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EFFECTS OF AGRICULTURAL LOANS IN DEVELOPING COUNTRIES – BENIN
CASE STUDY

DISSERTATION

A dissertation submitted in partial fulfillment of the requirements for the degree
of Doctor of Philosophy in the College of Agriculture, Food and Environment at the
University of Kentucky

By
Nicaise Sheila Mahutin Sagbo

Lexington, Kentucky

Co-Directors: Dr. Yoko Kusunose, Assistant Professor of Agricultural Economics
and Dr. Leigh Maynard, Professor of Agricultural Economics

Lexington, Kentucky

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ABSTRACT OF DISSERTATION

EFFECTS OF AGRICULTURAL LOANS IN DEVELOPING COUNTRIES – BENIN CASE STUDY

Limited access to financial services is known as a major constraint to agricultural development (FAO, 2002). Farmers need liquidity to face agricultural expenses throughout the production cycle but mainly at the beginning. Mainstream financial institutions are reluctant to serve the agricultural sector for several reasons. First, they consider the sector to be highly risky with low performance. Also, agricultural activities depend on the weather, they take place in remote rural areas, and commodities prices are volatile. All these aspects make it hard for conventional banks to reach their profit goals when lending to farmers. Since microfinance was conceived, it has generated much hope for alleviating poverty in low-income countries. Microfinance provides the poor with access to affordable capital by granting low-income individuals with loans they would not otherwise have access to, because of economic and geographic constraints.

The goal of the dissertation is to examine the role and the importance of microfinance in the agricultural sector of developing countries. A survey took place in October 2017, in both rural and urban areas of Benin and involved 750 agricultural households. Three different agricultural zones were selected: the North-East (cotton zone); the Center (tubers and cashew nut zone) and the South (a region with special crops such as vegetables, pineapple, palm tree, exotic plants). The study focuses on agricultural loans. It includes clients of the major microfinance institution in Benin: FECECAM - *Faîtière des Caisses d'Épargne et de Crédit Agricole Mutuel*.

This research contributes to the literature in several ways. The study allows shedding light on the effects of agricultural loans, specifically, on households' efficiency and labor employment, which are mostly overlooked in the microfinance literature. To overcome selection bias in microcredit evaluation, the research employs a *pipeline* design. Control and treatment groups consist of individuals who have chosen to participate in the microfinance program. The loan treatment considered is the experience with loans which includes program entry timing, loan take-up frequency, and the average amount of loan obtained over the 2012-2017 period. The study employs a cluster analysis technique to create reliable comparable groups.

Multiple variables and indicators are analyzed. A descriptive analysis of loan impact on farmers' labor input choices shows that past loans have residual effects on both hired and family labor use. Farm loans, especially those obtained for farm machinery significantly reduce expenditure on hired labor but more family labor is employed using machine loans while other loan categories reduced the use of family labor. The evaluation

of the whole-farm efficiency of borrowers in the presence of agricultural loans reveals significant technical and allocative errors leading to profit loss in all studied regions. However, experience with loans significantly increases farmers' whole-farm efficiency, particularly in the North. Finally, the assessment of well-being indicators suggests that those farm loans have a significant positive impact on sampled recipients' net farm income, food security and food quality statuses. Agricultural loans also have a positive impact on women's empowerment. The monitoring and implementation mechanism of FECECAM played a crucial role in the success of its loan programs.

KEYWORDS: Microfinance, Microcredit, Agricultural Loans,
Impact Evaluation, Pipeline Approach, Matching

Nicaise Sheila Mahutin Sagbo

March 15, 2019

EFFECTS OF AGRICULTURAL LOANS IN DEVELOPING COUNTRIES – BENIN
CASE STUDY

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March 15, 2019

To my late mother, Marguerite.

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TABLE OF CONTENT

ACKNOWLEDGEMENTS	iii
LIST OF TABLE	vii
LISTE OF FIGURES	viii
1. Introduction.....	1
1.1. Motivation and objective	1
1.2. Background and literature review	3
1.2.1. Microfinance: definition and approaches.....	3
1.2.2. Microfinance challenges	4
1.2.3. Microfinance and risk management	5
1.2.4. History of microfinance in Benin	7
1.2.5. Types of microfinance institutions in Benin	9
1.3. Presentation of the studied lender and its products.....	10
1.3.1. Why FECECAM?	10
1.3.2. Loan products.....	10
1.4. Survey design.....	12
1.4.1. Survey area, data collection, and data.....	12
1.4.2. Survey design.....	14
1.5. Impact assessment approach	15
1.5.1. Brief notes on microfinance studies history.....	15
1.5.2. Issues in identifying causal effects of microloans	16
1.5.3. Identification strategy	18
1.6. Description of the sample and summary statistics	21
1.6.1. Respondents' characteristics	21
1.6.2. Respondents' household characteristics	22
1.6.3. Credit history	23
Chapter 1 Tables and Figures	24
2.Agricultural loans and farm labor: a broader perspective on the impact of microcredit	33
2.1. Introduction.....	33
2.2. Farm household structure and labor use	35
2.3. Hypothesis of the chapter.....	37
2.4. Methodology	37
2.5. Results.....	39
2.5.1. Descriptive analysis	39
2.5.2. Agricultural loans and farm labor use.....	42
2.6. Conclusion	44
Chapter 2 Tables and figures	45

3.Does experience with agricultural loans improve farmers’ efficiency in Benin? A stochastic frontier analysis	51
3.1. Introduction.....	51
3.2. Conceptual framework.....	53
3.2.1. The concept of efficiency: definition and measurement	53
3.2.2. Agricultural loans and farmers’ efficiency	55
3.3. Empirical framework	58
3.3.1. The profit frontier function	58
3.3.2. Estimating the effect of loan experience on borrowers’ efficiency	60
3.3.3. ATE versus ATET	62
3.4. Results.....	63
3.4.1. Data overview	63
3.4.2. Stochastic profit frontier estimation.....	65
3.4.3. Profit efficiency scores	67
3.4.4. Agricultural loans and efficiency.....	68
3.5.Implications and Conclusion	71
Chapter 3 Tables and figures	73
4.Impact of agricultural loans on farmers’ well being	81
4.1. Introduction.....	81
4.2. Theoretical framework.....	83
4.2.1. MFIs’ strategy and expected impact of microcredit	83
4.2.2. Microloan allocation as determinant of its impact.....	84
4.2.3. Conceptual role of agricultural credit	85
4.3. Impact estimation.....	86
4.4. Results.....	88
4.4.1. Loan repurposing and loan sharing.....	88
4.4.2. Impact of loans experience on net farm income	89
4.4.3. Impact of loans experience on Food security and nutritional status	90
4.4.4. Impact of loans experience on women empowerment.....	92
4.5. Conclusion	93
Chapter 4 Tables and Figures	95
General conclusion and discussion	103
References.....	107
Vita.....	116

LIST OF TABLE

Table 1.1: Different farm loan products offered by FECECAM	24
Table 1.2: Proportion of cohorts	25
Table 1.3: Summary statistics of clusters identified	25
Table 1.4: Mean comparison of observed characteristics of experienced and inexperienced participants	26
Table 1.5: Gender and age of respondents by location	27
Table 2.1: Purpose of loan obtained from 2012 to 2017 (%).....	45
Table 2.2: Share of respondents using family labor, day laborers, seasonal laborers, and permanent workers (%).....	45
Table 2.3: Family labor in man-days used on all PUs and on sampled borrowers' PU ...	46
Table 2.4: Crops produced by respondents by region (% of area planted).....	46
Table 2.5: Few technologies used by respondents and their relative importance by region (%).....	46
Table 2.6: Tobit estimation results - Marginal effects of lagged loans amount on hired labor expenditure (in 100,000 FCFA)	47
Table 2.7: Tobit estimation results - Marginal effects of lagged loans amount on number of family man-days used.....	47
Table 2.8: Mean comparison of technologies by respondents used by region (% of respondents)	49
Table 2.9: Mean comparison of expenditure on hired labor, herbicide, and machine rental services (in FCFA)	49
Table 3.1: Summary statistics by region.....	73
Table 3.2: Maximum Likelihood estimates of profit frontier function by region	74
Table 3.3: Efficiency scores and mean comparison by region	75
Table 3.4: Treatment effect estimates by region.....	75
Table 4.1: Mean comparison (t-test) of farm characteristics between experienced and inexperienced borrowers	95
Table 4.2: Average causal effect of credit experience on net farm income (100,000 FCFA) (Two-nearest-neighbors' technique used).....	95
Table 4.3: Mean comparison (t-test) of food security, food quality and empowerment statuses between experienced and inexperienced borrowers	95
Table 4.4: Average causal effect of experience with farm loan on food security status (FIES score) (Two-nearest-neighbors' technique used).....	96
Table 4.5: Average causal effect of experience with farm loan on food quality (FCS) (Two-nearest-neighbors' technique used).....	96
Table 4.6: Average causal effect of experience with farm loan women's empowerment (WEAI) (Two-nearest-neighbors' technique used)	96

LISTE OF FIGURES

Figure 1.1: Number of clients served by MFIs over time in Benin	28
Figure 1.2: Amount of savings deposited to MFI over time in Benin	28
Figure 1.3: Loan application timing during the studied period	29
Figure 1.4: Distribution of respondents and sampled service points	30
Figure 1.5: Number of agricultural loan recipients between 2012 and 2017 in the population and in the sample by studied region.....	31
Figure 1.6: Number of years during which clients took loans by their entry time.	31
Figure 1.7: Average years of schooling by gender and location.....	32
Figure 1.8: Amount of FECECAM loan received over time by region and gender	32
Figure 2.1: Share of labor force employed in agriculture as a percentage of the total labor force in Benin.....	50
Figure 3.1: Contribution of farming activities to farmers' income.....	76
Figure 3.2: Covariates balance diagnostic box plots and Kernel density plot using the matched data in the North.....	76
Figure 3.3: Covariates balance diagnostic box plots and Kernel density plot using the matched data in the Center.....	77
Figure 3.4: Covariates balance diagnostic box plots and Kernel density plot using the matched data in the South.....	78
Figure 3.5: Estimated densities of predicted probabilities of getting each treatment level in the North (overlap check)	79
Figure 3.6: Estimated densities of predicted probabilities of getting each treatment level in the Center (overlap check)	79
Figure 3.7: Estimated densities of predicted probabilities of getting each treatment level in the South (overlap check)	80
Figure 4.1: Shares of loan repurposed by region (%)	97
Figure 4.2: Covariates balance diagnostic box plots and Kernel density plot using the matched data (Net farm income).....	97
Figure 4.3: Covariates balance diagnostic box plots and Kernel density plot using the matched data (Food Insecurity Experience Scale).....	98
Figure 4.4: Covariates balance diagnostic box plots and Kernel density plot using the matched data (Food Consumption Score).....	99
Figure 4.5: Covariates balance diagnostic box plots and Kernel density plot using the matched data (Women Empowerment in Agriculture Index).....	100
Figure 4.6: Overlap check for matching – Net farm income	101
Figure 4.7: Overlap check for matching – FIES score.....	101
Figure 4.8: Overlap check for matching – FCS score.....	102
Figure 4.9: Overlap check for matching – WEAI.....	102

1. Introduction

1.1. Motivation and objective

Since microfinance was conceived, it has generated a lot of hope for alleviating poverty in low-income countries. Microfinance provides the poor with access to affordable capital by granting low-income individuals with loans they would not otherwise have access to, not only because of economic reasons but also because of geographic ones. Microfinance also covers a variety of other products and services such as micro-savings, microinsurance, transfers, leasing, as well as financial services training.

Microfinance, and more specifically, microcredit programs, have been supported as sustainable interventions with the potential to alleviate poverty (Pankhurst and Johnston, 1999). However, the literature reveals discrepancies between what microfinance ought to do, and what it actually does. More, evidence of the effectiveness of microfinance is still unclear. On the one hand, studies show that microfinance does help the poor improve their productivity or their well-being and enables them to pull out of poverty (Girabi and Mwakaje, 2013; Otero, 1999; Pitt and Khandker, 1998). On the other hand, other studies claim that evidence supporting the positive impact of microfinance interventions are thin and lack rigor (Banerjee, Duflo, Glennerster, and Kinnan, 2014; Feder, Lau, Lin, and Luo, 1990; Roodman and Morduch, 2014).

The goal of this study is to examine the role and the importance of microfinance in the agricultural sector of developing countries. More specifically, the study aims at assessing the effects of agricultural loans on the rural world including farmers' well-being, production efficiency as well as their labor and technology use in the context of Benin—in West Africa. Benin has made significant progress in improving access to financial services over the past decades, and the country offers an interesting perspective for a research on the subject. For the most part, financial service access points in Benin are evenly distributed; there are no communes¹ in the country that do not have at least one access point. Indeed, most communes have at least six financial service providers present, potentially indicating local competition (Brosnan, 2016). Moreover, Benin ranks among the tops in microfinance in the West African Economic and Monetary Union (WAEMU),

¹ Communes are the second administrative territorial divisions in Benin and there are seventy-seven (77) communes in Benin.

with a substantial expansion of Microfinance Institutions (MFIs) in various forms, both in rural and urban areas (Lélart, 2007).

For the study, a survey took place in October 2017, in both rural and urban areas of Benin and involved 750 agricultural households. Three contrasting agricultural zones were selected: the North-East (cotton zone); the Center (tubers and cashew nut zone) and the South (zone with special crops such as vegetables, pineapple, palm tree, exotic plants). The study focuses on agricultural loans. It includes clients of the major microfinance institution in Benin: FECECAM - *Faîtière des Caisses d'Épargne et de Crédit Agricole Mutuel*. FECECAM was established in 1977 and represents as of 2017, more than 50%² of the microloan supply in Benin. In its current form, FECECAM is a network of savings and credit cooperatives or rural banks with 136 branches throughout the country. The lender has a long tradition of micro and medium agricultural loans for small and medium-sized farms. The data, therefore, consist of a cross-section of both self-reported and data provided by FECECAM.

This research contributes to the literature in several ways. The study allows shedding light on the effects of agricultural loans, specifically, on households' efficiency and labor employment, which are mostly overlooked in the literature. More, this study is one of the first of the kind, to our knowledge, in the Benin context and will produce a unique dataset. The fieldwork and the data gathered represent a major contribution both to the research world and practitioners. In fact, to increase the funding of the agricultural sector, support is expected from public and private entities, Governments and donors. But for this, evidences of positive impacts of agricultural loans on farms and development objectives are needed, including poverty reduction, job creation, and food security. Thus, the study will inform on the merits of external support to farm credit.

The rest of the dissertation is organized as follow. The first chapter introduces the context and justification of the study, presents the research design including the identification strategy, and provides a description of the sampled borrowers. The next chapter presents a descriptive analysis of how agricultural loans affect farm labor use by borrowers. The chapter relates credit availability to farmers' labor input decisions, which

² According to a speech of the Director of FECECAM in June 2017.

pertain both to direct and indirect expected impact of farm credit. It also examines the relation between labor and capital in the presence of farm loans. The third chapter of the dissertation assesses the effect of agricultural loans on input allocation decisions and farm profitability. It evaluates the impact of agricultural loans on the whole-farm efficiency of borrowers in Benin. The fourth chapter assesses the impact of agricultural loans on farmers' well-being measured by their net farm income, nutritional and food security status as well as women's empowerment in agriculture index for female borrowers. Finally, a general conclusion discusses the results of the dissertation and provide some recommendations to different actors of the credit sector.

1.2. Background and literature review

1.2.1. Microfinance: definition and approaches

Microfinance is the provision of various financial services to the working poor. Microcredit provides working poor with access to affordable capital by granting them loans they would not otherwise have access to, because they do not meet both the economic and geographic requirements of mainstream banks. Microfinance also covers a variety of other products and services such as micro-savings, microinsurance, transfers, leasing, as well as financial services training. This study focuses on microcredit and assesses its effect on agricultural households.

Two divergent approaches dominate the current debates in the microfinance field: the commercial approach or financial system approach and the poverty lending approach. The commercial approach, which has a strong neoliberal groundwork, targets the economically active poor—those with skills and earning capacity—and not the ultra-poor. This approach is based on full cost-recovery, institutional self-sustainability and demand-driven outreach principles (Batra, 2010). In contrast, the poverty lending approach, which is the dominant paradigm in developing countries, targets the extremely poor to help them out of poverty and gain empowerment. Under this approach, loans at below-market interest rates are provided to the poor with funds from donors or governments. Even though the approaches emphasize different aspects—on entrepreneurship and growth for the former, and on poverty alleviation and empowerment for the latter—there is evidence that both approaches contribute to the development of institutional microfinance (Batra, 2010). The

studied lender is a microfinance cooperative, which predominantly uses the financial system approach. Though FECECAM has to cover its cost by ensuring financial sustainability, the cooperative has a social component in its portfolio with very small loans offered especially to poor women who benefit from group lending. These group loans come with training and education on various aspects such as health, nutrition, and finance.

1.2.2. Microfinance challenges

In general, the microfinance sector face several challenges. One of the major challenges faced by the sector resides in the fact that clients are hard to evaluate in terms of risk and often costly to serve (Armendáriz de Aghion and Morduch, 2005). First, low-income households, typically excluded from the formal banking system, lack collateral that a financial institution needs in case of default. Second, mainstream banks tend to locate in urban centers while most of the poor in developing world live in rural areas. Consequently, the administrative costs of serving these rural clients are very high making it less profitable (Ellrich and Sarges, 2010). The fixed cost of lending is therefore too high for small loans, especially in rural areas. Third, creditors do not have complete information about the borrowers. Either adverse selection occurs and banks cannot easily determine riskier customers from safer and charge them accordingly, and/or moral hazard arises and lenders are unable to ensure that customers are doing their best to make their investment projects successful. In developing countries, weak judicial systems worsen these problems because of the difficulty to enforce contracts (Armendáriz de Aghion and Morduch, 2005).

Several mechanisms have been developed to cope with these challenges. A standard tool used involves requiring borrowers to apply for credit in voluntarily formed groups: assuming that borrowers have better information about each other and will avoid higher risk members (Armendáriz de Aghion and Morduch, 2005). The key feature of group lending is the so-called joint liability (Stiglitz, 1990). According to this principle, all group members are treated as being in default if a single member does not repay his loan. This model was first used by the Grameen Bank in Bangladesh. In Benin, microfinance institutions usually rely on group-based guarantees and women-led microcredits to cope with the information asymmetry and the lack of collateral. However, while this promoted

the expansion at the early stage, it also contributed to the prevalence of unauthorized MFIs (Cui, Dieterich, and Maino, 2016).

Several scholars point out the benefits of group lending (Armendáriz de Aghion and Morduch, 2000; Godquin, 2004; Gomez and Santor, 2003; Guttman, 2007). For instance, group meetings, through education and training, help clients with little experience improve the financial performance of their businesses (Armendáriz de Aghion and Morduch, 2000). Group lending plays a key role in mitigating risks associated with information asymmetry (Godquin, 2004). Because group borrowers are jointly liable, they have the incentive to monitor each other especially when one of them switches to a riskier project (moral hazard). Therefore, peer pressure and social ties help reduce group members' default (Guttman, 2007). For instance, utilizing data from two North American microfinance institutions, Gomez and Santor (2003) find evidence that those enrolled in group loans programs outperform individual borrowers in terms of default probabilities. They attribute that effect to the dual channels of sorting and incentives for greater effort once inside the group.

However, there are negative aspects to introducing group lending (Armendáriz de Aghion and Morduch, 2000; Besley and Coate, 1995; Kodongo and Kendi, 2013; Shankar, 2007). Group lending is often associated with additional costs such as group formation costs, training costs of borrowers on group procedures, supervision and a higher frequency of installment payments. The fact that all group members are penalized because of one or few members represent an unappealing trait of group lending. Furthermore, merely gathering good information does not guarantee contract enforcement or prevent strategic default. Even when loan officers collect the necessary information before and after the loan is given, they still face the problem of enforcing debt repayments once borrowers get their investment' returns. To circumvent the enforcement issue, most MFIs rely on dynamic incentives; that is, good borrowers receive larger loans over time and defaulting ones incur the risk of not receiving any more loans (Armendáriz de Aghion and Morduch, 2000).

1.2.3. Microfinance and risk management

Farmers in developing countries also face significant risk constraints along with capital constraints. If lack of access to credit can limit farmers' investment in activities with higher

profits, lack of access to formal insurance market can also prevent farmers from investing in activities that may be risky but have high expected returns (Cai, Chen, Fang, and Zhou, 2015; Karlan, Osei, Osei-Akoto, and Udry, 2014).

Karlan *et al.* (2014) reported that farmers in northern Ghana most often cite lack of capital as the reason why they have low farm investment, but they also understand the risk of unpredictable rainfall and claim to reduce their farm investment because of it. The results of their study show that capital constraints alone are not the problem but risk represents a key hindrance to investment. The study concludes that the binding constraint to farmer investment is uninsured risk as farmers are able to find resources to increase expenditure on their farms when provided with insurance against the main catastrophic risk they face.

Microcredit networks and infrastructure could be used to construct better risk-management tools. Although there has been some attempt at this, it has traditionally been life insurance, not rainfall or a form of agricultural insurance (Karlan *et al.*, 2014). Using the first large-scale randomized experimental evidence of the effect of micro-insurance on farmer production behavior, Cai *et al.* (2015) showed that micro-insurance may be as important as microfinance in poverty alleviation, and that micro-insurance can supplement and strengthen the effects of microfinance by protection the farmers from the inherent risk of entrepreneurial activities.

For developing countries, agricultural insurance is not the “miracle solution” but it has the potential to contribute to the development of more intensive and productive agricultural systems by managing residual risks and securing income and credit programs. In western African counties, crop insurances started very recently with the development of index based crop insurance pilot projects in Mali and Burkina Faso (cotton, maize), Benin (maize), and Senegal (groundnut, maize) (Muller *et al.*, 2013). In those countries, the index insurance pilot project covers farmers against rainfall deficit in order to protect them against drought but also to protect financial institutions against the risk of default of their borrowers.

In Benin, a local agricultural insurance institution has been created in 2007 to help farm households cope with risk: the Agriculture Mutual Insurance of Benin (*Assurance Mutuelle Agricole du Bénin - AMAB*). Besides the index insurance project for maize, AMAB offers other products such as multi-risk harvest insurance, livestock mortality insurance,

agricultural facilities and warehouse insurance, health insurance (hospitalization) for farmers, to name a few.

1.2.4. History of microfinance in Benin

The Republic of Benin is a small country in West Africa located between Nigeria and Togo. Its total area is 112,622 sq km (43483.58 sq mi). As of 2015, Benin has an estimated population of 10.9 million inhabitants. During the 2011-2015 period, Benin's real gross domestic product (GDP) growth increased from 4.6% in 2012 to 6.5% in 2014 and was among the best in WAEMU countries (The World Bank, 2016). However, poverty remains widespread and even rising in the country. In 2007, the national poverty rate in Benin is estimated at 32.2% for the monetary poverty and 39.6% for the non-monetary incidence of poverty (INSAE, 2009). According to The World Bank (2016), this rate rose to 40.1% in 2015.

Benin's experience with microfinance started in 1977, when a network of local farm co-operatives, *Caisses Locales de Crédit Agricole Mutuel (CLCAM³)* was created along with the national farm credit bank (*Caisse Nationale de Crédit Agricole (CNCA)*). The initial goal of the CNCA was to provide savings and credit services to farmers, government workers as well as business owners. The emergence of microfinance organizations as we know them today in Benin is a more recent phenomenon, the result of a series of events. First, in the mid-1980s, the West African Economic and Monetary Union (WAEMU or Union) countries, including Benin, faced a severe economic and social crisis. Benin experienced the bankruptcy of its banking system and the subsequent closure of all state banks⁴ which led to a lack of funding sources for all key sectors of the economy (Adechoubou, 1996). It is believed that the financial crisis resulted from excessive government intervention in the financial system. Consequently, in the early 1990s, the government undertook a series of reforms to create strict regulatory frameworks to support the emergence of a competitive private financial sector (Joseph, 2002). The government also pulled out of most state-owned enterprises.

³ Local farm co-operatives (CLCAM) were overseen by the national farm co-operatives' network of Benin which is FECECAM (*Faitières des caisses d'Épargne et de Crédit Agricole Mutuel du Bénin*) in its old form.

⁴ These include the CNCA in 1987, the Benin Bank for Development in 1989 and the Commercial Bank of Benin in 1990.

This withdrawal of the government facilitated the emergence of many micro-enterprises, most of them in the informal sector, whose financing needs were not taken into account by the formal financial sector in reconstruction. The WAEMU authorities, with the support of International Development Cooperation Agency (CID), therefore committed to broadening the financial landscape of the Union by promoting MFIs,⁵ which are designed to meet the diverse financial needs of the population. In Benin, as in the whole Union, the microfinance sector is, therefore, regulated by a law called the PARMEC⁶ Act. With this act, savings and credit unions, as well as cooperatives, can be approved and their local affiliates officially recognized by the respective Ministries of Finance of the member states. Since its adoption in 1993, the PARMEC Act has been a major tool for the development of the microfinance sector in West Africa by securing the collection of savings, helping to control credit management and contributing to the professionalization of MFIs (PNUD-Bénin, 2007). In 2012, Benin updated the PARMEC Act. Thus, in Benin, the operation of MFIs is now governed by the 2012 Act regulating MFIs.

As of June 30, 2017, the Ministry of Economy and Finance reported 98 registered MFIs operating in Benin with 639 service locations throughout the country (MEF, 2017). However, several other MFIs operate illegally in the country and including them brings the number of service points in the country up to 800 (PLURIEX, 2011). During the period 2005 to 2015, the number of clients collectively served by MFIs increased from 687,000 to 1,825,000. These figures reflect the rapid growth of MFIs in Benin even if a significant segment of the population remains excluded from financial services. Figure 1.1 shows the evolution of the number of clients over time.

As mentioned above, 78% of MFIs in Benin offer both credit and voluntary savings opportunities to their clients. The amount of deposit has exponentially increased over the last ten years. In 2005, clients' deposits amounted 39.8 billion FCFA⁷ while in 2015 deposits were about 93.5 billion FCFA. Over the same ten years' period, 74.2 billion FCFA

⁵ In Benin, MFIs are called decentralized financial systems (systèmes financiers décentralisés (SFD)). FECECAM is a classical MFI with a greater regulatory oversight.

⁶ PARMEC stands for *Projet d'Appui à la Réglementation des Mutuelles et Cooperatives d'Epargne et de Crédit* (Project to support the regulation of savings and credit unions and cooperatives)

⁷ 1 USD ≈ 540 FCFA

of credit were disbursed by MFIs in 2005 and 124.03 billion FCFA in 2015 (MEF, 2016). Figure 1.2 shows the amount deposited at MFIs over time in Benin

1.2.5. Types of microfinance institutions in Benin

There are several types of service providers in the microfinance sector in Benin. We can classify microfinance institutions in terms of their mode of operation or their legal status. In terms of legal status, two main categories exist:

- Unions and cooperatives of savings and credit: these are institutions incorporated and licensed to provide microfinance services.
- Institutions non-incorporated as unions or cooperatives of savings and credit. These institutions have their own legal status but also engage in microfinance activities. However, these institutions are required to sign an agreement with the Ministry of Finance which monitors their microfinance activities. Non-governmental Organizations (NGOs), Microfinance companies (for-profit), and governmental programs or projects are in this category.

When one considers the mode of operation, MFIs can be grouped into three main categories (Amouzou, 2008; PNUD-Bénin, 2007).

- Credit and savings institutions: they offer both credit products and voluntary savings. This type of institution includes unions and cooperatives as well as savings and credit groups. According to the 2005 MFI census⁸, they represent 78% of the microfinance institutions inventoried.
- Credit-only non-deposit taking institutions only grant credits, either from their own credit lines or foreign partners. This category encompasses most associations and microfinance companies. They represent about 18% of the MFI.

Organizations and projects with a microfinance component: they include non-governmental organizations (microfinance NGOs) as well as government initiatives. Programs of this kind operate either through direct credits to the population, or refinance other MFIs. Microfinance projects account for approximately 3% of microfinance initiatives at the national level.

