiency Distribution among Catfish Farms

Efficiency range	Frequency	Percentage
<0.2	8	02.67
>0.2 – 0.3	47	15.67
>0.3 – 0.4	130	43.33
>0.4 – 0.5	104	34.67
>0.5 – 1	11	03.66
Total	300	100.00
Mean	0.39	
Minimum	0.02	
Maximum	0.75	

Source*:* Field Survey (2018) Computation from STATA Version 14.2 for Windows

The mean allocative efficiency of the respondents was 0.39. However, cost efficiency of catfish enterprises can be improved by about 61% through available resources. Our result is far off compared to Mmereole (2016) with mean efficiency score of 65% but greater than that of Kaliba and Engle (2004) with a mean cost efficiency score of 33%. Increase in the cost of inputs forced catfish enterprises to supplement resources with less efficient inputs. Catfish enterprises supplemented their feeds with fillers such as rice, offals, brewery wastes, cassava-by-products, which reduced the cost efficiency in the production process. However, Figure 4.15 depicts a graphical representation of the allocative efficiency estimates for catfish production in the study area.



Source: Field Survey (2018) Computation from Microsoft Excel, 2007 Version

Figure 4.15: Allocative Efficiency Estimates

Test of hypothesis: The null hypothesis tested implies that inefficiency effects from catfish production enterprises in Benue Stat are absent. Therefore, H_0: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$ (also, H_0: $\gamma < 0$); when this restriction was imposed on the Frontier model, the value of the Logarithm of the Likelihood Function (LLF) reduced to 181.50 (see Table 4.21). This provides Likelihood Ratio (LLR) test statistic of 50.196, which is larger than the critical value of 12.483. Thus, we reject the null hypothesis and accept the alternative hypothesis which states that, "*inefficiency effects are present among catfish production enterprises in Benue*".

4.6.3 Profit efficiency

Parameters from the maximum likelihood estimates (MLE) of the stochastic profit frontier model are represented in Table 4.21. The normal/exponential model indicates that the estimated sigma squared (σ2) was 0.197 and statistically significant at 1 percent probability level and also significantly different from zero, which indicates correctness and good fit of the specified distributional assumption of the composite error term.

Table 4.21: Stochastic Profit Frontier Translog model and Inefficiency (n=300)

		Model 1 Normal/Half-normal Model				**Model 2 Normal/Exponential Model**			
		Coef.	Std. Err.	z	p > | z |	Coef.	Std. Err.	z	p > | z |
Frontier model									
Constant	β_0	4.603	0.000106	44000.00	0.000	1.121	0.633	1.77	0.076
VFING (kg/m^2)	β_1	0.305	0.00000687	44000.00*	0.000	0.698	0.087	8.05*	0.000
VFEED (kg/m^2)	β_2	-0.0631	0.0000136	-4647.040*	0.000	-0.142	0.099	-1.44	0.151
VLABO (man days/m^2)	β_3	-0.542	0.0000319	17000.00*	0.000	-0.163	0.152	-1.08	0.282
VPOSI (m^2)	β_4	4.603	0.000106	54000.00*	0.000	0.473	0.073	6.45*	0.000
Inefficiency model									
Constant	δ_0	-0.750	0.304	-2.46	0.014	-2.598	0.506	-5.13*	0.000
INT (%)	δ_1	-0.0450	0.192	-0.23	0.815	-0.152	0.299	-0.51	0.611
NMS (number)	δ_2	1.113	0.675	1.65	0.099	1.821	1.066	1.71	0.088
COLL (₦)	δ_3	0.666	0.754	0.88	0.377	1.230	1.116	1.10	0.270
GURA (number)	δ_4	-0.0770	0.277	-0.28	0.781	-0.172	0.443	-0.39	0.697
DPAY (₦)	δ_5	0.027	0.234	0.12	0.908	0.161	0.367	0.44	0.661
SENT (dummy)	δ_6	-0.422	0.235	-1.80	0.072	-0.608	0.384	-1.58	0.114
Variance parameters									
Sigma-squared	σ^2	9.22×10^{-9}	6×10^{-6}	1.53×10^{-3}		0.197	0.0186	10.587*	
Gamma	γ	1.000	1.8×10^{13}	5.56×10^{-14}		0.443	0.0762	5.813*	
Log Likelihood	LLF	3×10^{9}				139.020			
LR test of the one sided error	LR	-165.180*				-135.240*			

Note: * indicate that the parameter is significant at 1%

Source: Field Survey (2018) Computation from STATA Version 14.2 for Windows

Estimated gamma parameter (γ) of 0.076 was significant at 1 percent probability level; which implies that 7.6 percent variation in actual profit from maximum profit (profit frontier) between catfish enterprises was brought about by differences in catfish enterprises' practices rather than random variability. Thus, since gamma (γ) is greater than zero, inefficiency effects exist.

Monetary value (cost) of fingerlings (VFING) used by catfish production enterprises in Benue State showed positive and significant values at 1%. A unit increase in price of VFING leads to a corresponding coefficient increase in the normalized profit of catfish output by 0.698 units. This is not in tandem with *a priori* expectations that a unit cost decrease in fingerlings leads to an increase profit in catfish output.

Price value of standard feeds (VFEED) showed negative and significant values at 1%. More so, for every one unit increase in cost of VFEED, leads to a coefficient increase in the normalized profit of catfish by 0.142 units. This is in tandem with *a priori* expectations that a unit decrease in cost of standard feed leads to an increase in profit of catfish output.

Price value of labour (VLABO) variable showed negative and significant values at 1%. For every one unit decrease in cost of VLABO, we expect a 0.163 increase in catfish profit. This agrees with *a priori* expectations that increase in cost of labour leads to an increase in catfish profit. This study is opposed to the positive values for labour obtained from studies such as Oladimeji, Abdulsalam, Mani, Ajao and Galadima (2017) and Adeogun, Alimi and Adeyemo (2014).

Price value of VPOSI (pond size) is positive and significant at a value of 1%. The cost coefficient for the variable VPOSI is 0.473. This means that for a unit increase in cost of VPOSI, we expect a 0.473 increase in catfish profit. This is not tandem with *a priori* expectations that a unit decrease in cost of pond size leads to an increase in catfish profit.

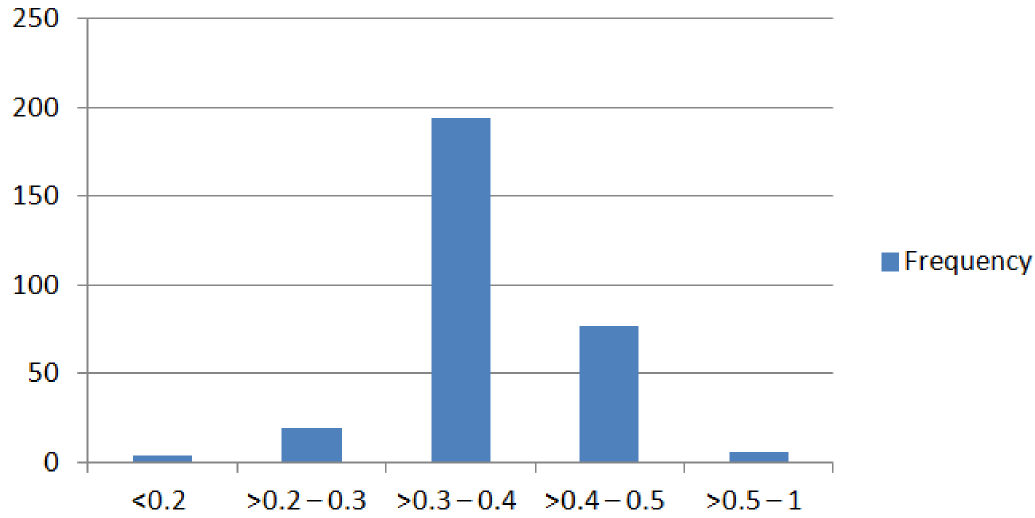
Frequency distribution of economic efficiency scores of catfish enterprise: From the study, about 72.42% of the catfish enterprises had profit efficiency scores of up to 0.4 while 27.58% of the catfish enterprises were able to achieve profit efficiency scores of above 0.40 (see Table 4.22).

Table 4.22: Profit Efficiency Distribution among Catfish Farms

Efficiency range	Frequency	Percentage
<0.2	4	1.33
>0.2 – 0.3	19	6.31
>0.3 – 0.4	194	64.78
>0.4 – 0.5	77	25.59
>0.5 – 1	6	1.99
Total	300	100.00
Mean	**0.34**	
Minimum	**0.14**	
maximum	**0.648**	

Source*:* Field Survey (2018) Computation from STATA Version 14.2 for Windows

The best catfish enterprise demonstrated a profit efficiency of 0.65 while the worst catfish enterprise had a profit efficiency of 0.14. The mean profit efficiency of the respondents was 0.34. However, profit efficiency of catfish enterprises can be improved by about 66% through available resources. Our result is far off compared to Sadiq, Singh, Suleiman, Isah, Umar, Maude, Lawal and Sallami (2015) with mean profit efficiency score of 69%, while Mmereole (2016) reported mean profit efficiency score of 57%. Figure 4.16 depicts a graphical representation of the profit efficiency estimates for catfish production in the study area.



Source*:* Field Survey (2018) Computation from Microsoft Excel, 2007 Version

Figure 4.16: Profit Efficiency Estimates

Test of hypothesis: The null hypothesis tested implies that inefficiency effects from catfish production enterprises in Benue State are absent. Therefore, H_0: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$ (also, H_0: $\gamma < 0$); when this restriction was imposed on the Frontier model, the value of the Logarithm of the Likelihood Function (LLF) reduced to 139.00 (see Table 4.23). This provides Likelihood Ratio (LLR) test statistic of 135.24, which is larger than the critical value of 12.483. Thus, we reject the null hypothesis and accept the alternative hypothesis which states that, "*inefficiency effects are present among catfish production enterprises in Benue*".

4.7 DIFFERENCE IN MICROCREDIT ACCESS, UTILIZATION AND REPAYMENT

Table 4.23 indicates ANOVA results for microcredit activity. We tested difference in microcredit activities such as microcredit access, microcredit utilization and microcredit repayment on three separate platforms of production, revenue generation and profit generation by catfish production enterprises.

Table 4.23: ANOVA Results of Microcredit Activities

Sources of Variation	SS	df	MS	F	P value
Difference of microcredit activities in Production					
Between groups	1.961	3	0.654	10.45**	0.000
Within groups	18.526	296	0.063		
Total	20.488	299	0.069		
Difference of microcredit activities in revenue generation					
Between groups	1.739	3	0.580	9.18**	0.000
Within groups	18.695	296	0.063		
Total	20.424	299	0.068		
Difference of microcredit activities in profit generation					
Between groups	3.241	3	1.080	4.11*	0.007
Within groups	77.889	296	0.263		
Total	81.13	299	0.271		

Note: * and ** indicate that the parameter is significant at 5% and 1% respectively

Source*:* Field Survey (2018) Computation from STATA Version 14.2 for Windows

Microcredit activities for production exhibited significant differences at 1 percent level. The significant F value of 10.45 tells us that at least one microcredit activity effect on production differs from zero, i.e. the means of microcredit access, utilization and repayment are not all equal when it comes to catfish production.

In the second case, microcredit activities for revenue generation exhibited significant differences at 1 percent level. The significant F value of 9.18 tells us that at least one microcredit activity effect on revenue generation differs from zero, i.e. the means of microcredit access, utilization and repayment are not all equal when it comes to catfish revenue generation.

For profit generation, microcredit access, utilization and profit exhibited significant differences at 5 percent level. The significant F value of 4.11 tells us that at least one of microcredit access, utilization and repayment effect on revenue generation differs from zero, i.e. the means of microcredit access, utilization and repayment are not all equal when it comes to catfish profit generation.

The significant F values tell us that at least one microcredit activity effect differs from zero, i.e., the means are not all equal. However, it does not tell us where the differences are. Bonferroni and Sidak multiple comparison tests can help to identify these differences. These tests examine the differences between each pair of means.

Multiple comparison tests: The difference between the means of microcredit access, utilization and repayment are reported on Table 4.24. With all three corrections, this difference is quite significant at the 0.01 level for both Bonferroni and Sidak multiple comparison tests. Basically, the adjustments all agree that there is difference between the means of microcredit access, utilization and repayment.

Table 4.24: Comparison of Scores by Microcredit Activities

Bonferroni Multiple Comparison Tests			
	Access	***Utilization***	***Repayment***
Access	1		
Utilization	0.5246* (0.000)	1	
Repayment	0.9262* (0.000)	0.4752 (0.000)*	1
Sidak Multiple Comparison Tests			
	Access	***Utilization***	***Repayment***
Access	1		
Utilization	0.5246* (0.000)	1	
Repayment	0.9262* (0.000)	0.4752* (0.000)	1

Note: *, indicate that the parameter is significant at 1%

Source*:* Field Survey (2018) Computation from STATA Version 14.2 for Windows

There are significant differences between microcredit access and microcredit utilization, microcredit access and microcredit repayment and microcredit repayment and microcredit utilization. The difference between the three groups does not fall short of being statistically significant.

