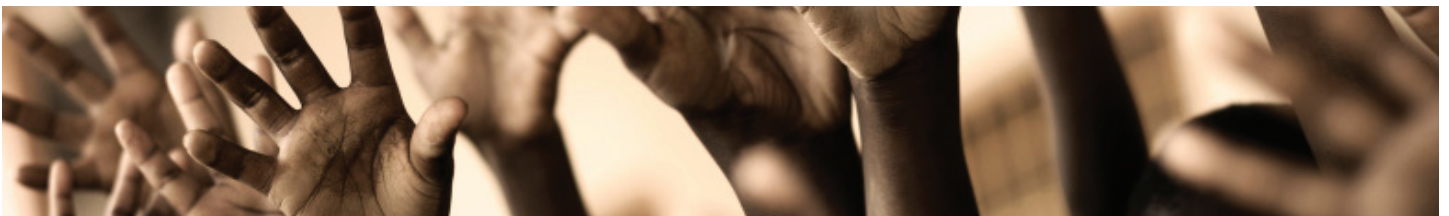


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**The impact of a rural microcredit scheme targeting women
on household vulnerability and empowerment:
Evidence from South West Nigeria**

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Abstract

The rapid expansion of microcredit in recent years is informed by the belief that removal of constraints to credit access facing the poor, particularly women, through microcredit can improve their well-being and ultimately help them out of poverty. However, the evidence supporting these promises has been largely inconclusive. This study examined the impact of a rural microcredit scheme targeting women on vulnerability and empowerment of the beneficiaries and their household members. The study was conducted in collaboration with the Amoye Microfinance Bank, Ikere Ekiti, Nigeria. Data was collected from a follow-up survey of 2,938 applicants, comprising 1,555 women who were successful (treated group) and 1,383 women who were unsuccessful (control group), and 8,418 household members. Eligibility for the microcredit was based on a credit scoring system. A regression discontinuity design was adopted to exploit the information around the eligibility threshold to identify the program impact. Vulnerability and empowerment were measured from five domains. The results showed that beneficiaries of the microcredit were significantly less vulnerable than non-beneficiaries, but not all of the measurement domains were significant. Also, beneficiaries were significantly more empowered than non-beneficiaries, and all of the measurement domains were significant. Additionally, indicators of labour market participation were significantly higher for household members of beneficiaries than for household members of non-beneficiaries. The analysis extended to examining associations between the estimated impacts and some institutional factors such as pricing, repayment method, loan duration and use of loan. The results suggest that these factors are potentially relevant for the aspect of design of microcredit schemes. The findings further inform the policy debate on the promises of microfinance, specifically relating to the multidimensional nature of the impacts, effects on family members of beneficiaries, and the relevance of institutional factors for microcredit design.

JEL: C21; C31; D14; G21; I32; O16; O55; Z13.

Keywords: Microcredit; Regression Discontinuity Design; Financial inclusion; Vulnerability; Female empowerment.

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I. Introduction

Microcredit interventions are increasingly being used in developing countries to mitigate credit market failures by providing access to credit at low interest rates to the poor and other financially excluded groups in the population. Microcredit interventions have expanded rapidly, with an increasing number of poor families benefiting. According to the Microfinance Summit Campaign (2014), the number of poor individuals reached increased from 8 million in 1997 to 116 million in 2012. Of this figure, 83.3% (96.3m) are women. Amongst the 3,718 microfinance institutions that have reported data since 1997, 28% (1,042) are from Sub-Saharan Africa (SSA), accounting for 8.5 million of the poorest families with microcredit, out of which 69% (5.9m) are women heads of household.¹

In recent years, however, the initial attraction and promises of microcredit have given way to controversies generated largely by the inconclusive and limited evidence of its impact. Evidence of the impact of microfinance varies according to the methodological approach used to identify impact, datasets used, as well as the outcomes examined (e.g. Banerjee 2013). Also, despite the rapid expansion of microcredit reaching the poor and their families, relatively little is known about the impact on those families. Household vulnerability and women empowerment are major pathways through which microcredit can impact poverty. Microcredit has been conceived as an important policy instrument to mitigate vulnerability to shocks, achieve gender equality and empowerment targets of the Millennium Development Goals (MDGs), and ultimately providing a way out of poverty (e.g. AfDB, 2013; Gaiha and Kulkani, 2011; Rai and Ravi, 2011; Stewart et al., 2010; Garikipati 2008). The case for targeting women for microcredit relates to the view that women are considered good credit risk, less likely to misuse loans and more likely to share the benefits with other members of the household, especially children, thereby reducing vulnerability, and more likely to empower them (e.g. Garikipati 2008, Khandker et al 1995).

Also, much of the evidence relating to vulnerability and empowerment impacts of microcredit are still largely dependent on how the outcomes indicators are measured and represented in estimated models. In assessing the impact of microcredits, it is important to consider the multidimensional nature of these outcomes. Households face vulnerability to shocks in different settings including social, economic, health, and the environment. Women empowerment occurs in multiple dimensions, including social, economic, cultural and familial and political (Kulkani 2011). It is possible to observe impacts in one or more of the dimensions and not in others. For the specific case of Nigeria, women are amongst the vulnerable group of the population facing various risks and socioeconomic shocks, in an environment where social norms and traditions make them subservient to their male counterparts. If access constraints are removed through microcredit, it is of interest to understand the impact on the beneficiaries and their families, particularly in terms of reduction in vulnerability to shocks and empowerment.

The central objective of this research was to evaluate the impact of rural microcredit on indicators of household vulnerability and women empowerment of the beneficiaries, and their household members. The scheme considered was a government-provided microcredit intervention, which differs markedly from the standard group lending microcredit product. Unlike group lending, the intervention was specifically designed to targeted women in the rural areas of Nigeria with limited access to financial services. Also, recipients did not have to form into groups, so that joint liability of group members was eliminated. Each applicant was treated on own merit through a credit-scoring system.²

¹ The figures for SSA are second to Asia and Pacific region in the developing world.

² The focus of this study is not about comparing group and individual lending models of microcredit. For a review of studies in this area, see Banerjee (2013).