⁸ Inventory done by the Microfinance Unit of the Ministry of Economy and Finance in 2005

1.3. Presentation of the studied lender and its products

1.3.1. Why FECECAM?

Established in 1977, FECECAM is the largest microlender in Benin and represents more than 50%⁹ of the microloan supply in the country. In its current structure, FECECAM is a network of savings and credit cooperatives that has the highest geographical coverage with its 136 branches throughout the country. It has a long tradition of small and medium-sized loans for farmers and agricultural businesses. FECECAM has been through multiple crises over the years that led the network to neglect the agricultural credit line in past decades for both internal and external reasons. The Federal German Ministry of Economic Cooperation and Development (BMZ), through the German Financial Cooperation (KfW), recently refinanced FECECAM with the aim of supporting rural credit in general and agricultural credit in particular. At the same time, through its technical branch of Cooperation (GIZ), the BMZ also finances technical support to farmers to facilitate their applying for, using, and repaying loans. In addition, the GIZ supports several agricultural commodity chains in Benin that it has identified as being under served by credit organizations. This is the main impetus behind the GIZ supporting financial institutions that specifically serve agriculture. This study has been commissioned and funded by the KfW.

1.3.2. Loan products

The refinancing and support from the German government enabled FECECAM to renew its focus on farm loans. In 2017, the cooperative included more than 1.5 million members and nearly 400,000 borrowers, with agricultural loans representing 20% of the total amount of loan disbursed (77,000 agricultural borrowers).

FECECAM offers a fairly large range of credit types and repayment options to meet the diverse needs of both rural and urban clients. Credit types vary from short term (6 to 12 months) to long-term loans. The lender offers both individual and group loans of variable sizes to its agricultural clients. In fact, the MFI offers different type of loans for

⁹ According to a speech of the Director of FECECAM in June 2017.

different agricultural activities or periods. For example, FECECAM offers loans for inputs purchase, planting, harvest, storage costs, as well as for *warrantage*¹⁰. Even the repayment options for agricultural loans are tailored to the cycle of the crop or the activity.

Table 1.1 summarizes the different types of agricultural loans. Note that the sample includes all loan products listed in the table.

FECECAM requires its clients to reside in the commune of the service point where they apply for a loan. Since FECECAM is a cooperative, it requires loan applicants to pay a one-time membership fee of 500 FCFA (0.90 USD). Loan applicants must also provide a member share of 1,000 FCFA. Applicants must also pay a 1,000 FCFA deposit fee for every 50,000 FCFA borrowed, but these deposits count toward repayment. In most cases, applicants must be members of FECECAM for at least three months prior to applying for a loan. They must also have a minimum savings of 20% of the amount requested. Only small size loans offered in groups are exempt¹¹ from these rules.

Additional loan amounts can be requested only if borrowers have repaid any previous loans, with the exception of farm loans obtained for specific agricultural activities; for example, a loan for planting can be followed by a loan for harvest even if the former loan is not fully repaid.

Generally, any amount of loan requested at FECECAM requires a (financial) collateral of 15% to 20% of the amount requested, depending on the service point. This requirement is in addition to the required minimum account balance mentioned above. FECECAM only requires asset collateral (e.g., land titles and other assets) for individual loans above 400,000 FCFA. In case of group loans, joint liability serves as the guarantee.

Some loans products come with technical support or training. For instance, with a product such the agricultural loan for rural women – CAFER (*Crédit Agricole aux Femmes Rurales*), women receive training in areas such as health, education, and production. A group facilitator and loan agent appointed by FECECAM regularly meets with the loan

¹⁰ The “warrantage” or inventory credit system allows farmers to use their harvest as collateral to obtain a loan rather than selling it at one at harvest, when prices are often low. This system was used by European farmers in the 19th century.

¹¹ Though, the one-time membership fee of 500 FCFA is paid by the group as a whole, not by the members individually.

recipients to supervised and train them. She also collects the repayment installments when they are due.

Overall, FECECAM agricultural credit program resembles a supervised credit program. In a supervised agricultural credit scheme, farmers receive credit in the form of an integrated package of financial support, technical guidance, as well as some inputs supply. More details about supervised credit programs can be found in Brake (1974) and Mohsin, Ahmad, and Anwar (2011). Before FECECAM's approval, the farmer and the credit agent make a farm (business) plan as well as a home plan. The home plan includes average monthly expenditures and forecasted changes during the loan cycle. The farm plan focuses on the operation to fund but also includes other farm activities that may generate income or benefit the funded activities. Through the plan, farmers are directed and advised. Certain commodities are promoted for their local economic potential and others are discouraged or disapproved¹². The supervised component of FECECAM credit program is discussed further in the dissertation.

As Figure 1.3 shows, over our six-year study period, credit applications consistently peak around the month of June. This is because the agricultural season, or the rainy season, in all regions of the country starts around that period.

1.4. Survey design

1.4.1. Survey area, data collection, and data

The core of the dissertation is a survey of FECECAM agricultural borrowers in three agricultural zones¹³ in Benin. Not having the means to cover all agricultural zones in Benin, three contrasting agricultural zones were chosen: the North-East (cotton zone); the Central (tubers and cashew nut zone); and South (zone with specialty crops such as vegetables, pineapple, palm tree, and ornamental plants). The survey was conducted in 30 FECECAM service points, covering 48 of the 77 communes of the country. On average, respondents

¹² For instance, in Benin the sale of adulterated gasoline is a common activity, even though forbidden. FECECAM does not fund such activities.

¹³ The Ministry of Agriculture of Benin had divided the country into seven different agricultural zones based on their agro-ecology and their potential in terms of commodities chain development. These zones have been called *pôles de développement agricole* (agricultural development poles).

live 25 km (16 miles) from their service points. Figure 1.4 shows the distribution of respondents and sampled services points.

The fieldwork took place in October 2017 and collected information about the 2016-2017 agricultural season. The data collection concerned several aspects of the borrowers' life and activities. The questionnaire comprises ten key modules. The first module collects information about the borrower's identification and socio-economic characteristics such as age, sex, status in their household, educational level, activities conducted and their contribution to the respondents' income over the studied period. The second module enquires about sampled borrowers' household composition as well as the time use of each household member during the 2016-2017 agricultural season. Time use information concerns mainly the time allocated to own productive activities as well as the time spent working on the borrower's farm or other household member's farm. The third module investigates the credit history of the respondents asking information such as the loan obtained from FECECAM and other MFI, when they were obtained, the respective amount of the loans, the funded activities, etc. It then focuses on details about the latest loan obtained from FECECAM and its terms as well as its utilization. That module also collect data on clients' satisfaction of FECECAM's loan program. The fourth module of the survey questionnaire is about crop production inputs and outputs costs and quantities. The module also includes land availability and land tenure. The fifth module contains information about inputs and outputs costs and quantities of trade and processing activities. Next, the same type of information is collected for livestock and animal husbandry. Other types of income generating activities output and expenses are captured in a separate module. Labor use during the studied agricultural season is the subject of a separate module. The module's questions are related to the labor type, labor quantity, work time, pay and type of contract, geographical origin of workers among other questions. The ninth module enquires about sampled borrowers' assets type and values (household durable goods and productive asset). The tenth module helps uncover borrowers' household food security and nutritional statuses as well as lean season information and coping mechanism. Note that these questions are asked to female borrowers directly or spouses in case when the sampled respondent is male. Finally, the survey closes with questions about sampled respondents'

perception of the impact of FECECAM loans on their activities as well as key outcome variables.

Overall, the dissertation draws upon three sources of data: a questionnaire-based survey of the sampled FECECAM clients, secondary data drawn from the FECECAM's database of agricultural borrowers, and a set of focus group discussions with the staff in the local branches.

1.4.2. Survey design

Identification and estimation of the effects of microcredit participation are difficult because of two levels of selection: self-selection into a microfinance program by the households, and the screening process of MFIs. To address these biases, this study employs the so-called pipeline design, which is typically used in cross-sectional setting in the absence of fully randomized experiments. This approach is justified by the fact that both its control and treatment groups consist of individuals who have chosen to participate in the microfinance program, addressing these two major sources of selection bias.

The sample was drawn from the FECECAM borrowers' database. First, the population of interest was narrowed down to individuals who borrowed from FECECAM for agricultural reasons from 2012 to 2017. This group includes borrowers who took a loan for crop production, animal husbandry, the processing of agricultural products, and trade in agricultural commodities. Then, a two-stage sampling approach was followed, with representative geographical areas selected in the first stage, and random sampling of FECECAM clients in the second stage. In the first stage, three agricultural zones (strata) were chosen and, from each zone, ten FECECAM branches (clusters) were drawn with a probability proportional to its size (in terms of agricultural clientele), resulting in 30 branches being selected out of 93 in total. Finally, 26 borrowers, with 13 being "new" and 13 being "old" were randomly selected per FECECAM branch. Clients were considered "old" if they had entered FECECAM loan program at least three years before the survey and "new" if they had entered within the year prior the survey.

In total, 780 agricultural borrowers were sampled. However, issues encountered during the data collection changed the ultimate ratio between old and new clients, and reduced the sample size. First, several new clients who had yet to repay their loans confused

the survey with a loan recovery mission. Many were reluctant to be interviewed and in some cases refused completely. Also, the data collection revealed that some borrowers from the initial sampling list had never taken agricultural loans, especially in the branches located in the South¹⁴. In some extreme cases, it was not even possible to reach the 26 agricultural borrowers targeted per branch. Either this was due to errors in the coding of their files during the application, or some loan agents purposely mis-categorized some clients' files so that the client could benefit from the relatively laxer terms¹⁵ of some of the agricultural loan products. Ultimately, the study sample comprised 748 usable observations, with the composition being 29% new loan recipients (entered in 2016 and 2017) and 71% old borrowers. Figure 1.5 shows the number of agricultural loan recipients between 2012 and 2017 in the population and in the sample by studied region.

1.5. Impact assessment approach

1.5.1. Brief notes on microfinance studies history

Key themes in microfinance research are asymmetric information and transaction costs present in imperfect rural credit markets (Marr, 2012). The concept of joint liability discussed above is the most studied aspect of several theoretical models. In spite of their usefulness, these theoretical models provide little knowledge about the impact that microfinance might have on its users as well various changes induced. Therefore, a second tradition in microfinance started dealing with the issue of impact on clients. In the process, researchers gradually shifted the focus from analyzing impacts on the microfinance-funded enterprise alone, to including changes at the household and individual levels (assuming non-separability between households' production and consumption functions), to the study of intra-household dynamics and gender empowerment, to looking at specific socio-economic impacts such as employment, technology, child nutrition and food security and to studying wider community impacts (Marr, 2012).

¹⁴ The South is a more urban area where agricultural activities are not as predominant compared to the other areas.

¹⁵ FECECAM usually requires loan applicants to maintain a saving account with the cooperative for at least three months before applying for a loan. However, that condition is not enforced in case of agricultural loans. Also, most agricultural loans below a certain amount do not require collateral.

1.5.2. Issues in identifying causal effects of microloans

Determining causality in microfinance studies is challenging. The assessment of the impact of a microloan program amounts to gauging how the program affected the participants and changed their lives. The issue with microcredit evaluation is that, once a person or a household makes the decision to participate in a loan program, it becomes impossible to know how their lives might have evolved without that loan. In other words, the biggest challenge in microfinance program evaluation is finding the counterfactual (Odell, 2015). A reflexive attempt is the use of non-borrowers. However, this is problematic because those who self-select into a loan program could be fundamentally different from those who never seek to borrow. If these distinguishing characteristics systematically affect the outcome variables, there is selection bias. Factors such as management and entrepreneurial abilities, risk preferences, resourcefulness, and trustworthiness—which are hard to measure—could explain differences between borrowers and non-borrowers. In addition, factors such as own financial constraints, assets, or technology use could also differentiate borrowers from non-borrowers. In fact, it could be that those with greater assets or those with a bigger operation (higher levels of inputs use and outputs) are the ones that get loans; or that the use of loans actually improves productivity. The location of the ‘treatment’ itself could also explain differences between borrowers and non-borrowers, as MFIs typically choose to locate themselves in accessible areas or places with higher economic potential. On top of this, loan providers use systematic loan-worthiness-screening criteria that distinguish clients from non-clients. Any estimation of loan effects in the presence of these issues of self-selection and/or endogenous program placement will yield biased parameter estimates. Thus, any evaluation of a microfinance program must use different methods to come up with a reliable estimate of the counterfactual.

For these reasons, in many settings, treatment effects estimated from Randomized Control Trials (RCT) are considered the gold standard. With an RCT, loans would be randomly assigned to some study participants (the treatment group) and not to others (the control group), or loan services would be offered to some randomly-assigned communities, and not to others. The fact that study participants are randomly assigned to one group or another eliminates any systematic differences between the two groups and thus, any

observed differences in measured outcomes between the two groups can be attributed to the credit or the treatment assigned. However, there are some criticisms about RTC and the broader validity of their results is not yet guaranteed (Banerjee, Duflo, Glennerster, and Kinnan, 2014; Karlan and Zinman, 2011). RCT are expensive to conduct and are often criticized for studying impact over a relatively short duration. More germane to this study, researchers argue that most RCT studies are conducted in areas where considerable microfinance lending already exists (Rajbanshi, Huang, and Wydick, 2015). Results from such studies should then not be generalized as the average impact of microfinance. However, studies such as Crépon, Devoto, Duflo, and Parienté (2015) and Rajbanshi et al. (2015) represent some of the first efforts to study the impact of microfinance in an area where no MFI was previously operating.

This study uses a quasi-experimental approach. In these studies, strategies are used by researchers to come up with a reliable control group without the use of random assignment. A widely used technique in quasi-experimental studies is the so-called “pipeline design”. This design compares a representative sample drawn from the population that has received ‘treatment’ with a sample drawn from a comparable population that is about to receive it for the first time (i.e., the pipeline group) (Coleman, 1999, 2006; Copestake, Bhalotra, & Johnson, 2001; Marr, 2012). The difficulty with the pipeline approach is that pipeline groups used as proxy for control groups could still introduce some bias to the estimates. However, it is considered to be an adequate alternative in cases where RCTs are not feasible.

In this instance, the pipeline design is used in a cross-sectional setting, where old¹⁶ MFI clients are used as the treatment group and new entrants as the control group. This approach is justified by the fact that both its treatment and comparison groups consist of individuals who have chosen to participate in the microfinance program, consequently addressing the largest sources of selection bias. Nonetheless, it makes the estimates vulnerable to other problems such as “attrition bias” caused by those who drop out of the treatment (Karlan, 2001; Karlan and Tedeschi, 2010). The performance of old borrowers may exceed that of new borrowers because of unobserved qualities in old borrowers that have allowed them

¹⁶ This approach has been developed by the Assessing the Impact of Microenterprise Services (AIMS) of the United States Agency for International Development (USAID) to assess impact.

to remain in the program. As a solution, Karlan (2001) suggests altering the veteran group to include those who drop out. The authors argue that this small correction can significantly improve the accuracy and therefore the reliability of the results.

1.5.3. Identification strategy

This research is based on data from a survey of FECECAM agricultural borrowers conducted in October 2017. The survey focuses on recipients who have been borrowing from the MFI for agricultural related reasons, at least since 2012. The sample includes some borrowers who had entered the program even before 2012 and borrowers who joined FECECAM from 2012 to 2017 (Table 1.2). By construction, the dataset retains all ‘dropouts;’ among the sampled clients, some have stayed ever since their entry and have taken loans multiple times (during several years) while others have dropped out after one or few loans. Over the six-year study period, the sampled borrowers have taken loans on average 3.11 (± 1.75) times. For example, among participants who entered the program in 2012 and 2013 there are, respectively, 1.39% and 5.75% who borrowed only during one year, 11.11% and 4.60% who borrowed during two years, 15.28% and 14.94% who borrowed from FECECAM during three years. Over this period, FECECAM has had a fairly stable operation and no new service point was opened. From a statistical point of view, this is fortunate as the propensity to enter did not change and new clients make a good comparison group for older ones, holding everything else constant.

Figure 1.6 presents the number of years during which the participants took loans, after their entry in the program.

This variation in the actual lending period or frequency of borrowing, allowed by the relatively long period considered, introduces a complication into dividing the sample into *old* and *new* clients just based on the time of entry as done by previous studies that used the cohort approach. In fact, as confirmed by figure 5, not all early clients borrowed for long. Put differently, not all early clients have the same *experience* with FECECAM credit program. In fact, participants have borrowed variable amounts between 2012 and 2017, and they have also borrowed several times, even within a year. In this context, program entry timing cannot solely determine the *experience with loan* from 2012 to 2017, which is the loan treatment here. An early entry increases participants’ likelihood to be

experienced as they are more exposed, but it does not exclusively determine their experience with loans.

A better definition of participants *experience* with loans would involve (i) the time since the first loan, which captures *seniority*, (ii) the number of loans received, to capture *regularity*, and (iii) the average amount of credit obtained over the period in question, to apprehend *intensity*. Therefore, the loan treatment in this study is captured using a combination of program entry timing, cumulative loan amounts, and the number of loans taken between 2012 and 2017. However it is measured, the effect of loans on a household is expected to build over time. For *experienced* clients, benefits from loan program participation would have already accrued over a certain period, say six years, while *inexperienced* clients would see little to no benefit depending on the time between their loan receipt and the reference period. The appropriateness of this approach rests on the absence of systematic differences between *experienced* and *inexperienced* borrowers. Consequently, differences in studied outcome variables between the two groups of clients can be attributed to credit, after controlling for factors such as demographics and environment.

Survey respondents received loans from other sources as well. However, only 5.2% of the respondents took additional loans from other formal MFIs during the period considered, while the majority, 94.6% of respondents, received loans exclusively from FECECAM, and 0.2% of the respondents took additional loans from informal sources such as moneylenders, relatives and friends. Thus, while the average loan size includes amounts received from other formal MFI during the considered period,¹⁷ the *loan effect* is effectively the *FECECAM agricultural loan effect*.

On average, respondents have joined FECECAM 5.58 years prior to the survey. They have obtained a loan three times already and have borrowed a total amount of 1,727,400 FCFA on average between January 2012 and October 2017. For a better grouping and description of the sample based on the loan treatment, a k-means cluster analysis is performed. Cluster analysis is an exploratory data-analysis technique which uses

¹⁷ In their review of 11 studies on credit studies, Gaile and Foster (1996) have pointed out the lack of including or mentioning the presence or absence of possibly competing financial institutions in the studied areas.

an algorithm to determine the natural groupings (or clusters) of observations. In this specific case, the k-means clustering defines groups by minimizing the heterogeneity of individuals *within* those groups. The number of (non-overlapping) groups to be created is specified by the user. For a more detailed description of the algorithm, the reader is directed to Makles (2012).

Table 1.3 summarizes the results of the k-means cluster analysis. We specify two groups, with the expectation that this would divide the sample into experienced borrowers and inexperienced borrowers. The first group includes borrowers, who, on average from 2012 to 2017, have joined FECECAM 15 years prior to the study, have taken a loan four times and have received an average of 1,126,000 FCFA of loan each time. The second group consists of borrowers, who, on average, entered the loan program only three years before the study, have taken two to three loans, and have received an average amount of 300,000 FCFA of loan each time they have borrowed. Indeed, we can call the first group the *experienced* borrowers while the second cluster can be called the *inexperienced* borrowers.

One can argue now that there is less heterogeneity within each group in comparison. Looking at characteristics other than those listed in table 1.3 for each of the two groups confirms that there are no critical differences between the two groups (Table 1.4). Experienced participants seem to be “an older version” of the inexperienced ones. In fact, experienced borrowers are older, therefore, they are mostly household heads, they have bigger household size, and they have been conducting their autonomous activities for longer. In addition, inexperienced borrowers seem to live farther from FECECAM service points than the experienced ones, which indicates that FECECAM is reaching farmers in remote areas as well. Admittedly, experienced borrowers are more educated than inexperienced ones. Nevertheless, no variable indicates critical differences between the two groups. Most differences are age-related. Matching methods will help eliminate these minor dissimilarities between the two groups, in order to estimate the causal effect of loan experience.

1.6. Description of the sample and summary statistics

1.6.1. Respondents' characteristics

Age and gender

Table 1.5. summarizes the proportion of male and female respondents as well as their average age by region. On average, sampled borrowers are 44 years old. This average age is consistent across gender and regions.

The sample includes 32.22 % of female borrowers and 67.78 % of male. The Center has the highest proportion of female respondents (40.64%). The lowest percentage of female borrowers is in the South, and this is partly explained by socio-cultural differences. In the South, women are less involved in agricultural activities. Also, para -agricultural activities such petty trade and processing of agricultural commodities in which women are mostly involved in this area is relatively less funded by agricultural lenders.

Education

Respondents level of education is measured using their years of schooling, which is the total number of years passing to the next grade level. The average number of years of schooling is low (see figure 1.7). It increases from the North to the South and male recipients are more educated than female recipients. On average, the respondents have not finished their primary school. It's only in the South that a substantial proportion of recipients have finished at least primary education.

Education level was also assessed using respondents' ability to communicate in French¹⁸. In fact, even though loan agents can speak the local languages, loan application documents as well as all administrative paperwork are written in French. Therefore, proficiency in French (speaking at least) is important. Yet, only 19.54% of the recipients can easily communicate in French. The South has the highest proportion of borrowers with good proficiency in French speaking while the North has the lowest rate. This confirms the finding (figure 1.7) that respondents in the South are more educated compared to other regions. There are twice less women fluent in French as men (11.76% versus 23.21%).

¹⁸ French is the official language of Benin.

These factors can affect recipients' ability to properly benefit from or manage their loan, and can also create a dependency on loan agents.

In the absence of school education, many rural people acquire varied experiences by temporarily migrating. In some ethnic groups, this is almost a rite of passage into adulthood (in the North-West in particular). Labor migration, in addition to the transfers it allows to poor communities and households, represents an opportunity for exchanges of agricultural and non-agricultural knowledge. 33.73% of borrowers have experienced labor migration; men more than women (39.53% versus 21.25%). Most male recipients migrate to work in agriculture in neighboring countries (Nigeria) while females migrate within the country especially in urban areas to work as housekeepers and maids. These are medium-term migrations which last on average 12.31 months for men and 6.66 months for women. Respondents' perceptions on the impact of these migration experiences on their current economic activities are mixed, but never negative. Some feel that they have learned new farming techniques while others have acquired a sense of business, entrepreneurship, and management.

1.6.2. Respondents' household characteristics

Respondents' households count on average 9.37 members in the North, 7.8 in the Center, and 7.00 members in the South. Using the FAO adult equivalent¹⁹ scale, the household sizes in terms of adult-mouths-to-feed are respectively 8.08 adult equivalents in the North, 6.65 in the Center, and 6.11 adult equivalents in the South. Given the average age of the borrowers, they belong to households with a high proportion of adults and young people and relatively few children, resulting in a large number of adult equivalent consumers.

Northern respondents have the largest household. In addition, household organization in the North is slightly different than the other studied regions. For instance, most households in the North maintain a traditional organization of a single shared

¹⁹FAO coefficients are applied to household members' age to convert household sizes into adult equivalent consumers. These coefficients are: 0.4 for children under 5, 0.7 for 6-10 years old, 1 for 16-50 year olds, 0.8 for the 56-65 age group and 0.8 for those over 65 years. Since rural women are responsible for a large number of activities requiring sustained physical activity and often being pregnant or breastfeeding, no additional coefficient has been applied to their physiological needs and to their conversion rate in adult equivalent.

“kitchen” where all wives cook for the entire household including the household head, other married sons or head’s brothers also staying in the household. Rural household organization in Benin is discussed further in chapter 3, section 3.2.1.

The majority of the respondents (68.67%) are the head of their households. The remaining 31.33% are adults conducting their own productive activities within a household. The sample includes only 8.9% of female household heads.

1.6.3.Credit history

Almost all respondents received individual loans; only 3.6% of the respondents received their loans through group lending.

Figure 1.8 shows the average amount of FECECAM loans received by respondents from 2012 to 2017, per region and per gender. On average, Southern borrowers receive higher amounts of loans compared to the other regions for all years considered. The amount of loans received increases from the North to the South. Disaggregation by gender reveals that women receive smaller amounts of loan compared to men. The difference is important in the North and the South but not so much in the Center.

Chapter 1 Tables and Figures

Table 1.1: Different farm loan products offered by FECECAM

Loan products	Amounts	Annual interest rates	Duration	Individual / Group
<i>TPCF - Tout Petit Crédit aux Femmes (tiny loans for women)</i>	10,000 FCFA ²⁰	19%	0-12 months	Group loans but given individually
<i>TPCH - Tout Petit Crédit aux Hommes (tiny loans for men)</i>	10,000 FCFA	19%	0-12 months	Group loans but given individually
<i>CEE - Crédit Épargne avec Education (savings-credit with education)</i>	30,000 – 400,000 FCFA	19%	6-12 months	Group loans but given individually for women
<i>CAFER - Crédit Agricole aux Femmes Rurales (agricultural loans for women in rural areas)</i>	30,000– 450,000 FCFA	19%	0-12 months	Group loans but given individually
<i>CFC - Crédit aux Femmes Commerçantes (loans for female small businesses)</i>	30,000– 400,000 FCFA	19%	0-12 months	Individual loans
	10,000-5M FCFA	19%	Short-term: 0-12 months	
<i>CAEP - Crédit à l'Agriculture ; à l'Élevage et à la Pêche (loans for crop production, livestock, and fishing)</i>	30,000-30M FCFA	18%	Mid-term: 24-36 months	Individual and group loans
	30,000-30M FCFA	18%	Long-term: 36-120 months	

Source: FECECAM

²⁰ 1 US dollar is approximately 550 FCFA (1 FCFA ≈ 0.0018 USD)

Table 1.2: Proportion of cohorts

Cohort	Share in sample (%)
Before 2012	29.01
Entered in 2012	9.49
Entered in 2013	11.76
Entered in 2014	8.02
Entered in 2015	11.76
Entered in 2016	18.05
Entered in 2017	11.90
Total	100

Table 1.3: Summary statistics of clusters identified

Variable	Group 1	Group 2	All
	<i>Experienced borrowers</i>	<i>Inexperienced borrowers</i>	
Average loan size over the studied period (100,000 FCFA)	11.26 (12.63)	3.02 (2.61)	4.70 (7.00)
Number of loans between 2012 and 2017	4.05 (1.77)	2.87 (1.67)	3.11 (1.76)
Time since first loan with FECECAM ²¹ (Years)	15.16 (7.33)	3.12 (2.83)	5.58 (6.40)
Number of observations	153	595	748

Notes: The k-means cluster analysis uses the Euclidian distance as the measure of similarity (dissimilarity) between observations.

²¹ The research accounts for other sources of formal loans. Thus, respondents were also asked about their first formal loan with any other MFI. On average, they entered a formal MFI program since 5.83 (6±.85) years. A two-sample t-test shows that there is no significant difference between the mean of the two variables: time since first FECECAM loan and time since first formal loan. This also confirms that the majority of the borrowers interviewed use FECECAM as their primary formal loan provider.

Table 1.4: Mean comparison of observed characteristics of experienced and inexperienced participants

Variables	Experienced	Inexperienced	Difference
Age (years)	50.53	41.68	8.85***
Gender (Female =0; Male=1)	0.76	0.66	0.10**
Household head (Yes=1; No=0)	0.79	0.66	0.13***
Number of years of schooling	4.72	3.10	1.62***
Number of years of conducting autonomous activities	25.49	17.16	8.33***
Learned a profession other than farming (Yes=1; No=0)	0.33	0.27	0.06
Number of income generating activities conducted	2.89	2.74	0.16
Is a grower (Yes=1; No=0)	0.78	0.85	-0.06*
Number of different crops produced	1.83	1.84	-0.01
Number of processing and trace activities	0.48	0.36	0.12**
Raise Animal (Yes=1; No=0)	0.13	0.14	-0.01
Belong to a family of native or first comers in the area (Yes=1; No=0)	0.58	0.55	0.03
Have migrated at least once in search of work (Yes=1; No=0)	0.24	0.22	0.01
Work migration length (month)	12.94	9.89	3.04
Number of farmers' organizations membership	0.18	0.20	-0.02
Number of ROSCA ²² membership	0.80	0.91	-0.11
Benefit from extension services in 2017 (Yes=1; No=0)	0.29	0.23	0.05
Number of extension worker visits in 2017	1.06	0.75	0.31
Time to the closest FECECAM branch one-way (minutes)	22.37	34.03	-11.66
Cost to the closest FECECAM branch one-way (FCFA)	459.80	687.28	-227.48***
Repurposed the latest loan obtained (Yes=1; No=0)	0.78	0.81	-0.02

²² Rotating Savings and Credit Association

Table 1.4 (Continued): Mean comparison of observed characteristics of experienced and inexperienced participants

Variables	Experienced	Inexperienced	Difference
<i>Household characteristics</i>			
Household size	8.85	7.89	0.96***
Number of production unit heads ²³	2.57	2.33	0.24***
Number of consumption units (mouths to feed based on needs) (adult equivalent ²⁴)	7.79	6.76	1.03***
Number of cooking units ²⁵	1.52	1.26	0.25***
Total workforce available in the household based on member time allocation (adult equivalent)	6.56	5.52	1.04***

Notes: *** p<0.01, **p<0.05, * p<0.1.