4.8 CONSTRAINTS OF CATFISH ENTERPRISES IN THE STUDY AREA

Catfish enterprises in the study area encountered some problems which hindered them from accessing microcredit that would have been used for catfish production. These challenges include absence of banks in the locality, high interest rate, bureaucratic bottlenecks, late approval, lack of guarantor, amount given is too small, lack of collateral, negotiating your produce before production, sentiments due to social relations, delay in approval of loan, delay in payment and lack of awareness (see Table 4.25).

Table 4.25: Microcredit Challenges Affecting Catfish Production Enterprises

Challenges	Mean Score	Interpretation	Rank
Absence of microcredit sources in the locality	3.60	high	1st
High interest rate	3.50	high	2nd
Bureaucratic bottlenecks	3.43	high	3rd
Late approval	3.40	high	4th
Lack of Guarantor	3.21	high	5th
Amount given is too small	3.20	high	6th
Lack of Collateral	3.16	high	7th
Negotiating your produce before production	3.01	high	8th
Sentiments due to social relations	2.89	high	9th
Delay in approval of loan	2.75	high	10th
Delay in payment	2.60	high	11th
Lack of awareness	2.58	high	12th

Source: Field Survey, 2018
Note: Mean score is benchmarked at 2.00

Absence of microcredit sources in the locality had the highest mean score of 3.60. This was followed by high interest rate (3.50), bureaucratic bottlenecks (3.43), late approval (3.40), guarantor (3.21), amount given is too small (3.20), collateral (3.16), negotiating your produce before production (3.01), sentiments (2.89), delay in approval of loan (2.75), delay in payment (2.60) and lack of awareness (2.58).

In terms of lack of awareness, a similar report brought about by poor access to information was given by Ugbajah and Ugwumba (2013) to have constrained farmers; in addition, the mean score of 3.00 recorded by that study is greater than the 2.58 recorded by this study. Sentiments arising from emotions towards family responsibilities are among the major causes of default in utilization and repayment of loans by farmers; this corroborates Igwilo (2012). However, the mean score of 2.89 recorded by sentiments variable in this study is close to the score recorded by Ugbajah and Ugwumba (2013). Note that, the mean score is benchmarked at 2.50 for a variable to qualify as a constraint for this study.

Applying STATA, the Principal Component Analysis (PCA) was carried out to explore the underlying constraints (12 items) influencing catfish production enterprises in the study area. Bartlett's Test of Sphericity and the Kaiser–Mayer–Olkin (KMO) measure of sampling adequacy analyzing the strength of association among variables items. The KMO measure of sampling adequacy was first computed to determine the suitability of using factor analysis. It helped to predict whether constraint data are suitable to perform factor analysis. KMO was used to assess which variables to drop from the model due to multicollinearity problem. The value of KMO varies from 0 to 1, and KMO overall should be 0.60 or higher to perform factor analysis. If this is not achieved, then it is necessary to drop the variable(s) with lowest anti image value until KMO overall rises above 0.60. Result of the Bartlett's test of sphericity and the KMO revealed that the 12 variable items of catfish production constraints were highly significant and eventually concluded that these constraints were suitable for the factor analysis (seeTable 4.26).

Table 4.26: Component Factor Analysis

Challenges	**Factor**
Absence of microcredit sources in the locality	0.628
High interest rate	0.773
Bureaucratic bottlenecks	0.635
Late approval	0.828
Lack of Guarantor	0.602
Amount given is too small	0.751
Lack of Collateral	0.670
Negotiating your produce before production	0.653
Sentiments due to social relations	0.845
Delay in approval of loan	0.845
Delay in payment	0.843
Lack of awareness	0.678

Notes: KMO measure of sampling adequacy = 0.625; total variance explained = 67.12 per cent, Barlett's Test of Sphericity (BTS) = 668.914, Eigen value = 4.727

Source*:* Field Survey (2018) Computation from STATA Version 14.2 for Windows

CHAPTER 5

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The broad objective of this study was to examine the effects of microcredit access, utilization and repayment on catfish production enterprises in Benue State, Nigeria. The study area is Benue State of Nigeria. The population of catfish production enterprises in Benue State consists of various production systems. These production systems are as follows: concrete, earthen, tarpaulin and fiber or plastic systems of catfish production. Multistage sampling technique was used in selecting respondents for the study. Thus, a total sample size of 300 catfish production enterprises was selected for this study. The instrument for data collection and analysis was structured research questionnaire. The study used descriptive statistics to examine and analyze objectives one, two, three and eight, respectively. Objectives four to seven utilized inferential statistics. The statistical techniques adopted were: frequency distributions, means and percentages to examine variables, multiple regression, logit regression, SEM, stochastic frontier, analysis of variance (ANOVA), and likert scale. The analytical tools used were STATA, Version 14 for Windows and SmartPlS, Version 3 for Windows.

The mean microcredit access (MACES) for the study area was ₦130, 630.60 which is less than the average credit of ₦170, 173.40 accessed by catfish production enterprises in a study by Mgbedu and Achike (2017); however, Edet, Atairet, Nkeme and Udoh (2014) had a higher average of accessed credit of ₦1, 838, 709 in Akwa Ibom State. The average amount of microcredit, catfish production enterprises intended to borrow (AMIB) was ₦236, 882.90. The mean default rate in the repayment of microcredit loans (DEBT) stood at ₦7, 115.709, which corroborates the stand of the Ministry of Agriculture, Makurdi (2018) that fish production enterprises repay borrowed credit more often than crop production enterprises, because they are less susceptible to environmental forces compared to crop.

The study revealed that a total of ₦ 39,189,185 of microcredit was accessed by catfish production enterprises. This far outweighs the ₦ 7,355,036 by Edet *et al.* (2014) as accessed credit by fish traders. Microcredit obtained from owner's equity funding (OEF) was highest with a mean value of ₦ 86,326.62. The second highest microcredit lender was cooperatives (COS) with a mean value of ₦ 19,140. Thirdly, family and friends (FAF) contributed an average of ₦ 10,413. The fourth ranking microcredit lender was from formal financial institutions (FORMAL) such as Bank of Industry (BOI), Bank of Agriculture (BOA), microfinance and community banks with a mean value of ₦ 8,416.67. The fifth ranking microcredit lender was private money lenders (PRIV) with a mean value of ₦ 6, 335.33.

The study disclosed that of the total sum of ₦ 39,189,185 accessed microcredit (MACES) by catfish production enterprises; a huge sum of ₦ 28,582,422 was utilized in catfish production business. Microcredit was used in the purchase of inputs such as standard feeds, fingerlings, labour, etc. However, the utilization index for accessed microcredit was 0.73; this translates into 73% of utilized microcredit in the study area.

In the case of microcredit repayment, a vast sum of ₦ 37,054,472 was repaid by catfish production enterprises. This implies that 94% of the total sum of ₦ 39,189,185 accessed microcredit (MACES) by catfish production enterprises was repaid. This is as a result of less environmental hindrance to catfish production business in the year 2017 (Ministry of Agriculture, Makurdi, 2018). The very high repayment index of

0.94 for this study, is above the repayment index (0.63) recorded by Edet *et al.* (2014). Both of these studies oppose Ajayi, Enendu and Idowu (2009); Alade (2003) and Ojo (1985) that small holders loan schemes in Nigeria is characterized by high rate of default.

The study indicates that favours due to social relations between the catfish enterprise and borrower (FAVSOCREL) is the only independent variable that was significant at 1%. This entail that the more interactions and social relations management has with the borrower, the less loan favours the enterprise is likely to obtain from credit source(s). This is contrary to *a priori* expectations that increase in social relations of management with the borrower results to a corresponding increase in the amount of microcredit accessed by the catfish production enterprises. This could be as a result of insensitivity of borrowers to social and personal relationships when it comes to parting away with limited cash; the tight economic recession experienced in 2017 made it necessary for credit sources to do away with sentiments.

The interest rate on loan (INTRATE) was negative and insignificant. The negative value exhibited by INTRATE indicates that the variable has inverse relationship with amount of loan acquired; implying that increase in the interest charge on loan will lead to the decrease in the amount of loan acquired. This study confirms the findings of Mba (2009); Oni, Oladele and Oyewole (2005) and Njoku and Nzewa (1990). However, this result is in conflict with the finds of Edet *et al.* (2014) who reported a positive and significant value at 10 percent probability level.

Logit model was used to estimate the determinants of microcredit utilization; this show that an increase in pond size (POSI) factor was statistically positive and significant at a value of 5%. For the POSI factor, the likely utilization rate of microcredit loan (i.e. odds ratio of high against low utilization) is increased by a factor of 0.00122, other factors remain constant. The variable, MACES (microcredit access) is positive and significant at a value of 1%. The coefficient (or parameter estimate) for the variable MACES is 0.0000205. This means that for a one-unit increase in MACES (in other words, going from high to low), we expect a 0.0000205 increase in the log-odds of the dependent variable utilization rate of microcredit (i.e. holding all other independent variables constant).

The study used Structural Equation Modeling (SEM) for purposes of analyzing the determinants of microcredit repayment such as social, economic and contract specific factors. SEM was used to test the relationship among the constructs. For the whole model, the statistical result shows that Chi-square value of 222, 091.25 which is significant at 1%. Standard estimation of the full model of the three paths indicates significance for both Content Specific Factors and Social Factors respectively. Economic Factors however, was not significant even at 5% but was at 10% which is a bit far off for this study. Content Specific Factors and Social Factors improve repayment of microcredit by catfish production enterprises in Benue State compared to Economic Factors which contributes little to repayment of borrowed loans. Thus, the null hypothesis was rejected and the alternative hypothesis accepted, which states that, “determinants of microcredit repayment have significant effect on catfish production enterprises”.

5.2 CONCLUSION

Microcredit access (MACES) has more effect on catfish output in the study area with its 1.028 Beta coefficient estimate. This is followed by microcredit repayment (REPAY) with coefficient value of 0.767 while, microcredit utilization (UTILIZED) was last with an effect of 0.561 on catfish output in the study area. These three independent variables have positive signs as expected. The coefficients agreed with the *a priori* expectation, which states that, a unit increase in MACES, REPAY and UTILIZED leads to a corresponding increase in catfish output in the study area. The Multiple coefficient of determination (R^2) value is 0.960, which indicated that there is a very strong and significant relationship between the indicators. The results indicate that the calculated value of F-test at 1% level showed significant value of 10.45.

Investment within the catfish production enterprise required the deployment of microcredit in the purchase of variable inputs in order to generate revenue. Investment is associated with the cost price of the variable inputs in the market. Microcredit access, utilization and repayment variables' value of the coefficient (Beta) in the revenue regression equation were significantly different from zero at 5%, 1% and 10% respectively. Microcredit access (MACES) has more effect on catfish revenue in the study area with its 1.007 Beta coefficient estimate. This is followed by microcredit repayment (REPAY) with coefficient value of 0.769 while, microcredit utilization (UTILIZED) was last with an effect of 0.523 on catfish revenue in the study area. These three independent variables have positive signs as expected. The coefficients agreed with the *a priori* expectation, which states that, a unit increase in MACES, REPAY and UTILIZED leads to a corresponding increase in catfish revenue in the study area. The Multiple coefficient of determination (R^2) value is 0.850, which indicated that there is a strong and significant relationship between the variables. The F-test result indicates a calculated value of 9.18 which was significant at 1% level.

The main aim of establishing the catfish production enterprise is to maximize profit. An investment however, that does not do so needs to be re-evaluated. The Beta coefficient estimates of Microcredit access and repayment in the regression equation were significantly different from zero at 5% and 10% respectively. However, microcredit utilization coefficient estimate was not significant. Microcredit access (MACES) has more effect on catfish profit in the study area with its 2.294 Beta estimate. This is followed by microcredit repayment (REPAY) with coefficient value of 1.761 while, microcredit utilization (UTILIZED) was last with an effect of 0.241 on catfish profit obtained in the study area. These three independent variables have positive signs as expected. The coefficients agreed with the *a priori* expectation, which states that, a unit increase in MACES, REPAY and UTILIZED leads to a corresponding increase in catfish profit in the study area. The Multiple coefficient of determination (R^2) value is 0.400, which indicated that there is a very considerable and significant relationship between the indicators. The results indicate that the calculated value of F-test at 1% level showed significant value of 4.1.