Two key research questions were addressed, namely; (i) What is the impact of the rural microcredit scheme on household vulnerability and women empowerment of the beneficiaries?; and (ii) To what extent are families/households of beneficiaries affected by the microcredit scheme? This research was conducted in collaboration with the Amoye Microfinance Bank (AMFB), Ikere Ekiti, Nigeria. A total of 3,397 women applied for the microcredit at AMFB during March-June 2012. Eligibility for the microcredit was based on a points-based scoring system, determined by the officials of the bank. The assignment rule implies that applicants who scored 70 points and above were approved to receive the microcredit.

Regression discontinuity (RD) design was used to exploit the information around eligibility threshold to identify program impact. Some evidence of imperfect compliance of the assignment rule in the data compelled adoption of a fuzzy RD design. In addition to administrative data provided by AMFB, data was also collected from a follow-up survey of 2,938 women and their households, comprising 1,555 applicants who were successful (treated group) and 1,383 who applied but were unsuccessful (untreated group). Data were collected on 8,418 household members. A multidimensional approach was adopted in measuring household vulnerability and women empowerment, implying measuring each of them as a composite variable constructed from different domains. Household member level outcomes included labour market participation and household per capita income, expenditure and savings.

The results showed that the treated women were significantly less vulnerable than the untreated women, but not all of the domains made significant contributions to this result. For empowerment, the treated women were significantly more empowered than the untreated women and each of them made significant contributions to the result. Also, household members of treated women benefited from the microcredit more than household members of untreated women, particularly in terms of labour market participation. An extension of the analysis showed an association between the key outcomes and aspects of the microcredit design such as pricing, repayment method, loan duration and use of loan.

The findings offer the first set of evidence of the impact of microcredit in the context of a government-provided model of microcredit. Also, the findings further inform the policy debate on the promises of microfinance, specifically relating to the multidimensional nature of the impacts, effects on family members of beneficiaries, and the relevance of institutional factors for microcredit design. In the absence of a randomised experiment, the study provides alternative approach to evidence-based policy-making designed to strengthen the connection between microcredit and poverty reduction through reduction in household vulnerability and women empowerment. For Nigeria, this evaluation study demonstrates the effectiveness of the rural microcredit scheme, which justifies the resources the government committed to the scheme, as well as accountability to the public.

The remaining parts of the paper are organised as follows. The next section (Section 2) provides a description of Nigeria's institutional background and an overview of the microcredit scheme at Amoye Microfinance Bank. Section 3 presents an overview of the theoretical and empirical literature. The hypotheses tested are stated in Section 4. Section 5 presents the methodology, including the RD design model, data and variables. Section 6 presents and discusses the results. Section 7 presents the conclusion and policy implications.

II. Nigeria's institutional background and overview of microcredit scheme at Amoye Microfinance Bank

Nigeria has an estimated population of about 170 million, and has recorded one of the fastest economic growth rates in Africa, averaging 7.4% since 2010 (International Fund for Agricultural Development, IFAD, 2014; World Bank, 2014). However, the majority of the Nigerian population lives in absolute poverty (i.e. inability to meet daily needs of shelter, food and clothing). The proportion of the population living in

absolute poverty increased from 55% in 2008 to 60% in 2012 (National Bureau of Statistics, NBS 2013). The majority (95 million) of Nigerian population lives in rural areas, where absolute poverty is more prevalent at 55% amongst the rural population. Additionally, women in Nigeria account for about 50% of the population, but are amongst the most vulnerable groups in the population. The country's poor rural women depend largely on subsistence farming for food and income (NBS 2014). Yet women heads of households are the most chronically poor members of rural communities (IFAD 2014). The number of women heads of household has increased considerably in recent years, from about 16% in 2008 to 19.3% in 2013 (World Bank, 2014). Also, agricultural production as the source of income is often hindered by shocks such as the vagaries of weather, drought, bush fire, ill health, and fluctuating prices of farm outputs. The inability of households to cope with these shocks when they occur (vulnerability) manifests in various forms including food shortage in households, particularly during the pre-harvest period.

Microfinance in Nigeria has been driven largely by the Federal government's desire to enhance the flow of financial services to the rural areas, where the majority of the population lives, and where there is a high proportion of the unbanked poor people (Central Bank of Nigeria, CNB, 2005). In 2011, the CBN set aside funds for lending to small and medium enterprises through microfinance banks, partly in the hope to significantly reduce the population of women excluded from the financial system by 2020 (CBN 2012). The Amoye Microfinance Bank Ltd. (AMFB), located in Ikere, Ekiti State in the South Western part of Nigeria, is amongst 792 banks licensed to operate as a microfinance bank in Nigeria. AMFB has operated effectively for over 20 years and is privately owned by the indigenes of Ikere community. The number of customers is about 8,000, comprised mainly of market women, civil servants, pensioners and artisans. Over the years, AMFB has earned the reputation of being a leading provider of credit for personal and business empowerment for socioeconomic development of the community (AMFB 2013). Ikere Ekiti, where AMFB is located, is a rural town of about 173,000 people (2011 census). The commercial activities in Ikere evolve around trading mainly by women in the five local markets and surrounding towns and villages (Ekiti State Government, EKSG 2011). Moreover, Ekiti state is a social and culturally homogenous society, in which traditional norms and culture is held in high esteem. The poverty level in Ekiti State ranges between 38% and 60% of households living on \$1 US dollar a day or less (Adebo and Adeboye, 2011).

Microcredit application process

Microfinance banks involved in the scheme were expected to make the microcredit available to women applicants without the need for collateral, but all applicants were expected to have an account with the bank. Eligibility for the microcredit was based on a points-based scoring system, determined by the officials of the bank on the basis of information provided in the application form and 'personal relationship'. In principle, only applicants who scored at least 70 points were approved to receive the microcredit. A total of 3,397 women applied for the microcredit at various times during March - June 2012. Of this total, 1,778 (or 52.3%) applicants were successful, whilst the remaining 1,619 applicants were unsuccessful. However, [Table 1](#) shows the extent to which eligible applicants were successful in getting the microcredit (debtor group), or vice versa.

Table 1: Eligible applicants and successful applicants

Treatment status	Eligible applicants		
	No	Yes	Total
No	998 61.6%	621 38.4%	1,619 100%
Yes	595 33.5%	1,183 66.5%	1,778 100%

Total	1,593	1,804	3,397
	46.9%	53.1%	100%

Source: Authors' calculation from bank's administrative data.