Table 1.5: Gender and age of respondents by location

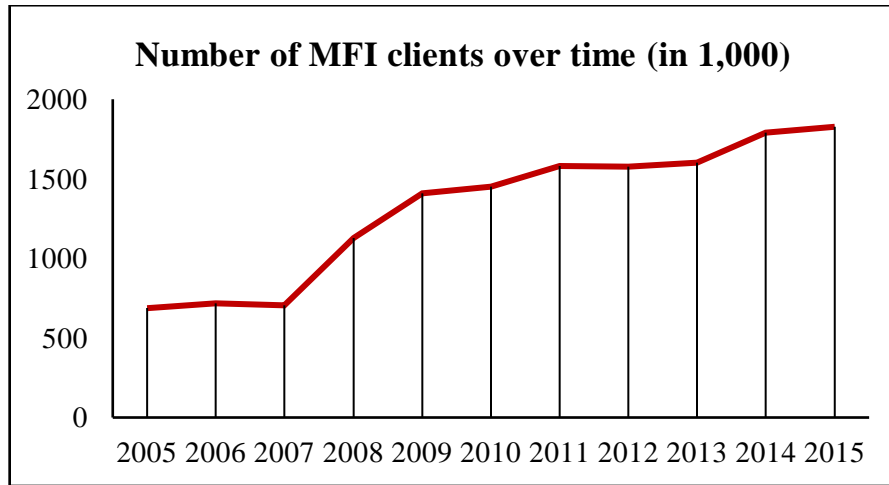
	Proportion (%)		Age (years)	
	Female	Male	Female	Male
North	27.52	72.48	43.68 (±12.01)	42.53 (±11.33)
Center	40.64	59.36	41.12 (±9.88)	41.81 (±12.83)
South	28.45	71.55	45.06 (±9.51)	46.68 (±10.33)
Total	32.22	67.78	42.99 (±10.55)	43.72 (±11.65)

²³ A production unit is a homogenous unit within the farm household which has autonomy in terms of activity, decision, and resources use but which head (household member and dependent) still reports to the household head.

²⁴ To convert household members into adult equivalent consumers, we use FAO coefficients of conversion: 0.4 for children under 5, 0.7 for 6-10 years old, 1 for 16-50 year olds, 0.8 for the 56-65 age group and 0.8 for those over 65 years. Since rural women are responsible for a large number of activities requiring sustained physical activity and often being pregnant or breastfeeding, no additional coefficient has been affected for their physiological needs and conversion rate in adult equivalent.

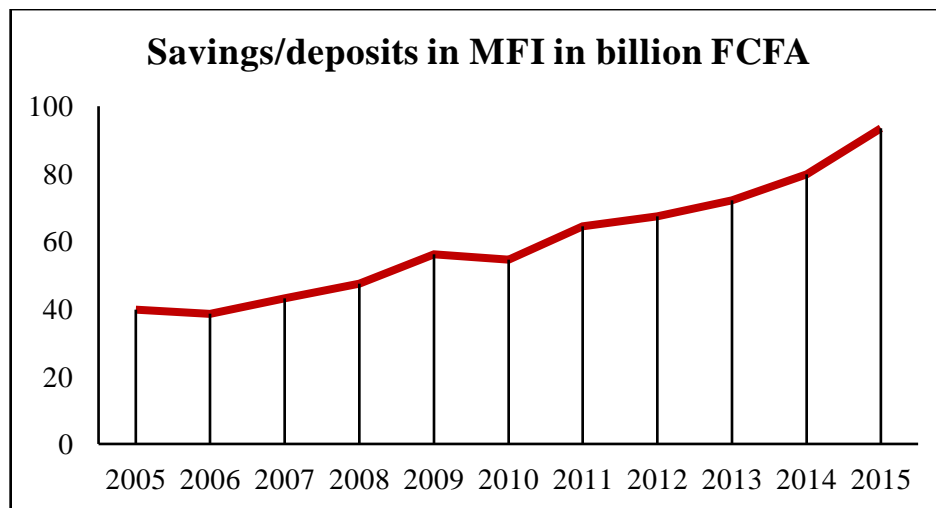
²⁵ The “cooking units” or “kitchens” refer to distinct food management and food preparation units within a household

Figure 1.1: Number of clients served by MFIs over time in Benin



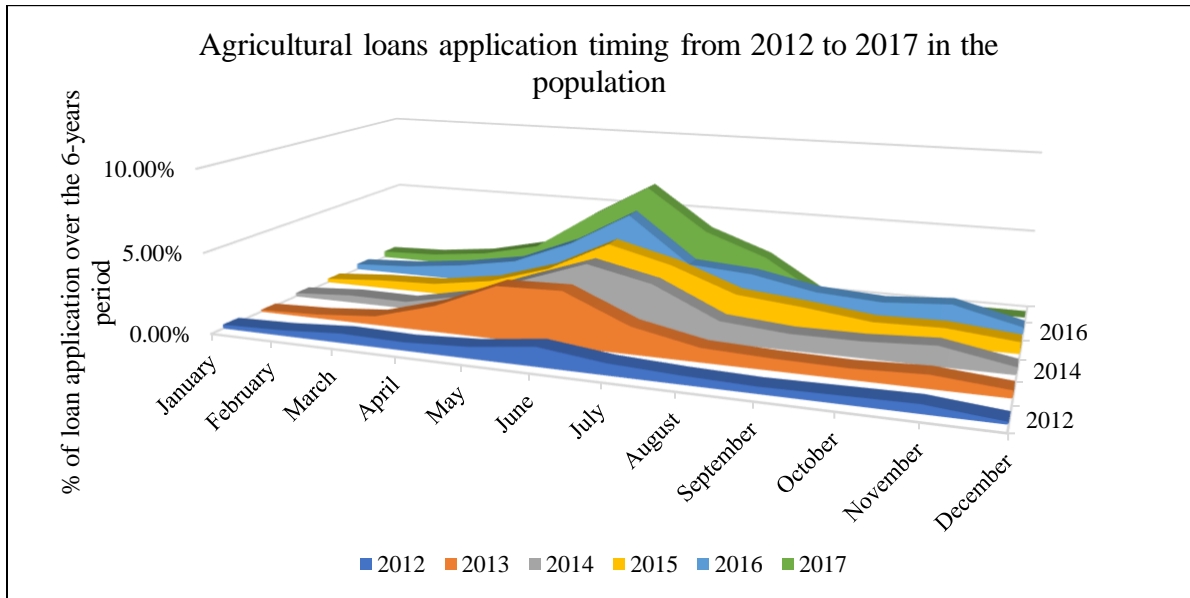
Source: Ministry of Economy and Finance, 2016

Figure 1.2: Amount of savings deposited to MFI over time in Benin



Source: Ministry of Economy and Finance, 2016

Figure 1.3: Loan application timing during the studied period



Source: FECECAM database

Figure 1.4: Distribution of respondents and sampled service points

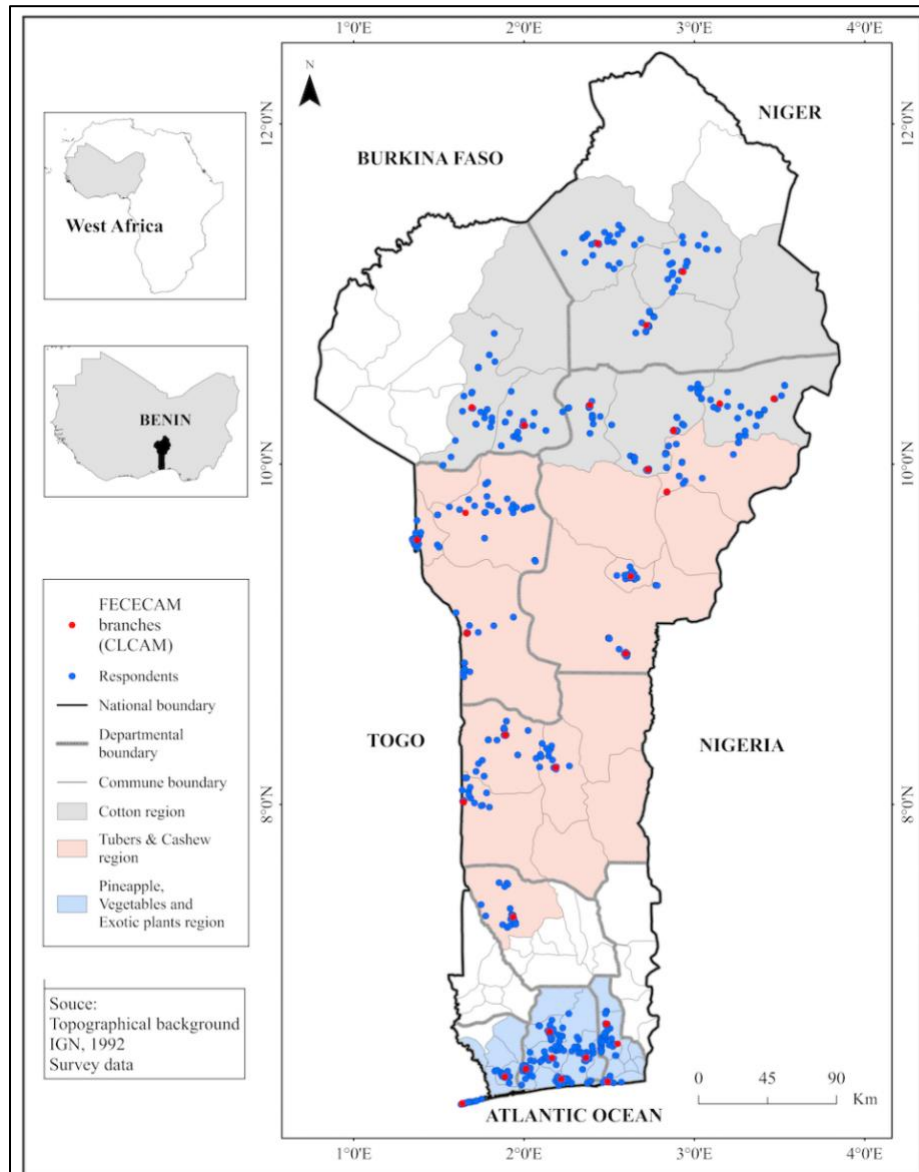


Figure 1.5: Number of agricultural loan recipients between 2012 and 2017 in the population and in the sample by studied region²⁶

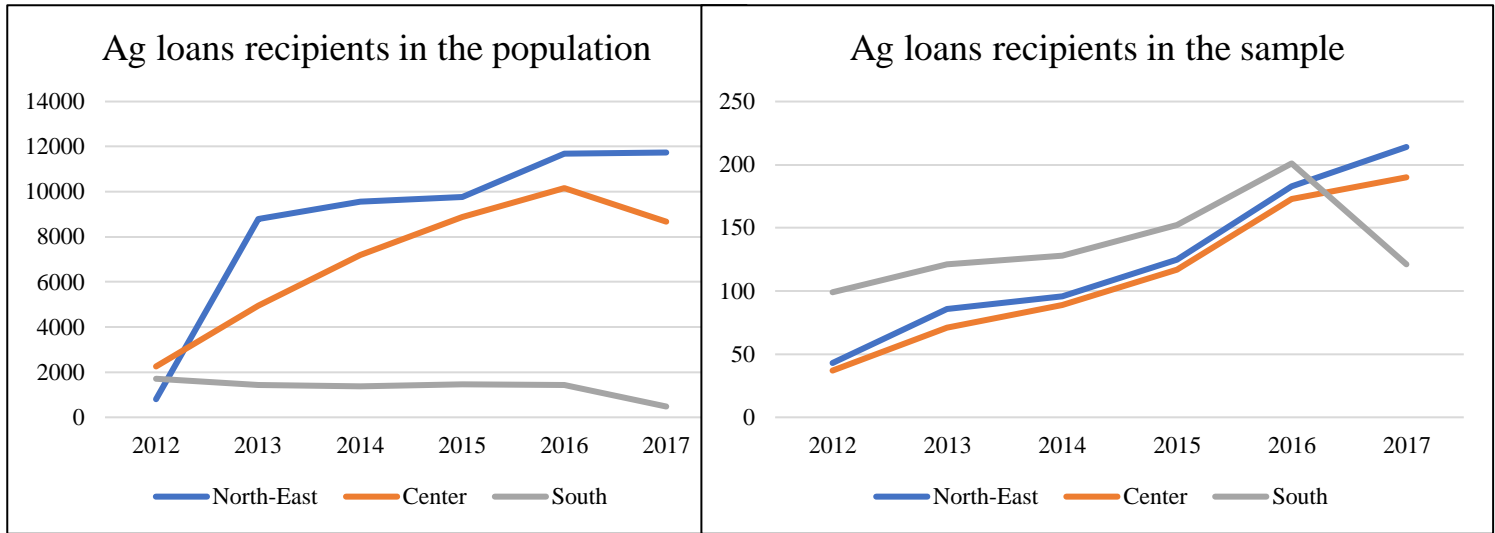
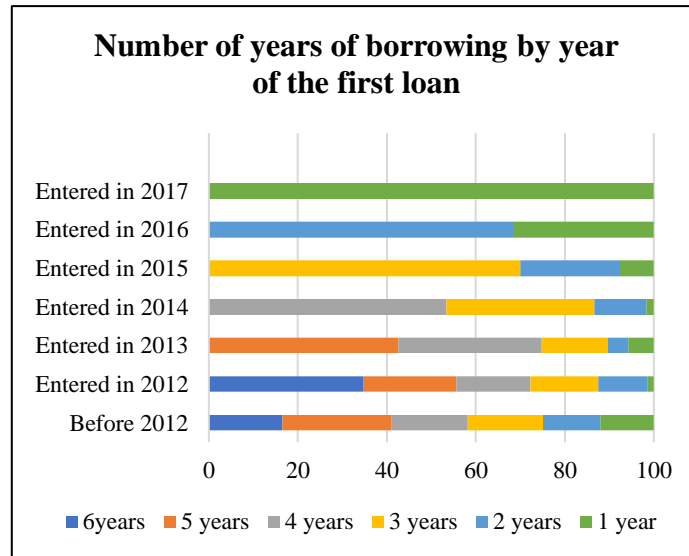


Figure 1.6: Number of years during which clients took loans by their entry time.



²⁶Borrowers in the South have been oversample in order to obtain the 26 recipients per service point like the other regions.

Figure 1.7: Average years of schooling by gender and location

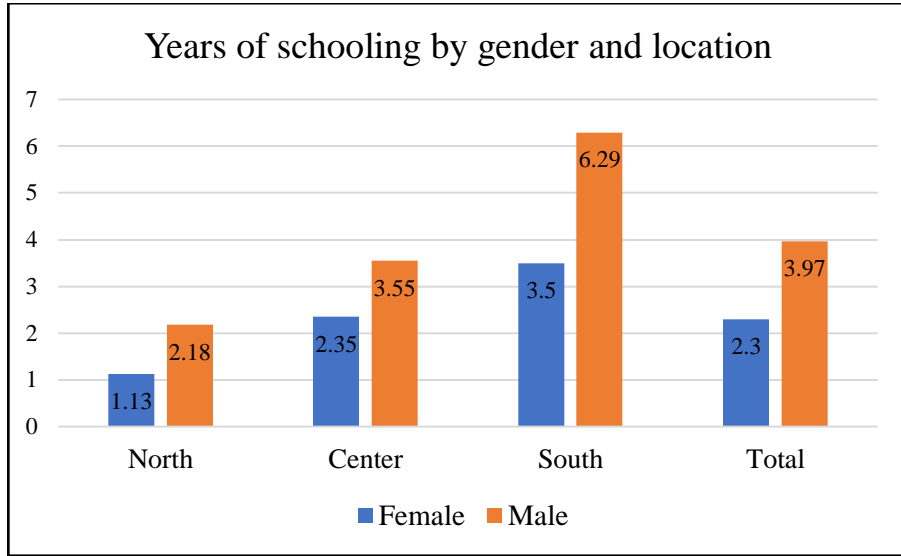
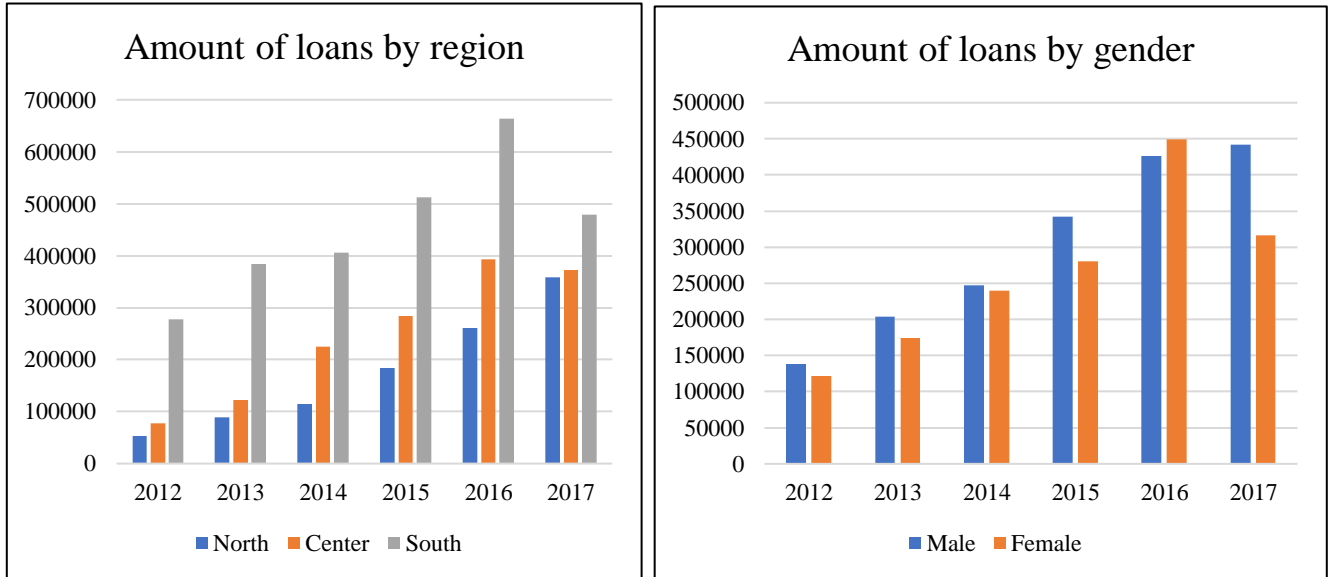


Figure 1.8: Amount of FECECAM loan received over time by region and gender



2. Agricultural loans and farm labor: a broader perspective on the impact of microcredit

2.1.Introduction

The agricultural sector continues to play a significant role in the development of low-income countries. The sector represents a significant part of the economy of these countries in terms of both aggregate income and total labor force. By generating income and employment in rural areas, agriculture contributes to both poverty reduction and income growth in developing countries where nearly 60% of the labor force is employed in agriculture (Dethier and Effenberger, 2012).

Population growth is projected to keep its upward trend and highest population growth rates will continue to be in developing regions for the coming decades (UN-DESA, 2010). This rapid growth of the population places higher demands on global agricultural production. According to the theory of intensification of farming systems developed by Boserup (1965) and Ruthenberg (1971), the BR model of intensification, population growth provides the necessity for agricultural intensification, while market access created by rapid urbanization and economic growth offer new opportunities. However, output growth requires increased cost of labor and other inputs per farmed area (Binswanger-Mkhize and Savastano, 2017). Moreover, agricultural productivity growth drives not only increased factors use but also the adoption of technology by farmers, e.g. land-saving technologies such as organic manure and fertilizer to offset declining soil fertility or labor-saving technologies such as machines.

Most intensification and modernization pathways require funding, which is not always available to farmers in developing countries, especially the smallholders. Thus, rural credit market has a crucial role to play in factor markets as it provides working poor with access to affordable capital to acquire the needed inputs.

The objective of this chapter is to relate credit availability to farmers' labor input decisions. Rural wage labor market has the potential to develop economic linkages between the small pool of households owning large shares of productive land and the remaining landless or those with limited access to land but with excess labor. Thus, rural labor market could serve as an important pathway out of poverty enabling resource-poor farmers with

excess labor to earn wage income and improve their economic well-being. More, credit provision could also play an important role on the rural labor market by allowing farmers to purchase the inputs they need, including labor. In developing countries, job creation is a major concern for policymakers. In these countries where agriculture represents an important source of livelihood and a sizeable share of the economy, farm labor market represents a significant source of employment opportunity.

The agricultural sector in Benin is dominated by small to medium farm households conducting polyculture often associated with small livestock (poultry, small ruminants, or pigs). These farm households count on average seven members and farm 1.7 ha of land. Only 5% of farms in the South and 20% in the North exploit more than 5 ha (MAEP, 2011). Given the small farm sizes and other economic constraints, agriculture is operated predominantly by human power—76% of land preparation is done manually and 23% by animal draft. Figure 4.1. depicts the percentages of labor force employed in agriculture over time in Benin.

The relevance of a study on the effects of agricultural loans on farm labor use can be easily established. Several scholars feared that agricultural intensification may worsen the conditions of smallholder farmers in developing countries as large holders, not only, may grab their land, but also invest in labor-saving technologies, leaving landless farmers with excess labor unemployed. Finding evidence suggesting that agricultural loans foster labor hiring in the sector would invalidate such hypothesis and reinsure stakeholders and actors of both the agricultural and credit sectors.

The literature on the impact of microcredit on employment is very scant, and results are very mixed. According to Erhardt (2017), the evidence of the effects on employment is still limited for two reasons. First, the vast majority of evaluated programs are not designed to create employment. Rather, they aim at increasing income and consumption, poverty reduction or various other outcomes such as children school attendance or empowerment of women. Second, those studies which do assess programs aiming at employment creation are usually limited to the impact on self-employment. In the literature, only very few evaluations investigate the impact of microfinance on labor demand and most of them focus on child labor (e.g. Angelucci, Karlan, & Zinman, 2015; Banerjee, Duflo, Glennerster, & Kinnan, 2014; Blume & Breyer, 2011; Hazarika & Sarangi, 2008).

In this chapter, a descriptive analysis of the role of agricultural loan in borrowers' labor input choices is performed. The chapter uses data of growers' subsample. The analysis does not claim causality but allows to examine how lagged farm loans received over the studied period are correlated with farmers' current labor use. Results suggest that past loans have residual effects on both hired and family labor use of agricultural borrowers. Farm loans, especially those obtained for farm machinery are significantly correlated with reduction in hired labor expenditure. However, more family man-days are employed using the machine loans while other loan categories reduce the use of family labor.

2.2. Farm household structure and labor use

Considering the full nature of a farm household socio-economic organization is essential to understand how agricultural loans may affect farm households in general and its labor use in particular.

The neoclassical agricultural household model conceives the farm household as a production and consumption unit, which converts its resources as well as purchased goods and services into values or utility when consumed (Becker, 1965; Lamarche, 1991; Mendola, 2007; Taylor and Adelman, 2003).

Allocation within a farm household is similar to the allocation that takes place within a firm. Most farm households have a hierarchical structure in which much of the control over the household resources (land and capital) are concentrated in the hands of the household head (Fafchamps, 2002). Beside an hierarchical structure, farm households often establish an explicit division of labor along with a system of delegation of authority (Fafchamps, 2002; Fafchamps and Quisumbing, 2003). The structure of farm households in Benin is consistent with this model.

In Benin, there are several modes of social organization. The notion of household varies depending on the country's regions from a small household with a head, and his wife (wives) and (their) children, to a household with multiple generations of "households" (for example siblings or close relatives with their spouses and children), all living in the same place, and reporting to the household head, often the elder. The case of Benin is similar to those of other Sub-Saharan African countries described by Fafchamps (2002) who stated that households in those countries are large and occasionally encompassing several couples

with their children. In parts of Benin, household members conduct multiple income generating-activities both on their own account and in collaboration with others (Fafchamps, 2002). The farm household engages in both market and non-market tasks such as farming, animal husbandry, fishing, crafts, trades, processing, gathering (fruits, nuts, fuelwood, water, etc.) (e.g. Fafchamps, 2002; Hunt, 1991). In Benin, as it is the case in most developing countries, there are many children on the farm households and they spend most of their time helping around the house or the farm. It is often argued that, the big size of the farm household is motivated by the fact that both children and wives serve as labor (Binswanger and McIntire, 1987; Fafchamps, 2002; Fafchamps and Quisumbing, 2003).

In Benin, the household is organized around a socially recognized head of household and includes all permanent dependents (often relatives) and migrants sent elsewhere for work or education/training but who maintain social and economic relations with the household (provide it with resources or still depend on the head). The farm household head controls most of the household resources; he allocates usufruct rights, and to some extent, he controls the labor force of his dependents. These resources are allocated to activities under his supervision or to those of his dependents (family workforces) who also manage autonomous production units of variable size within the farm household. It is important here to make the distinction between the household as a production unit (as defined earlier in this chapter) and production units within a farm household. In this study, a “production unit” (PU), is a homogenous unit within the farm household which has autonomy in terms of activity, decision, and resources use but which head (household member and dependent) still reports to the household head. The household head’s production unit is considered the main production unit and it is often the largest PU within the farm household. All the surveyed borrowers are production unit heads (PUH). 73.77% are the heads of their household whereas 26.23% are adult dependents conducting their own productive activities within the farm household.

In Benin, as in most African societies, there are detailed evolved laws and customs governing the use and transfer of productive resources (land and capital) along with specific tasks and role division among household members according to their status (e.g. Fafchamps and Quisumbing, 2003). These rules ensure the welfare of the household as a group by requiring work and economic participation from all members. For instance, all

dependents owe their labor to the household head (e.g. Iversen, 2002). Children also owe their labor to their respective mother. The household head in return provides shelter to the entire household, food²⁷ to some extent and also provides pieces of land²⁸ to each adult dependent in case they farm on their own account. Young children in the household, often male, may earn some pocket money or school fees by cultivating their own field, but they must first work on the household head's field. Fafchamps (2002) described similar practices in his work on intra-household resources allocation. In Northern regions of Benin, adult sons often work for the household head on his fields in exchange for shelter, food, durable goods such as cellphones, radio, motor bikes, or for a full dowry or money to marry.

2.3. Hypothesis of the chapter

It is important to formulate hypotheses that will guide the conduct of this section of the dissertation. The hypotheses are the following:

H1: Farmers in Benin reduce their family labor use in the presence of agricultural loans.

H2: Farmers in Benin use more hired labor when they receive agricultural loans.

2.4. Methodology

A key threat to identification in microfinance studies is selection bias. Our study addresses this issue by using a cohort approach. The research is based on a cross-sectional data from a survey of FECECAM agricultural borrowers conducted in October 2017. The survey focuses on recipients who have been borrowing from the MFI for agricultural related reasons, at least since 2012. The sample includes some borrowers who had entered the program even before 2012 and borrowers who joined FECECAM from 2012 to 2017. By construction, the dataset retains all 'dropouts;' among the sampled clients, some have stayed ever since their entry and have taken loans multiple times (during several years)

²⁷ For instance, Fafchamps, (2002) reported that in many Sahelian villages, the household head produces the main cereal which he provides part of to feed the household while women must provide the "sauce", that is, the vegetables and condiments that spice up the household meal. Our field observation confirms this. More, in Benin, the farm household head could give a small financial allowance to his wives for items they cannot produce such as salt, oil, seasonings, etc.

²⁸ Evidence in the literature suggest that the practice of dependent's plots, mostly observed in Western and Central Africa, is mainly a way to overcome commitment failure within the household (Balsvik, 1995; Fafchamps, 2002).

while others have dropped out after one or few loans. Section 1.5.3 details the sampling and identification strategies.

The goal of this chapter is to measure the effects of agricultural loans on farm labor use of loan recipients. The analysis is restricted to borrowers who among other activities, grew crops during the agricultural season 2016-2017 and have obtained at least once a loan for that purpose from FECECAM during the six-years prior to the period of the survey.

In general, FECECAM provides loans to farmers for specific activities. For instance, loans are provided for activities such as land preparation and planting, for inputs purchase or harvest. Table 4.1 summarizes the percentages of the different purposes for which sampled borrowers have received loans from FECECAM from 2012 to 2017. Over the six-years period considered, 26% of farmers took out loans from FECECAM for planting. This specific loan product is also called “agricultural season loan” and farmers can request a lump sum amount of loan for the entire production season, provided that the crop is clearly specified, or farmers can request smaller separate²⁹ loans at different times of the production cycle. 21.6% of borrowers received loans for farm inputs purchase. Only 2.5% of the surveyed borrowers received loans for the purpose of agricultural machine purchase.