The study employed technical efficiency score of 300 catfish production enterprises Benue State. Using Translog Normal Half-Normal and exponential Stochastic Frontier Models (i.e., TNHNSFM and TNESFM), the study examined variations in efficiency among the enterprises. The inefficiency model, however did not show any significant values in respect of the six variable items for technical, allocative and profit efficiencies.

The difference in microcredit activities such as microcredit access, microcredit utilization and microcredit repayment on three separate platforms of production, revenue generation and profit generation by catfish production enterprises were tested using ANOVA. Microcredit activities for production, revenue and profit exhibited significant differences. The difference between the means of microcredit access, utilization and repayment is quite significant at the 0.01 level for both Bonferroni and Sidak multiple comparison tests, basically, the adjustments all agree that there is difference between the means of microcredit access, utilization and repayment. There are significant differences between microcredit access and microcredit utilization, microcredit access and microcredit repayment and microcredit repayment and microcredit utilization. The difference between the three groups does not fall short of being statistically significant.

5.3 RECOMMENDATIONS

Based on the findings of this study, the following recommendations are appropriate:

i. Catfish production enterprises should engage the office of the Director of Fisheries under the Benue State Ministry of Agriculture to enquire about skills in writing a feasibility study for their enterprises in order to access more microcredit from BOI and BOA
ii. Credit sources should ensure prompt processing of loan applications and timely disbursement of loans to successful applicant without delay
iii. Vocational training and financial education are essential for catfish managers in order to properly utilize credit acquired for catfish production enterprises

iv. The credit made available by BOI, BOA, cooperatives, etc, to catfish production enterprise need to be increased so that the enterprise could make greater impact on fish production and economic growth of the Nation

v. The interest rate charged on microcredit by private money lenders should be reduced because high interest rate will scare potential catfish enterprises

vi. There should be a strong enlightenment campaign to educate the management of catfish production enterprise on the implication of loans by financial houses, Non Governmental Organizations (NGOs) and Government institutions.

vii. Government should fund more microcredit institutions so that their interest rate would be reduced for catfish production enterprises to obtain credit with ease

viii. Catfish production enterprises should organize and or join catfish production associations or groups because this is likely to improve the profitability of catfish production in the study area

5.4 SUGGESTION FOR FURTHER STUDY

i. A Comparative Analysis of the Utilization and Repayment of Microcredit between Yam and Rice Farmers in Benue State;

ii. Structural Equation Modeling (SEM) of the Determinants of Microcredit Access, Utilization and Repayment in Sorghum Production within the Middle Belt Region of Nigeria; and

iii. Effect of the Utilization of Anchor Borrowers Credit on Production Capacity of Beneficiary Farmers in North Central Nigeria: A Stochastic Frontier Approach

5.5 CONTRIBUTIONS TO KNOWLEDGE MADE IN THIS STUDY

This dissertation examined effects of microcredit access, utilization and repayment on catfish production in Benue State. The current state of knowledge in the field of microcredit consists of two dimensions; the most abundant mass of studies stem from: microcredit access and microcredit utilization in Benue State. Most studies focus more on the socio-economic features of the catfish farmer and his household; few studies examined issues surrounding the catfish enterprise as a business unit taking into consideration the demographic and economic profile. The study provided a series of arguments on how this Ph.D. dissertation contributes to a significantly less explored realm in microcredit access, utilization and repayment and how these three dimensions affect catfish production enterprises. The author also argues why it is important to support and expand microcredit access and microcredit utilization research for catfish production in the study area.

Much work has not been done as regards the economic and demographic profile of catfish production enterprises. However, many research has been carried out as regards socio-economic features of catfish farmers in Benue State and Nigeria (Folayan and Folayan, 2017; Akarue and Aregbor, 2015) as a whole. Studies such as Sampou (2006), highlighted the problems of microcredit acquisition and utilization among small-scale fish farmers neglecting the repayment aspect. From observation, this study found out that little works on microcredit access, utilization and repayment in Benue State in particular exists. This review brings out the gap in Literature which this study tried to examine.

The study disclosed that of the total sum of ₦ 39,189,185 accessed microcredit (MACES) by catfish production enterprises; a huge sum of ₦ 28,582,422 was utilized in catfish production business. Microcredit was used in the purchase of inputs such as standard feeds, fingerlings, labour, etc. However, the utilization index for accessed microcredit was 0.73; this translates into 73% of utilized microcredit in the study area. Credit theories of money states that, money creation involves the simultaneous creation of debt. In application to this study, microcredit repayment resulted in a vast sum of ₦ 37,054,472, which was repaid by catfish production enterprises. This implies that 94% of the total sum of ₦ 39,189,185, accessed microcredit (MACES) by catfish production enterprises was repaid. However, credit theories of money are relevant in this case but debt minimization recorded by catfish farmers in the study area is advantageous. This is as a result of less environmental hindrance to catfish production business in the year 2017 (Ministry of Agriculture, Makurdi, 2018). The very high repayment index of 0.94 for this study, is above the repayment index (0.63) recorded by Edet *et al.* (2014). Both of these studies oppose Ajayi, Enendu and Idowu (2009); Alade (2003) and Ojo (1985) that small holders loan schemes in Nigeria is characterized by high rate of default.

Catfish production enterprises should engage the office of the Director of Fisheries under the Benue State Ministry of Agriculture to enquire about skills in writing a feasibility study for their enterprises in order to access more microcredit from BOI and BOA. Credit sources should ensure prompt processing of loan applications and timely disbursement of loans to successful applicant without delay. There should be a strong enlightenment campaign to educate the management of catfish production enterprise on the implication of loans by financial houses, Non Governmental Organizations (NGOs) and Government institutions.

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APPENDIX 1

QUESTIONNAIRE

First Objective: Demographic and economic profile of catfish production enterprises in the study area

1. Years of operation: ………………………………………. years
2. Number of microcredit sources: ……………………………….
3. Pond type/system: a) concrete [ ], b) earthen [ ], c) plastic [ ], d) tarpaulin [ ], e) fiber
4. Bank account for enterprise: a) yes [ ], b) no [ ]
5. Amount of microcredit intended to borrow: ………………………………………. ₦
6. Amount of microcredit borrowed to enterprise: …………………………………… ₦
7. Interest charges: ……………………………………….. %
8. Amount owed currently: …………………………………… ₦
9. Payment schedule: a) daily [ ], b) weekly [ ], c) monthly [ ], d) yearly [ ]
10. Existence of microcredit org. which offers loans to catfish production business: a) yes [ ], b) no [ ]

Second Objective: Sources and amount of microcredit accessed by catfish production enterprise

i. microcredit obtained from bank of agriculture/other formal credit institutions: ₦…………….
ii. microcredit obtained from owner's equity funding: ₦……………………
iii. microcredit from family and friends for last season's catfish production: ₦…………………
iv. microcredit from cooperative society for last season's catfish production: ₦…………………
v. microcredit from private money lenders for last season's catfish production: ₦………………

Third Objective: The level of microcredit utilization and repayment

1. Amount of microcredit utilized during the last production season ₦………………………….
2. Amount of microcredit repayment carried out for last season ₦……………………………….

Fourth Objective: Determinants of microcredit access, utilization and repayment

Determinants of Microcredit Access

Factors
1. Lending capacity of lender: ……………………….. a) less than ₦ 250, 000 [ ], b) equal or greater than ₦ 250, 000 [ ]
2. Favours due to social relations between catfish enterprise and lender: ……………………….. a) less than ₦ 250, 000 [ ], b) equal or greater than ₦ 250, 000 [ ]
3. Interest rate on loan: ……………………………..%
4. Length of waiting to receive loan from lender: ……………………….. days
6. Amount of accessed microcredit in Naira: …………………………… ₦

Determinants of Microcredit Utilization

Factors
1. Diversion of loan: …………………………………₦
2. Pond size: …………………………………………..m^2
3. Microcredit access: …………………………………₦
4. Lender's supervision on utilization of loan: a) high [ ], b) low [ ]

Determinants of Microcredit Repayment

The aim of this section is to examine the effect of social, economic content-specific factors on repayment of microcredit loans by catfish producers in Benue State. This will be measured using likert like scale of 1=abysmal [A]; 2=not adequate [NA]; 3=moderate [M]; 4=adequate [AD]; 5=superb [S]

Factors	**A**	**NA**	**M**	**AD**	**S**
Social Factors					
Age of the enterprise					
Mortality rate of fish					
Farm size					
Employee size					
Diversion of loan					
Incidence of diseases and pests					
Pond size					
Monopoly power created by informal lenders					
Use of modern machinery and equipments					
Social relations of management to the borrower					
Experience of management					
Educational qualification of management					
Economic factors					
Interest rate on loan					
Income of the catfish enterprise					
Loan size					
Net profit					
Fluctuations in commodity prices					
Market value of catfish					
Market price fluctuations					
Exchange rate of Naira to Dollar					
Asset base of catfish enterprise					
Contract-specific factors					
Lender's supervision on utilization of loan					
Number of repayment installments					
Down-payment of loan					
Length of waiting to receive loan from lender					
Length of repayment period					
Repayment of microcredit loans					
Payment is in accordance with the lender's terms					
Repayment does not affect profit of the catfish production business					

Fifth Objective: Effect of microcredit access, utilization and repayment on of catfish output

a) Amount of microcredit accessed during the 2017 production season ₦…………………
b) Amount of microcredit utilized during the 2017 production season ₦…………………
c) Amount of microcredit repayment carried out for 2017 production season ₦……………
d) Catfish output in Kg……………………………………….

Sixth Objective: Compute the efficiency of catfish production enterprises in Benue State

Catfish production variable inputs, inefficiency variables, cost price of inputs and profits from catfish production enterprises

a). Catfish production variable inputs

i. fingerlings used in catfish production …………………….(kg)
ii. quantity of standard feeds used …………………….(kg)
iii. labor requirements …………………….(man-days)
iv. pond size of catfish enterprise ………………..(m^2)

b). Inefficiency variables

i. collateral ₦………………
ii. interest rate ……………….percent
iii. guarantor a). yes [ ], b). no [ ]
iv. number of microcredit sources ……………….
v. defaulting in payment a). yes [ ], b) no [ ]
vi. sentiments a). yes [ ], b). no [ ]

c). Cost price of inputs used in catfish production

1. cost of fingerlings used in catfish production ₦………………
2. cost of quantity of standard feeds used ₦………………
3. cost of labor requirements ₦………………
4. cost of pond size of catfish enterprise ₦………………

2. Catfish output

b) catfish yield or output for last season: …………………….kg
c) price value of catfish output: ₦………………………….……

3. Revenue and profit from catfish production

a) revenue from catfish production business: ₦…………………………
b) profit from catfish production business: ₦……………………………

Seventh Objective: differences in microcredit access, utilization and repayment

e) Amount of microcredit accessed during the 2017 production season ₦…………………
f) Amount of microcredit utilized during the 2017 production season ₦…………………
g) Amount of microcredit repayment carried out for 2017 production season ₦……………

Eight Objective: This aims to examine the constraints to microcredit access, utilization and repayment by catfish production enterprises in Benue State. Note: SD=strongly disagree, D=disagree, A=agree, SA=strongly agree. Constraints that affect microcredit accessibility are as follows:

Factors	**SD**	**D**	**A**	**SA**
High interest rate				
Bureaucratic bottlenecks				
Late approval				
Guarantor				
Collateral				
Absence of banks in the locality				
Delay in approval of loan				
Lack of awareness				
Amount given is too small				
Sentiments				
Delay in payment				
Negotiating your produce before farming				
Other (please specify)				

APPENDIX 2

ABRIDGED COMPUTER PRINTOUT OF THE VARIOUS COMPUTER PACKAGES USED IN DATA ANALYSIS

Objective 1

OBJECTIVE 1 - Notepad

File Edit Format View Help

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  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
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Notes:
      1.  Unicode is supported; see help unicode_advice.