As the table shows, 1,183 (or 66.5% of the total) eligible applicants received the microcredit, whilst 595 (or 33.5%) amongst the ineligible received the microcredit. However, 621 (or 38%) of eligible applicants were unsuccessful. These figures suggest that the microcredit assignment process has not followed strict adherence to the credit score rule. This outcome reflects the influence of 'personal relationships' in determining who received the microcredit and who did not, which was not part of determinants of the credit scores.³

III. Literature review

The rationale for microfinance is informed by the recognition that access to finance constitutes a major factor constraining the poor, particularly women, from escaping the shackles of poverty. The lack of access to credit has been blamed on two main factors. The first relates to the problem of asymmetric information in which lenders do not have sufficient information about the credit worthiness of the borrowers, which leads to charging high interest rates to overcome the risk of unobserved 'bad' borrowers. The second relates to the view that poor people do not have assets, which they could pledge as collaterals to obtain loans from the formal financial institutions. These factors have led to the exclusion of poor people, especially women, from the financial system, and exacerbate the level of poverty. Microfinance has evolved to overcome access constraints by providing group lending and regular savings schemes to poor households (e.g. Gaiha and Kulkani, 2013; Armendariz and Morduch, 2005). The rapid expansion of microcredit in recent years has been based on the belief that removal of constraints to credit access facing the poor, particularly women, through microcredit can improve their well-being by reducing their vulnerability to shocks, make them financially inclusive, empower them, and ultimately help them out of poverty (e.g. Gaiha and Kulkani, 2013; Rai and Ravi, 2011; Stewart et al., 2010; Garikipati 2008).

Household vulnerability has been defined in the literature generally in relation to poverty. Some studies consider household vulnerability as a cause of persistent poverty and poverty traps. Others consider it as the risk and uncertainty dimensions of household well-being that conventional measures of poverty do not always capture (Swain and Floro, 2012). From this point of view, household vulnerability relates to not only the degree of exposure of members of a household to risks, shocks, and proneness to the vagaries of daily life, but also the mechanisms through which households mitigate risks and cope with the effects of shocks. Rural households in particular face multiple risks and shocks as well as proneness to several forms of hardship caused by circumstances that are largely beyond their control. The multiple risks, shocks and economic stress manifest in several ways such as food shortage in a household and increased demand for health care, which require the use of available resources as mechanisms to deal with them. Such mechanisms include selling household assets and engage children in labor to generate income in support of the family for consumption smoothing, payment of children school fees, buying farming inputs, etc. (Swain and Floro, 2012).

³ According to the Managing Director of the bank, leaders and other influential people in the community recommended applicants for the microcredit. It was believed that since the applicants do not necessarily have to have collateral to get the microcredit, recommendations from the community leaders and other notable people in the community provided a kind of indirect collateral and assurance for repayment of the loan.

Empowerment is also a multifaceted concept, defined in the literature as relating to increasing capabilities towards poverty reduction through improved gender equality (e.g. Duflo, 2012; Golla et al., 2011; Kabeer 1999). Empowerment encompasses several dimensions, including social, economic and political, through which the capacity of individuals or groups could be enhanced towards making choices and to transform those choices into desired actions and outcomes. According to Eyben et al. (2008), empowerment has social, political and economic dimensions. The focus of this study is on economic empowerment, relating to power and agency and other economic choices and decisions, the expansion of assets and capabilities of people to participate in, bargain with, influence, control, and hold accountable institutions that affect their lives (e.g. Golla et al., 2011).

Essentially, women are generally at the centre of economic empowerment largely because of what is commonly known as the 'missing women' due to Amartya Sen (Sen, 1990), relating to the persistence of gender inequality in SSA (cited in Duflo, 2012). This perception formed the basis of the gender equality and empowerment targets of the MDGs (MDG3), which recognises the importance of women's empowerment as an effective strategy to combat poverty and to stimulate sustainable development (United Nations, 2000). Economically empowered women have incentives to contribute more to their households, societies and national economies, and they are more likely to invest extra income into their children's education and health, thereby providing a route towards sustainable development (Golla et al., 2011).

3.1. Microfinance, household vulnerability and (women's) empowerment

The essence of microfinance is to remove constraints to access to credit facing poor people through microcredit and/or microsavings. Stewart et al. (2010) provided a framework describing the causal pathways through which microfinance reduces household vulnerability and enhances women's empowerment. The causal pathway begins when the client receives the microcredit and spends in investment for the future through business, education, health, nutrition, housing, and/or on consumption spending such as expenditures on durable assets. This spending has a direct impact on clients' capabilities; it increases their ability to deal with shocks (vulnerability), and also provides scope for (women's) empowerment.

Moreover, IFAD (2009) provided a framework explaining why women are the target for microcredit interventions. Granting women access to credit enhances their social, economic and political empowerment; and household well-being. Pitt and Khandker (1998) used data on group-based lending in Bangladesh to show that microcredit has a large effect on the behaviour of poor households when women are participants. Women are economically empowered via microfinance due to their roles in household financial management, which enables them access to money and an opportunity to start their own income-generating activities, increase investment in existing activities, acquire assets or raise their status in household economic activities through their capital contribution to the household.

Also, channeling microcredit to women may increase their active role in intra-household decision making, decrease their own and household vulnerability, and increase investment in household well-being. Household members such as children benefit in terms of expenditures on education, health and nutrition. Other members of the household such as the husband and other adults may benefit as they are relieved of financial pressure within the household. Investment in household businesses may enhance labour market participation of household members.

3.2. Empirical evidence

The theoretical literature is clear on the mechanisms through which improved access to credit through microfinance interventions can reduce vulnerability to risks and shocks and empower women. However, the

empirical evidence supporting these propositions has been largely inconclusive. In their review of evaluation studies in Asia, Roodman and Morduch (2009) concluded that "30 years into the microfinance movement we have little solid evidence that it improves the lives of clients in measurable ways". Also, Rooyen et al. (2012) review evaluation studies of the impact of microfinance on poor people in SSA and come to a similar conclusion that "microfinance does harm, as well as good, to the lives of the poor".