To estimate the impact of these different loans on farmers’ labor use, loan purposes have been regrouped in five categories: (i) loan for planting or agricultural season, (ii) loan for harvest, loan for farm inputs purchase, (iv) loan for purchase of agricultural machines, and (v) other loans.

Labor use decisions in the presence of agricultural loans

The previous section describes the household structure and organization in the study area. In light of that particular configuration of the farm household, agricultural loans are expected to first influence family labor use. In fact, when a PU head receives a farm loan to expand its activities and needs additional labor force, (s)he has the choice between family labor or hired labor. The PU could also invest in agricultural machines to perform certain tasks, which would make it more productive, and over time, demand more labor for

²⁹ Both FECECAM and its clients find it less risky to take loans for inputs purchase and then for the harvest once it is secured rather than taking a bigger loan for the whole agricultural season and face a weather shock or insect attack.

other labor intensive tasks such as harvest for example. When the PU head is the household head, (s)he has the ability to pull more of its dependent's labor force as described earlier. However, family labor is becoming more constrained as schooling is required and children spend more time at school at the expense of the farm. Increased children schooling is also a common expected outcome of loans. Thus, the more children and dependents are schooled the less the PU use family labor. However, children schooling in the presence of agricultural credit is not addressed here.

Production units' labor use is defined as followed:

$$L_i = f(C_{t,i}; X_i; \beta) \quad (1)$$

where L_i is the amount of family labor used in man-days or the expenditure on hired labor for each PUH during the agricultural season 2016-17. $C_{t,i}$ is a vector of lagged loan amounts received for planting/agricultural season, input purchase, machine purchase, harvest or other purposes each year between 2012 and 2017. Loan amounts received for farm activities are expected accumulate over time or at least has residual effects years later. X_i is a vector of covariates including PU, household and farm characteristics as well as location dummies.

The outcome variables considered are non-negative, thus, equation (1) is estimated using a tobit model. The tobit regression is suitable to the left-censored nature of the independent variable.

The estimation equation, illustrating the cases of hired labor is expressed as:

$$\begin{aligned} Hired\ Labor_i = & \beta_0 + \beta_1 Planting2012_i + \beta_2 Input2012_i + \beta_3 Harvest2012_i + \\ & \beta_4 Machine2012_i + \beta_5 Other2012_i + \dots \dots + \beta_{26} Planting2017_i + \beta_{27} Input2017_i + \\ & \beta_{28} Harvest2017_i + \beta_{29} Machine2017_i + \beta_{30} Other2017_i + \beta X_i + \varepsilon_i \end{aligned} \quad (2)$$

2.5. Results

2.5.1. Descriptive analysis

Type of labor used by borrowers

Table 4.2 presents the proportion of respondents using different types of labor by region. Overall, surveyed PUH use a combination of family and hired labor. There are three categories of hired labor used by respondents: daily-paid laborers, seasonal workers and permanent workers. Seasonal laborers often come from different places, and stay on the

farm household for a given time, usually planting season or harvest time, and receive lump sum wages for their work. They are often hosted and fed by the PUH.

The proportion of respondents using family labor for their productive activities decreases from the North to the South. However, this type of labor remains the most common labor source, except in the South where 89.33 % of the respondents use daily-paid laborer. 11.24% of the borrowers in the South hire permanent workers on their farm. This share of permanent farm workers use is the highest across all three regions, indicating some modernization on farms in the Southern region. The use of seasonal laborers is more common in the Center.

Family labor force

The survey reports the percentage of time allocated by each household member to its own activities and to working or helping on all production units within the farm household. Time use is allocated to education, domestic chores, social and recreational activities, and to working on each production unit. For children under five years of age, time use is zero whereas most children in age to be in school spend on average, for boys 56% and 46% for girls of their time working on the production units of the household during the agricultural season 2016-17. The household head's PU is where all household members spent the most time compared to other PUs.

Table 4.3 summarizes family labor in man-days used on all production units and specifically on the loan recipient's production unit during the agricultural season studied. Households in the North use more man-days in the North than all other regions. The small number of family man-days in the South may be an indicator of increased schooling or reduced farming activities— the South is the most urbanized region of the country.

Surveyed household member (sampled loan recipient), employs including himself/herself, on average 63.74% of the total family labor force (65.08% in the North, 65.67% in the Center, and 58.66 % in the South).

Crops produced

Overall, sampled borrowers grow on average 2.25 different crops. Table 4.4 recapitulates the relative importance (%) of the different crops produced by respondents by

region. Overall, cash crops are mostly produced in the Northern and Central areas while food crops are produced in the South. Respondents in the North mostly grow maize and cotton which cover respectively 33.83% and 26.20% of the farmed areas. Soybean is also relatively important in that region and covers 13.76% of the areas. Apart from those three leading commodities, everything else is marginal. In the Center, the most produced crops are similar to the North, except cashew production (9.2%) is about as important as cotton's. Peanuts is also relatively important in the Center (7.36%). In the Southern regions, the cropping system is dominated by food crops. Maize remains the most produced crop but followed by pepper, tomato, cassava, and pineapple. These last two commodities are highly processed and are the main raw materials that sustain the small and medium processing units in the South.

The special case of cotton

In Benin, cotton contributes to about 40 % of foreign exchange earnings, and the sector represents 12 % of the GDP according to the Ministry of Agriculture³⁰. It is the most organized commodity chain in Benin. Cotton producers receive in-kind loans for seeds, pesticides, herbicides, and chemical fertilizers at the beginning of each production season. The inputs costs are deducted from their production before they are being paid for their harvest, which is sold to the professional cotton association - AIC (*Association Interprofessionnelle du Coton*). The AIC is a non-governmental association in charge of key aspects of the sector such as inputs supply, extension, quality control, and payment to farmers.

Even though, most inputs are provided in forms of in-kind loans for the season, cotton growers still borrow additional substantial loans from FECECAM for their production. These loans are presumably for inputs not provided by the AIC such as labor and machine services.

Cotton production take place exclusively in the Northern and Central areas of the country. In fact, no respondent in the South grow cotton (see Table 4.4). In those cotton production areas, as shown earlier, farmed areas are higher (8.29 ha and 6.71 ha respectively against 3.58 ha in the South) and mechanization as well. It therefore seems that areas where other

³⁰ Cited by Sasse (2016).

farm inputs are available, farmers still take out loans for hired labor or agricultural machines.

Technologies used by respondents

It is important to discuss alternative technologies used by sampled farmers instead of manpower. Table 4.5 summarizes a few technologies used by sampled borrowers. Herbicide is used by nearly all borrowers in the North; 95.04% of producers report using herbicide on some of their plots. Similarly, agricultural machines (mostly tractors) and draft animal rental services use decreases from the North to the South. Also, respondents who own agricultural machines and draft animal are mostly found in the North. The use of both machines rental services and the purchase of labor-saving equipment are very minimal in the South where the farmed areas are smaller compared to other regions. In fact, in the South, sampled borrowers planted an average 3.58 ha, all crops combined, while respondents in the North and the Center farmed on average 8.29 ha and 6.71 ha respectively.

2.5.2. Agricultural loans and farm labor use

Hired labor

Preliminary results (table 4.6) suggest that lagged amounts of loan taken from FECECAM have residual effects on current hired labor use. A very interesting and intuitive result is the effect of loans received for farm machines purchase on hired labor expenditure. All lagged loan amounts received statistically significantly affect current total expenditure on hired labor. Machine loans received in a more distant past have bigger marginal effects on current hired labor expenditure than recent machine loans. However, results show that recent loans received in 2016 and 2017 for machine purchase significantly reduces expenditure on hired labor respectively by 454,000 FCFA and 13,000 FCFA³¹. The effects of lagged amount of loans received for other purposes on hired labor expenses are mixed.

As expected, PU with bigger farm sizes spend more on hired labor. In the Northern and Central regions, where farm sizes are bigger, borrowers spend more on hired labor

³¹ 1 US dollar is approximately 550 FCFA (1 FCFA \approx 0.0018 USD)

compared to the South and seem to invest more in agricultural machines/tools or rental services than in manpower.

Furthermore, when asked about how easily they were able to find and hire labor in their area during the studied agricultural season, 20.45%, 30.30% and 24.20% of respondents respectively in the North, in the Center and in the South found it difficult to hire labor in their area. Also, when asked about their opinion on the impact of increased use of loan on the local labor market, more farmers in the North (26.45%) and the Center (16.84%) affirm that labor wage rates increased as a result of credit use in the area. In certain farmers' opinion, mostly from the South (42.27%) and the Center (18.29%), the supply of labor force has actually increased in their area as a result of loan and more laborers are coming in from neighboring countries, mainly Togo and Nigeria. These statistics suggest that the effects of loans on the labor market is somewhat complex. Multiple effects interact leading to mixed outcomes depending on regional context.

Family labor

There are less residual effects of past agricultural loans on family labor compared to hired labor. Machine loans statistically significantly increased the number of man-days of household members allocated to all PU and to the recipient's PU in particular by respectively 27.17 and 26.80 man-days for the agricultural season 2016-17. Even though this result is surprising, it could be explained by the fact that farmers may be substituting labor in general by machines but use more family labor to perform the "reduced" tasks with these technologies. For example, farmers could use their dependents to operate draft animals for land preparation or for herbicide use. This invalidates our hypothesis that farmers reduce family labor use when they receive agricultural loans.

To complement the estimation of the effect of lagged loan categories on labor use, mean comparison of technologies used by respondents by region is performed. Tables 4.8 and 4.9 show the results and confirm that borrowers in the Northern and Central regions invest more in technologies, which could be qualified as labor-saving; whether it is through the use of machines rental services or the direct purchase of the machines and draft animals. In the two regions, experienced borrowers significantly invest/spend in these technologies than control inexperienced ones. Borrowers in the two regions also seem not only, to use

less herbicides than the Southern ones, but also within the regions, experienced farmers employ less herbicides than inexperienced borrowers.

2.6. Conclusion

This chapter examines the role of agricultural loans in farmers' labor input choice. The effect of farm credit on employment is of great importance, not only for the farmers themselves but also at the macroeconomic level. With the significant unemployment rates that prevail in most poor economies and the current context of massive migration from rural to urban areas or from developing countries to developed ones, a highly-expected outcome from farm credit is to generate growth in borrowers' income with job creation other than self-employment. However, even in the latter case, loans could make individual farmers more productive and help them out of poverty.

The results of this chapter show that the impact of agricultural loans on labor is quite mixed. Certainly, loan availability made it possible for recipients to substitute hired labor for family labor, invest in technologies and agricultural machines to avoid exhausting manual work. The study showed that past loans have residual effects on both hired and family labor use. Farm loans, especially those obtained for farm machinery significantly reduce expenditure on hired labor but more family labor is employed using the machine loans while other loan categories reduced the use of family labor.

The weakness of the estimated effects of credit on farm employment is also related to the growing scarcity of labor force in rural areas. First, children who would have been employed as family labor are now in school. In fact, out-of-school children rate has significantly decreased in Benin over the past ten years according to the UNESCO (2016) data. Therefore, hired labor, previously made up of young people seeking their own income in addition to the work they do on the household (head) production units, is less available. Also, rural flight may be another cause of labor shortage. At the same time, wage rates are increasing in some areas. Overall, multiple interacting mechanisms explain the effects of agricultural loans on farm employment.

Chapter 2 Tables and figures

Table 2.1: Purpose of loan obtained from 2012 to 2017 (%)

Loan type	2012	2013	2014	2015	2016	2017	Total
Not for a particular activity	0.4	0.3	1.1	2.3	2.2	1.1	1.5
For planting /agricultural season loan	27.9	30.9	36.0	27.7	19.9	24.0	26.0
For crop storage cost	6.1	4.6	2.1	4.2	3.4	4.0	3.8
For warrantage / inventory credit	0.0	1.4	0.3	0.0	1.9	0.2	0.8
For harvest	1.0	2.2	2.9	2.0	3.2	0.9	2.1
For inputs purchase	16.0	16.0	18.8	18.6	23.1	27.5	21.6
For agricultural machine purchase	5.3	3.2	2.5	2.8	1.7	2.2	2.5
For agricultural products processing	2.1	1.0	1.5	3.1	2.2	2.0	2.1
For food crop trade	7.2	6.6	7.0	9.7	9.3	7.2	8.1
For trade of agricultural-related products	17.6	22.3	17.7	17.3	19.4	15.9	18.3
Others	16.5	11.3	10.0	12.4	13.7	15.0	13.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 2.2: Share of respondents using family labor, day laborers, seasonal laborers, and permanent workers (%)

Regions	N	Family labor	Day laborer	Seasonal laborer	Permanent worker
North	244	93.85	80.33	15.57	2.05
Center	203	92.12	77.34	29.06	2.96
South	178	72.47	89.33	25.84	11.24
All	625	87.20	81.92	22.88	4.96

Table 2.3: Family labor in man-days used on all PUs and on sampled borrowers' PU

Regions	Family labor in man-days used on borrower's PU			Family labor in man-days used on all PU		
	Female	Male	Total	Female	Male	Total
North	160.71	406.79	567.50	334.77	537.21	871.98
Center	170.00	334.48	504.48	354.22	414.01	768.23
South	102.33	282.85	385.17	325.77	330.84	656.61
All	147.23	348.61	495.84	338.48	439.43	777.92

Table 2.4: Crops produced by respondents by region (% of area planted)

	North	Center	South	All
Maize	33.83	35.86	17.55	30.71
Cotton	26.2	13.33	0	15.91
Soybean	13.76	20.23	0	12.59
Peanuts	4.64	7.36	0.63	4.57
Cashew	3.15	9.2	0	4.34
Pepper	0	1.15	15.05	3.9
Cassava	0.83	1.84	11.91	3.76
Tomato	0	0.23	14.73	3.53
Sorghum & millet	5.81	2.07	0	3.24
Rice	5.14	1.84	1.25	3.17
Beans	2.49	2.53	4.39	2.95
Yam	3.81	3.45	0	2.8
Sweet potato	0	0	8.46	1.99
Onion	0	0	3.45	0.81
Other crops	0.33	0.46	0.31	0.36
Oil palm tree	0	0	0.94	0.22
Pineapple	0	0	11.6	2.72
Other vegetables	0	0.46	9.72	2.43
Total	100	100	100	100

Table 2.5: Few technologies used by respondents and their relative importance by region (%)

	North	Center	South	All
Herbicide users	95.04	74.49	45.93	74.59
Machines/draft animal rental	47.92	21.54	5.23	27.35
Own agricultural machine/draft animal	52.82	16.19	3.57	30.10

Table 2.6: Tobit estimation results - Marginal effects of lagged loans amount on hired labor expenditure (in 100,000 FCFA)

	2017		2016		2015		2014		2013		2012	
	Coeff	Std. Err.	Coeff	Std. Err.	Coeff	Std. Err.	Coeff	Std. Err.	Coeff	Std. Err.	Coeff	Std. Err.
Planting loan	0.03	0.04	-0.53***	0.08	0.85***	0.07	0.28***	0.11	-0.70***	0.14	-0.62***	0.14
Harvest loan	0.38	0.29	0.21	0.20	0.34	0.32	-2.09*	1.18	0.04	0.49	6.60***	1.07
Inputs purchase loans	-0.13**	0.06	-0.04	0.08	0.34***	0.12	-0.15	0.12	0.13	0.17	-0.29	0.28
Machine purchase loan	-0.13**	0.05	-4.54**	1.85	6.95***	2.80	2.34**	1.13	-3.47***	1.37	-6.04**	2.83
Other loans	0.03	0.06	0.14**	0.06	-0.05	0.10	-0.03	0.08	-0.22**	0.10	0.15	0.16

Note: Controls variables are omitted for ease of presentation. Control variables comprise total number of loans taken between 2012 and 2017, the number of years since first received a loan from FECECAM, dummy for loans received from other MFI, dummy for other household member received a loan, total farmed area, cotton area, soybean area, maize area, respondent's age, age squared, number of crops produced, dummy for household head, total household size, respondent's level of education, net farm and non-income in 2016-2017, total value of productive assets owned, total estimated value of household durable assets owned, and location dummies

Table 2.7: Tobit estimation results - Marginal effects of lagged loans amount on number of family man-days used

	Family man-days employed on respondent's PU											
	2017		2016		2015		2014		2013		2012	
Planting loan	-6.85	4.90	-4.52	8.79	2.37	8.27	-0.98	12.24	12.56	15.93	-13.94	15.66
Harvest loan	-27.05	32.74	6.57	23.33	19.38	37.74	-143.85	134.00	71.97	56.27	-93.64	124.97
Inputs purchase loans	-4.04	4.88	7.65	7.32	2.59	12.44	-16.98	13.04	31.00*	18.72	-2.29	29.57
Machine purchase loan	26.80***	6.33	150.84*	79.81	-237.51	168.19	-128.47	85.93	241.72**	110.55	91.88	172.69
Other loans	0.54	7.24	6.69	6.81	-19.93*	10.75	43.90***	9.53	47.11***	11.84	-1.34	17.99

Table 2.7 (Continued): Tobit estimation results - Marginal effects of lagged loans amount on number of family man-days used

	Family man-days employed on all PUs of the household											
	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006
Planting loan	-7.16	5.75	-8.90	10.31	5.66	9.71	-4.54	14.36	-2.65	18.70	1.89	18.38
Harvest loan	7.96	38.43	10.44	27.39	37.76	44.30	-145.65	157.28	90.05	66.04	104.89	146.68
Inputs purchase loans	-6.45	5.72	0.53	8.60	22.89	14.60	-30.18**	15.30	39.29*	21.97	46.38	34.71
Machine purchase loan	27.17***	7.43	133.08	93.68	-165.50	197.40	-104.52	100.85	160.08	129.75	64.17	202.69
Other loans	-2.49	8.50	4.93	8.00	-16.24	12.62	38.31***	11.18	32.48**	13.90	-8.56	21.12

Note: Controls variables are omitted for ease of presentation. Control variables comprise total number of loans taken between 2012 and 2017, the number of years since first received a loan from FECECAM, dummy for loans received from other MFI, dummy for other household member received a loan, total farmed area, cotton area, soybean area, maize area, respondent's age, age squared, number of crops produced, dummy for household head, total household size, respondent's level of education, net farm and non-income in 2016-2017, total value of productive assets owned, total estimated value of household durable assets owned, and location dummies

Table 2.8: Mean comparison of technologies by respondents used by region (% of respondents)

Regions	Type of technology	Experienced	Inexperienced	Difference
North	Herbicide use	92.31	95.79	-03.48
	Machines/draft animal rental	50.00	47.34	02.66
	Own machine/draft animal	68.18	48.34	19.84**
Center	Herbicide use	68.18	75.29	-07.11
	Machines/draft animal rental	27.27	20.81	06.46
	Own machine/draft animal	33.33	13.33	20.00**
South	Herbicide use	53.49	43.41	10.08
	Machines/draft animal rental	09.30	03.88	05.43
	Own machine/draft animal	06.45	02.47	03.98
All	Herbicide use	73.50	74.85	-01.34
	Machines/draft animal rental	30.77	26.53	04.24
	Own machine/draft animal	41.11	27.02	14.09***

Table 2.9: Mean comparison of expenditure on hired labor, herbicide, and machine rental services (in FCFA)

Regions	Variable	Experienced	Inexperienced	Difference
North	Hired labor cost	141659.7	99660.00	41999.69
	Herbicide cost	137399.00	92237.08	45161.95**
	Rental cost	98309.62	41603.55	56706.06***
Center	Hired labor cost	395650.00	148958.90	246691.10***
	Herbicide cost	63393.18	35197.25	28195.93**
	Rental cost	46295.45	14700.29	31595.17***
South	Hired labor cost	555136.50	313353.90	241782.60**
	Herbicide cost	38621.40	27871.32	10750.08
	Rental cost	266162.80	5116.28	261046.5*
All	Hired labor cost	341380.10	172975.5	168404.7***
	Herbicide cost	87180.51	55263.22	31917.29***
	Rental cost	150218.80	22560.90	127657.9***

Figure 2.1: Share of labor force employed in agriculture as a percentage of the total labor force in Benin



Source: World Bank

3. Does experience with agricultural loans improve farmers' efficiency in Benin? A stochastic frontier analysis

3.1. Introduction

In Benin, as in most developing countries, the performance of the agricultural sector plays a significant role in the overall economic growth and development. In 2014, the agricultural sector contributed an average of 32.7% to the country's gross domestic product (GDP), and about 70% of the labor force was engaged in agriculture (MAEP, 2017). Therefore, in Benin, agricultural growth plays an outsized role in reducing rural poverty (Christiaensen, Demery, and Kuhl, 2011). Generally, the expected role of credit in the agricultural sector is to relax farmers' financial constraints and to increase their use of productivity-increasing inputs. The expected impact of agricultural loans is, therefore, to help farmers bring their input levels closer to the optimal levels, thereby increasing output and productivity (Feder, Lau, Lin, and Luo, 1990). Because rural finance programs are subsidized using limited taxpayer money, it is necessary to quantify their impact. If, on the other hand, the marginal productivity of farm credit is minor, then resources may be better used elsewhere.

This study evaluates the impact of agricultural loans on the whole-farm efficiency of borrowers in Benin. First, a stochastic translog profit frontier model is estimated, and farm efficiency scores are derived. Then, using a propensity-score matching technique, the efficiency scores of experienced borrowers are compared to those of inexperienced ones, providing a measure of the marginal effect of loan experience. In the context of this research, whole-farm profit efficiency is the most appropriate measure of loan impact since households tend to have multiple farming activities, and even a loan taken for a specific activity will ease a household's overall cash constraint.

An important policy concern in Benin, as in many countries in sub-Saharan Africa, is how to raise agricultural production, given limited resources, to meet the growing demand of a growing population. Future agricultural growth must rely more on raising productivity rather than expanding resources. The potential importance of efficiency as a way of fostering production has generated a substantial number of studies (Bravo-Ureta and Pinheiro, 1993). Before further discussion, it is important to distinguish between

efficiency and productivity. Productivity growth can be achieved through technological progress and/or efficiency improvements; with each implying a different set of policies (Coelli, 1995). The efficiency of farmers and, more specifically, the efficiency gains from experience with agricultural loans matter because such gains present a sustainable and relatively low-cost way to achieve productivity growth. Measuring efficiency is the first step to potential resource savings (Bravo-Ureta and Rieger, 1991). If farmers are thus found to be reasonably efficient in their resource allocation, then the implication is that improving productivity necessitates new technology and inputs, something that would require investments in inputs provision, infrastructure, extension services and farm management services (Mubarak Ali and Byerlee, 1991). Lastly, there are various measures of efficiency in the literature. However, many of these are, by definition, partial measures (e.g., yield and labor productivity). Analysing profit efficiency—a process that generates measures of both technical and allocative efficiency—provides a more comprehensive view.

In contrast to most previous studies in the area, this study utilizes a comprehensive definition of agricultural loans. Agricultural loans, here, refer to loans taken for all agriculture-related activities, including crop production, animal husbandry, processing, and trade and storage of agricultural commodities. Given the income-generating nature of all of these activities, restricting the evaluation of the effect of credit to crop production alone as a proxy for the rural world is a limiting approach. In the context of Benin, doing so would also systematically exclude rural women, since it is typically women who carry out these post-production activities.

The study estimates the effects of agricultural loans provided by one particular micro-lender in Benin: *Faîtière des Caisses d'Épargne et de Crédit Agricole Mutuel* (FECECAM). In its current form, FECECAM is a network of savings and credit cooperatives with 136 service points throughout the country. It is, by far, the largest source of agricultural loans in Benin. This analysis exploits differences in when clients took out their first agricultural loan with FECECAM as the main source of identification of the effects of FECECAM's agricultural loans. The study relies on a "pipeline" design, or cohort approach, in which subjects enter a program at different times. In this specific case, the design allows the comparison of individuals with greater experience with credit to those with little or none. The pipeline design represents a good alternative to a fully randomized

assignment because it offers a convincing control (Duvendack et al., 2011). Compared to studies that use similar methods and even compared to most microcredit impact studies, this research spans a larger impact timeframe (e.g., (Copestake, Bhalotra, and Johnson, 2001; Maldonado and González-Vega, 2008). To the best of my knowledge, this study is the first of its kind to be carried out in Benin.

The remainder of this chapter is organized as follows: In the next section a conceptual framework explains the notion of efficiency and its underlying theoretical foundation, as well as laying down the hypothesized relationship between loans and efficiency. Then the following section describes the profit frontier function and the process of using it to estimate the average causal effect of FECECAM loans. Finally, the last section presents and discusses the results.

3.2. Conceptual framework

3.2.1. The concept of efficiency: definition and measurement

The concept of efficiency is widely used in economics. It refers to the success of an agent, herein a farmer, in producing the maximum possible output from a given set of inputs (Farrell, 1957). Broadly, the notion of efficiency characterizes the utilization of resources. In a sense, efficiency is a relative concept: it compares the performance of a production unit to a standard.

Standard production theory, with its underlying concept of the production function, provides the basic framework for the efficiency measures. The production function represents the *maximum* amount of output attainable from a given input bundle with fixed technology (Aigner, Lovell, and Schmidt, 1977). Similarly, a cost function gives the *minimum* level of cost at which it is possible to produce some level of output, given input prices. Finally, a profit function provides the *maximum* profit that can be attained, given output price and input prices (Førsund, Lovell, and Schmidt, 1980). For each of the functions presented, the concept of maximality or minimality is essential. The term *frontier* can be meaningfully applied in each case because each function sets a limit to the range of possible observations. A frontier denotes a bounding function (Coelli, 1995). The pioneering work of Farrell (1957) led to the estimation of the so-called frontier production functions, instead of the *average* production functions estimated previously. The

production possibility frontier provides the theoretical representation of the farm production function and delimits the set of all possible outputs attainable for a level of input sets and technology available (Schmidt, 1985). Hence, one may observe points below the production (profit) frontier (farms producing less than the maximal possible output) or points on the frontier (efficient farmers) but no points can lie above the production (profit) frontier. The amount by which a farm lies below its production or profit frontier and the amount by which it lies above its cost function can be used as a measure of its *inefficiency*.

The frontier function model of Farrell (1957) uses the efficient unit isoquant³² to measure economic³³ efficiency, and to decompose this measure into technical and allocative efficiency (Bravo-Ureta and Pinheiro, 1993). In the frontier function model, deviations from the frontier isoquant are associated with technical inefficiency and deviations from the cost minimizing input ratios denote allocative inefficiency. Technical efficiency (TE) indicates the farmer's ability to produce the maximum output possible (the frontier output) given a set of inputs and technology. Put differently, technical inefficiency reflects the failure of attaining the highest possible level of output given inputs and technology. Allocative (or price) efficiency (AE) measures the farmer's success in choosing the optimal input quantities that minimize costs, given the level of output and the relative factor prices. Stated differently, allocative efficiency refers to the ability of the farmer to use inputs in optimal proportions given their respective prices. Economic or total efficiency measures the overall performance of the farmer and is equal to the product of allocative and technical efficiencies. The choice of a specific measure of efficiency depends on the objective.

Generally, there are two classes of frontier estimation methods: parametric and non-parametric. Parametric frontiers rely on a specific functional form; they use econometric techniques to estimate the pre-specified functional form and inefficiency is modeled as an additional stochastic term. The stochastic frontier analysis proposed by Aigner et al. (1977) is an example of parametric frontier approach. Non-parametric frontiers do not rely on a

³² The concept of frontier unit isoquant used by Farrell, (1957) evolved into the production and cost frontiers of today (Kopp and Diewert, 1982).

³³ Some of the paper's terminology differs from what Farrell used in his work. For instance, Farrell used the term *price* efficiency instead of *allocative* efficiency and the term *overall* efficiency instead of *economic* or *production* efficiency. The terminology employed in this paper follows what has been often used in recent literature.

specific functional form and use linear (or mathematic) programming. They were first used by Farrell (1957) and reformulated as a mathematical programming problem by Charnes, Cooper, and Rhodes (1978). Data envelopment analysis is the most commonly used non-parametric approach. Frontier models can also be categorized into deterministic and stochastic frontiers. In deterministic models, measurement errors or other sources of noise are not taken into since the model assumes that any observed deviation from the estimated frontier is due to inefficiency, while the stochastic approach allows for statistical noise (Bravo-Ureta and Pinheiro, 1993; Coelli, 1995).