. import excel "C:\Users\USER\Desktop\ARMSTRONG DISSERTATION MOUAU 2018\222222
> DATA-MICROCREDIT-AND-CATFISH-PRODUCTION.xlsx", sheet("Sheet1") firstrow

. save "C:\Users\USER\Desktop\ARMSTRONG-DISSERTATION-MOUAU-2018\CORRECT DATA -
> ARMSTRONG - DISSERTATION.dta", replace
file C:\Users\USER\Desktop\ARMSTRONG-DISSERTATION-MOUAU-2018\CORRECT DATA - ARM
> STRONG - DISSERTATION.dta saved

. summarize MACES AMIB DEBT PAYS EXIMC YOOP NMS PSYS ACCT INT

    Variable |        Obs        Mean    Std. Dev.       Min        Max
             |
       MACES |        300    130630.6    52989.61      35000     324000
        AMIB |        300    236882.9    67232.26      35000     470000
        DEBT |        300    7115.709    12397.31          0      59616
        PAYS |        300    3.156667    .6378178          2          4
       EXIMC |        300    .7666667    .4236593          0          1
             |
        YOOP |        300    5.606667    2.605363          2         13
         NMS |        300    2.846667    .8238637          2          4
        PSYS |        300    2.493333    .8239448          1          5
        ACCT |        300    1.053333    .2250728          1          2
         INT |        300    6.456667      5.0926          0         20
```

Objective 2

OBJECTIVE 2 - Notepad

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```
summarize FORMAL FAF COS PRIV SAV

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
      FORMAL |        300    8416.667    11431.48          0      50000
         FAF |        300       10473     9087.07          0      38000
         COS |        300       19140    14368.78          0     100000
        PRIV |        300    6335.333    5019.322          0      20000
         OFF |        300    86475.62    43306.81      20000     250045
```

Objective 3

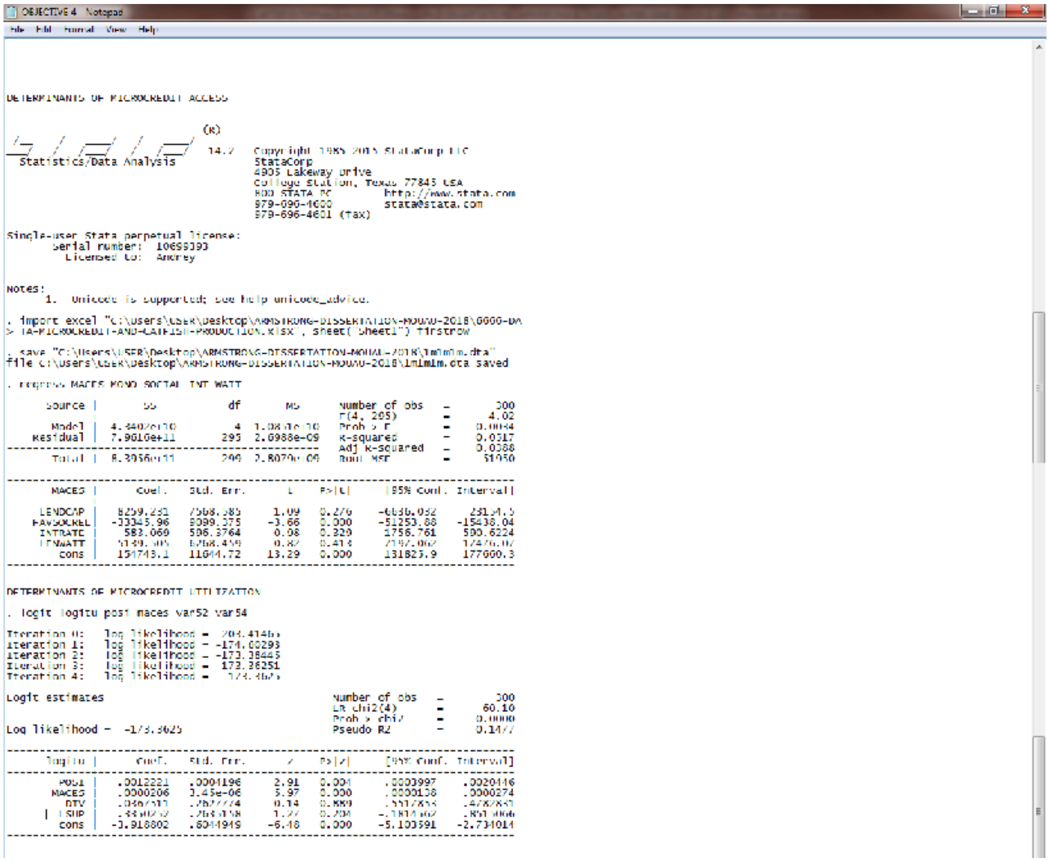
OBJECTIVE 3 - Notepad

File Edit Format View Help

```
. summarize MACES AMIB UTILZED UNUTILIZED DEBT

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
       MACES |        300    130630.6    52989.61      35000     324000
        AMIB |        300    236882.9    67232.26      35000     470000
    UTILIZED |        300    95774.74    48868.77      28100     252200
  UNUTILIZED |        300    35355.88    41990.23        100     259200
       REPAY |        300    7115.709    12397.31          0      59616
             |
       RFPAY |        300    123514.9    51080.25   28755.84     324000
```

Objective 4



```
OBJECTIVE 4 - Notepad
File Edit Format View Help

DETERMINANTS OF MICROCREDIT ACCESS

                                                (R)
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. import excel "C:\Users\USER\Desktop\ARMSTRONG-DISSERTATION-MOUAU-2018\GOOD-DA
> TA-MICROCREDIT-AND-CATFISH-PRODUCTION.xlsx", sheet("Sheet1") firstrow

. save "C:\Users\USER\Desktop\ARMSTRONG-DISSERTATION-MOUAU-2018\1m1m1m.dta"
file C:\Users\USER\Desktop\ARMSTRONG-DISSERTATION-MOUAU-2018\1m1m1m.dta saved

. regress MACES MONO SOCIAL INT WATT

      Source |       SS           df       MS      Number of obs   =       300
-------------+----------------------------------   F(4, 295)       =      4.02
       Model |  4.3402e+10         4  1.0851e+10   Prob > F        =    0.0034
    Residual |  7.9610e+11       295  2.6988e+09   R-squared       =    0.0517
-------------+----------------------------------   Adj R-squared   =    0.0388
       Total |  8.3956e+11       299  2.8079e+09   Root MSE        =     51950

------------------------------------------------------------------------------
       MACES |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     LENDCAP |   8259.231   7568.585     1.09   0.276    -6636.032     23154.5
   FAVSOCREL |  -33345.96   9099.375    -3.66   0.000    -51253.88   -15438.04
     INTRATE |    583.069   596.3764     0.98   0.329     1756.761    590.6224
     LENWATT |   5139.505   6268.459     0.82   0.413     7197.062    17476.07
        cons |   151743.1   11644.72    13.29   0.000     131825.9    177660.3
------------------------------------------------------------------------------

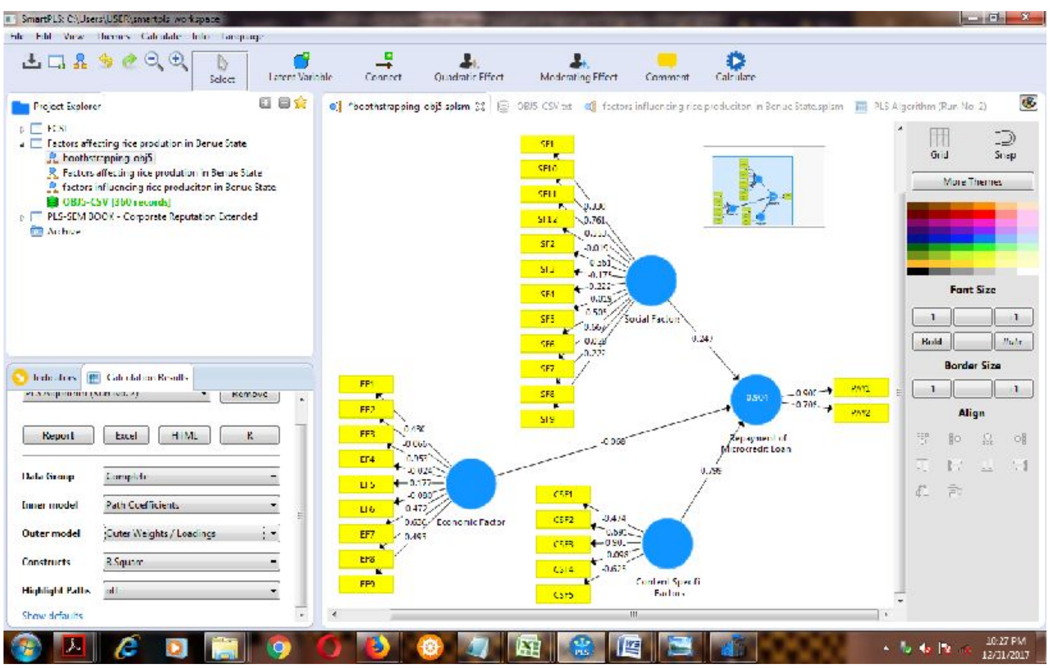
DETERMINANTS OF MICROCREDIT UTILIZATION

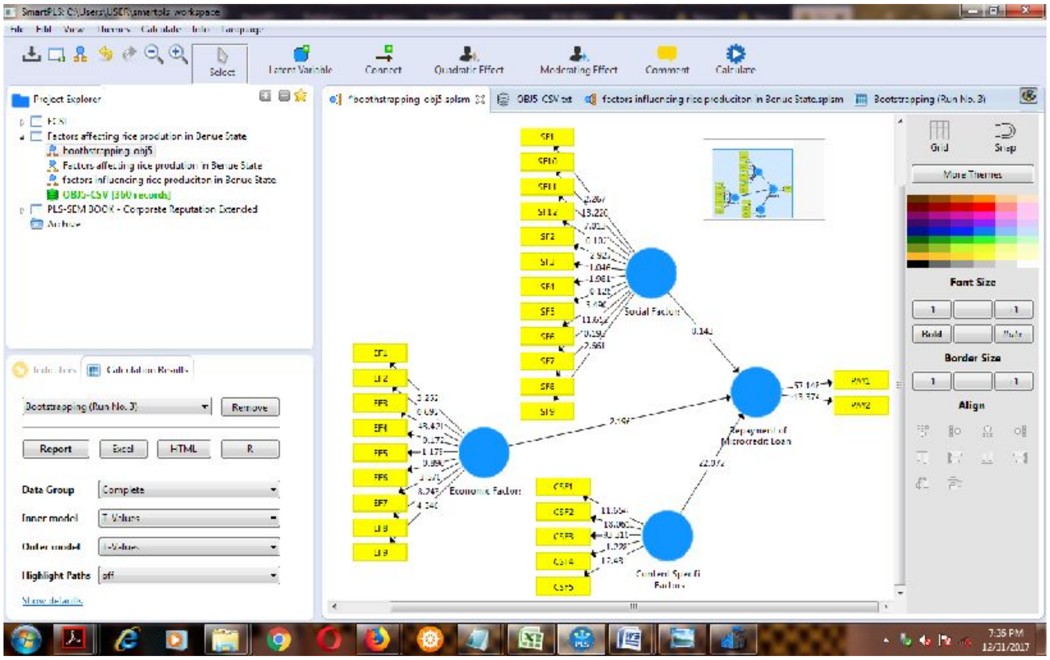
. logit logitu post maces var52 var54

Iteration 0:   log likelihood = -203.41465
Iteration 1:   log likelihood = -174.60293
Iteration 2:   log likelihood = -173.38445
Iteration 3:   log likelihood = -173.36251
Iteration 4:   log likelihood = -173.3625

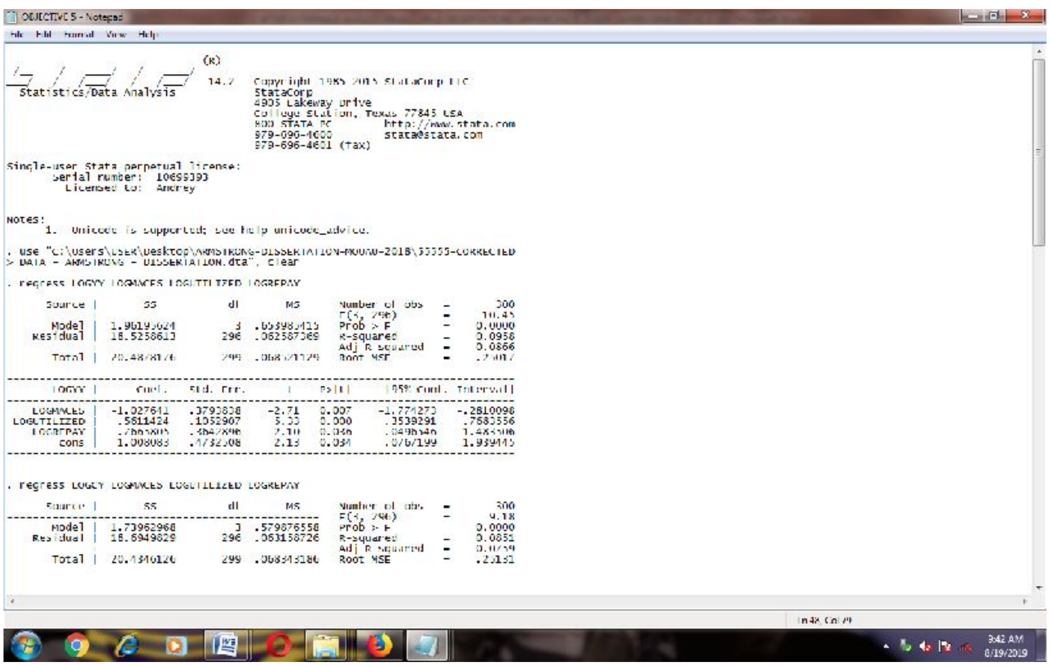
Logit estimates                                   Number of obs   =        300
                                                  LR chi2(4)      =      60.10
                                                  Prob > chi2     =     0.0000
Log likelihood = -173.3625                        Pseudo R2       =     0.1477

------------------------------------------------------------------------------
      logitu |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        POST |   .0012221   .0004196     2.91   0.004     .0003997    .0020446
       MACES |   .0000206   3.45e-06     5.97   0.000     .0000138    .0000274
         DTV |   .0367511   .2627774     0.14   0.889    .5517853     .4782857
        LSUP |   .3350252   .2635158     1.27   0.204    -.1814562    .8515066
        cons |  -3.918802   .6044949    -6.48   0.000    -5.103591   -2.734014
------------------------------------------------------------------------------
```