Evidence from recent randomized evaluation studies in several countries including countries in SSA found little evidence supporting the impact of microfinance on the lives of the poor (e.g. Banerjee et al., 2013; Karlan and Zinman, 2010). A number of studies have specifically examined the effect of microfinance in terms of reducing household vulnerability, based on production and consumption smoothing (e.g. Swain and Floro, 2012; Morduch 1999) and poverty related outcomes. Becchetti and Castriota (2011) provided evidence of the effectiveness of microfinance to reduce shocks or enhance recovery from shocks. The authors found that microfinance provided to locals after the 2004 tsunami helped to reduce the income gap between those affected and those not affected.

A strand of evaluation studies has also examined the empowerment effect of microcredit on women, but the results have been inconclusive. Some studies found that lending to women may benefit their households, but this has not translated into their empowerment, and indeed has actually disempowered them (e.g. Garikipati, 2008). Lakwo (2006), comparing clients with non-clients in grouped-based microcredit lending in rural Uganda, found a significant positive impact on indicators of women empowerment such as gaining financial management skills, ownership of bank accounts and ownership of assets. A randomised evaluation of the Intervention with Microfinance for AIDS and Gender Equity (IMAGE) program in rural South Africa by Pronyk et al. (2008) also found mixed results. The authors found positive impact in terms of improvement in women's ability to negotiate safe sexual practices and avoid partner violence, but causality could not be inferred due to the presence of complementary programs. Kim et al. (2009) found no effect of microcredit even when a microcredit intervention alone was evaluated under the same IMAGE program.

Garikipati (2008) specifically examined the impact of microcredit targeting women on household vulnerability and empowerment in India. The author estimated program impacts on five vulnerability indicators and seven empowerment indicators, using logit models. In terms of vulnerability, the study found that microcredit increased the ability to cope with shocks and access to social capital. In terms of empowerment however, the study found that the loan given to women were often diverted into enhancing family assets and as such microcredit disempowered women, as they lack co-ownership of those assets. The author concluded that the household may benefit at the expense of women's empowerment.

In summary, the empirical studies on the impact of microcredit on vulnerability and women's empowerment have yielded diverse, mixed and inconclusive results. Firstly, empirical results vary according to the method used to identify impact. Difficulties in identifying impacts limit the extent to which causal inference can be drawn. In most cases, microcredit schemes contain information on program design such as eligibility criteria. The information around such criteria is rarely exploited to identify program impact. Secondly, evidence relating to vulnerability and empowerment is still largely dependent on how these outcomes are measured. These outcomes occur in multiple dimensions. The use of social and economic indicators of coping strategies have been suggested and have been found to provide a better understanding of the directions through which microcredit impacts vulnerability and women's empowerment (e.g. Günther and Harttgen, 2009).

Finally, the traditional group-lending or self-help model of microcredit has dominated the empirical literature. However, government-funded individual lending model of microcredit has been growing in developing countries. The Nigerian scheme was a government-provided microcredit, which operates in an institutional setting that differs markedly from the traditional group-lending model of microcredit. Unlike the traditional self-help group lending model, the microfinance banks (MFIs) in Nigeria are run much like

commercial banks, seeking financial sustainability whilst also seeking profits. Even though the MFIs operate on a standalone basis, they are affiliated to the formal banks that provide them with financial backing. As such, the MFIs are subject to the control of the affiliated banks. This is unlike the group-lending models, which are subject to the control of members. Theory suggests that microfinance works under different institutional contexts, which may feed into the impacts (Rooyen et al., 2012).

IV. Statement of hypotheses

In order to adequately address the stated research questions the following hypotheses were tested:

- i) The applicants for the microcredit scheme were generally similar in characteristics at the baseline. If only women who faced credit constraint apply for microcredit, on average therefore, eligible applicants should have similar characteristics at the time they apply (baseline). This hypothesis is necessary for the choice of control group to establish appropriate counterfactual.
- ii) Increase in household income as a result of the microcredit will enhance their ability to cope with risks and shocks, thereby reducing vulnerability.
- iii) Increase in household income as a result of the microcredit will enhance capabilities of the beneficiaries, thereby making them more empowered.
- iv) The impacts on vulnerability and (female) empowerment do not vary according to the domains in which the outcomes are measured.
- v) The microcredit scheme will benefit the household members of the beneficiaries, particularly if the microcredit was invested in a family business or in a new business that facilitates employment of family members.

V. Methodology and data

There are three dimensions to the methodological limitation in previous studies. Firstly, most of the evaluation studies have adopted the 'with' and 'without' approach, comparing microcredit clients and non-clients (or would-be clients) to identify impact (e.g. Swain and Floro 2012). In most cases, however, clients and non-clients are very different in characteristics. Estimates of the impact are biased and validity compromised if the differences in characteristics correlate in some ways with the outcome of interest. The second dimension relates to the inability to establish an appropriate counterfactual to represent the control group. Comparing outcomes of clients and non-clients even in a randomised setting will not identify program impact if the control group is misrepresented (e.g. Banerjee et al., 2013; Pronyk et al., 2008).

A key characteristic of the scheme under study is that beneficiaries were selected based on meeting some threshold credit points. The presence of the eligibility threshold enables adequate representation of the counterfactual. The relevant control group in this case was those who applied for the microcredit but were unsuccessful. Under certain identification assumptions, the threshold credit point (eligibility threshold) above (below) which the applicant was successful (unsuccessful), provides a source of variation in outcomes between the two groups of applicants that could be exploited to estimate the causal effects, using regression discontinuity design (e.g. Lee and Lemieux, 2010; Lee, 2008; Hahn et al., 2001; Thistlethwaite and Campbell, 1960).

5.1. Regression discontinuity design

Regression discontinuity (RD) design exploits the information on a given eligibility threshold to examine program impact. RD design is considered as good as randomised evaluation design if the identification assumptions are met and agents cannot precisely manipulate the variable through which eligibility for treatment is determined (Shahidur et al., 2010). The model for the estimation of the treatment effect can be specified as:

$$Y_i = \alpha_0 + \alpha_1 D_i + \alpha_2 X_i + e_{i1} \quad (1)$$

where Y_i is an outcome variable for the i^{th} individual; D_i is a binary variable for treatment status, taking a value of 1 if the individual received the microcredit and a value of 0, otherwise; X_i is the assignment variable (also known as the forcing or running variable) through which the treatment status is determined.