3.2.2. Agricultural loans and farmers' efficiency

Despite the expansion of microloan programs, the literature lacks consensus regarding the effectiveness of such programs. On one hand, studies show that microfinance does help the poor improve their productivity as well as their well-being and enables them to pull out of poverty (Girabi and Mwakaje, 2013; Otero, 1999; Pitt and Khandker, 1998). On the other hand, other studies claim that evidence supporting the positive impact of microfinance interventions is thin and lacking in rigor (Banerjee et al., 2014; Feder et al., 1990; Roodman and Morduch, 2014).

Agriculture in developing countries has experienced profound changes in the face of a rapid technological change. In a traditional agriculture, farmers mostly depend on their own resources and have had a long period to adjust their management to the most efficient use of their resources in their environment. However, in a dynamic setting, characterized by a continually changing technical and economic environment, it is more difficult for farmers to adjust their allocative decisions to keep up with changes in their environment and, simultaneously maintain an efficient allocation of resources. Thus, in such context, farmers are more likely to be in a state of continuous disequilibrium with potentials and benefits in improving their information and skills to reduce their technical and allocative errors (Ali and Byerlee, 1991).

Access to financial instruments closely influences farmers' decision to invest and to produce (Karlan, Osei, Osei-Akoto, and Udry, 2014). Microfinance services in general, and microcredit specifically has a very important role to play in today's technically-dynamic agriculture that depends greatly, *inter alia*, on the use of purchased inputs, hired

labor, machinery services or financial services. In fact, when assessing the determinants of farm level variation in efficiency, several studies conclude that access to credit has a positive and statistically significant impact on farmers' technical and allocative efficiency (Ali, Parikh, and Shah, 1994; Bravo-Ureta and Pinheiro, 1993). For instance, five out of eight studies in the review of Bravo-Ureta and Pinheiro, (1993) showed that credit has a positive and significant effect on the efficiencies of the farmers. The current study identifies different channels of influence of agricultural loans on farmers' efficiency.

At the beginning of the production period, agricultural loans may augment farmers' initial endowment to help them face lump sum productive investments. Given the indivisible nature³⁴ of some inputs needed, lump sum expenses are required. Cash constraint could lead to a bad combination of inputs if the farmer is unable to purchase those inputs at all, causing inefficiencies. Credit availability, therefore, allows constrained farmers to make the optimal input mixes to produce efficiently (*optimal input mix effect*).

Given that production efficiency depends on input decisions, microfinance services, and more specifically agricultural loans will increase borrower's productive power by fostering investment in farming activities and improving farmers' access to inputs. More specifically, agricultural loans will lead to the purchase of better performing or modern inputs that may be costly but have higher returns. Even though these technologies may increase the production cost, they often have economies of scale that lead to higher output levels per production costs. Obviously, everything else equal, farmers with better inputs access are expected to have higher efficiency levels compared to the constrained ones who are more likely to underinvest in resources. Thus, agricultural loans will positively affect farmers' total efficiency. Production loans, by relaxing farmers' budget constraint grants them the opportunity to purchase and use technologies such as improved seeds, fertilizers, pesticides, farm machinery, etc. Most of these technologies will increase farmers' output, profit, and productivity (*scale effect*).

However, one can argue that the mere provision of loans may help farmers operate at a higher production frontier but might not necessarily make them more efficient. In this study, the treatment variable considered is not the access to credit but the *experience with*

³⁴ For example, farmers cannot purchase portions of a pesticide bottle because (s)he has a small farm.

the loans over a relatively extended period of time. If the simple provision of loans does not help farmers improve their resource allocation, their experience with the loans over time is more likely to help them learn the best practices, and this learning and experience will ultimately help farmers adjust their technical and allocative decisions to reach an equilibrium of efficiency. Farmers with more experience with loans are expected to be more efficient as they learned over time how to choose the right proportions of inputs to produce the most possible output not only to be profitable but also to be efficient. Furthermore, most loan programs including FECEAM's offer training as well as educational support to their clients to help them improve their management as well as their financial skills to better conduct their funded activities. In this case, it is reasonable to expect such loan programs to have a positive impact on clients' allocative efficiency particularly. Recall, allocative efficiency is the ability to use optimal proportions of inputs. Allocative inefficiencies are errors in the allocation of inputs within expenditure levels. These inefficiencies, for the factors that depend on the farmers, are caused mostly by inadequate information; other causes of allocative inefficiency include market failure in input supply, differential risk effects of inputs, institutions (e.g., tenancy) (Ali and Byerlee, 1991). Borrowers with higher numbers of loans, which imply several pieces of training from the MFI, are expected to have a higher (allocative) efficiency score (*learning/experience effect*). More, credit users with frequent extension visits and a higher educational level may have higher efficiency levels.

Finally, the examination of secondary data provided by FECECAM showed that some farmers requested amount of loans that are smaller than the amounts they have in their saving account(s). In other words, they could have invested their savings in their productive activities but they prefer to take out loans. These borrowers argued that such behavior "pushes them to work harder and produce better". FECECAM staff members confirm this explanation of such behavior arguing that, having the weight of a loan that needs to be repaid, gives some borrowers a reason to "work harder" to have a successful production season. Even though, this argument is anecdotal, one can argue that agricultural loans have an *incentivizing effect* that pushes farmers to produce the highest possible output with their resources. Farmers improve their production process to be able to make profit and repay the loan including the interests.

3.3. Empirical framework

3.3.1. The profit frontier function

In the literature, technical and allocative inefficiencies have been widely studied in the context of single-output technologies (Kumbhakar, 1996). This paper models these inefficiencies in a multiple-output, multiple-input context. The sample agricultural borrowers conduct several productive activities including multiple crops production, animal raising, processing and trade of agricultural products. Overall, they conduct on average 2.77 (± 1.21) distinct income generating activities including non-farm one. More in detail, on average, sampled borrowers produce 1.84 (± 1.24) different crops, conduct 0.38 (± 0.64) distinct agricultural products processing and trade activities, and 13.90 % ($\pm 34.62\%$) raise animals. In such context, inputs can be assumed non-allocable, meaning that one observes the total quantities of the different inputs used in the production process, instead of the quantities of each inputs allocated to different outputs (Kumbhakar, 1996). The production process is therefore represented by a single equation including all outputs and inputs.

Typically, (economic) efficiency is analyzed by examining separately its two components: technical and allocative efficiencies, and the conventional production function approach suffices to measure these efficiencies. However, a production function may not be appropriate when estimating the production efficiency of individual farms when they face different input and output prices and have different factor endowments (Ali and Flinn, 1989; Yotopoulos and Lau, 1979). In fact, in such case, farms have different best-practice or frontier production functions and, thus, operate at different optimal points. Consequently, a stochastic profit frontier function, which is more suitable, is applied to directly estimate farm-specific efficiencies. This estimation process incorporates prices differences, market distortions but maintains the advantage of the stochastic frontier properties in efficiency analysis (Ali and Flinn, 1989; Wang, Cramer, and Wailes, 1996). The profit frontier combines both measures of efficiency into one, the profit efficiency. In this profit relationship, errors in the production decision translate into lower profits or revenue for the farmers (Ali et al., 1994). In addition, deviation of actual profits from the

profit frontier function can be interpreted as the aggregated technical and allocative inefficiency (Ali et al., 1994).

Scholars have also argued that socio-economic variables should be incorporated directly in the frontier model because such variables may have direct impact on the efficiency (Battese and Coelli, 1995; Kumbhakar, Ghosh, and McGuckin, 1991). Put differently, the stochastic frontier model should be estimated as a function of explanatory variables, reflecting farm-specific characteristics. This study integrates directly farm-specific characteristics in the estimation of the stochastic profit frontier function.

The stochastic profit function is defined as followed:

$$\pi_i = f(x_i; \beta)\varepsilon_i \quad (1)$$

where π_i is the profit aggregated over all farming activities of the i^{th} borrower and calculated as the gross revenue less the variable costs. x_i is a vector of input expenditures (labor and other variable costs/capital) of the i^{th} borrower and β is the unknown parameters to be estimated. The i^{th} borrower makes profit using the technology $f(x_i; \beta)$. A borrower make lower profit than predicted by the profit function when errors occur in the production system, leading to inefficiencies denoted by ε_i . The inefficiency term satisfies the condition $0 < \varepsilon_i < 1$ and the closer ε_i is to 1, the more (profit) efficient the borrower is.

To estimate the stochastic profit frontier, the study assumes that the profit function takes a translog³⁵ form. The translog functional form offers a relative flexibility compared to a Cobb-Douglas function. In fact, a translog profit function does not impose assumptions about constant elasticities of production nor elasticities of substitution between inputs, allowing the data to reveal the actual curvature of the function, rather than imposing a priori assumptions. The translog profit frontier, illustrating a case of two inputs, is expressed as:

$$\log \pi_i = \beta_0 + \beta_1 \log x_{1i} + \beta_2 \log x_{2i} + \beta_3 \log x_{1i} \log x_{2i} + \beta_4 \log x_{1i} \log x_{1i} + \beta_5 \log x_{2i} \log x_{2i} + \varepsilon_i \quad (2)$$

Consistent with the frontier concept, the error term ε_i in the profit function is also a compound disturbance term, which have a strictly nonnegative and symmetric distribution, respectively.

$$\varepsilon_i = u_i + v_i$$

³⁵ Several studies including Kopp and Smith (1980) indicated that functional specifications have little to no impact on measured efficiency.

v_i , which is the idiosyncratic component, is independently (iid) $\sim N(0, \sigma_v)$ distributed over the observations and reflects random factors beyond the control of producers such as the weather. u_i is a one-sided disturbance term that represents the inefficiency component. It is assumed to have a half-normal distribution (non-negative and absolute value of a normal distribution).

Next, the profit inefficiency term is specified as a function of covariates Z_j including socio-demographic as well as farm-specific characteristics such as borrowers' education, contact with extension service, etc.

$$u_i = \alpha_0 + \sum_j \alpha_j Z_{ji} + \xi_i$$

Both the profit frontier function and the inefficiency models are estimated jointly using the maximum likelihood estimation method.

3.3.2. Estimating the effect of loan experience on borrowers' efficiency

The ultimate goal of the study is to estimate the average causal effect of FECECAM loans on the efficiency of its agricultural borrowers. Earlier, in section 1.5.3, the biggest threat to identifying that causal effect has been addressed. The study exploits clients' program entry timing along with their borrowing history with FECECAM to construct reliable treatment and control groups using a clustering technique. The treatment considered is the experience with FECECAM loans. The treated group represents borrowers, to whom the MFI has been lending for an extended period. More specifically, the treated group includes borrowers, who, on average, have joined FECECAM 15 years prior to the study, have taken four times a loan and have received an average of 1,126,000 FCFA of loan each time. A total of 153 borrowers (20.45%) meet those conditions in the sample. The control group consists of borrowers, who, on average, entered the loan program only three years before the study, have obtained a loan two to three times, and have received an average amount of 300,000 FCFA of loan each time they have borrowed. 79.55% of the sample falls into that category.

The K-means cluster analysis permits to create two groups within which observations are very similar, but observations in different groups could also be dissimilar. In other words, borrowers within the treatment or the control group share very similar

characteristics, however, as shown by the results from the t-test (table 1.4), experienced borrowers could differ from inexperienced ones based on some observable features such as age.

One way to bridge that gap between the treatment and the control group is to match similar borrowers based on those factors of dissimilarity across groups, that actually are not influenced by their experience with loans, but instead determine their likelihood to be treated, here to be an experienced borrower. All these factors are “summarized” for each subject in a so-called propensity score, in this case, the propensity to be an experienced borrower. More specifically, the propensity scores are the conditional (predicted) probabilities of receiving treatment given pre-treatment or baseline characteristics. The study computed the propensity scores of the sampled borrowers using a logistic function.

$$p(x) = \text{prob}(D = 1|z) = E(D|z)$$

Where D is the dependent variable and takes the values $D = 0$ for control observations and $D = 1$ for treated observations; z is a set of explanatory variables.

The covariates used to predict sampled borrowers’ probability to be treated are the lender’s selection criteria along with other factors drawn from the literature. For instance, the borrower’s age is an important criterion of selection for the cooperative and thus, a significant predictor of treatment. To be eligible for a loan with FECECAM, applicants must be 18 to 70 years old at most. Applicants must also have some experience conducting income generating activities as well. Therefore, working young and middle-aged adults are more likely to have some borrowing experience with FECECAM. Women are also “trusted” because they tend to have a lower rate of default. For proximity matter, FECECAM requires all its applicants to reside in the town or at least in the Commune³⁶ in which they are requesting a loan. Indicators of wealth and the ability to provide collaterals also greatly affect the lender’s decision to provide a loan. Consequently, predicting variables used are socio-demographic characteristics such as age, gender, educational level, status in the household, work migration experiences as well as household structure including household size, family workforce computed in adult equivalent³⁷. The covariates

³⁶ Communes are the second administrative territorial divisions in Benin after villages/cities and there are seventy-seven (77) communes in Benin.

³⁷ To estimate family workforce in adult equivalent (eqa), the age of each household member actually working or helping on the production units of the household is multiplied by the following coefficients: 0.33

also comprise socio-economic features such as the number of income generating activities, years of experience conducting farming activities, land available to the household, household assets, farm and non-farm income, and the proximity to a FECECAM service point as well as the location in an agricultural zone. Note that except for gender and location, these variables are related to the age of the borrower.

In a next step, individuals from the treatment group, the experienced borrowers, are matched to those in the control group that have similar level of propensity score. Given that the number of borrowers in the control group is more than three times the number of those in the treatment group, each experienced borrower is matched to three nearest “neighbors” in the control group, i.e., the three nearest inexperienced borrowers with similar propensity scores. Finally, treatment effects are calculated by comparing the outcomes (efficiency levels) of matched observations. The causal effect of FECECAM loan experience on the whole-farm efficiency of borrowers is assessed using two treatment effects statistics: the Average Treatment Effect (ATE) and the Average Treatment Effect on the Treated (ATET or ATT).

3.3.3. ATE versus ATET

The average treatment effect (ATE) measures the effect that a substantial experience with FECECAM loans would have on the entire population or what would have happened, had all borrowers been treated or experienced. To obtain the ATE, the potential outcome (PO) of each subject in the sample is calculated first. The PO is the outcome that would be observed if each sampled individual received a specific value of the treatment (the counterfactual). For experienced borrowers, the PO if they were inexperienced is computed while for the PO if experienced is estimated for borrowers in the control group. The ATE is the average difference between the actual outcome and the potential outcome of each subject.

The average treatment effect on the treated (ATET or ATT) estimates the effect of the treatment on those who received it, in other words, how much the efficiency of the

eqa for a child from 6 to 10 years, 0.66 for a child from 11 to 15 years old, 1 for a person from 16 to 50 years old, 0.66 from 51 to 65 years and 0 beyond. These are the FAO coefficients for adult equivalency in labor force.

treatment group improved as a result of their experience with FECECAM loans. The ATET is the difference between the outcome of the treated and the control groups.

The ATE and the ATET answer different economic policy questions, especially in cases like this where participation is voluntary. The ATE estimates the effect of a policy or program on the persons induced to change participation status by the policy/program. It ignores the effect of the variation in policy parameter on inframarginal person (Heckman, 1997). Participation in FECECAM's loan program is voluntary and one can argue that there will always be individuals who will choose not to borrow from the institution. Instead of considering the marginal effect of FECECAM loans for the entire population, the effects of FECECAM loans in its current state, on those who choose to participate may be more informative. For the German Development Institute who commissioned this investigation, the ATET estimating the effects on those who actually choose to borrow is a better indicator of the effect of loan on efficiency compared to the ATE expressing the effects of loans in a hypothetical scenario where everyone in the population would borrow from FECECAM. In the case of a required vaccine for instance, the ATE would be more meaningful.

The ATET, however, can be criticized from different standpoints. In general, the assumptions required to estimate the ATET are less restrictive and weaker than those required to estimate the ATE. Thus, ATET could suffer from biases, especially in observational studies if the treatment and the control groups are not similar. Though, it is shown not to be case in this study (see section 1.5.3.). Typically, the ATET should³⁸ give the same results as a t-test between the outcomes of the treatment and the control groups.

3.4. Results

3.4.1. Data overview

Variables description

Table 3.1 presents a descriptive summary of the variable used in the analysis. The sample includes 67.78% of male respondents, and the average age of all respondents is about 43 years. The average credit user has three years of education, conducts three income

³⁸ Unlike the ATE, the estimation of the ATET requires finding matches for treated subjects only. Thus, all individuals in the control group may not be used.

generating activities, farm and non-farm included, and has been conducting those activities for 19 years. Their households have an average of eight members, which is relatively large compared to the country mean of 5.87³⁹ recorded by Benin's population census of 2013. Likewise, the area of land available and owned by the households of the respondents is high, 9.3 ha on average. Even the mean value of household durable goods or assets owned by the respondents in 2017 during the survey indicates that the sample of borrowers does not mainly include the traditional poor small farmers. The average value of the household assets owned by the respondents is 2,000,000 FCFA.

Farming activities

The study considers all farm related activities funded by FECECAM. Specifically, agricultural loans, in this analysis, refers to loans taken for agricultural related activities including crop production, animal husbandry, processing, and, trade of agricultural commodities. As shown earlier, farmers in Benin are engaged in multiple farming activities that contribute to their income, thus to their farm profit. Each respondent weighted the relative contribution of their various activities to their monetary income. The average weight obtained represents an approximate value of the relative contribution of each type of activity to the farmer's income. The relative contribution of the activities are described by region in figure 3.1.

Overall, in all studied regions, crop production remains the main source of income for the sampled borrowers. It comprises more than 50% of their income. The contribution of crop production to the respondent's income increases from the South to the North. For borrowers in the North, crop production comprises 82.2% of income. Maize is the main crop produced (30.5% of income), followed by cotton (27.4%) and soybean (11.7%). Concerning animal raising, cattle dominate. Agricultural products are marginally processed but mainly used in local street food production in this region.

In the Center, even though crop production is the main source of income, trade of agricultural products represents a sizeable portion of the recipients' income. Trade in the Center totalizes the highest contribution to income compare to the North and the South. Processing activities remain moderate, but more important than in the North. Animal

³⁹ Data made available by Benin Data Portal (2016).

husbandry contributes to 4.1% of recipients' income in the region, and mostly through livestock trade. Animal husbandry is more diversified compared to the North, and cattle are dominant but followed by pigs.

While income structures in the North and Center do not differ fundamentally, it is not the case in the South. The main source of income remains crop growing (57.0%) but the leading crops are pepper (8.6%), maize (6%), cassava (6%), pineapple (5.6%), sweet potato (4.9%) and tomato (4.8%). Farm produces are more often processed locally (10.5%), with alcohol production at the top of a long list of processing activities (cassava in flour, palm nuts in oil, cereals in various products, smoked fish, soy in milk and derivatives, etc.). Animal raising is more important than in other regions (4.5%), and is dominated by poultry and pigs.

Overall, agricultural borrowers in the North specialize mostly in crop production while in the Center, production and trade dominate; and in the South, production and processing are the farming main activities.

3.4.2. Stochastic profit frontier estimation

The first step is the estimation of a stochastic translog profit function, which represents the best-practice technology against which the efficiency of the borrowing farmers can be measured. The results are presented in table 3.2. Following Kumbhakar et al. (1991), the specification includes direct estimation of determinants of profit efficiency along with the parameters of the frontier model. To capture regional heterogeneity, the profit frontier is estimated per studied region: the North, the Center and the South.

Prior to the profit frontier estimation, a likelihood ratio test of the presence of an inefficiency component in the model is performed. The test's null hypothesis is $H_0: \sigma_u^2 = 0$ against the alternative hypothesis $H_1: \sigma_u^2 > 0$. If the null hypothesis is true, then the stochastic frontier model reduces to the classical Ordinary Least Square (OLS) model with normal errors. In the specification combining all regions as well as in the specifications for the North and the South, the null hypothesis is rejected, indicating that a significant part of the variability in profits among agricultural borrowers is explained by existing differences in efficiency levels. The estimation of a stochastic profit function is therefore justified. However, in the Center, we fail to reject the null hypothesis.

Furthermore, the variance ratio parameter, $\lambda = \sigma_u/\sigma_v$, proposed by Battese and Corra (1977) is greater than 0 and relatively large ($\lambda = 2.21$ in the North, $\lambda = 0.78$ in the Center, and $\lambda = 1.65$ in the South). This result implies that deviations from the maximum profit among agricultural borrowers in the North and the South stemmed from differences in producer practices rather than random variability ($\lambda > 1$). In the Center, however, λ is different than zero but less than unity indicating that the idiosyncratic component dominates in the determination of the error term. There is some inefficiency but the differences in profit among borrowers in the Center is prominently caused by random factors outside the farmers' control.

The sum of all parameters of the profit frontier model is lower than unity ($\sum_j \beta_j < 1$) in all regions indicating that borrowers operates with diminishing returns to scale technology. In the South, both the increase in labor and other variable inputs are positively and significantly associated with increase in output and profit. Across all regions, other variable inputs (capital) significantly and positively affect the profit.

Recall, labor cost includes the value of in-kind and cash payments to hired laborers. A variable indicating whether respondents report no labor expenditure has been included in the inefficiency model. The statistically insignificant coefficient on that variable in the North and the Center implies that profit does not really change when no labor expense is reported. In fact, one can consider hired labor in this case as an indicative of the size of the farm operation in those two regions—descriptive statistics show that borrowers in those areas use mostly family labor: respectively 93.85% and 92.12% in the North and the Center. A Probit regression of labor expenditure report shows that small farmers with less capital do not hire any labor in those regions. Conversely in the South, where borrowers employ mostly paid labor, the coefficient on the variable indicating that respondents report no labor expenditure is positive and statistically significant. This result denotes that in the South, labor expenditure is a significant share of the total cost such that farmers who do not pay for labor in kind or in cash have higher profits.

A dummy variable for whether the sampled borrower belongs to a family of native or first comer in the area displays a positive and significant coefficient in the Center and in the South. This variable has been included in the model essentially to capture land resourcefulness. In the South and the Center where land resources are scarcer than the

North, it makes sense that natives who own more land see a significantly positive effect on their profit efficiency. In the Center and the South, specialization seems to improve profit efficiency—the coefficient on the number of activities is negative in both regions but statistically significant in the South only.

Surprisingly, the joint estimation of the frontier model and the efficiency factors indicates inconclusive results on the relation between efficiency and household size or family labor force.

In the Center, gender significantly affects the efficiency of the borrowers. In fact, *ceteris paribus*, female agricultural borrowers are more efficient than male ones. They possess less assets than male borrowers do, but they utilize their resources more optimally. This result is very interesting and has important policy implications. It confirms previous studies' finding and the belief in the development arena that, policies targeting (rural) women tend to be more effective. Resources or more specifically, money placed in women's hand seems to have bigger effect, not only on the household as demonstrated previously (e.g. Thomas (1990)), but also on the farm. Put differently, the result supports the recommendation that development program should target women because they tend to be more efficient in resources use.

Surprisingly, the number of years of education has a negative effect on efficiency in most regions. The coefficient is only statistically significant in the South. This result can be explained by the fact that, the more educated the borrowers are, the more they tend to practice farming as their secondary activity and therefore, are less efficient at it. For instance, several respondents in the sample are school teachers or civil servants living in rural areas and conducting some farming activities for additional income. The negative sign on the coefficient of the number of income generating activities, even though it is not statistically significant, supports this explanation.

3.4.3. Profit efficiency scores

The stochastic profit function model permits to uncover efficiency scores of agricultural borrowers. These efficiency score are summarized in table 3.3. Recall, the closer the efficiency scores are to the unity the more efficient the farmer is. On average, farmers' efficiency level is about 41% in the North, 57% in the Center and 44% in the

South. In general, sampled borrowers display low levels of profit efficiency denoting that their farm as a whole could be about twice as profitable as it is.

The survey data help to better understand the different mechanisms contributing to the different levels of efficiency per region. In the South, the most urbanized part of the country, as well as in the North, the region with the highest agricultural production, borrowers invest substantially in mechanized production equipment as well as in transportation means⁴⁰. In the South for instance, where farmers practice a lot of horticulture, loans are frequently used to acquire irrigation equipment; whereas in the North, sampled borrowers invest in tractors and land preparation machines. These technologies help farmers reach a certain level of efficiency in production by increasing their output (technical efficiency) but the cost associated with the investment into these technologies increase their cost of production (allocative inefficiency) in the short term studied. Consequently, in the North and the South the profit efficiency scores are the lowest. In the Center, the investment in agricultural machines is moderate but hired labor is predominant. Labor costs are often lower expenditure compared to machines and equipment making sampled farmers in the Center more cost efficient in the short-term given the technology used, compared to those in the North and the South. This result validates the previous result that differences in profit in the Center is mostly caused by random factors.

3.4.4. Agricultural loans and efficiency

To assess the impact of agricultural loans on farmers' efficiency, the study employs a treatment-effects model. A treatment effect is the change in an outcome caused by a subject, here the agricultural borrower that receives a treatment instead of another. Three main conditions underlie the use of treatment-effects estimators—the conditional-independence (CI) assumption, the overlap assumption and the independent and identically distributed (i.i.d.) sampling assumption.

The CI assumption ensures that the potential outcomes are conditionally independent of the treatment and that no unobservable variable affect both treatment

⁴⁰ Results from the previous chapter (Chapter 2) demonstrates this statement.

assignment and the potential outcomes, after conditioning on the observed covariates z . Stated simply, under the CI assumption, there is selection on observables. To ensure that the CI assumption is met, the study chooses a set of covariates that jointly determine the selection process and the efficiency level of the borrowers' farm. Also, given the sampling framework and the identification strategy, one can argue that there are no unobserved confounders or if any, potentially the morality of the client or her trustworthiness, they are highly correlated with the covariates included in the model. Finally, there is a high degree of post-match balance across the covariates. In fact, the box plots of matched data depicted in figure 3.2 (North), figure 3.3 (Center) and figure 3.4 (South) indicate covariate balance. Kernel density plots using the matched data also suggest balance.

The overlap assumption requires that each individual have a positive probability of receiving each treatment level. Rosenbaum and Rubin (1983) call the combination of the CI and the overlap assumptions strong *ignorability*. To check whether the overlap assumption is violated, the estimated densities of the probability of getting each treatment level are plotted. Figures 3.5, 3.6 and 3.7 display the estimated densities of the predicted probabilities that an unexperienced borrower is unexperienced and the density of the predicted probabilities that an experienced borrower is unexperienced, respectively in the North, the Center and the South. The graphs show that the two estimated densities have most of their respective masses in areas in which they overlap each other, and in all cases, neither plot display most of its probability mass near 0 or 1. There is no evidence, therefore, that the overlap assumption is violated.

The propensity score matching estimator is subsequently implemented and the propensity scores are modeled using a logistic model, incorporating covariates such as age, age square, gender, status in the household, education level, household size, assets, income, proximity to a FECECAM branch, number of income generating activities, land availability, and migration experience. Treated borrowers are matched to three control borrowers with the closest propensity scores due to the higher number of control subjects (almost three-fold).

After matching treated and untreated borrowers based on their propensity scores, i.e. their predicted probabilities to be treated, the average treatment effects and average treatment effect on the treated estimates have been elicited.

The matching results are summarized in table 3.4. Profit efficiency scores derived from models estimated per region are the outcome variable in the estimation of the ATE as well as the ATET. Section 3.3.3. earlier discussed the relevance of each statistic estimated. Even though the result table report both the ATE and the ATET, the latter is the most relevant figure in the case of this study. Though, the ATE shows that experience with loan clearly has the potential to significantly increase the whole-farm efficiency of borrowers by 3%, 2% and 5% respectively for those located in the North, the Center, and the South.

The statistic of interest, the ATET gives mixed results. In the North, farmers with extensive experience with loan—loan experience according to the study is detailed in section 1.5.3.—significantly improved their whole-farm efficiency by 3.5%. This number is very similar to the ATE obtained in the region and also similar to the difference in means from the t-test, even though that difference (4%) was not statistically significant. In the Center, ATET has a negative sign and is statistically significant. This surprising result could be due to the small number of treated subjects in that region (only 33 experienced borrowers versus 181 control). In fact, in the Center, even though the overlap and CI assumptions are met, the match balance or overlap degrees are still low. Also, the frontier estimation showed that in the Center, differences in profit are predominantly caused by random factors out of farmers' control. In the South, the ATET is not statistically significant even though it has a positive sign implying that loan experience may improve borrowers' whole farm efficiency.

It is noteworthy that the frontier estimation shows that sampled borrowers located in the North and the South have the lowest profit efficiency scores whereas the matching results reveal that borrowers located in those regions have the highest gain in efficiency from loan experience.