Objective 5



```
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> DATA - ARMSTRONG - DISSERTATION.dta", clear

. regress LOGYY LOGMACES LOGUTILIZED LOGREPAY

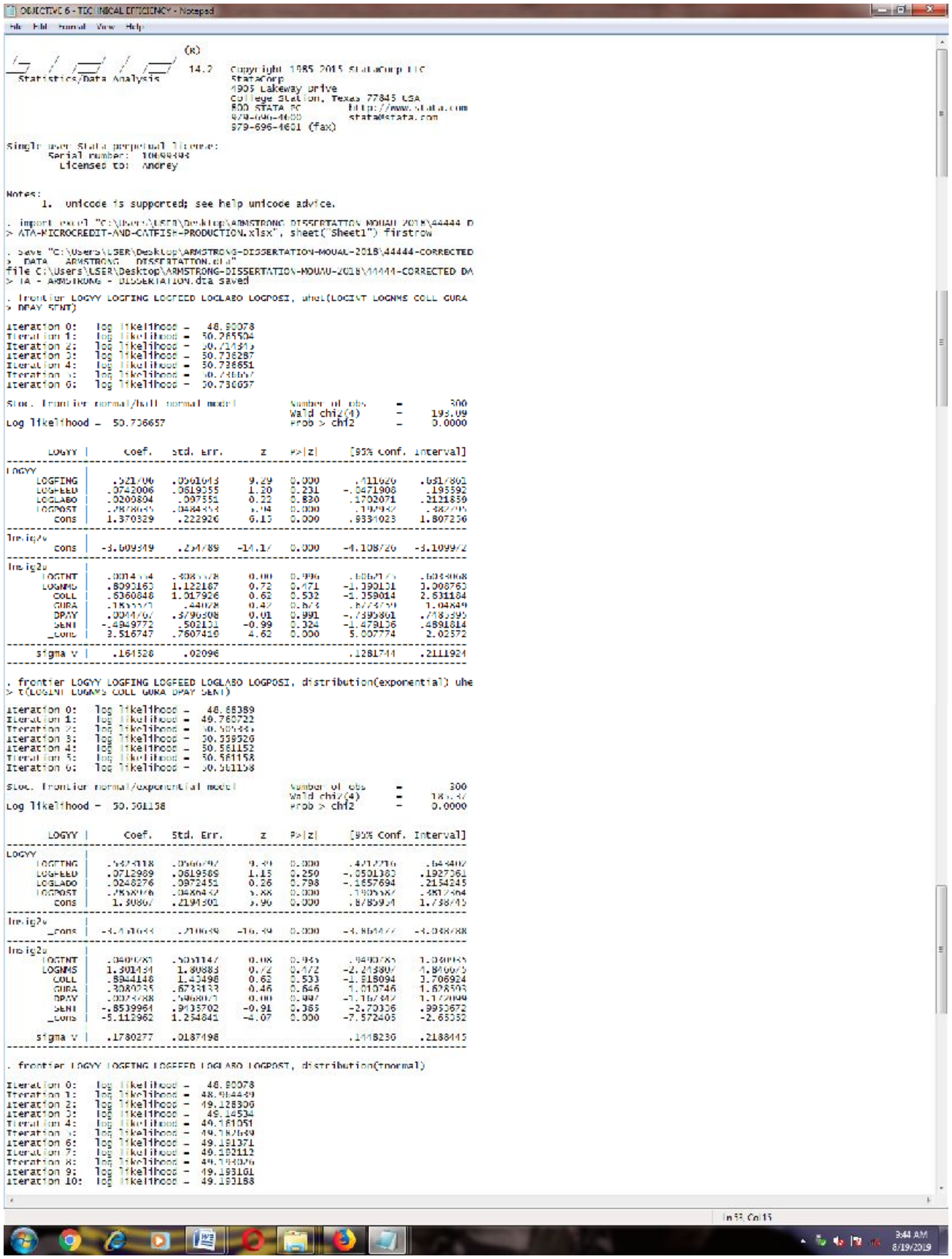
      Source |       SS           df       MS      Number of obs   =       300
-------------+----------------------------------   F(3, 296)       =     10.45
       Model |  1.96195624         3  .653985415   Prob > F        =    0.0000
    Residual |  18.5258613       296  .062587369   R-squared       =    0.0958
-------------+----------------------------------   Adj R-squared   =    0.0866
       Total |  20.4878176       299  .068521129   Root MSE        =    .25017

------------------------------------------------------------------------------
       LOGYY |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    LOGMACES |  -1.027641   .3793838    -2.71   0.007    -1.774273   -.2810098
 LOGUTILIZED |   .5611424   .1052907     5.33   0.000     .3539291    .7683556
    LOGREPAY |   .7663805   .3642896     2.10   0.036     .0496546    1.483106
       _cons |   1.008083   .4732308     2.13   0.034     .0767199    1.939445
------------------------------------------------------------------------------


. regress LOGCY LOGMACES LOGUTILIZED LOGREPAY

      Source |       SS           df       MS      Number of obs   =       300
-------------+----------------------------------   F(3, 296)       =      9.18
       Model |  1.73962968         3  .579876558   Prob > F        =    0.0000
    Residual |  18.6949829       296  .063158726   R-squared       =    0.0851
-------------+----------------------------------   Adj R-squared   =    0.0759
       Total |  20.4346126       299  .068343186   Root MSE        =    .25131
```

Objective 6



```
OBJECTIVE 6 - TECHNICAL EFFICIENCY - Notepad
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                                     (R)
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. import excel "C:\Users\USER\Desktop\ARMSTRONG DISSERTATION MOUAU 2018\44444 D
> ATA-MICROCREDIT-AND-CATFISH-PRODUCTION.xlsx", sheet("Sheet1") firstrow

. save "C:\Users\USER\Desktop\ARMSTRONG-DISSERTATION-MOUAU-2018\44444-CORRECTED
>  DATA - ARMSTRONG - DISSERTATION.dta"
file C:\Users\USER\Desktop\ARMSTRONG-DISSERTATION-MOUAU-2018\44444-CORRECTED DA
> TA - ARMSTRONG - DISSERTATION.dta saved

. frontier LOGYY LOGFING LOGFEED LOGLABO LOGPOST, uhet(LOGINT LOGNMS COLL GURA
> DPAY SENT)

Iteration 0:   log likelihood =  48.90078
Iteration 1:   log likelihood = 50.265504
Iteration 2:   log likelihood = 50.714315
Iteration 3:   log likelihood = 50.736287
Iteration 4:   log likelihood = 50.736651
Iteration 5:   log likelihood = 50.736657
Iteration 6:   log likelihood = 50.736657

Stoc. frontier normal/half-normal model          Number of obs     =        300
                                                 Wald chi2(4)      =     193.09
Log likelihood =  50.736657                      Prob > chi2       =     0.0000

------------------------------------------------------------------------------
       LOGYY |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
LOGYY        |
     LOGFING |   .5217706    .0561613     9.29   0.000      .411626    .6317801
     LOGFEED |   .0742006    .0619355     1.20   0.231    -.0471908     .195592
     LOGLABO |   .0200804     .097551     0.22   0.830     .1702071    .2121859
     LOGPOST |   .2878685    .0484353     5.94   0.000     .1929342    .3827795
       _cons |   1.370329     .222926     6.15   0.000     .9334023    1.807256
-------------+----------------------------------------------------------------
lnsig2v      |
       _cons |  -3.609349     .254789   -14.17   0.000    -4.108726   -3.109972
-------------+----------------------------------------------------------------
lnsig2u      |
      LOGINT |   .0014554    .4085578     0.00   0.996    -.8062175    .8048068
      LOGNMS |   .8093163    1.122187     0.72   0.471    -1.390131    3.008763
        COLL |   .6360848    1.017926     0.62   0.532    -1.359014    2.631184
        GURA |   .1855577      .44028     0.42   0.673    -.6773759     1.04849
        DPAY |   .0044767    .3790308     0.01   0.991    -.7395801    .7485395
        SENT |  -.4949772     .502131    -0.99   0.324    -1.479136    .4891814
       _cons |   3.516747    .7607419     4.62   0.000     5.007774     2.02572
-------------+----------------------------------------------------------------
     sigma_v |    .164528      .02096                      .1281744    .2111924
------------------------------------------------------------------------------

. frontier LOGYY LOGFING LOGFEED LOGLABO LOGPOSI, distribution(exponential) uhe
> t(LOGINT LOGNMS COLL GURA DPAY SENT)

Iteration 0:   log likelihood =  48.68389
Iteration 1:   log likelihood = 49.760722
Iteration 2:   log likelihood = 50.505443
Iteration 3:   log likelihood = 50.559526
Iteration 4:   log likelihood = 50.561152
Iteration 5:   log likelihood = 50.561158
Iteration 6:   log likelihood = 50.561158

Stoc. frontier normal/exponential model          Number of obs     =        300
                                                 Wald chi2(4)      =     185.37
Log likelihood =  50.561158                      Prob > chi2       =     0.0000

------------------------------------------------------------------------------
       LOGYY |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
LOGYY        |
     LOGFING |   .5328118    .0566797     9.40   0.000     .4217216    .6438402
     LOGFEED |   .0712989    .0619589     1.15   0.250    -.0501383    .1927361
     LOGLABO |   .0248276    .0972451     0.26   0.798    -.1657694    .2154245
     LOGPOST |   .2858076    .0486432     5.88   0.000     .1905587    .3812564
       _cons |    1.30867    .2194301     5.96   0.000     .8785954    1.738745
-------------+----------------------------------------------------------------
lnsig2v      |
       _cons |  -3.451633     .210639   -16.39   0.000    -3.864477   -3.038788
-------------+----------------------------------------------------------------
lnsig2u      |
      LOGINT |   .0400283    .5051147     0.08   0.945    -.9490785    1.029135
      LOGNMS |   1.301434     1.80883     0.72   0.472    -2.243807    4.846675
        COLL |   .8944148     1.43498     0.62   0.533    -1.918094    3.706924
        GURA |   .3080235    .6733133     0.46   0.646     1.010746    1.628503
        DPAY |   .0023788    .5968071     0.00   0.997    -1.167442    1.172099
        SENT |  -.8539964    .9135702    -0.91   0.365     -2.70336    .9953672
       _cons |  -5.112962    1.254841    -4.07   0.000    -7.572405    -2.65352
-------------+----------------------------------------------------------------
     sigma_v |   .1780277    .0187498                      .1448230    .2188445
------------------------------------------------------------------------------

. frontier LOGYY LOGFING LOGFEED LOGLABO LOGPOST, distribution(tnormal)

Iteration 0:   log likelihood =  48.90078
Iteration 1:   log likelihood = 48.984449
Iteration 2:   log likelihood = 49.128306
Iteration 3:   log likelihood =  49.14534
Iteration 4:   log likelihood = 49.181051
Iteration 5:   log likelihood = 49.187649
Iteration 6:   log likelihood = 49.191371
Iteration 7:   log likelihood = 49.192112
Iteration 8:   log likelihood = 49.193076
Iteration 9:   log likelihood = 49.193161
Iteration 10:  log likelihood = 49.193188

Ln 53, Col 15
3:44 AM
8/19/2019
```

OBJECTIVE 6 ALLOCATIVE EFFICIENCY Notepad

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```
. frontier LOGCY LOGCFING LOGCFEED LOGCLABO LOGCPOSI, uhet(LOGINT LOGNMS COLL G
> URA DPAY SENT)

Iteration 0:   log likelihood =  48.590369
Iteration 1:   log likelihood =  48.669056
Iteration 2:   log likelihood =  50.002777
Iteration 3:   log likelihood =  50.174033
Iteration 4:   log likelihood =  50.194505
Iteration 5:   log likelihood =  50.195787
Iteration 6:   log likelihood =  50.195819
Iteration 7:   log likelihood =  50.195858
Iteration 8:   log likelihood =  50.195859