Let c be the eligibility threshold determining the cutoff point, above which the individual received the program. Equation (1) can then be re-stated as;

$$Y_i = \beta_0 + \beta_1 D_i + \beta_2 (X_i - c) + e_{i2} \quad (2)$$

In Equation (2), the assignment mechanism for receiving microcredit is conditional on meeting the eligibility cutoff point:

$$D_i = \begin{cases} 1 & \text{if } X_i \geq c \\ 0 & \text{if } X_i < c \end{cases}$$

$D_i = 1 [X_i \geq c]$ for the treated individuals when the credit score is above the cutoff point. $D_i = 0$, $X_i < c$ for the untreated (or control) group, when the score is less than the cutoff point.

The term $(X_i - c)$ allows for the centering at the cutoff point, so that when $X = c$, the average effect for the treated can be stated as;

$$E[Y | D = 1, X = c] = \beta_0 + \beta_1 \quad (3); \quad \text{and}$$

for untreated groups;

$$E[Y | D = 0, X = c] = \beta_0 \quad (4)$$

Therefore, the treatment effect is given by β_1 , the difference between (3) and (4);

$$E[Y | D = 1, X = c] - E[Y | D = 0, X = c] = \beta_1 \quad (5)$$

Note that the centering at the cutoff point $(X_i - c)$ allows the treatment effect to be estimated at different levels of the credit score X . In line with the potential outcomes framework (Rubin 1974), the counterfactual is conditional on X and estimation of the treatment effect is based on the continuity of (3) and (4). Largely because (5) is based essentially on extrapolation due to lack of overlap at $X = c$, it is important that the functional relationship between Y and X be specified correctly.

In practice, the two major types of RD design are Sharp RD and Fuzzy RD. Whether an RD design can be considered as 'sharp' or 'fuzzy' design depends on whether the probability of treatment, D rises sharply from 0 to 1, or rises discontinuously but not from 0 to 1 and also meets some validity assumptions. The simplest version of RD design is the Sharp RD, in which the treatment status D is a deterministic and a discontinuous function of the assignment variable X at the cutoff point c (see Lee and Lemieux, 2010).

However, the fuzzy RD design (FRD) was motivated in this study largely because the scheme used by administrators did not strictly adhere to the assignment rule (see [Table 1](#)), suggesting a situation of imperfect compliance. As [Figure 3](#) shows, there is an imperfect relation between the assignment variable (credit score) and the probability of getting the microcredit. The figure confirms that the microfinance bank did not approve the microcredit in strict adherence to the credit score ($c \geq 70$). There appears to be a bunch of applicants with a credit score just above the threshold who were unsuccessful, and vice versa. It is possible that the scheme administrators considered other factors, which made treatment assignment conditional on these factors. These 'other' factors may be unobservable to the researcher but are correlated with the outcome of interest, thereby imposing endogeneity bias into the treatment assignment.

An implication of the fuzzy RD is that the treatment status D is no longer a deterministic function of X , but of the treatment probability at the cutoff c . Let T_i be an indicator variable (called *eligible*), capturing the strict eligibility for the microcredit, taking the value of 1 if the individual met the cutoff, and value 0, otherwise. Then, T_i is a variable that instrument for treatment status D . Empirically, fuzzy RD design is estimated by instrumental variable (IV) technique, such as two-stage least squares (2SLS), based on the same assumptions in the standard IV framework (e.g. van der Klaauw, 2002; Hahn et al., 2001).

For the eligibility indicator, $eligible_i = \mathbf{1}(X_i \geq c)$; and allowing a flexible specification of Eq. (2), the empirical first-stage and the reduced-form equations of the IV model can be stated as follows;

$$D_i = \tau_0 + \tau_1 eligible_i + \tau_2 f(\tilde{X}_i) + e_{i3} \quad (6);$$

and

$$Y_i = \nu_0 + \nu_1 eligible_i + \nu_2 g(\tilde{X}_i) + e_{i4} \quad (7)$$

where the centring term $(X_i - c) = \tilde{X}_i$; $f(\cdot)$ and $g(\cdot)$ are smooth functions often represented by polynomials of order p ; τ_1 measures the discontinuous change in eligibility at the cutoff (i.e. the probability that those who were eligible belonged to the treated group); ν_1 measures the treatment effect (i.e. the difference in outcome variable; Y_i between treated and untreated individuals above and below the cutoff point. In a just identified model (i.e. where *eligible* serves as the only instrument), the IV estimator is $\beta_{IV} = \frac{\nu_1}{\tau_1}$.

In the estimation, the centered \tilde{X}_i was used. Also, it was assumed that both functions $f(\cdot)$ and $g(\cdot)$ polynomials are of the same order, p , which allowed estimation of local polynomial regressions. Additionally, the specification of the above empirical IV model was made more flexible by including interaction terms between \tilde{X}_i and D_i .

5.2. Data

The data used in this study was collected from bank administrative data and a follow-up survey. The bank administrative data contained information on the applicants, including names and addresses, telephone number, date of application, credit status, credit score, and the interest rate faced by the successful applicants. The personal information was used to re-contact the applicants for the follow-up. Since RD design is better with large sample size, the entire $N=3,397$ applicants were sampled, which more than triples the minimum sample size calculated initially.

The questionnaire design used for the follow-up survey followed the format of the Nigeria's Living Standards Measures Study of the General Household Survey-Panel 2010/11 developed at the World Bank (NBS 2013).⁴ The questionnaire was mainly closed-ended, comprising 77 questions divided into four modules: general household characteristic, household vulnerability and empowerment domains, household members, and beneficiary-specific modules. The survey was carried out during August and November 2014, representing at least one year since the scheme was implemented. However, only $n=2,938$ out of the $n=3,397$ originally proposed could be interviewed, thereby achieving a high re-contact rate of 86.5%. The respondents comprise $n=1,555$ and $n=1,383$ customers in the treated and untreated groups, respectively. The household member data comprised $n=8,148$ after removing data on non-responding individuals.