Overall, judging by the ATET, matching results indicate that the use of agricultural loans significantly increase the profit efficiency levels of experienced borrowers particularly in the North. Even though the change in efficiency is small, it has some important financial implications for the borrowers. In fact, these results put into perspective mean that over the six-years period studied (2012-2017), borrowers who received on

average four times (± 1.77 times) an average amount of loan of 1,126,000 FCFA⁴¹ ($\pm 1,2630,000$ FCFA) improved their whole-farm profit efficiency by 3.5% on average for those located in the North. In that region where the mean farm profit for the 2016-2017 agricultural season is 2,062,000 FCFA ($\pm 4,797,800$ FCFA), the improvement in efficiency represents a yearly gain in profit of 72,170 FCFA ($\pm 167,923$ FCFA). This gain is quite significant in a country like Benin where 40.1% of the population live below the poverty line (The World Bank, 2016).

The results of the study clearly indicate that FECECAM's loans not only help borrowers become better farmers but also improve their resource allocation.

3.5. Implications and Conclusion

The performance of the agricultural sector has a key role to play in the sustainable economic development of African countries. Yet, intensification and modernization typically require capital, which is not often available to farmers. The lack of capital represents a significant constraint to the development of the agricultural sector. The goal of this chapter is to gauge the effectiveness of agricultural credit programs as a policy tool for increasing the income and the productivity of farmers. More specifically, the chapter examines the effect of agricultural loans on input allocation decisions and farm profitability. It evaluates the impact of agricultural loans on the whole-farm efficiency of borrowers in Benin. The analysis exploits differences in loan take-up timing, frequency and amount received as the source of identification of the effects of agricultural loans provided by the largest microfinance institution in Benin (FECECAM).

Using primary data on the clients of FECECAM, this chapter, first, estimates a farm-level stochastic profit frontier. The results of the frontier analysis reveal, among other things, that even though (or, perhaps, *because*) rural women own fewer assets than their male counterparts, they are made more efficient by loans in their resource allocation. This result supports the fact that development programs targeting women have bigger effect.

Next, the frontier function allows the estimation of borrowers' profit efficiency scores, which is an aggregate measure of technical and allocative efficiency. The estimated

⁴¹ About 2,000 USD

average profit efficiency is about 41% in the North, 57% in the Center and 44% in the South, denoting the presence of significant technical and allocative errors leading to profit loss in all studied regions. Sampled borrowers' farm could be about twice as profitable as it is. In light of the survey and the previous chapter, the chapter discusses the mechanisms explaining the differences across regions in efficiency levels. Farmers located in North and the South have the lowest average efficiency scores due to higher costs of production (take loan for machines and equipment purchase) while borrowers in the Center are able to keep their production cost low by using hired labor. In all regions, FECECAM loans help borrowers obtain inputs and technology they need to increase their production.

Then, propensity score matching technique helps compare the efficiency scores of experienced borrowers to inexperienced ones, providing a measure of the marginal effect of loan experience. The ATE shows that experience with loan clearly has the potential to significantly increase the whole-farm efficiency of borrowers by 3%, 2% and 5% respectively for those located in the North, the Center, and the South. The two regions with the lowest efficiency scores have the highest (potential) gain in profit efficiency. Considering the sampled farmers who are actually treated, experience with loan significantly increase their efficiency particularly in the North, leading to a yearly gain in profit of about 72,170 FCFA.

These results have important policy implications. First, results suggest that there are significant inefficiencies in the way farmers allocate resources to their farming activities. Furthermore, the use of agricultural loans in Benin clearly helps farmers improve their productivity and profitability. The study provides a proof of the effectiveness of agricultural credit programs and shows that agricultural loans have the potential to improve farmer's livelihoods.

Chapter 3 Tables and figures

Table 3.1: Summary statistics by region

Variable	(North)		(Center)		(South)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
<i>Farm production variables</i>						
Farm profit (100,000 FCFA)	20.622	47.978	43.957	143.848	33.084	103.925
Labor ^a cost (100,000 FCFA)	1.197	2.048	1.577	3.015	2.868	6.071
Other variable input cost (100,000 FCFA)	7.481	9.938	7.237	40.580	9.518	27.603
<i>Other variables</i>						
Age (years)	42.848	11.513	41.530	11.697	46.214	10.111
Gender (Female =0; Male=1)	0.725	0.447	0.594	0.492	0.715	0.452
Household head (Yes=1; No=0)	0.674	0.470	0.629	0.484	0.757	0.430
Belong to a family of native or first comers in the area (Yes=1; No=0)	0.674	0.470	0.522	0.501	0.456	0.499
Experience in conducting farm activities (Years)	17.063	11.158	17.164	10.617	22.622	11.007
Years of schooling (Years)	1.887	3.492	2.924	4.308	5.430	6.132
Length of (work) migration (Months)	5.934	24.117	12.769	42.490	11.561	32.754
Household size (Count)	9.354	4.897	7.809	3.940	7.004	2.999
Workforce available in the household (Adult equivalent)	3.387	2.236	2.910	1.612	2.506	1.423
Number of income generating activities (Count)	3.191	1.325	2.667	1.131	2.435	1.034
Land available to the household (Ha)	12.765	13.703	9.151	11.892	5.784	21.821
Value of household durable goods owned (100,000 FCFA)	7.291	24.092	16.015	50.947	38.000	69.610
Non-farm income in 2016-2017 (100,000 FCFA)	1.178	2.925	2.815	10.890	4.220	16.994
Number of extension visits received (Count)	0.922	2.029	0.784	2.599	0.644	3.770
Average loan taken between 2012 and 2017 (100,000 FCFA)	659.572	707.855	813.147	773.218	438.235	421.173
Cost one-way trip to closest FECEAM branch (FCFA)	20.622	47.978	43.957	143.848	33.084	103.925

^a Labor cost includes the value of in-kind and cash payments to aids and workers for tasks undertaken during crop production, processing and trade of agricultural products, and animal raising.

Table 3.2: Maximum Likelihood estimates of profit frontier function by region

	(North)		(Center)		(South)	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
<i>Frontier variables</i>						
Log labor cost	0.004	0.518	0.523	0.413	0.672**	0.335
Log other variable inputs cost	0.511***	0.100	0.392***	0.075	0.353***	0.071
Log other variable inputs cost square	0.053	0.039	0.112***	0.026	-0.050**	0.025
Log labor cost square	0.090	0.276	0.081	0.161	-0.169	0.153
Log labor cost x Log other variable inputs cost	-0.186	0.214	-0.312**	0.137	0.120	0.083
<i>Inefficiency covariates</i>						
Report no labor expenditure (Yes=1; No=0)	-0.254	0.186	0.257	0.220	0.806***	0.267
Age	0.050	0.040	-0.013	0.048	-0.003	0.069
Age square	-0.001	0.000	0.000	0.001	0.000	0.001
Gender (Female =0; Male=1)	0.000	0.252	-1.055***	0.274	0.170	0.322
Household head (Yes=1; No=0)	-0.245	0.234	0.728***	0.286	-0.683**	0.336
Belong to a family of native or first comers (Yes=1; No=0)	-0.060	0.173	0.437***	0.174	0.324*	0.192
Experience in conducting farm activities	0.006	0.010	0.018	0.015	0.007	0.012
Years of schooling	-0.020	0.022	0.021	0.022	-0.031*	0.017
Length of (work) migration	-0.001	0.004	0.000	0.003	-0.002	0.003
Household size	-0.029	0.019	0.081**	0.034	0.027	0.042
Family workforce used in the household in 2017 (Adult equivalent)	0.001	0.045	-0.130	0.089	-0.003	0.081
Number of income generating activities	0.027	0.062	-0.059	0.089	-0.231**	0.097
Land available to the household	0.011*	0.006	0.012	0.009	0.000	0.004
Value of household durable goods owned	0.003	0.003	0.001	0.002	0.002	0.001
Non-farm income	0.030	0.028	0.013	0.016	0.003	0.016
Number of extension agent visits received	0.014	0.048	-0.001	0.032	-0.013	0.020
Constant	1.872**	0.948	2.153*	1.137	3.918**	1.681
<i>Variance parameters</i>						
Sigma_v (σ_v)	0.693	0.085	1.090	0.153	0.837	0.137
Sigma_u (σ_u)	1.529	0.151	0.850	0.524	1.380	0.263
Sigma2 ($\sigma^2 = \sigma_u^2 + \sigma_v^2$)	2.818	0.401	1.911	0.604	2.605	0.556
Lambda ($\lambda = \sigma_u/\sigma_v$)	2.208	0.213	0.780	0.666	1.649	0.383

Notes: *** p<0.01, **p<0.05, * p<0.1.

Table 3.3: Efficiency scores and mean comparison by region

	All		Experienced (N=145)		Inexperienced (N=529)		Difference	
	Mean	Std. Err.	Mean	Std. Err.	Mean	Std. Err	Mean	Std. Err
North (N=220)	0.414	0.013	0.445	0.029	0.405	0.014	0.040	0.031
Center (N=214)	0.568	0.007	0.597	0.016	0.562	0.007	0.035*	0.018
South (N=181)	0.436	0.013	0.457	0.021	0.428	0.016	0.029	0.030

Notes: *** p<0.01, **p<0.05, * p<0.1.

Table 3.4: Treatment effect estimates by region

Region	ATE		ATET	
	Coefficient	AI⁴² Robust Standard Errors	Coefficient	AI Robust Standard Errors
North	0.030***	0.003	0.035***	0.006
Center	0.023***	0.001	-0.023***	0.004
South	0.048***	0.004	0.007	0.008

Notes: *** p<0.01, **p<0.05, * p<0.1.

⁴² Stands for Abadie-Imbens robust standard errors

Figure 3.1: Contribution of farming activities to farmers' income

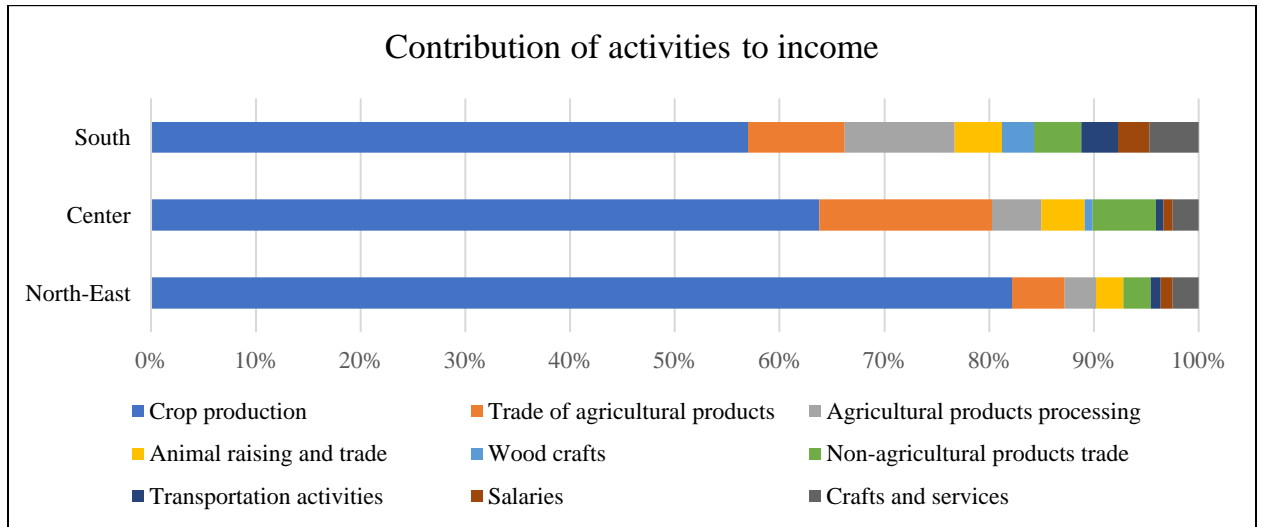
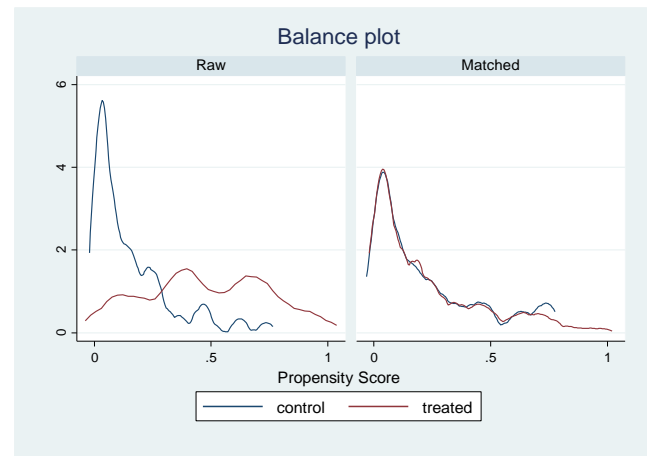
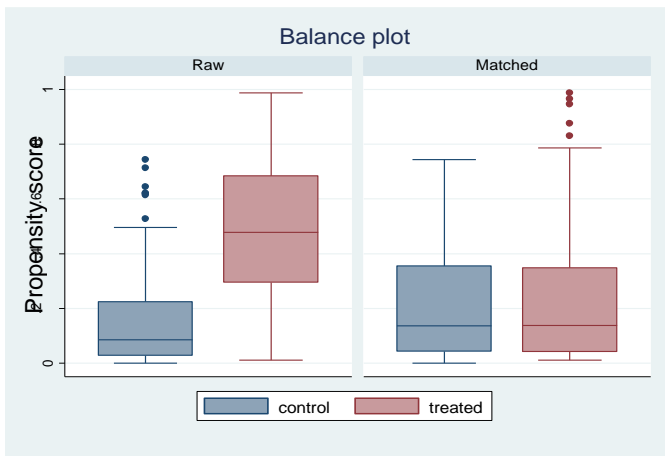


Figure 3.2: Covariates balance diagnostic box plots and Kernel density plot using the matched data in the North

- **ATE estimation**



- **ATET estimation**

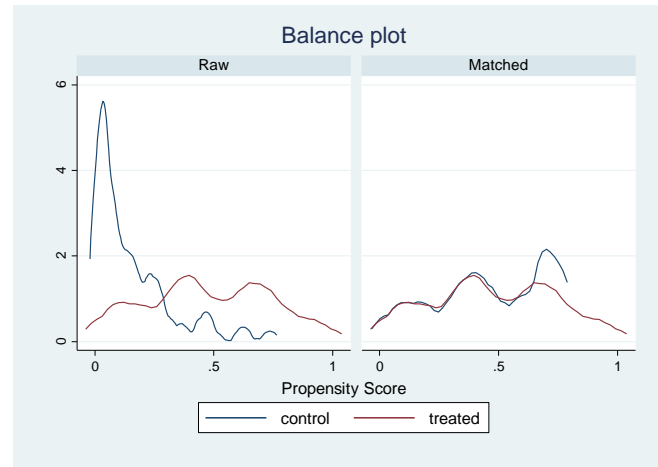
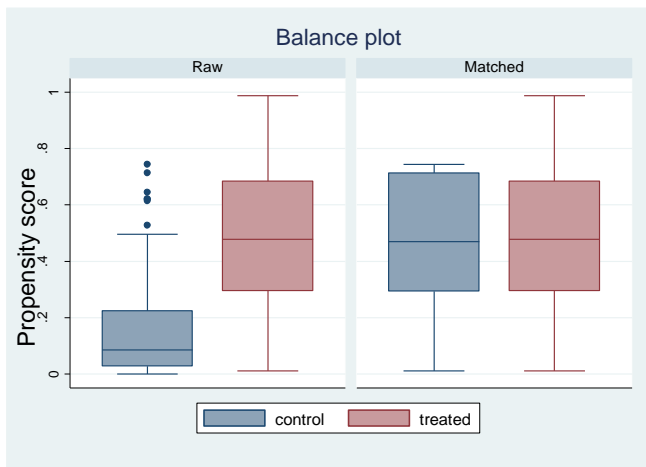
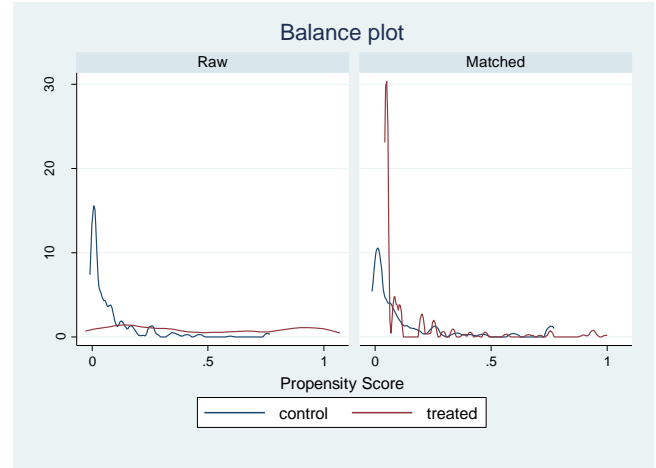
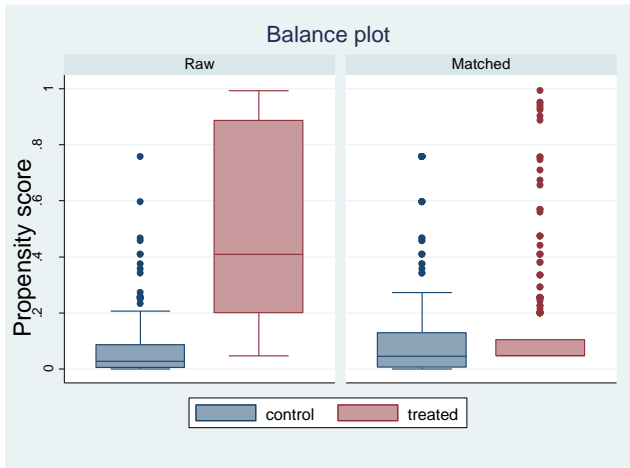


Figure 3.3: Covariates balance diagnostic box plots and Kernel density plot using the matched data in the Center

- **ATE estimation**



- **ATET estimation**

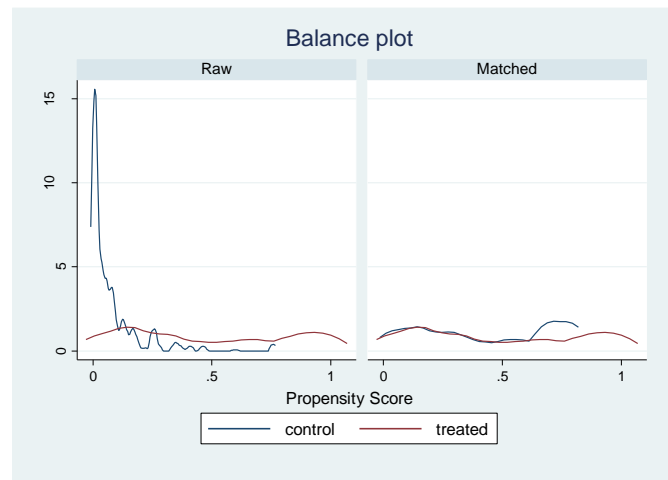
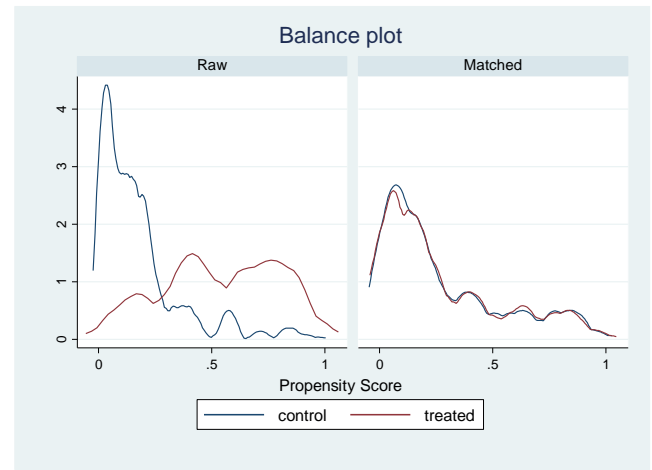
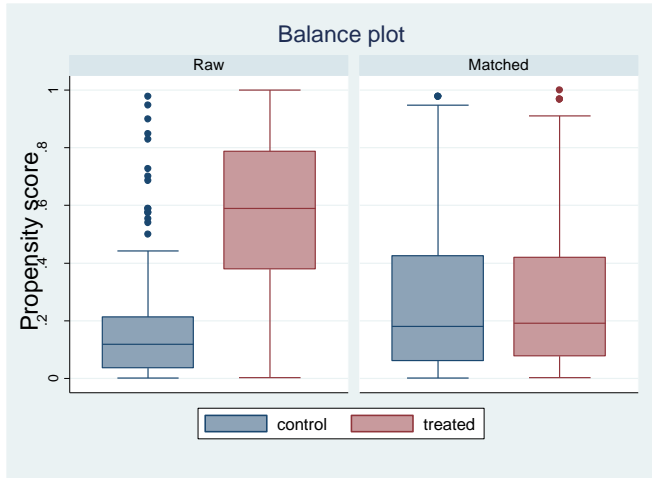


Figure 3.4: Covariates balance diagnostic box plots and Kernel density plot using the matched data in the South

- **ATE estimation**



- **ATET estimation**

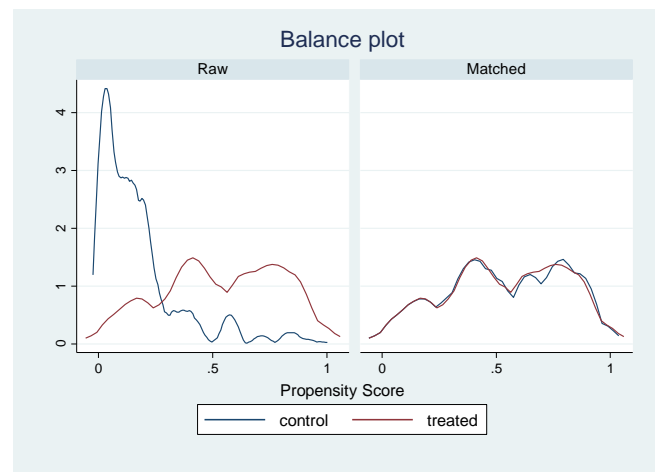
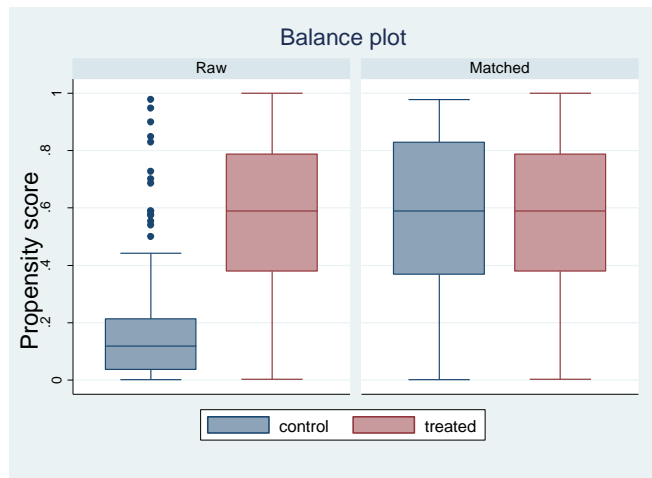


Figure 3.5: Estimated densities of predicted probabilities of getting each treatment level in the North (overlap check)

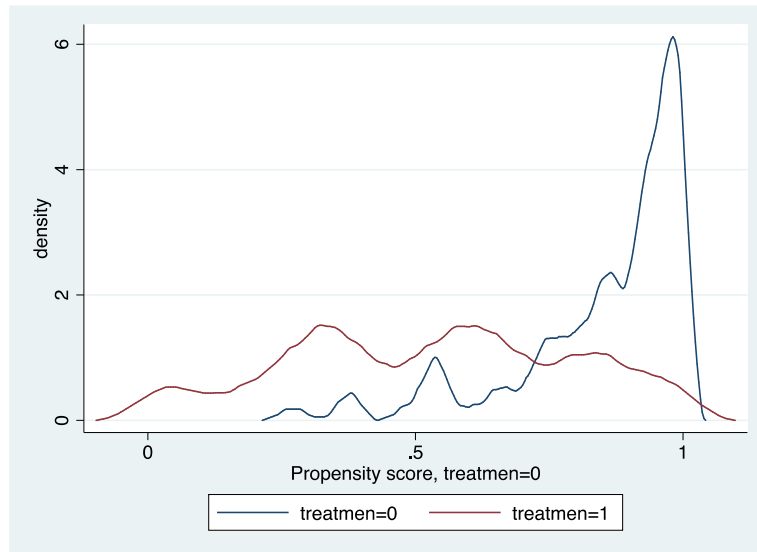


Figure 3.6: Estimated densities of predicted probabilities of getting each treatment level in the Center (overlap check)

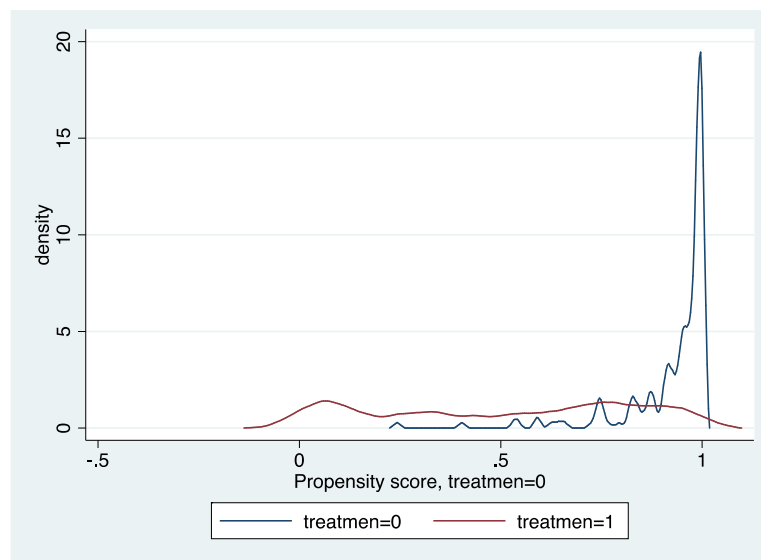
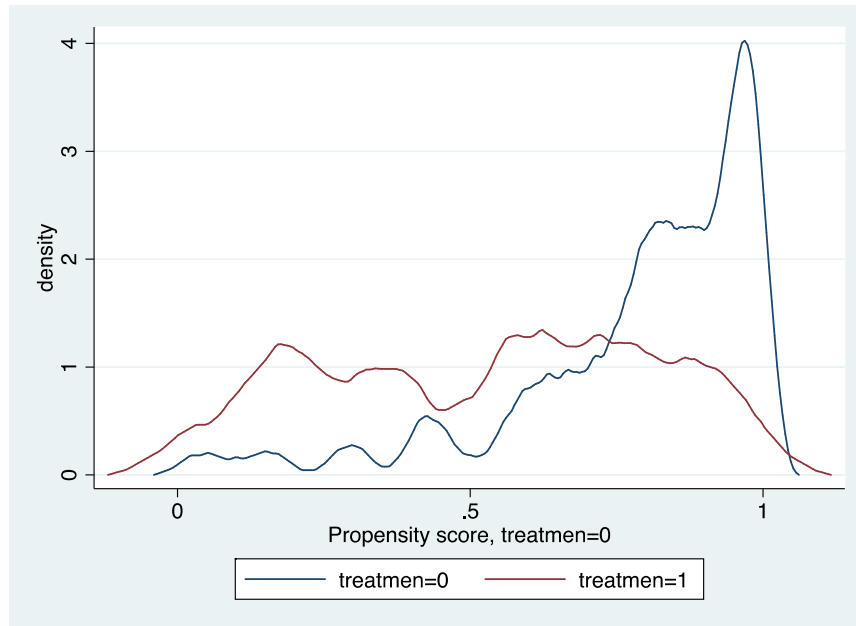


Figure 3.7: Estimated densities of predicted probabilities of getting each treatment level in the South (overlap check)



4. Impact of agricultural loans on farmers' well being

4.1. Introduction

Given the importance of the agricultural sector in developing countries in general and in Africa in particular, the sustainable economic development in these countries are conditioned by the development of their agricultural sector. Limited access to financial services is known as a major constraint to agricultural development (FAO, 2002). Farmers need liquidity to face agricultural expenses throughout the production cycle but mainly at the beginning. Production, as well as investment decisions of most farmers, are greatly influenced by their access to financial instruments.