Stoc. frontier normal/half-normal model          Number of obs      =       300
                                                 Wald chi2(4)       =    181.57
Log likelihood =  50.195859                      Prob > chi2        =    0.0000

------------------------------------------------------------------------------
       LOGCY |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
LOGCY        |
    LOGCFING |   .5390554   .0567243     9.52   0.000     .4287778     .651133
    LOGCFEED |   .0504015   .0629823     0.80   0.423    -.0729436    .1737467
    LOGCLADU |   .0168684   .0987948     0.17   0.864    -.1767658    .2105026
    LOGCPOSI |   .2619545   .0497762     5.26   0.000     .1643949     .359514
       _cons |   1.468046    .426675     3.44   0.001     .6318785    2.305214
-------------+----------------------------------------------------------------
lnsig2v      |
       _cons |   3.482176   .2850727    12.22   0.000     4.040908    2.923444
-------------+----------------------------------------------------------------
lnsig2u      |
      LOGINT |   .0295172    .367232     0.08   0.936     .6902443    .7492788
      LOGNMS |   .9843884   1.367306     0.72   0.472     1.696481    3.663258
        COLL |   .6867937   1.110383     0.62   0.536    -1.489517    2.863104
        GURA |    .224051   .5111704     0.44   0.661    -.7778245    1.225927
        DPAY |   .0649152   .4491225     0.15   0.884     .7986751    .9245774
        SENT |   -.450569   .6517873    -0.69   0.489    -1.728049    .8269107
       _cons |  -3.926122   1.167555    -3.36   0.001    -6.214487   -1.637757
-------------+----------------------------------------------------------------
     sigma_v |   .1753295   .0249908                      .1325962    .2318367
------------------------------------------------------------------------------

. frontier LOGCY LOGCFING LOGCFEED LOGCLADU LOGCPOSI, distribution(exponential)
>  uhet(LOGINT LOGNMS COLL GURA DPAY SENT)

Iteration 0:   log likelihood =  48.518474  (not concave)
Iteration 1:   log likelihood =  49.299669
Iteration 2:   log likelihood =  50.062247
Iteration 3:   log likelihood =  50.176998
Iteration 4:   log likelihood =    50.1918
Iteration 5:   log likelihood =  50.192209
Iteration 6:   log likelihood =   50.19221

Stoc. frontier normal/exponential model          Number of obs      =       300
                                                 Wald chi2(4)       =    164.09
Log likelihood =   50.19221                      Prob > chi2        =    0.0000

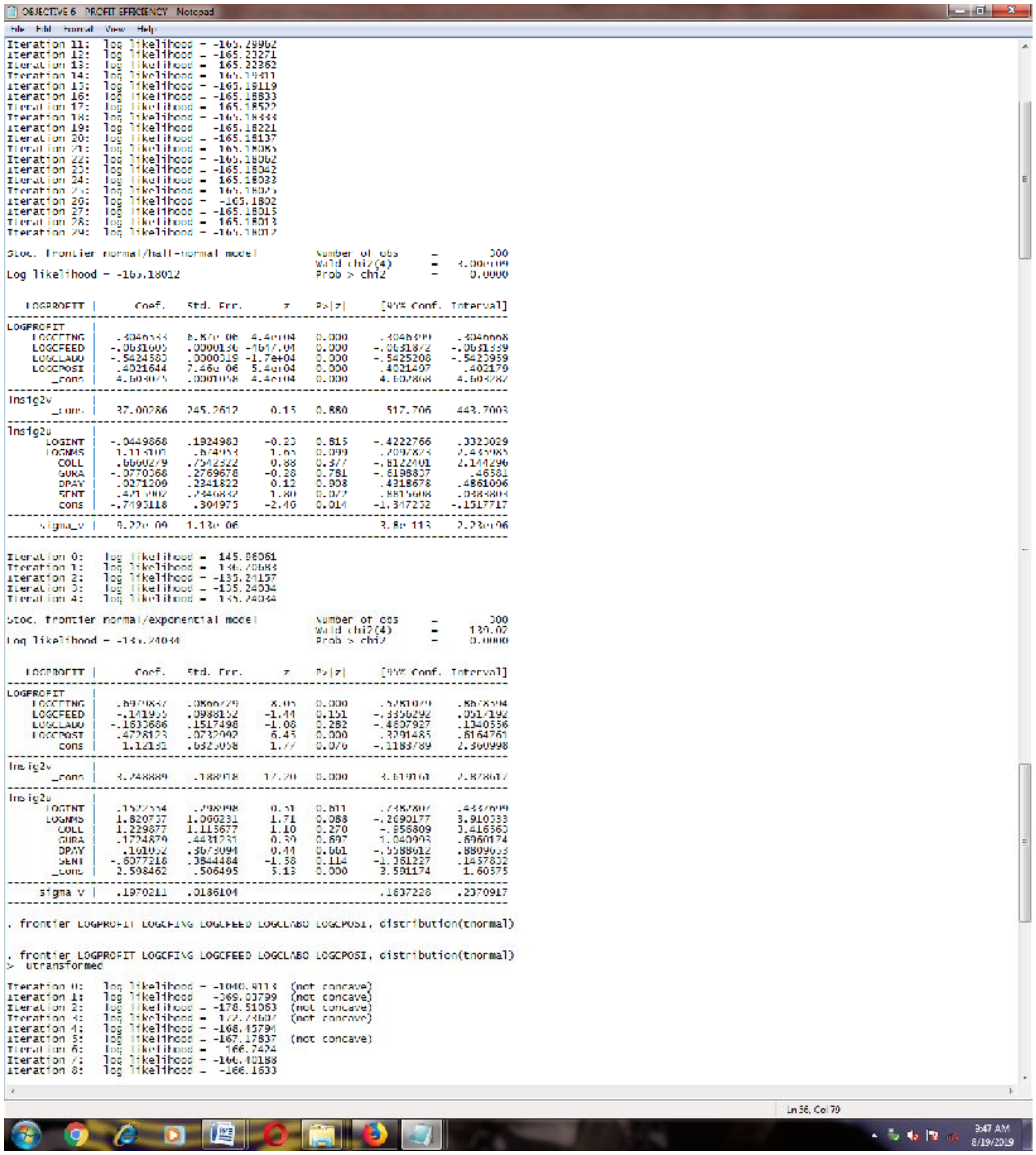
------------------------------------------------------------------------------
       LOGCY |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
LOGCY        |
    LOGCFING |   .5465949   .0578066     9.46   0.000     .4333011    .6598888
    LOGCFEED |   .0472068   .0630015     0.75   0.454    -.0762737    .1706874
    LOGCLADU |   .0211129   .0983568     0.21   0.830     -.171663    .2138887
    LOGCPOST |   .2606106    .050342     5.18   0.000     .1619512    .3592881
       _cons |   1.393164   .4272206     3.27   0.001     .5578275    2.232507
-------------+----------------------------------------------------------------
lnsig2v      |
       _cons |   3.366029   .2454171    13.71   0.000     3.846638    2.884621
-------------+----------------------------------------------------------------
lnsig2u      |
      LOGINT |   .1262445   .6455448     0.20   0.845        1.130    1.391489
      LOGNMS |   1.623567   2.490187     0.65   0.514    -3.257698    6.504832
        COLL |   .9523176    1.53544     0.62   0.535     -2.05709    3.961725
        GURA |   .3811562    .848182     0.45   0.653     -1.28125    2.043562
        DPAY |    .064956   .7012404     0.09   0.926     1.309945    1.439567
        SENT |  -.8333837   1.292835    -0.64   0.519    -3.367294    1.700327
       _cons |  -5.692771   2.196455    -2.59   0.010    -9.997743   -1.387799
-------------+----------------------------------------------------------------
     sigma_v |   .1858300   .0228054                      .1461212     .236387
------------------------------------------------------------------------------

. frontier LOGCY LOGCFING LOGCFEED LOGCLABO LOGCPOST, distribution(tnormal)

Iteration 0:   log likelihood =  48.590369
Iteration 1:   log likelihood =  48.630896
Iteration 2:   log likelihood =  48.716212
Iteration 3:   log likelihood =  48.743833
Iteration 4:   log likelihood =  48.764401
Iteration 5:   log likelihood =  48.782604
Iteration 6:   log likelihood =  48.803654
Iteration 7:   log likelihood =  48.805249
```

Ln 16, Col 79

3:45 AM 8/19/2019



```
Iteration 11:  log likelihood = -165.28962
Iteration 12:  log likelihood = -165.23271
Iteration 13:  log likelihood = -165.22362
Iteration 14:  log likelihood = -165.19411
Iteration 15:  log likelihood = -165.19119
Iteration 16:  log likelihood = -165.18833
Iteration 17:  log likelihood = -165.18522
Iteration 18:  log likelihood = -165.18333
Iteration 19:  log likelihood = -165.18221
Iteration 20:  log likelihood = -165.18137
Iteration 21:  log likelihood = -165.18065
Iteration 22:  log likelihood = -165.18062
Iteration 23:  log likelihood = -165.18042
Iteration 24:  log likelihood = -165.18033
Iteration 25:  log likelihood = -165.18025
Iteration 26:  log likelihood = -165.1802
Iteration 27:  log likelihood = -165.18015
Iteration 28:  log likelihood = -165.18013
Iteration 29:  log likelihood = -165.18012

Stoc. frontier normal/half-normal model          Number of obs   =        300
                                                 Wald chi2(4)    =   3.00e+09
Log likelihood = -165.18012                      Prob > chi2     =     0.0000

   LOGPROFIT |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
LOGPROFIT    |
    LOGCFING |   .4046333   8.87e-06  4.4e+04   0.000     .4046399    .4046068
    LOGCFEED |  -.0631605   .0000136 -4647.04   0.000    -.0631872   -.0631339
    LOGCLABO |  -.5424583   .0000319 -1.7e+04   0.000    -.5425208   -.5423959
    LOGCPOSI |   .4021644   7.46e-06  5.4e+04   0.000     .4021497     .402179
       _cons |   4.603075   .0001058  4.4e+04   0.000     4.602868    4.603282
-------------+----------------------------------------------------------------
lnsig2v      |
       _cons |   37.00286   245.2612     0.15   0.880     517.706    443.7003
-------------+----------------------------------------------------------------
lnsig2u      |
      LOGINT |  -.0449868   .1924983    -0.23   0.815    -.4222766    .3323029
      LOGNMS |   1.113100   .674053     1.65   0.099     .2097823    2.435985
        COLL |   .6660279   .7542322     0.88   0.377    -.8122401    2.144296
        GURA |  -.0770368   .2769678    -0.28   0.781    -.6198837      .46581
        DPAY |   .0271209   .2341822     0.12   0.908     .4318678    .4861006
        SENT |   .4215002   .2346832     1.80   0.072     .8815608    .0383803
        cons |  -.7493118   .304975    -2.46   0.014    -1.347232   -.1517717
-------------+----------------------------------------------------------------
     sigma_v |   9.22e-09   1.13e-06                      3.8e-113    2.23e+06
------------------------------------------------------------------------------

Iteration 0:   log likelihood =  145.96061
Iteration 1:   log likelihood =  136.70684
Iteration 2:   log likelihood = -135.24157
Iteration 3:   log likelihood = -135.24034
Iteration 4:   log likelihood =  135.24034

Stoc. frontier normal/exponential model          Number of obs   =        300
                                                 Wald chi2(4)    =     130.02
Log likelihood = -135.24034                      Prob > chi2     =     0.0000

   LOGPROFIT |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
LOGPROFIT    |
    LOGCFING |   .6979837   .0866729     8.05   0.000     .5281079    .8678594
    LOGCFEED |   -.141955   .0988152    -1.44   0.151    -.3356292    .0517192
    LOGCLABO |  -.1633686   .1517498    -1.08   0.282    -.4607927    .1340556
    LOGCPOST |   .4728123   .0732092     6.45   0.000     .3291485    .6164761
        cons |    1.12131   .6325058     1.77   0.076    -.1183789    2.360998
-------------+----------------------------------------------------------------
lnsig2v      |
       _cons |   3.248889   .188918    17.20   0.000     3.619161    2.878617
-------------+----------------------------------------------------------------
lnsig2u      |
      LOGINT |   .1522554   .298998     0.51   0.611     .7387802    .4437609
      LOGNMS |   1.820737   1.060231     1.71   0.088    -.2690177    3.910333
        COLL |   1.229877   1.115677     1.10   0.270     -.956809    3.416563
        GURA |   .1724879   .4431231     0.39   0.697     1.040903    .6960174
        DPAY |    .161052   .3673094     0.44   0.661    -.5588612    .8809653
        SENT |  -.6077218   .3844484    -1.58   0.114    -1.361227    .1457832
       _cons |   2.508462   .506495     5.13   0.000     3.501174     1.60575
-------------+----------------------------------------------------------------
     sigma_v |   .1970211   .0186104                      .1637228    .2370917
------------------------------------------------------------------------------