In order to ensure that non-response was random, however, it was examined whether there was significant correlation between the observable characteristics and non-response according to the recipient status. Thus, a variable was generated called *non_response*, which takes a value of 1 in the case of non-response and a value of 0 otherwise. A probit regression was carried out, specifying *non_response* as a function of eligibility, customer characteristics and their interactions. The results of the probit regression are presented in [Table 2](#). There were no significant correlations between non-response and these characteristics.

5.3. Description of variables and summary statistics

Three groups of variables were used in this study, namely: individual and household level baseline characteristics, main outcome variables, and institutional level variables. The individual and household level baseline characteristics comprised demographic and socioeconomic characteristics of the applicants, including age, marital status, education level completed, and occupational status. Household characteristics included household size and composition, sex, and relationship to the applicant.

A key identification assumption in RD design approach relates to the exchangeability of baseline characteristics of treated and untreated individuals. Exchangeability (also known as balancing) requires that the treated and control groups are similar at the baseline. The exchangeability assumption was tested, using the demographic and socioeconomic characteristics of the applicants. [Table A3a](#) and [A3b](#) in the **Annex** document present the results of the test for individual-level and household member

⁴ The questionnaires were translated into the local Yoruba language to ensure that enumerators and interview team face no difficulty when they communicate with the elderly people.

characteristics, respectively. For individual-level data ([Table A3a](#)), generally there were no statistically significant differences between the treated and untreated groups across the baseline characteristics, except for *age* and the *Crop farmer* category of occupation. Similarly for the household member characteristics ([Table A3a](#)), significant differences in characteristics between the treated and untreated customers were observed only in five out of 44 variables. On the basis of these results, it was concluded that the treated and untreated groups were comparable in their baseline characteristics and Hypothesis (I) is confirmed.

The main outcomes of interest in this study were overall household vulnerability and overall women's empowerment. These variables were composite variables constructed from the response options from specific questions in the questionnaire survey. Previous studies of the impact of microfinance have also used composite variables constructed from composite variables (e.g. Notenbaert et al., 2013; Gola et al., 2011; Garikipati, 2008). [Box A1](#) in the [Annex](#) presents the formula used to construct the outcome variables. [Table A1](#) in the [Annex](#) provides a description of variables used to construct the main outcome variables and how the scores were derived. Household vulnerability was measured from five domains of coping strategies: value of household assets, frequency of child labour, food shortage in the family, health services demand, and experience of and ability to cope with environmental shocks. Overall, the household vulnerability score was then aggregated as the sum of the scores from the five domains. The higher the score, the more vulnerable the household is.

Economic empowerment was also measured from five domains, comprising; financial inclusion; ownership and control of productive assets; household decision making; networking/community activities and perception of self-confidence; and contribution to household expenses. A similar method was used for the other domains of empowerment. The higher the score, the more empowered the individual is. Finally, household member level outcomes included labour supply, comprising number of household members (18 years and above) working, and hours of work per week. Others are; household monthly per capita income, expenditures and savings.

[Table A4](#) in the [Annex](#) presents the summary statistics for all outcome variables. The mean values of the domains for overall household vulnerability score were generally lower for the treated group than for the untreated group, except for value of household assets. Hence, the overall household vulnerability score was also lower, suggesting that the treated customers were generally less vulnerable than customers in the untreated group. The mean values of the domains for overall empowerment score were generally higher for the treated customers than for untreated customers. Hence, the overall empowerment score was also higher, suggesting that the treated customers were generally more empowered as a result of the microcredit program. Also, the mean values of both household income and expenditure per capita were higher for the treated customers than for the untreated customers.

The lower segment of [Table A4](#) shows the summary statistics for the household member outcomes. The mean values for all of the labour-related indicators were higher for individuals in treated households than in untreated households, except average income from labour source. Average household income and expenditure per capita were both higher in treated households than in untreated households.

The institutional variables were observed only for the treated individuals who received the microcredit. [Table A5](#) shows the summary statistics of the institutional variables. A little over 24% of the recipients of the microcredit had made a full repayment; 24% reported to have made savings from the loan. At the time of our survey, the average recipient had held the loan for at least 22 months. Furthermore, a majority (43.9%) of the women used the loan to support their own business, a majority (34%) making loan repayment through their cooperatives, and a considerable proportion (27%) making monthly repayment directly to the bank.

VI. Results

6.1. Validity of RD design

[Figure 3](#) plots the possibility that the microcredit assignment process has not followed strict compliance to the assignment rule. This provided the basis of adopting a fuzzy RDD. Manipulation of the assignment variable may affect the validity of the RD design. Activities such as favoritism or corruption in the allocation of the credit scores could be sources of manipulation. Thus, the validity of the RD design was tested based on McCrary (2008).⁵ This was a test for possibility that agents precisely manipulate the assignment variable. The test implies that the treated and untreated applicants were insignificantly different at the cutoff. A continuous distribution at the cutoff provides evidence against manipulation of the running variable. The test resulted in an estimated discontinuity of 0.074, and the standard error is 0.124, which gives the z-statistic of 0.593. The binsize and IK bandwidth was 0.020 and 0.374, respectively. Therefore, the null hypothesis of continuity could not be rejected. [Fig. 4](#) provides the plot of the test.⁶

6.2. Graphical evidence of local average treatment effects

[Figure 5](#) presents plots of the RD design treatment effects associated with some of the outcomes ([5a-5f](#)). The plots show the mean of the predicted RD design estimates of the LATE and associated confidence intervals (CI) for the outcomes, which have been obtained from a local polynomial regression that included up to 5th order polynomials in the assignment variable.⁷ As the CIs indicate, the main treatment effects are estimated for individuals closest to the left of the cutoff and individuals closest to the right of the cut-off, and at these points the CIs are closest. The plots for vulnerability, empowerment and per capita income show a clear discontinuity at the cutoff between the treated and untreated individuals and the gaps between the two fitted lines are the RD design estimates of the LATE. For overall household vulnerability score, the fitted line is lower for individuals above the cutoff on average than for individuals below the cutoff, suggesting a reduction in household vulnerability. For overall empowerment score, the fitted line is higher for individuals above the cutoff on average than for individuals below the cutoff, suggesting an increase in the female empowerment score. However, the plot for the value of household assets shows no clear discontinuity at the cutoff, suggesting no difference between the treated and untreated individuals, and as such the value of household assets makes no contribution to the reduction in the overall household vulnerability score.