Mainstream financial institutions are reluctant to serve the agricultural sector for several reasons. First, they consider the sector to be highly risky with a low performance. In addition, agricultural activities depend on the weather, they take place in remote rural areas, and commodities prices are volatile. All these aspects make it hard for standard banks to reach their profit goals when lending to farmers.

Microfinance was initiated with the belief that access to credit has the potential to transform the lives of those living in poverty (Grameen Foundation, 2016; Village Invest, 2016). In fact, microfinance, and more specifically microcredit has a dual mission: financial inclusion and poverty alleviation. In the past 20 years, the microfinance sector has experienced a rapid expansion, and the number of low-income households worldwide with a microloan has considerably grown. From 1997 to 2010, an eighteen-fold growth is recorded with an increase from 7.6 million to 137.5 million low-income families that received a microloan (MSC, 2012).

However, evidence of the effectiveness of microfinance is still unclear. The literature shows discrepancies between what microcredit ought to do theoretically and empirical evidence. For instance, evidence from Cambodia suggest that microcredit may be most appropriately conceptualized as a coping strategy instead of a poverty alleviation one because borrowers perceive loans as useful in coping with household vulnerability, but not transforming it (Bylander, 2015). In fact, microcredit opponents often argue that borrowers would use microloans for consumption instead of investment in profitable activities, resulting in repayment default, debt, and ultimately worsening the conditions of the borrowers. More, farmers in developing countries face significant risk constraints along

with capital constraints. If lack of access to credit can limit farmers' investment in activities with higher profits, lack of access to formal insurance market can also prevent farmers from investing in activities that may be risky, but have high expected returns (Cai, Chen, Fang, and Zhou, 2015; Karlan, Osei, Osei-Akoto, and Udry, 2014). Furthermore, if the funding of the agricultural sector must come from both the private and public sectors, it is essential to demonstrate its value empirically, and provide reliable figures on the impact of microfinance programs on agricultural clients' living standards. Only, past studies on the impact of credit suggest opposing results. On the one hand, studies show that microfinance does help the poor improve their productivity or their well-being and enables them to pull out of poverty (Girabi and Mwakaje, 2013; Pitt and Khandker, 1998). On the other hand, other studies claim that evidence supporting the positive impact of microfinance interventions are thin and lack rigor (Banerjee, Duflo, Glennerster, and Kinnan, 2014; Roodman and Morduch, 2014).

The goal of this chapter of the dissertation is to assess whether agricultural loans work as expected. The section estimates the impact of agricultural loans provided by the largest microloan provider in Benin on farmers' wellbeing. It tests the hypothesis that experience with microcredit improves the well-being of the borrowers.

A simple model is developed to demonstrate how the allocation of agricultural loans to the different needs of the recipient is a key determinant of how microloans affect the livelihoods of their users. The model argues that to uncover an effect from microcredit, loans have to be used for their purposes and suitable variables related to those purposes need to be measured. It is possible that several studies which found no or negative impact from microcredit use may have either missed the loan repurposing aspect, chosen the wrong outcome variables or may have actually measured the effect of a "misuse" of loans.

The study employs four variables to gauge borrower's well-being. The average impact of loan experience is estimated on borrowers' net farm income gained during the agricultural season 2016-17. Net farm income is calculated as the sum of all revenues from farm activities and farm-related services less cash and non-cash expenses. In addition, the impact of FECECAM farm loans on recipients' nutritional and food security status is estimated. Borrowers nutritional status is measured using the Food Consumption Score (FCS) and their food security status is assessed by the Food Insecurity Experience Scale

(FIES). Finally, the study takes a look at the specific impact of agricultural loans on rural women using the composite and multidimensional indicator WEAI–women’s empowerment in agriculture index.

Overall, the analysis shows that farm loans provided by FECECAM has a positive and significant impact on borrower’s well-being. Female borrowers experience higher positive impact of the loans compared to male.

4.2. Theoretical framework

4.2.1.MFIs’ strategy and expected impact of microcredit

When providing microloans, the strategy used by an MFI might greatly affect users’ perception of the loans and even the outcomes. Several studies, in fact, showed that borrowers sometimes perceive loans from governmental institutions or development programs as gifts and therefore fail to repay. For instance, studies by Houngan, (2015) and Mazumder and Lu, (2015) indicated respectively in Benin and in Bangladesh that, microcredit effects are consistently higher among non-governmental recipients compared to governmental programs. FECECAM is a cooperative established since 1977, which has substantial experience in credit disbursement. Over time, the lender has improved and adjusted its loan programs’ implementation. FECECAM offers loans for specific purposes and has a strict monitoring mechanism to ensure that borrowers use loans for their stated purposes. After a thorough screening process for selection, the MFI ensures that borrowers are actually using the loan for the initial activities through multiple site visits. These actions ensure the selection of “good borrowers”, the good use of the loan provided but are also deployed to guarantee a high repayment rate and the success of the programs.

Furthermore, a mandatory business management class is offered to all borrowers after they are approved for a loan. Some branches offer technical assistance to the borrowers depending on their activities, especially to women’s lending groups. During the loan application, the farmer and the credit agent make a farm business plan as well as a home plan for the coming agricultural season. As discussed earlier in the dissertation, these practices make FECECAM loan programs very similar to supervised credit programs. Farmers are provided loans but are also overseen and supported throughout the process. In those conditions, one can expect an extended use of agricultural loans from FECECAM to

have the expected outcomes on the users' socio-economic conditions. These empirical observations lay the foundation for a discussion on loans expected impact.

4.2.2. Microloan allocation as determinant of its impact

Let's consider a farm borrower who manages his economic activities within a farm household. In general, farmers are concerned about production as they are about consumption. An agricultural loan, even though received for a specific purpose, still represents an increase in borrowers' total cash, given that money is fungible. Thus, agricultural loans temporarily relax recipients' budget constraint. Suppose the borrower is faced with only two choices. He/she can either use the loan for increasing productivity or use it for consumption smoothing⁴³. How the loan is allocated to his/her needs, as a result, is a function of the farmer's most pressing needs. In fact, loans provide our agent with the facility to absorb random shocks in his income, and therefore prevent these shocks from being transmitted into variations in consumption. Consequently, borrowers with more assets are more likely to use their loan for increasing productivity as they will first use their assets to cushion random income shocks while those with fewer assets are prone to repurpose their loans towards consumption smoothing. In other words, we expect borrowers with higher ability to pool risks across time to spend their loans towards production instead of consumption smoothing. The central assumption here is that agricultural loans have a positive impact or increase long-term productivity when they are actually used towards their stated purpose, holding everything else constant (markets access, extension services, weather, skills, and other factors). Accordingly, if agricultural loans are working as expected, one should not expect an immediate short-term increase in consumption, but rather a sustained increase in production which will eventually entail a sustained increased consumption afterward.

Moreover, if agricultural loans, which are offered for increasing productivity, are used instead for patching consumption, one can argue that borrowers become less likely to produce the additional output needed to cover the additional charges represented by the

⁴³ For simplicity, production here includes both the direct use of loans for inputs purchase as well as productive investments. Also, we ignore the case where loans could be given or shared with friends or relatives.

interest rate and the initial loan to be repaid. Consequently, if agricultural loans do not lead to increased production, the repayment aspect of the loans become very burdensome for borrowers who might even avoid taking loans for that reason. It follows that, *ceteris paribus*, if agricultural loans are used for consumption smoothing, one can expect a higher default risk.

4.2.3. Conceptual role of agricultural credit

At the individual level, an agricultural loan is expected lead to an immediate increase in the use of inputs (land, capital, labor) toward agricultural activities or more specifically toward the activity for which the loan had been taken. Given that certain inputs such as fertilizers or new machines benefit various operations within the farm household, one can expect a positive impact on borrower's net farm income. Following a classical production theory, a logical hypothesis is that an agricultural loan relaxes the budget constraint facing the farmers and allows them to efficiently allocate factors of production to maximize their profit. Overall, the anticipated pathway of the effects of FECECAM loans at the individual level is the following. Agricultural loans allocated toward increasing productivity is likely to stimulate a growth in the activity for which the loan is taken. The income from this activity is prone to affect other activities of the borrower (growth, substitution) and in total, these changes over time affect the accumulation of capital, knowledge, technologies, economic and social links, and thus the borrower's total income (farm and non-farm). This income will be partly allocated to productive investments and in the long-term to household durable goods acquisition. Hence, for variables such as farm size, labor use⁴⁴, productive assets accumulation, inputs expenses per farm area (hectare), and net farm income, our model predicts an immediate sustained increase.

Furthermore, most microfinance programs target women with the goal to empower them. The idea of promoting women's empowerment by the provision of credit is not only based on the assumption that women's involvement in economic activities will strengthen their social and political position, but also on the evidence that credit to women has a positive impact on child welfare, girls' schooling and food security. Our model also permits

⁴⁴ The case of labor use will be discussed in detail in chapter 4.

predictions of the effects of microloans on women's empowerment. In this study, the definition of empowerment follows Kabeer (1999). One can argue that the women's empowerment in agriculture index employed in the study is a good composite and multidimensional index to assess whether agricultural loans are actually increasing long-term productivity in the special case of women in agriculture. In fact, the index takes into account five main aspects of rural women's constraints: (i) autonomy in decision-making about their income generating activities; (ii) right over productive or household durable goods including their holding; (iii) autonomy in the decision to take out loans; (iv) public speaking and groups membership; and (v) the use of their time. For women who have borrowed for an extended period of time, agricultural loans should help them gain more autonomy and empowerment.

Finally, the model predicts an increase in consumption in the long run, subsequent to an income rise, as a result of agricultural effectively increasing long-term productivity. Indicators of household's food security and food quality are employed to test that assumption. Those who have borrowed for a longer period of time should display better figures of food security and food quality indexes.

4.3. Impact estimation

The objective of this chapter is to estimate the average causal effect of FECECAM loans on various indicators of borrowers' well-being. Sections 1.5.2 and 1.5.3 respectively discuss threats to identifying causal effects in microcredit studies and how the research design and identification strategy addressed these threats. The research samples FECECAM agricultural loan users only and exploits the timing of their entry into the program along with their borrowing history with the MFI to construct reliable treatment and control groups using a clustering technique. The loan treatment here is the *experience* with FECECAM loans as defined in section 1.5.3.

To estimate the effect of loan experience on farmers' well-being, the study uses a treatment-effects model. Four indicators serve to measure the well-being of borrowers: the net farm income, the Food Insecurity Experience Scale (FIES), the Food Consumption Score (FCS), and the Women's Empowerment in Agriculture Index (WEAI).

Outcomes of treatment and control groups are compared using a propensity score matching technique, providing a measure of the marginal effect of loan experience. The propensity scores are computed using a logistic model. Given the ratio between experienced and inexperienced borrowers, each subject in a treatment group is matched to two borrowers with the closest propensity scores in the opposite group.

The propensity score matching procedure is detailed in the previous chapter (see section 3.4.4). Figures 4.2-4.5 depict the box plots of match data as well as Kernel density plots using the matched data. Both graphs indicate in each case, a high or at least a satisfactory degree of post-match balance (the conditional independence assumption is met). Figures 4.6 to 4.9 display the estimated densities of the predicted probabilities that an inexperienced borrower is inexperienced and the density of the predicted probabilities that an experienced borrower is inexperienced, respectively in the case of the net farm income, the FIES, the FCS, and the WEAI specifications. The figures show that the overlap assumption is also met in all cases.

In general, borrowers in the treatment group are matched to those in the control group based on selection criteria used by the lender as well as other factors drawn from the literature and relevant to each specific indicator studied. These covariates include age, gender, education, status in the farm household, work migration experiences as well as household structure including household size, workforce available in the household in adult equivalent. The covariates also involve characteristics such as the number of income generating activities, the years of experience conducting farming activities, proximity to a FECECAM service point as well as the location in an agricultural zone. Two treatment effects statistics are estimated:

- The average treatment effect (ATE) measures the effect that a substantial experience with FECECAM loans would have had on the entire population of borrowers or what would have happened, had all borrowers been experienced ones.
- The average treatment effect on the treated (ATET or ATT) estimates the effect of the treatment on those who received it, put differently, how much the well-being of the treatment group improved as a result of their experience with FECECAM loans.

The previous chapter discusses the two statistics (see section 3.3.3) and argue that instead of using the marginal effect of FECECAM loans on the entire population (ATE), the effects

of FECECAM loans in its current state, on those who actually chose to participate (ATET) may be more informative. For the German Development Institute who commissioned this investigation, the ATET estimating the effects on those who actually choose to borrow is a better indicator of the effect of loan on efficiency compared to the ATE expressing the effects of loans in a hypothetical scenario where everyone in the population would borrow from FECECAM. In the case of a required vaccine for instance, the ATE would be more meaningful.

4.4. Results

4.4.1. Loan repurposing and loan sharing

As mentioned earlier, FECECAM has tailored its agricultural loans to meet the need of its clients. These farm loans are offered for specific purposes and the lender develops a firm monitoring mechanism to ensure that clients are implementing the stated initial purpose of the loan. Figure 4.1. displays the percentage of respondents who used their loans for reasons different than the one stated in their loan application.

Overall, 23.4% of the loans received in 2017 were not used solely for the activity for which they were requested. Most “changes in the purpose” are in fact an extension of the use of the loans to more diversified agricultural or trade activities while some cases are due to health expenses, and others are diversions in the strict sense of the term. The practice of using a loan for extended agricultural activities is more frequent in the North (33.2% of the respondents) where loans taken for cotton for example will be used to finance all or other crops production.

With regard to diversion from the initial object of the loan, 4% of the recipients shared their loan with others by becoming "resellers" (lenders) of money or promoters of young farmers' groups. Some recipients say that when other people who borrow from them know that they also got a loan to fund them, they are more inclined to reimburse. Finally, some respondents took agricultural credit but used it to pay their children school fees and then paid back with revenues from their farming activities.

Surprisingly, loan sharing among household members is less common: only 4.1% of male and 4.3% of female respondents did it. The perception that women are forced to share their loans with their spouses is therefore not entirely valid, at least in Benin case.

The sharing is often between father and son or among brothers, often working together and developing parallel autonomous activities.

4.4.2. Impact of loans experience on net farm income

The average impact of loan experience is estimated on borrowers' net farm income gained during the agricultural season 2016-17. The net farm income is calculated as the sum of all revenues from crops, livestock, processing or sale of farm products, as well as farm-related services less cash and non-cash expenses. Expenses include the loan obtained and its interest, expenditures on feed, seeds, fertilizers, other inputs, rent, hired labor, and in-kind payment to workers and landlords.

Table 4.1. compares the mean values of different farm characteristics variables of experienced and inexperienced borrowers. T-test results indicate that there is a statistically significant difference of 4,240,000 FCFA between experienced borrowers' net farm income while matching results indicate smaller figures. The average treatment effect of loan experience on net farm income is 1,374,000 FCFA while the average treatment effect on the treated is 365,000 FCFA (table 4.2.). These figures suggest that farm loans provided by FECECAM not only have the potential to significantly improve the net farm income of borrowers but also have significantly improved this net farm income for sampled experienced borrowers during the studied agricultural season. In Benin where 40.1% of the population lived below the poverty line in 2015 (The World Bank, 2018) and where poverty is more prevalent in rural areas, these increase in net farm income represent significant additional gains for rural borrowers.

Results also indicate that both the ATE and the ATET are higher for female borrowers compared to males. In fact, the effect of loan is 7 to 14 times higher for female borrowers. Female are often the most affected by poverty in general and in Benin in particular, and these results indicate that loans has the potential to alleviate that. This result is interesting and important for policy implication. It validates the hypothesis underlying development strategies that target women when it comes to loan programs. Also, if rural women who constitutes the most impoverished segment are shown to significantly improve their net income as a result of a sustained use of credit, then one can argue that agricultural loans have the potential to alleviate poverty. For male borrowers, these results mean that over

the six-years period studied (2012-2017), receiving on average four times (± 1.77 times) an average amount of loan of 1,126,000 FCFA⁴⁵ ($\pm 1,2630,000$ FCFA) caused an increase of 386,000 FCFA in their net farm income after the loan is repaid with its interest while for female borrowers, this increase is nearly ten times higher (3,172,000 FCFA).

By disaggregating the results per activity group such as crop production, livestock, processing and trade of farm products, results show a negative coefficient for female borrowers for crop denoting that with improved income, female tend to move away from growing crops and move toward sale and processing of farm products, where a positive coefficient is seen.

Finally, taking into account regional heterogeneity shows farmers in the Center and the North have the highest gain in net farm income.

4.4.3. Impact of loans experience on Food security and nutritional status

Food security

The study assesses the impact of FECECAM loans on recipients' household food security status. To do so, a set of questions were asked to those in charge of the meal preparation in the household. Female sampled borrowers were directly asked these questions while the wives answered in the case of sampled male borrowers. These females are referred to as "cooking units' heads".

In this study, the terms "cooking units" and "kitchens" refer to distinct food management and food preparation units within a household. This notion of a cooking unit is connected to the notion of "consumption community"⁴⁶ which Gastellu (1979) defines as the group of people involved in the depletion of part of the production for the purpose of rebuilding the labor force. Each of the cooking units has one or more heads who are usually the wives. They grow part of the food consumed in their kitchens and also receive transfers of food products from their spouse or the household head. Each cooking unit head is therefore responsible for a stock of food (or a granary) they manage.

⁴⁵ About 2,000USD

⁴⁶ In his approach, Gastellu, (1979) argues that, the term "community" seems to be better suited than that of "unit" when it comes to studying economic mechanisms at the local level in African rural communities. According to him, the term "community" highlights the privileged exchanges that connect individuals from the same group. However, he acknowledges that the community is sometimes reduced to the unit.

More than half (53.48%) of the cooking unit heads indicated that they have experienced a lean period during the agricultural season 2016-17. Yet, it is rarely a matter of famine or severe shortage but rather unsatisfactory situations in quantity and quality (22.2%) or in quality only (37.4%). The duration of the post-harvest abundance spans an average of 25 weeks in the North, 22.7 weeks in the Center and only 8 weeks in the South where several borrowers do not grow their own food at all. However, lean periods are longer in the North compared to the South.

Food insecurity is measured using the FIES score – Food Insecurity Experience Scale. A series of eight questions were asked, ranging from the feeling of worry about running out of food to the reality of the shortage that happens when a person stays at least one day without eating, due to the lack of resources. The more a person is worried or faced with food insecurity, the higher the score. This score is correlated with the subjective perception of the household food situation and therefore seems well standardized.

Overall, sampled borrowers do not seem food insecure judging by the average FIES score of 1.98 (\pm 2.65). The average FIES score is lower in the North (1.64) compared to the Center and the South (2.00 and 3.23 respectively). Food insecurity experience may be lower in the North because the majority of the borrowers grow their own food.

Comparing the mean FIES scores (t-test) between treatment and control borrowers show that there is a small statistically significant difference of 0.50 points (table 4.3). In fact, when asked about their perception of the impact of FECECAM loans on their food security status, sampled borrowers believe that credit has had a positive effect on their food security situation.

Table 4.4 summarizes ATE and ATET of FECECAM loans on borrowers' household food security status. Matching results also indicate that FECECAM loans statistically significantly reduces the anxiety of food insecurity of borrowers, even if the effect is small. Recall, the lower the FIES scores the better whereas the more a person is worried or faced with food insecurity, the higher the score.

Food quality assessment using the food consumption score

Food quality is assessed using the Food Consumption Score (FCS) developed by the World Food Program. The FCS score is calculated using the frequency of consumption

of different food groups consumed by the borrowers' household during the seven days before the survey. Higher food consumption scores indicate a good and diversified diet. For illustration, there are five food groups commonly accepted and a person eats on average three meals a day. If all food groups are consumed at each meal during the seven days of the week, one should expect a food consumption score of 105.

Descriptive statistics indicate that the majority (86.06%) of the sampled borrowers has a diet of acceptable quality judging from a dietary diversity perspective while 13.94% have a poor diet. The average FCS is 48.79 (± 12.68).

Both means comparison test and matching results show that agricultural loans improve the diet of borrowers. The difference in FCS scores is moderate but statistically significant. The effect of loan experience on borrowers' diet decreases from the North to the South, judging by the ATET. Borrowers in the North have statistically significantly improved their food consumption score by 7.42 points due to their experience with loans

The effect of loan on female borrowers' food quality is potentially three times higher than male's judging by the ATE.

4.4.4. Impact of loans experience on women empowerment

Women accumulate most roles and tasks in rural households (Owitti, 2015; Pitcher, 1996; Sow, 2010). They not only allocate their time to working on the household head's field, but also manage their own productive activities on top of house chores. Women are engaged in caregiving and reproductive roles as well. Women's empowerment is assessed by the women's empowerment in agriculture index described earlier in the conceptual framework (section 4.2.3).

The mean WEAI in the sample is 3.28 (± 0.52) which indicates that on average, sampled women have a good empowerment index. The highest possible empowerment index is 5. Some could argue that, only the fact that they are able to take loans is an indication of their empowerment status. However, getting loans is not enough to assess the empowerment status of a woman in this context. The WEAI offers a good composite indicator of women's empowerment status by including other aspects of rural women's life such as the autonomy in decision-making about their income generating activities and

about the use of their time, the right over productive or household durable goods including their holding, public speaking and groups membership.

The majority (81.55%) of the sampled female borrowers declare that FECECAM loans have improved their status in their households. They believe that the loans received help them gain more respect from their husband, co-wives and in-laws. Female borrowers state that they have acquired financial autonomy, no longer wait for their husband to help them take care of themselves or the children. In fact, sometimes, husband and wife help each other. Other female respondents stress that they were able to overcome widowhood or marital separation or fill the gap of a missing household head thanks to credit.

The analysis of actual computed WEAI indexes support the subjective evaluation of female borrowers' status in their household and community, when they use agricultural loans. First, a mean comparison between treatment and control group indicates a very small positive effect of loan experience on women's empowerment, even if that difference is not statistically significant. Then, matching results show that FECECAM loans significantly improve WEAI indexes of female experienced borrowers, had all female borrowers been experienced (ATE of 0.44). The statistic of interest, which is the average treatment effect on the treated also indicates that experience with FECECAM loan significantly increases the WEAI index of actual experienced respondents (ATET of 0.17). Agricultural loans therefore help improve women's status in their household. This result is important and interesting from a policy standpoint. Targeting rural women in loan programs can and has actually improved their living conditions. FECECAM agricultural loan program has not only improve the income level of the female recipients but has helped them improved their status in their household and community by empowering them.

Given the small number of female respondents (only 32% of the sample) and the even smaller number of female treated borrowers, it was not possible to perform the propensity score matching per studied area.

4.5. Conclusion

The chapter estimated the average causal effect on the well-being of agricultural loans provided by the largest microlender in Benin. The analysis uses propensity score matching technique to compare the indicators of experienced borrowers to those of the

inexperienced. Experience with loan includes the borrower's seniority captured by the time of first entry into the loan program, the average amount borrowed over the six-years period studied, and the number of loans obtained.

Results indicate that farm loans have a significant impact on sampled recipients' net farm income, food security and food quality statuses, and have a positive impact on women's empowerment. In fact, over the six-years period studied (2012-2017), receiving on average four times (± 1.77 times) an average amount of loan of 1,126,000 FCFA ($\pm 1,2630,000$ FCFA) created for experienced borrowers, a gain in net farm income of 365,000 FCFA, a reduction in food insecurity anxiety by 0.24 points, an improvement in food consumption of 2.29 points, and for female borrowers, a gain of 0.17 points in their empowerment index.

Therefore, loans significantly increased the net farm income of experienced borrowers and their household saw an improvement in their food consumption quality as well as in their food security status. Women not only improve their income levels as well, but were also able to improve their status in the household. Loans helped them accumulate assets, gain financial autonomy and better provide for their personal need as well as their children's.

Benin case thus indicates that agricultural loans has the potential to improve farmers condition and alleviate poverty, especially in rural areas. The results of this chapter have important policy implications. They validate the hypothesis underlying development strategies that target women when it comes to loan programs. The results also indicate that agricultural loans have the potential to alleviate poverty. FECECAM loans in Benin, significantly improved the income and the living conditions of the poorest group which is the women. However, it is noteworthy that the monitoring and implementation mechanism of FECECAM played a crucial role in the success of its loan. The lender's program resembles a supervised credit program which had proven to be very effective around the world.

Chapter 4 Tables and Figures

Table 4.1: Mean comparison (t-test) of farm characteristics between experienced and inexperienced borrowers

Variables	Experienced	Inexperienced	Difference
Number of farming activities conducted	2.89	2.74	0.16
Total farmed area (ha)	8.33	6.01	2.33***
Total farm revenue (100,000FCFA)	96.50	33.46	63.04***
Total farm expenditure (100,000FCFA)	20.81	7.11	13.70***
Total net farm income (100,000FCFA)	66.1670	23.76	42.40***

Notes: *** p<0.01, **p<0.05, * p<0.1.

Table 4.2: Average causal effect of credit experience on net farm income (100,000 FCFA) (Two-nearest-neighbors' technique used)

	ATE	ATET
All Borrowers	13.74***	3.65**
- Female	41.97***	31.72***
- Male	-2.27***	3.86***
North	-0.01	7.27***
Center	-21.17***	10.50*
South	-14.04***	-2.59

Notes: *** p<0.01, **p<0.05, * p<0.1.

Table 4.3: Mean comparison (t-test) of food security, food quality and empowerment statuses between experienced and inexperienced borrowers

Variables	Experienced	Inexperienced	Difference
Food Insecurity Experience Scale	1.58	2.08	-0.50*
Food Consumption Score	53.97	47.47	6.50***
Women's Empowerment in Agriculture Index	3.36	3.26	0.09

Notes: *** p<0.01, **p<0.05, * p<0.1.

Table 4.4: Average causal effect of experience with farm loan on food security status (FIES score) (Two-nearest-neighbors' technique used)

	ATE	ATET
All Borrowers	-0.69***	-0.24***
- Female	-1.65***	-0.43***
- Male	-1.04***	-1.00***
North	-0.37***	-0.30***
Center	-0.60***	-1.48***
South	-1.28***	1.44***

Table 4.5: Average causal effect of experience with farm loan on food quality (FCS) (Two-nearest-neighbors' technique used)

	ATE	ATET
All Borrowers	3.73***	2.29***
- Female	10.88***	1.32
- Male	3.99***	3.89***
North	5.38***	7.42***
Center	7.86***	3.31***
South	4.80***	2.82***

Table 4.6: Average causal effect of experience with farm loan women's empowerment (WEAI) (Two-nearest-neighbors' technique used)

	ATE	ATET
All Borrowers	0.44***	0.17***
North		
Center		
South		

Given the small number of female respondent per region, there was not sufficient information to estimate the ATE and the ATET per region.