. frontier LOGPROFIT LOGCFING LOGCFEED LOGCLABO LOGCPOSI, distribution(tnormal)

. frontier LOGPROFIT LOGCFING LOGCFEED LOGCLABO LOGCPOSI, distribution(tnormal)
> utransformed

Iteration 0:   log likelihood = -1040.4114  (not concave)
Iteration 1:   log likelihood = -369.03799  (not concave)
Iteration 2:   log likelihood = -178.51063  (not concave)
Iteration 3:   log likelihood = -172.73607  (not concave)
Iteration 4:   log likelihood = -168.45794
Iteration 5:   log likelihood = -167.17837  (not concave)
Iteration 6:   log likelihood = -166.7424
Iteration 7:   log likelihood = -166.40188
Iteration 8:   log likelihood = -166.1633
```

```
OBJ 6 EFFICIENCY ESTIMATES FOR EACH CATFISH FARMER - Notepad
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                                      (R)
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                                              College Station, Texas 77845 USA
                                              800-STATA-PC        http://www.stata.com
                                              979-696-4600        stata@stata.com
                                              979-696-4601 (fax)

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. import excel "C:\Users\USER\Desktop\ARMSTRONG-DISSERTATION-MOUAU-2018\55555-D
> ATA MICROCREDIT AND CATFISH PRODUCTION.xlsx", sheet("Sheet1") firstrow

. save "C:\Users\USER\Desktop\ARMSTRONG-DISSERTATION-MOUAU-2018\55555-CORRECTED
>  DATA - ARMSTRONG - DISSERTATION.dta"
file C:\Users\USER\Desktop\ARMSTRONG DISSERTATION MOUAU 2018\55555 CORRECTED DA
> TA - ARMSTRONG - DISSERTATION.dta saved

. summarize effY effCY effPROFIT

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
        effY |        300    .3290247    .2007466       .098          1
       effCY |        300    .3170086    .2029938      .0945          1
   effPROFIT |        300    .2464898    .2194153   .0013304          1

. tabulate TECHNICAL EFFICIENCY ESTIMATES

       effY |      Freq.     Percent        Cum.
            |
       .098 |          1        0.33        0.33
       .102 |          1        0.33        0.67
       .103 |          3        1.00        1.67
       .105 |          4        1.33        3.00
       .107 |          2        0.67        3.67
       .109 |          4        1.33        5.00
       .112 |          6        2.00        7.00
       .113 |          5        1.67        8.67
       .122 |          1        0.33        9.00
       .123 |         17        5.67       14.67
       .141 |          6        2.00       16.67
        .15 |          4        1.33       18.00
       .156 |          1        0.33       18.33
        .16 |          2        0.67       19.00
       .161 |          6        2.00       21.00
       .165 |          2        0.67       21.67
       .171 |          2        0.67       22.33
       .174 |          7        2.33       24.67
       .175 |          2        0.67       25.33
      .1751 |          6        2.00       27.33
        .18 |          2        0.67       28.00
      .1814 |          6        2.00       30.00
       .184 |          2        0.67       30.67
       .188 |          1        0.33       31.00
       .189 |          3        1.00       32.00
        .19 |          2        0.67       32.67
         .2 |          4        1.33       34.00
       .205 |          3        1.00       35.00
       .206 |          1        0.33       35.33
        .21 |          1        0.33       35.67
       .212 |          6        2.00       37.67
       .213 |          5        1.67       39.33
       .216 |          1        0.33       30.67
        .22 |          1        0.33       40.00
       .222 |          7        2.33       42.33
        .23 |          3        1.00       43.33
       .231 |         13        4.33       47.67
       .234 |          4        1.33       49.00
        .25 |          2        0.67       49.67
        .26 |          2        0.67       50.33
       .276 |          1        0.33       50.67
         .3 |          2        0.67       51.33
        .31 |          3        1.00       52.33
       .311 |          4        1.33       53.67
        .32 |          1        0.33       54.00
       .321 |         19        6.33       60.33
        .33 |          1        0.33       60.67
       .332 |          6        2.00       62.67
       .338 |          1        0.33       63.00
        .34 |          3        1.00       64.00
       .341 |          5        1.67       65.67
       .342 |          8        2.67       68.33
       .346 |          2        0.67       69.00
        .35 |          1        0.33       69.33
        .36 |          2        0.67       70.00
       .367 |          1        0.33       70.33
        .38 |          1        0.33       70.67
       .386 |          4        1.33       72.00
       .398 |          2        0.67       72.67
         .4 |          1        0.33       73.00
       .402 |          3        1.00       74.00
       .403 |          1        0.33       74.33
       .404 |          2        0.67       75.00
       .405 |          1        0.33       75.33
        .43 |          1        0.33       75.67
       .432 |          5        1.67       77.33
       .435 |          1        0.33       77.67
       .447 |          2        0.67       78.33
        .45 |          2        0.67       79.00
        .46 |          1        0.33       79.33
       .493 |          1        0.33       70.67
       .503 |          1        0.33       80.00
       .504 |          1        0.33       80.33
        .51 |          1        0.33       80.67
       .512 |          3        1.00       81.67
       .513 |          2        0.67       82.33
        .52 |          1        0.33       82.67
       .532 |          2        0.67       83.33
       .542 |          2        0.67       84.00
       .543 |          5        1.67       85.67
       .548 |          1        0.33       86.00
       .557 |          1        0.33       86.33
       .586 |          1        0.33       86.67
       .603 |          1        0.33       87.00
       .604 |          1        0.33       87.33
       .606 |          1        0.33       87.67
       .623 |          1        0.33       88.00
       .632 |          2        0.67       88.67
        .64 |          1        0.33       89.00
       .673 |          1        0.33       89.33
        .68 |          1        0.33       89.67
       .682 |          1        0.33       90.00
       .684 |          1        0.33       90.33
        .69 |          2        0.67       91.00
       .697 |          2        0.67       91.67
       .724 |          1        0.33       92.00
       .734 |          2        0.67       92.67
       .742 |          3        1.00       93.67
        .77 |          1        0.33       94.00
      .7814 |          6        2.00       96.00
       .812 |          1        0.33       96.33
        .84 |          2        0.67       97.00
       .876 |          2        0.67       97.67
       .882 |          1        0.33       98.00
        .89 |          2        0.67       98.67
         .9 |          1        0.33       99.00
        .99 |          2        0.67       99.67
          1 |          1        0.33      100.00
------------+-----------------------------------
      Total |        300      100.00
```

OBJ 6 EFFICIENCY ESTIMATES FOR EACH CATFISH FARMER - Notepad

File Edit Format View Help

. tabulate ALLOCATIVE EFFICIENCY ESTIMATES

[illegible]	Freq.	Percent	Cum.
.0945	1	0.33	0.33
.0963	1	0.33	0.67
.098	1	0.33	1.00
.0981	1	0.33	1.33
.1008	2	0.67	2.00
.1017	1	0.33	2.33
.102	1	0.33	2.67
.103	3	1.00	3.67
.105	3	1.00	4.67
.107	1	0.33	5.00
.109	3	1.00	6.00
.1098	1	0.33	6.33
.1107	7	2.33	8.67
.112	4	1.33	10.00
.113	4	1.33	11.33
.1170	2	0.67	12.00
.123	10	3.33	15.33
.131	4	1.33	16.67
.135	1	0.33	17.00
.144	1	0.33	17.33
.1449	2	0.67	18.00
.15	3	1.00	19.00
.156	1	0.33	19.33
.1566	2	0.67	20.00
.1575	1	0.33	20.33
.15750	3	1.00	21.33
.16	1	0.33	21.67
.161	4	1.33	23.00
.162	1	0.33	23.33
.16476	2	0.67	24.00
.165	2	0.67	24.67
.1656	1	0.33	25.00
.171	3	1.00	26.00
.174	5	1.67	27.67
.175	1	0.33	28.00
.1751	3	1.00	29.00
.18	2	0.67	29.67
.1814	4	1.33	31.00
.184	1	0.33	31.33
.1845	1	0.33	31.67
.188	1	0.33	32.00
.189	3	1.00	33.00
.19	1	0.33	33.33
.1908	2	0.67	34.00
.1917	1	0.33	34.33
.1998	3	1.00	35.33
.2	3	1.00	36.33
.205	2	0.67	37.00
.206	1	0.33	37.33
.2079	5	1.67	39.00
.21	1	0.33	39.33
.2106	3	1.00	40.33
.212	4	1.33	41.67
.213	4	1.33	43.00
.216	1	0.33	43.33
.22	1	0.33	43.67
.222	4	1.33	45.00
.23	3	1.00	46.00
.231	8	2.67	48.67
.234	2	0.67	49.33
.25	2	0.67	50.00
.26	1	0.33	50.33
.27	2	0.67	51.00
.276	1	0.33	51.33
.279	2	0.67	52.00
.2799	1	0.33	52.33
.288	1	0.33	52.67
.2880	7	2.33	55.00
.297	1	0.33	55.33
.2988	3	1.00	56.33
.3042	1	0.33	56.67
.3060	2	0.67	57.33
.3078	4	1.33	58.67
.31	1	0.33	59.00
.311	3	1.00	60.00
.3114	1	0.33	60.33
.315	1	0.33	60.67
.321	12	4.00	64.67
.324	2	0.67	65.33
.332	3	1.00	66.33
.34	3	1.00	67.33
.341	3	1.00	68.33
.342	5	1.67	70.00
.346	1	0.33	70.33
.3474	1	0.33	70.67
.3582	1	0.33	71.00
.3618	1	0.33	71.33
.3627	1	0.33	71.67
.3636	2	0.67	72.33
.3645	1	0.33	72.67
.367	1	0.33	73.00
.386	3	1.00	74.00
.387	1	0.33	74.33
.3888	2	0.67	75.00
.3915	1	0.33	75.33
.398	1	0.33	75.67
.4	1	0.33	76.00
.402	2	0.67	76.67
.432	3	1.00	77.67
.447	2	0.67	78.33
.4437	1	0.33	78.67
.45	2	0.67	79.33
.4527	1	0.33	79.67
.4536	1	0.33	80.00
.46	1	0.33	80.33
.4617	1	0.33	80.67
.4887	1	0.33	81.00
.51	1	0.33	81.33
.512	3	1.00	82.33
.513	1	0.33	82.67
.52	1	0.33	83.00
.5274	1	0.33	83.33
.532	2	0.67	84.00
.547	2	0.67	84.67
.5127	1	0.33	85.00
.543	4	1.33	86.33
.5436	1	0.33	86.67
.548	1	0.33	87.00
.557	1	0.33	87.33
.6057	1	0.33	87.67
.606	1	0.33	88.00
.6138	1	0.33	88.33
.621	1	0.33	88.67
.623	1	0.33	89.00
.632	2	0.67	89.67
.64	1	0.33	90.00
.6516	1	0.33	90.33
.6606	1	0.33	90.67
.68	1	0.33	91.00
.684	1	0.33	91.33
.69	1	0.33	91.67
.693	1	0.33	92.00
.697	2	0.67	92.67
.70326	3	1.00	93.67
.7408	1	0.33	94.00
.734	1	0.33	94.33
.742	3	1.00	95.33
.756	1	0.33	95.67
.7814	3	1.00	96.67
.7884	1	0.33	97.00
.84	1	0.33	97.33
.876	1	0.33	97.67
.882	1	0.33	98.00
.89	2	0.67	98.67
.891	1	0.33	99.00
.9	1	0.33	99.33
.99	1	0.33	99.67
1	1	0.33	100.00

OBJ 6 EFFICIENCY ESTIMATES FOR EACH CATFISH FARMER - Notepad

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      Total |        300      100.00
```