6.3. Two-stage instrumental variables estimation results

The two-stage instrumental variable estimator (IV-2SLS) was used to estimate the models. Estimates were robust to arbitrary heterogeneity and consistent in the presence of over-identification. The optimal bandwidth strategy recently proposed by Calonico et al. (2014) (or CCT 2014, henceforth) was used as a benchmark for the estimations.⁸ The models estimated included quadratic specification of the assignment variable (centred credit score) and its interaction with the treatment status. The models

⁵ The McCrary (2008) test involves an estimation of the discontinuity in the density function of the assignment variable at the eligibility threshold.

⁶ Note that the credit score figures have been standardised for the range -1, 1 where 0= cutoff point. Note also that the R-statistical software was used for the estimation and plot.

⁷ As it turns out, lower-order polynomials such as quadratic specification appears suffice to model the smooth functions $f(\cdot)$ and $g(\cdot)$ in equations (6) and (7), respectively.

⁸ For the CCT estimator, the kernel used was triangular, which has been shown to have better properties at the boundaries, which is what seems to matter in RD design (CCCT 2014). Alternative bandwidths selectors such as the Imbens and Kalyanaraman (2012) (IK bandwidth selector) and cross-validation method (CV) proposed by Ludwig and Miller (2007) are available for only sharp RD designs.

estimated controlled for customer characteristics in order to obtain more precise estimates.⁹ The treatment status (Debtor) was the instrumented. The characteristics served as included restrictions.

Results are reported for the first-stage (Eq.6), reduced-form (Eq. 7) and LATE estimations. The first stage regressions are reported in the upper segment of [Table 6](#) and [Table 7](#) for the household vulnerability and empowerment outcome indicators, respectively. For both of these outcomes and their respective domains, the first stage regressions show that initial eligibility based on the creditscore is a very strong predictor for treatment status (debtor) (i.e. whether the applicant was successful in getting the microcredit). The coefficients on eligibility are highly significant, large in magnitude, and the R² exceeds 0.56 generally across the models. Consistent with the graphical evidence in [Fig A5](#), eligible applicants with a credit score above 70 points have a significantly higher probability of receiving the microcredit.

The middle segments in [Tables 6](#) and [7](#) show the estimates of the reduced form models. The estimates suggest that eligibility for the microcredit has a highly statistically significant effect on the outcome indicators. For overall household vulnerability score and associated domains, the coefficients are always negative and significant at the 1% level. For overall empowerment score and associated domains, the coefficients are always positive and significant at the 1% level.

Comparing the reduced-form estimates with the estimates of LATE from IV-2SLS (third segments in [Table 6](#) and [7](#)) across all of the models, the magnitudes of the treatment effects from the actual receipt of the microcredit are generally higher in absolute value terms than the effects of program eligibility. This supports the use of instrumental variable to identify program impact. Finally, the estimates of LATE from IV-2SLS are internally consistent, as they are the ratios of reduced-form coefficients to the coefficients of the first-stage regression ($\frac{\nu_1}{\tau_1}$).

6.4. The impact of Amoye microcredit scheme on household vulnerability

The third segment in [Table 6](#) reports the IV-2SLS estimates of the LATE, indicating the impact of the microcredit on indicators of household vulnerability. Consistent with Hypothesis (II), the coefficient on the overall vulnerability score is negative, indicating that treated customers are less vulnerable than untreated customers. The average overall vulnerability score for the treated customers is about 0.8 points lower than the average overall vulnerability score for the untreated customers, representing a decrease of approximately 6%.¹⁰ Columns 2-6 in [Table 6](#) show the domains of the overall vulnerability score. Consistent with Hypothesis (III), the impacts of the microcredit vary across the domains through which overall vulnerability was measured. The impact of the microcredit is statistically significant for two out of the five domains of household vulnerability (frequency of child labour and food shortage in household). The microcredit does not have any impact on vulnerability indicators such as value of household assets, health service demand, and experience of and ability to cope with environment shocks, though they have the expected signs. Generally, the results are consistent with Kurkani (2011), supporting the multidimensional approach to measuring vulnerability and empowerment that microcredit may have affected in some domains without any effect in others.

6.5. The impact of Amoye microcredit scheme on women's empowerment

The third segment in [Table 7](#) reports the IV-2SLS estimates of the LATE, indicating the impact of the microcredit scheme on indicators of women's empowerment. Consistent with Hypothesis (III), the

⁹ The characteristics included were age, age squared, and categories of marital status, education level completed, and occupational status, with each category having a reference group.

¹⁰ The percentage is calculated as $((\hat{\beta}_0 + \hat{\beta}_1) / \hat{\beta}_0) * 100$, where $\hat{\beta}$ are estimated coefficients. Note that the coefficient on the constant is for the untreated customers. The same method is used for all outcomes.

coefficient on the overall empowerment score is positive, indicating that treated customers are more empowered than untreated customers. The average overall empowerment score for the treated customers is about 10.3 score points higher than the average overall empowerment index score for the untreated customers, representing an increase of approximately 30.5% score points.

Columns 2-6 in [Table 7](#) show the domains of the overall empowerment score. The microcredit has a significant positive impact on all of the five domains contributing to the overall empowerment score: financial inclusion (i.e. the use of formal and informal financial services and products); ownership and control over productive assets; household decision making; networking, community activities and perception of self-confidence; and capability of the beneficiaries to contribute to household expenses. For each of these domains, the score is significantly higher for the treated customers than the score for the untreated customers.

The findings on women's empowerment are generally consistent with previous studies, suggesting that microcredit empowers women (e.g. Rai and Ravi, 2011; Kabeer, 2001; Swain and Floro, 2012). The result on networking and community activities agrees with findings by Swain and Wallentin (2009) that microfinance builds social capital through enhancing the capacity of the beneficiaries to undertake networking and community activities and reinforcing their self-confidence. However, the result contrasts sharply some previous findings group-lending model of microcredit (e.g. Garikipati, 2008; Banerjee et al., 2013).