Figure 4.1: Shares of loan repurposed by region (%)

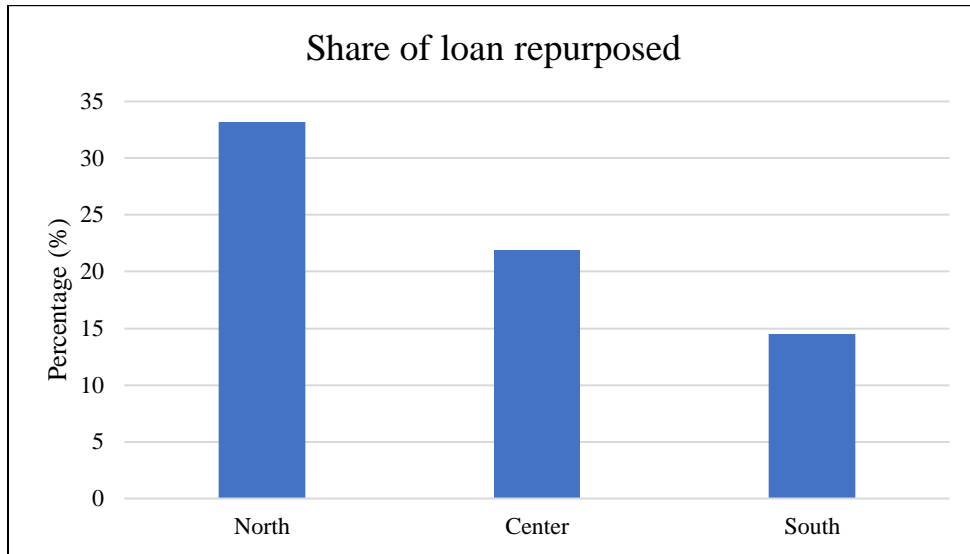
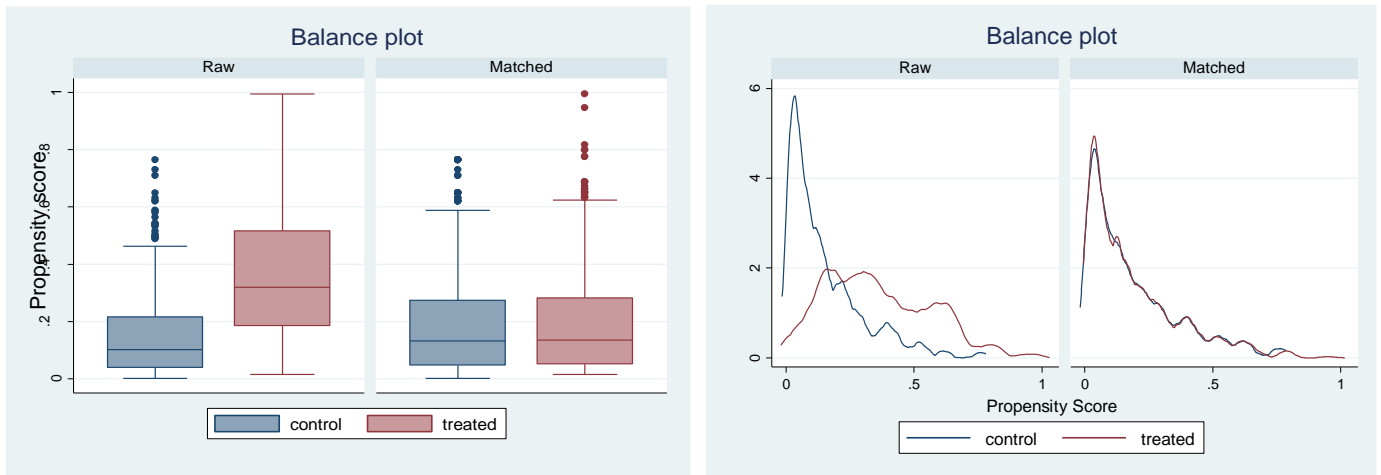


Figure 4.2: Covariates balance diagnostic box plots and Kernel density plot using the matched data (Net farm income)

- **ATE estimation**



- **ATET estimation**

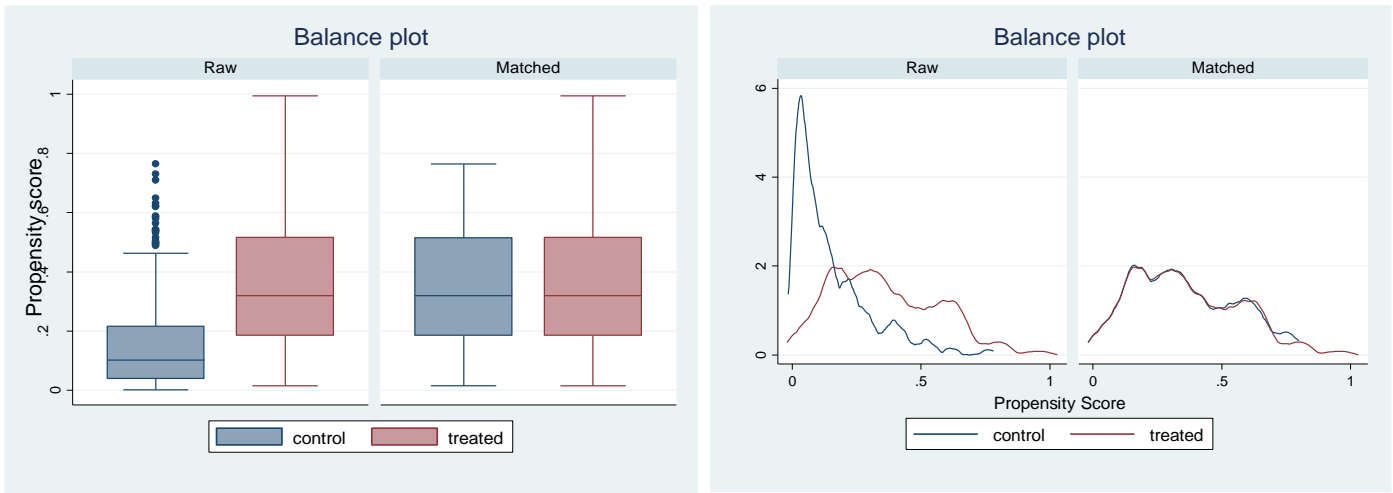
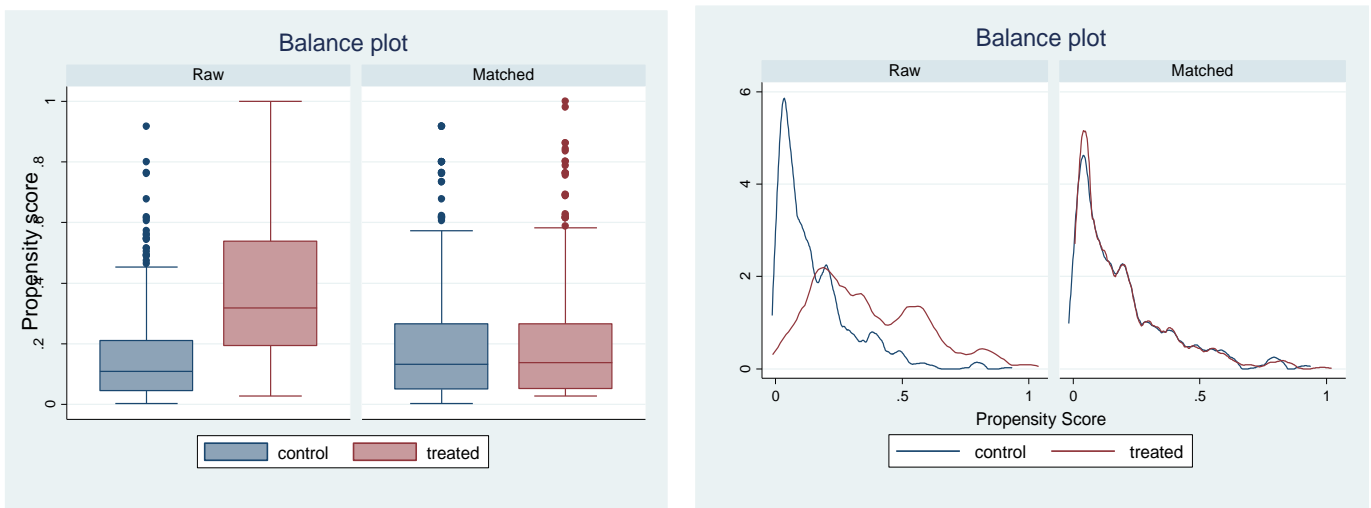


Figure 4.3: Covariates balance diagnostic box plots and Kernel density plot using the matched data (Food Insecurity Experience Scale)

- **ATE estimation**



- **ATET estimation**

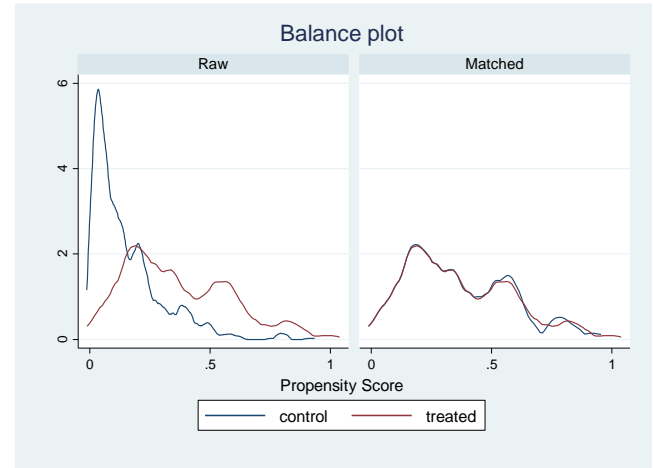
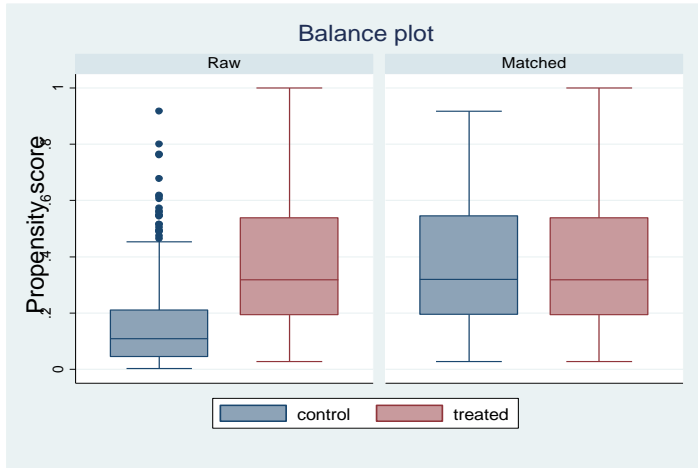
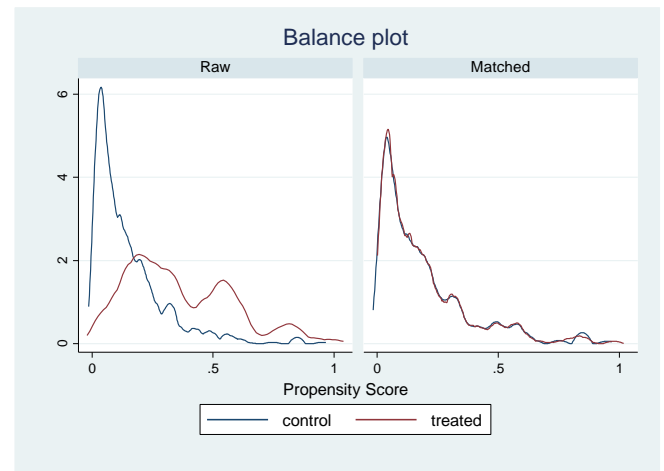
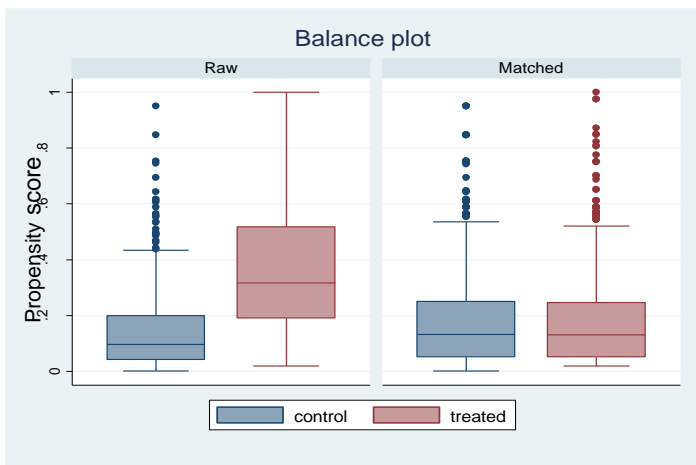


Figure 4.4: Covariates balance diagnostic box plots and Kernel density plot using the matched data (Food Consumption Score)

- **ATE estimation**



- **ATET estimation**

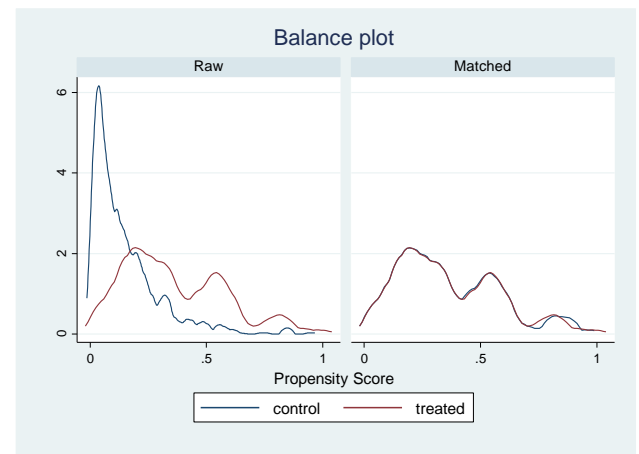
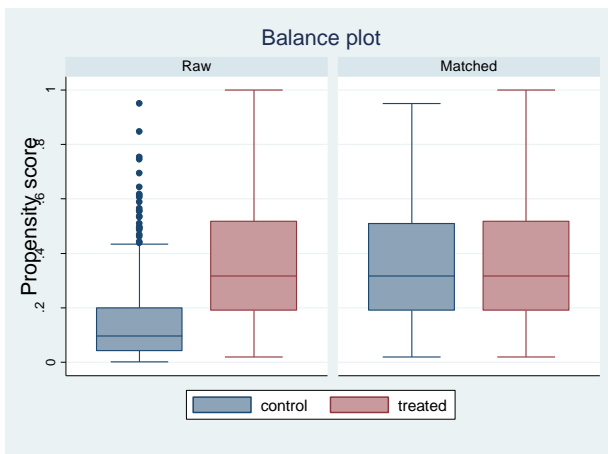
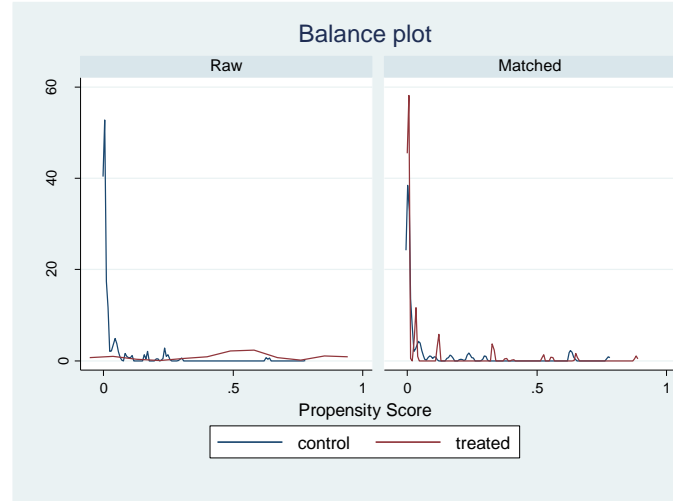
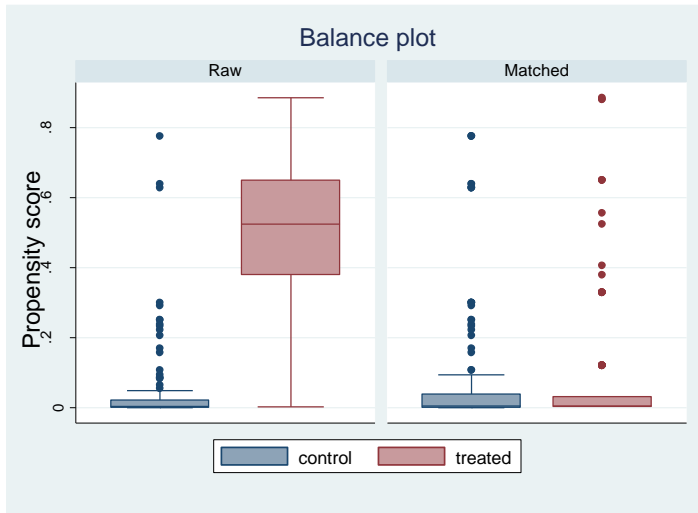


Figure 4.5: Covariates balance diagnostic box plots and Kernel density plot using the matched data (Women Empowerment in Agriculture Index)

- **ATE estimation**



- **ATET estimation**

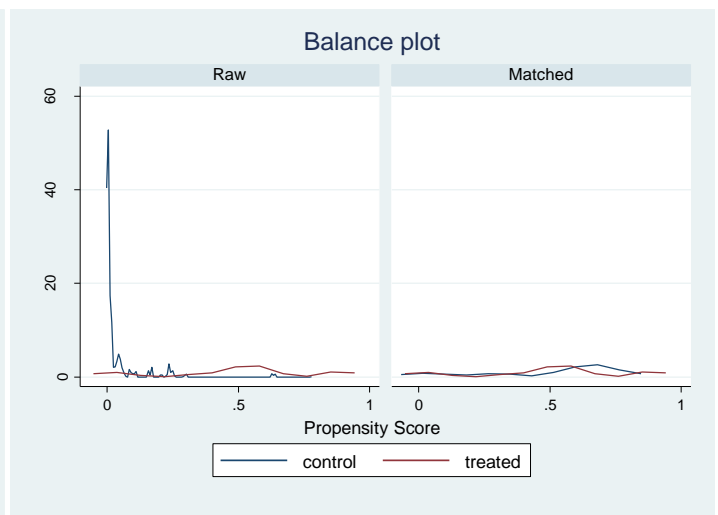
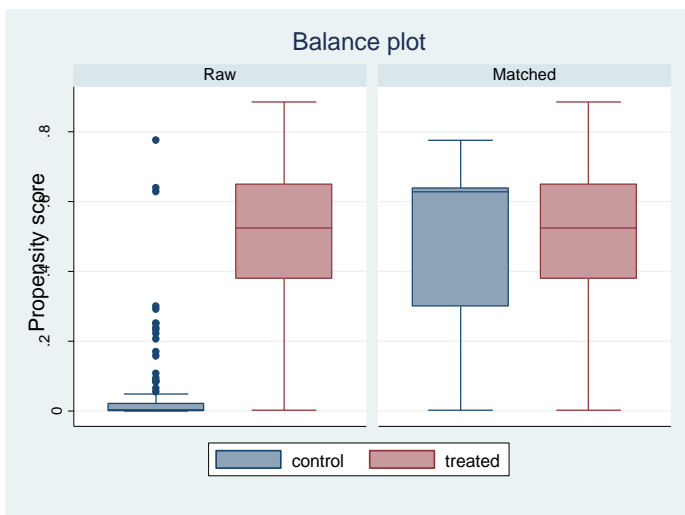


Figure 4.6: Overlap check for matching – Net farm income

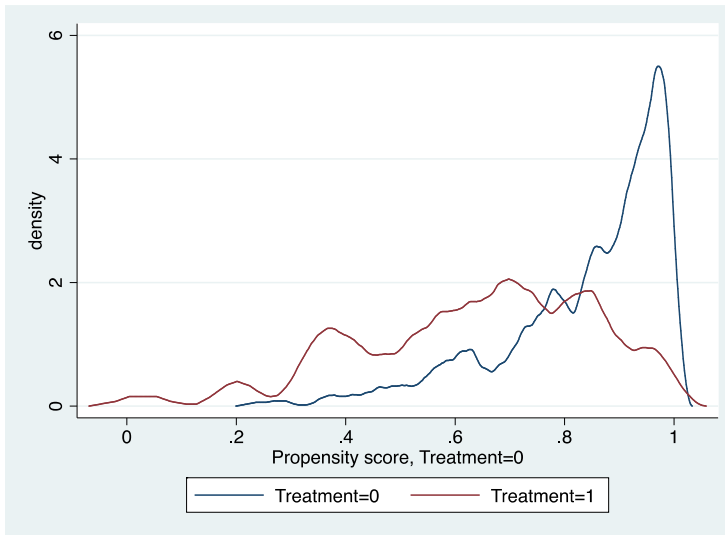


Figure 4.7: Overlap check for matching – FIES score

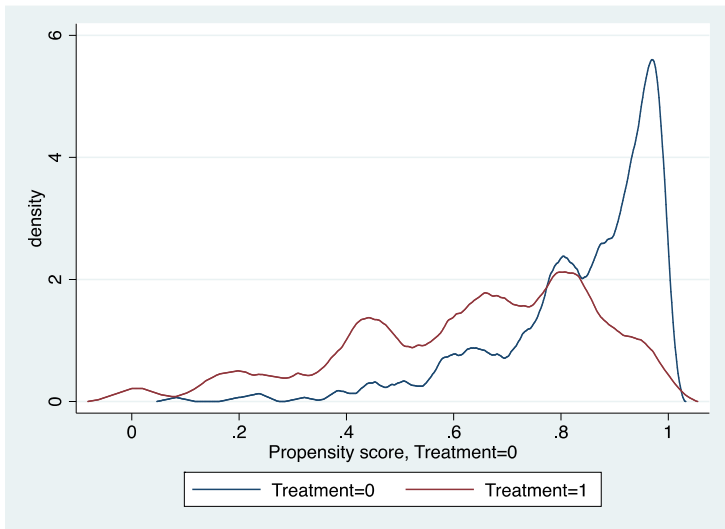


Figure 4.8: Overlap check for matching – FCS score

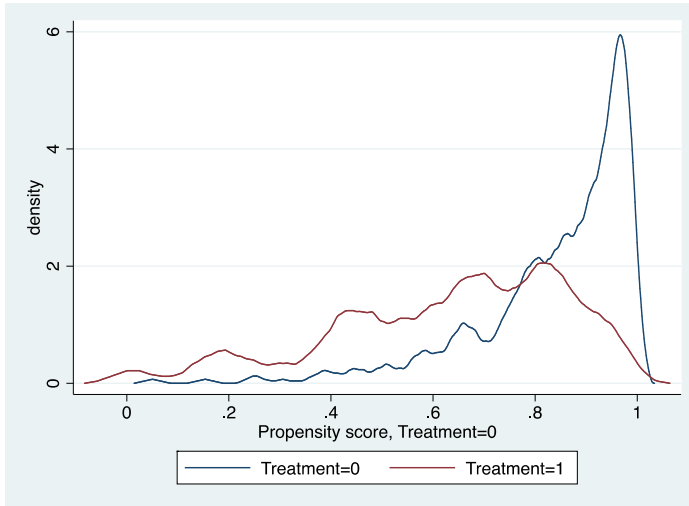
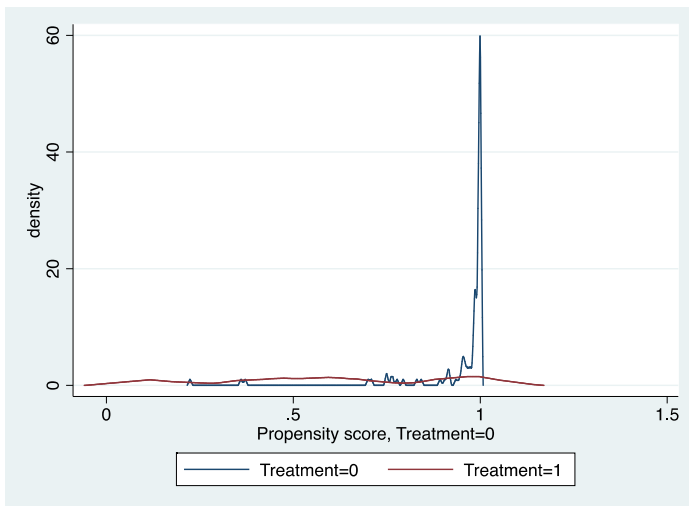


Figure 4.9: Overlap check for matching – WEAI



General conclusion and discussion

In development economics, a basic hypothesis is that more capital inputs are needed, not only at the aggregate level but also at the individual producer level to improve the agricultural sector (Colyer and Jimenez, 1971). Microfinance, and more specifically, microcredit programs, have been supported as sustainable interventions with the potential to alleviate poverty (Pankhurst and Johnston, 1999). However, the allocation of investment funds to farmers, especially those located in rural areas, is quite challenging. For capital to be effectively used by farmers, it is essential to invest in human capital and correct deficiencies in farmers' capability (Colyer and Jimenez, 1971). In developed countries such as the United-States of America, supervised credit programs had proven to help battle chronic poverty in rural areas (Roberts, 2013). FECECAM the largest microlender in Benin has been providing loans to farmers and non-farmers since 1977. Over time, the lender has improved and adjusted its loan programs' implementation. The Federal German Ministry of Economic Cooperation and Development (BMZ), through the German Financial Cooperation (KfW), has refinanced FECECAM in its effort to supporting rural credit in general and agricultural credit in particular and is interested in furthering their support to the lender. Though before, the KfW wants to examine the merit of supporting the provision of loans to the rural world. The goal of this study commissioned and funded by the KfW is to evaluate the impact of agricultural loans on the livelihoods of recipients.

Impact evaluation in the case of microcredit programs is often challenging due to two levels of selection: self-selection into a microfinance program by the borrowers, and the screening process of the microfinance institution. To address these biases, this study employs the so-called pipeline design, which is typically used in a cross-sectional setting in the absence of fully randomized experiments. This approach is justified by the fact that both its control and treatment groups consist of individuals who have chosen to participate in the microfinance program, addressing these two major sources of selection bias. Given the relatively long period studied, the analysis has been innovative in defining the loan treatment along with creating reliable treatment groups. The loan treatment considered is the experience with loans which includes program entry timing, loan take-up frequency and the average amount of loan obtained over the 2012-2017's period. To create reliable comparable groups, the study employs a cluster analysis technique.

To assess the impact of FECECAM loans on clients' livelihoods, multiple variables and indicators are analyzed. The dissertation starts by providing a descriptive analysis of the impact of farm loans on farmer's labor use. The impact of loan is often discussed at the recipient level but the second chapter of the dissertation looks beyond. It examines the role of agricultural loans in farmers' labor input choice. The effect of farm credit on employment is of great importance, not only for the farmers themselves but also at the macroeconomic level. The results of the chapter show that impact of agricultural loans on labor is quite mixed. It suggests that past loans, clearly have residual effects on both hired and family labor use. However, loans specifically obtained for farm machinery significantly reduce expenditure on hired labor but more family labor is employed using machine loans while other loan categories reduced the use of family labor. Results from the chapter also bring up the question of the growing scarcity of labor force in rural areas, which is due to multiple reasons including rural flight but positive ones such as increased children schooling. Taking into account regional heterogeneities in the analysis of the chapter offers interesting perspectives. In areas where labor is more expensive, and farm areas are larger (North), farmers invest more in agricultural machines or technologies and employ more family labor. In areas with affordable and better labor availability, farmers increase their expenditure on hired labor. Certainly, loan availability made it possible for recipients to invest in technologies and agricultural machines to avoid exhausting manual work.

The third chapter of the dissertation evaluates the impact of agricultural loans on the whole-farm efficiency of borrowers. Beyond the monetary benefit of loans, this chapter examines the potential human capacity building and the knowledge gaining aspect of extended exposure to loan programs such as FECECAM's. Because rural finance programs are subsidized using limited taxpayer money, it is necessary to evaluate how they affect the marginal productivity of recipients. Results from chapter 3 indicate that lack of funds is not the most critical problem faced by most farmers in developing countries such as Benin. Adams and von Pischke (1991) reached the same conclusion. Even though sampled farmers have had a relatively long period of access to credit and loan take-up, they still display low levels of profit efficiency—the ability to produce the highest possible output at the lowest cost. Land tenure, lack of extension services, low yields, modern inputs

availability and costs, output prices, risk, and weather turn out to be more critical factors limiting farmers' productivity and development. The third chapter also shows that the monitoring, the technical assistance, and the training that accompany FECECAM's loan program may be instrumental, perhaps the key to the results. In most branches, the lender offers tailored technical support to its clients, depending on their activities, once they are approved for a loan. Female lending groups receive special attention and assistance from the cooperative. FECECAM also offers specific and targeted loans and deploys a rigorous monitoring mechanism to ensure that loans are correctly being utilized. To guarantee a high repayment rate (93.87% as of December 2017), the cooperative uses innovative approaches and regularly organizes recovery missions to collect outstanding loans. Though all this contributes to the "success" of the loan program, it is costly to the loan provider, raising the issues of providing affordable financial services to the poor and running a financially sustainable loan program. Mobile financial services could be a solution to cost reduction for a microlender such as FECECAM.

Finally, in the fourth chapter, long-term direct benefits of loan use are analyzed. The chapter estimated the average causal effect of FECECAM loans on its clients' well-being measured by net farm income, food insecurity experience scale, food consumption scores, and women's empowerment in agriculture index. These are commonly studied outcome variables when it comes to credit impact assessment. Here they are argued to pertain to longer-term effects of agricultural loans. The positive impact of loan experience found in the case of all studied indicators is interesting. FECECAM's loan implementation and monitoring practices play undoubtedly a key role here. When agricultural loans are obtained and properly used for a purpose that was initially evaluated and planned, there are higher chances that these loans would deliver expected results such as improving income, which may allow to improve food security or food quality status and help gain some autonomy. The chapter provides a simple yet valuable lesson for future impact credit evaluation studies: the context of the loan program as well as the evaluation indicators are essential. Not detecting an effect on a specific variable does not necessarily mean the unworthiness of microcredit in battling poverty in developing countries.

Overall, FECECAM loan program can use some improvements. The MFI could better target rural female and their activities. The study shows that studied female

borrowers tend to move away from crop production towards value-adding activities (processing and trade) as their income improves. FECECAM could also improve its level of support to farmers by providing or facilitating their access to more technical assistance. More, the use of mobile technologies could help the cooperative reduce the cost of operation in some cases.

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PROFESSIONAL EXPERIENCE

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