. tabulate PROFIT EFFICIENCY ESTIMATES

eff PROFIT	Freq.	Percent	Cum.
.0013304	1	0.33	0.33
.0017184	1	0.33	0.67
.0018293	1	0.33	1.00
.0019101	1	0.33	1.33
.0034368	1	0.33	1.67
.0058758	1	0.33	2.00
.0070058	1	0.33	2.33
.0073171	1	0.33	2.67
.0099778	1	0.33	3.00
.0128603	2	0.67	3.67
.0131375	1	0.33	4.00
.0134701	1	0.33	4.33
.015133	1	0.33	4.67
.0157082	1	0.33	5.00
.0161863	1	0.33	5.33
.016796	1	0.33	5.67
.0169628	1	0.33	6.00
.0172949	1	0.33	6.33
.0182373	1	0.33	6.67
.0184035	2	0.67	7.33
.0197561	1	0.33	7.67
.02051	1	0.33	8.00
.0206208	1	0.33	8.33
.0218058	1	0.33	8.67
.0265188	1	0.33	9.00
.0271064	2	0.67	9.67
.028714	1	0.33	10.00
.0289135	1	0.33	10.33
.0314856	2	0.67	11.00
.0350166	1	0.33	11.33
.0404102	1	0.33	11.67
.0417406	1	0.33	12.00
.0426275	1	0.33	12.33
.0435144	1	0.33	12.67
.0452882	1	0.33	13.00
.0479047	1	0.33	13.33
.0487751	1	0.33	13.67
.0505543	1	0.33	14.00
.0526608	3	1.00	15.00
.0527716	1	0.33	15.33
.0548226	1	0.33	15.67
.0552106	1	0.33	16.00
.0565965	1	0.33	16.33
.0588692	1	0.33	16.67
.05898	4	1.33	18.00
.0598016	1	0.33	18.33
.0593681	2	0.67	19.00
.060643	1	0.33	19.33
.0619744	1	0.33	19.67
.0650776	1	0.33	20.00
.0654102	1	0.33	20.33
.0666297	1	0.33	20.67
.068159	1	0.33	21.00
.0690687	1	0.33	21.33
.0692239	1	0.33	21.67
.0720621	2	0.67	22.33
.0722838	1	0.33	22.67
.074612	1	0.33	23.00
.0759978	1	0.33	23.33
.076663	1	0.33	23.67
.0784922	1	0.33	24.00
.0788248	1	0.33	24.33
.0796563	1	0.33	24.67
.079878	1	0.33	25.00
.0799889	1	0.33	25.33
.0805766	1	0.33	25.67
.0805132	1	0.33	26.00
.0818182	1	0.33	26.33
.0837583	1	0.33	26.67
.0866408	1	0.33	27.00
.0875277	1	0.33	27.33
.0883592	1	0.33	27.67
.0885755	1	0.33	28.00
.0906874	1	0.33	28.33
.0916851	1	0.33	28.67
.0916962	1	0.33	29.00
.0927948	1	0.33	29.33
.097561	1	0.33	29.67
.0983925	1	0.33	30.00
.0995565	1	0.33	30.33
.099939	3	1.00	31.33
.1002772	1	0.33	31.67
.1017184	1	0.33	32.00
.1018798	1	0.33	32.33
.1019956	2	0.67	33.00
.1023282	1	0.33	33.33
.1034759	1	0.33	33.67
.1039357	1	0.33	34.00
.1074279	1	0.33	34.33
.1103104	1	0.33	34.67
.1105987	1	0.33	35.00
.1107871	1	0.33	35.33
.1150776	1	0.33	35.67
.1167406	1	0.33	36.00
.1168514	1	0.33	36.33
.1189579	1	0.33	36.67
.1196281	1	0.33	37.00
.1199557	1	0.33	37.33
.1211752	1	0.33	37.67
.1238914	1	0.33	38.00
.1242239	1	0.33	38.33
.1248337	1	0.33	38.67
.125316	1	0.33	39.00
.1268736	1	0.33	39.33
.1287694	1	0.33	39.67
.1341463	1	0.33	40.00
.1347018	1	0.33	40.33
.1360863	1	0.33	40.67
.1370288	1	0.33	41.00
.1383703	1	0.33	41.33
.1388581	1	0.33	41.67
.1393016	1	0.33	42.00
.1402439	2	0.67	42.67
.1407777	1	0.33	43.00
.14102	1	0.33	43.33
.1423503	3	1.00	44.33
.1427484	1	0.33	44.67
.1437916	1	0.33	45.00
.1440687	1	0.33	45.33
.1519056	1	0.33	45.67
.1537694	1	0.33	46.00
.1603104	1	0.33	46.33
.1720621	1	0.33	46.67
.1742816	1	0.33	47.00
.1761641	1	0.33	47.33
.1801552	1	0.33	47.67
.1804878	1	0.33	48.00
.188581	1	0.33	48.33
.1918514	1	0.33	48.67
.1925166	1	0.33	49.00
.1954545	1	0.33	49.33
.1969512	1	0.33	49.67
.1978936	4	1.33	51.00
.1997783	1	0.33	51.33
.2006098	1	0.33	51.67
.2010532	1	0.33	52.00
.2011086	1	0.33	52.33
.2025499	1	0.33	52.67
.204878	1	0.33	53.00
.2067073	1	0.33	53.33
.2092572	1	0.33	53.67
.2121508	1	0.33	54.00
.2125277	1	0.33	54.33
.2129712	1	0.33	54.67
.2174058	3	1.00	55.67
.2177938	1	0.33	56.00

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 .2178492 |          2        0.67     56.67
 .2191796 |          1        0.33     57.00
 .2241685 |          1        0.33     57.33
 .2257206 |          1        0.33     57.67
 .2258813 |          1        0.33     58.00
 .2261080 |          1        0.33     58.33
 .2264967 |          1        0.33     58.67
 .2266075 |          1        0.33     59.00
  .226663 |          1        0.33     59.33
 .2277162 |          1        0.33     59.67
 .2304878 |          1        0.33     60.00
 .2319843 |          1        0.33     60.33
 .2362528 |          1        0.33     60.67
 .2395344 |          1        0.33     61.00
 .2415743 |          1        0.33     61.33
 .2418559 |          1        0.33     61.67
 .2460643 |          1        0.33     62.00
 .2472284 |          1        0.33     62.33
 .2477848 |          1        0.33     62.67
 .2482262 |          1        0.33     63.00
 .2486142 |          1        0.33     63.33
 .2516073 |          2        0.67     64.00
 .2532151 |          1        0.33     64.33
 .2549335 |          1        0.33     64.67
 .2562084 |          1        0.33     65.00
 .2587583 |          1        0.33     65.33
 .2588692 |          3        1.00     66.33
 .2600887 |          1        0.33     66.67
 .2667406 |          1        0.33     67.00
 .2672506 |          1        0.33     67.33
 .2674058 |          1        0.33     67.67
 .2694013 |          1        0.33     68.00
 .2719446 |          1        0.33     68.33
 .2760532 |          1        0.33     68.67
 .2824834 |          1        0.33     69.00
 .2840477 |          1        0.33     69.33
 .2854545 |          1        0.33     69.67
 .2885421 |          1        0.33     70.00
 .3019401 |          1        0.33     70.33
 .3030188 |          1        0.33     70.67
 .3038248 |          2        0.67     71.33
 .3053760 |          1        0.33     71.67
 .3070953 |          1        0.33     72.00
 .3077605 |          1        0.33     72.33
 .3087583 |          1        0.33     72.67
 .3124871 |          1        0.33     73.00
 .3126386 |          1        0.33     73.33
 .3160754 |          1        0.33     73.67
 .3174058 |          1        0.33     74.00
   .31949 |          1        0.33     74.33
 .3204545 |          1        0.33     74.67
```

Ln 440, Col 49

3:54 AM 8/19/2019

Objective 7

OBJECTIVE 7 - Notepad

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```
  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
___/   /   /___/   /   /___/   14.2   Copyright 1985-2015 StataCorp LLC
  Statistics/Data Analysis            StataCorp
                                      4905 Lakeway Drive
                                      College Station, Texas 77845 USA
                                      800-STATA-PC        http://www.stata.com
                                      979-696-4600        stata@stata.com
                                      979-696-4601 (fax)

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Notes:
      1.  Unicode is supported; see help unicode_advice.

. use "C:\Users\USER\Desktop\ARMSTRONG-DISSERTATION-MOUAU-2018\55555-CORRECTED
> DATA - ARMSTRONG - DISSERTATION.dta", clear

. spearman MACES UTILZED REPAY, stats(rho obs p) bonferroni pw

+-----------------+
| Key             |
|-----------------|
| rho             |
| Number of obs   |
| Sig. level      |
+-----------------+

             |    MACES  UTILZED    REPAY
-------------+---------------------------
       MACES |   1.0000
             |      300
             |
             |
     UTILZED |   0.5246   1.0000
             |      300      300
             |   0.0000
             |
       REPAY |   0.9262   0.4752   1.0000
             |      300      300      300
             |   0.0000   0.0000
             |

. spearman MACES UTILZED REPAY, stats(rho obs p) sidak pw

+-----------------+
| Key             |
|-----------------|
| rho             |
| Number of obs   |
| Sig. level      |
+-----------------+

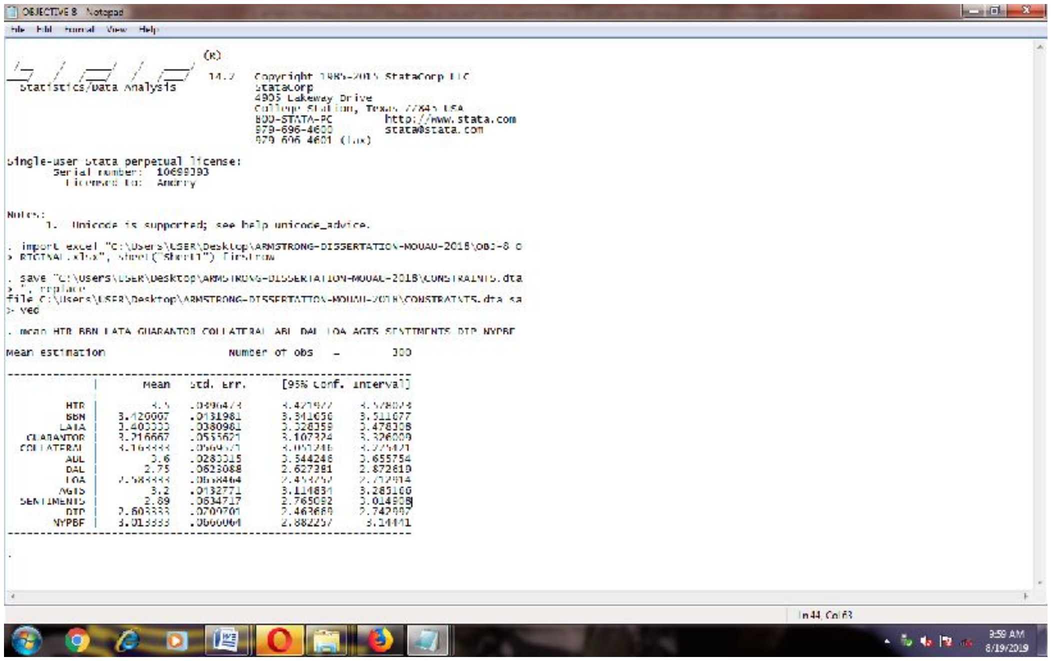
             |    MACES  UTILZED    REPAY
-------------+---------------------------
       MACES |   1.0000
             |      300
             |
             |
     UTILZED |   0.5246   1.0000
             |      300      300
             |   0.0000
             |
       REPAY |   0.9262   0.4752   1.0000
             |      300      300      300
             |   0.0000   0.0000
             |

.
```

Ln 35, Col 25

3:56 AM 8/19/2019

Objective 8



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OBJECTIVE 8 - Notepad
File Edit Format View Help

                                              (R)
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Notes:
      1.  Unicode is supported; see help unicode_advice.

. import excel "C:\Users\USER\Desktop\ARMSTRONG-DISSERTATION-MOUAU-2018\OBJ-8 O
> RIGINAL.xlsx", sheet("Sheet1") firstrow

. save "C:\Users\USER\Desktop\ARMSTRONG-DISSERTATION-MOUAU-2018\CONSTRAINTS.dta
> ", replace
file C:\Users\USER\Desktop\ARMSTRONG-DISSERTATION-MOUAU-2018\CONSTRAINTS.dta sa
> ved

. mean HTR BBN LATA GUARANTOR COLLATERAL ABL DAL LOA AGTS SENTIMENTS DIP NYPBF

Mean estimation                   Number of obs   =        300

--------------------------------------------------------------
             |       Mean   Std. Err.     [95% Conf. Interval]
-------------+------------------------------------------------
         HTR |        3.5   .0396478      3.421977    3.578023
         BBN |   3.426667   .0431981      3.341656    3.511677
        LATA |   3.403333   .0380981      3.328359    3.478308
   GUARANTOR |   3.216667   .0555621      3.107324    3.326009
  COLLATERAL |   3.163333   .0569571      3.051246    3.275421
         ABL |        3.6   .0283315      3.544246    3.655754
         DAL |       2.75   .0623088      2.627381    2.872619
         LOA |   2.583333   .0658464      2.453757     2.71291
        AGTS |        3.2   .0432771      3.114834    3.285166
  SENTIMENTS |       2.89   .0634717      2.765092    3.014908
         DIP |   2.603333   .0709701      2.463669    2.742997
       NYPBF |   3.013333   .0660064      2.882257     3.14441
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                                                             Ln 44, Col 63
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