6.6. The impact of Amoye microcredit scheme on household members of beneficiaries

The impact of the Amoye microcredit scheme on household members was examined with respect to labour market participation, household per capita income, expenditures per capita, and savings per capita. [Table 8](#) presents the results. For labour market participation, the microcredit scheme has a highly significant effect on labour share of income of household member, the share of adults who are working in the household, as well as the number of hours worked per week by adult household members. All of these labour market incomes are significantly higher in households of treated women than in households of untreated women. Moreover, the results on labour market participation do not indicate a substitution effect, which would potentially arise if increased household income led members of the family to reduce their labour supply. The microcredit has a highly significant positive effect on all three indicators of household member financial status. Household income, expenditures and savings per capita increase by approximately 20%, 13%, and 29%, respectively. These results are consistent with Hypothesis (V).

6.7. Effects of institutional factors and loan use on the treatment effects

The analysis was extended to associations between the main outcomes (household vulnerability and women's empowerment) and the institutional variables, including pricing (interest rate), repayment method, loan duration, loan amount, and use of loan.¹¹ [Table 9](#) presents the results. The pricing faced by the beneficiaries has no effect on the estimates of the LATE for either vulnerability or empowerment. However, the methods of repayment show mixed results. Making repayment of the microcredit through cooperatives is significantly associated with a higher vulnerability score, reflecting the collective risk that membership in cooperatives imposes on members, but is not associated with empowerment. In contrast,

¹¹ Estimation was based only on the sample of beneficiaries of the microcredit by interacting the treatment status (debtor) with each of the institutional variables.

making repayment of the microcredit through daily/weekly collection by bank staff is significantly associated with a lower household vulnerability score and significantly associated with a higher empowerment score. This method of payment does not impose collective risk or peer pressure to make repayment as in the case of cooperatives.

Also, loan duration is significantly associated with a lower household vulnerability score and a higher empowerment score. The longer a beneficiary holds the microcredit (in months) the less vulnerable, and the more empowered than a beneficiary who holds the microcredit for a short period. Holding the microcredit for a longer duration with smaller repayments spread over time allows longer-term investment. However, the size of the loan is not associated with either household vulnerability or empowerment.

Moreover, the use of the loan has mixed effects on household vulnerability and women's empowerment. Using the microcredit for purposes such as asset purchase, child education, and marriage/funerals makes no difference to the treatment effect. However, using microcredit to establish new business, support own or family business, all are significantly associated with a lower overall household vulnerability score. In terms of empowerment, using the microcredit for non-business or social activities (children education, marriage or funeral) makes no difference to the treatment effect. However, using the microcredit to purchase assets such as land is significantly associated with a lower empowerment score. This result seems consistent with previous finding that even though asset acquisition increases, ownership of such assets still resides with the husband (e.g. Garikipati, 2008). Also, it is the custom of the Ekiti people studied in this paper that whatever the wife owns belongs to the husband. An increase in assets that does not lead to a change in such traditional beliefs and customs will not generate real empowerment.

Using the microcredit to establish new business or support family business is significantly associated with a higher empowerment score, but using it to support one's own business is significantly associated with a lower empowerment score. The contrasting results on empowerment may be reflecting the relationships that exist in families, which may be affecting the extent of the women empowerment. It appears that investing the microcredit on new or family business or supporting one's own business has a competition effect on the extent of women empowerment. The findings on the use of loans contrast Garikipati (2008) that suggested that these categories of loan use are substitutable / competing at reducing vulnerability, but actually disempowered women. The present findings suggest the reverse, indicating they are complementary to reducing household vulnerability, but competing at empowering women.

6.8. Robustness and sensitivity checks

The robustness of the results was examined through their sensitivity to changes in some parameters. The goal is to improve the credibility of the estimates. Results obtained from an RD design may be sensitive to the estimation window used, as different estimation windows tend to produce different estimates (e.g. Lee and Lemieux, 2010; McCrary, 2008). Credibility requires that identification of the LATE be not sensitive to a particular functional form of the assignment variable or data points. Firstly, as a robustness check on the probit estimation of non-response, a joint significance test of the parameters could not reject the hypothesis of random non-response; $Chi2(3) = 10.07, p\text{-value} = 0.180$. Secondly, sensitivity of the IV-2SLS estimation results was also examined to changes in the estimation window or bandwidth (BW) and varying the order of the polynomials, p relative to the benchmark or preferred model. [Tables 10](#) and [Table 11](#) present the results for vulnerability and empowerment, respectively. [Box 2](#) in the **Annex** provides the details of the sensitivity check. The results showed that the BW at 12% used in the preferred model was indeed optimal.

6.9. Multiple inference and limitations of study

It is sometimes argued that evaluation of a program with multiple dimensions of outcomes may create a multiple inference problem, potentially arising from multiple hypothesis testing implicit in the measurements (Duflo et al., 2013). However, the analysis undertaken in this study did not involve multiple hypothesis testing, as each domain was examined separately. The estimate from individual domains did not sum to the overall estimate. A key limitation of this study relates to the external validity of the findings. A dimension to this limitation is whether the results could be generalized into providing a guide for other banks or whether Ikere is representative of rural areas in Nigeria. However, the design of the scheme was the same irrespective of the location of the bank. The rural areas in south-west Nigeria are homogenous in terms of sociocultural values, language, ethnicity and geography and local government administrative units to which they belong. Thus, external validity is more of a limitation of the RD design method adopted (estimates are local average treatment effects), rather than the location of study. Another dimension to the limitation relates to the inability to make causal inference regarding the influence of the institutional factors and loan use on the treatment effects. Even as the results are suggestive for the design of microcredit scheme, they can only be considered as associations. The aspect of institutional design of microcredits is an area we hope to pursue more rigorously in future research.

VII. Conclusions and policy implications

This study has examined the impact that a government-provided microcredit scheme targeting women in rural areas may have on vulnerability and empowerment of the beneficiaries and members of their households. Two main research questions were addressed. The first relates to whether microcredit improves indicators of household vulnerability and women empowerment, paying particular attention to the multidimensional nature of these outcomes. The second relates to an understanding of the extent to which family members of beneficiaries were affected. The analysis was extended to examine whether the institutional factors and the use of loan affected outcomes. These questions were addressed in the context of a recent government-funded microcredit scheme targeted at women in rural areas in Nigeria. [Table 12](#) provides a summary of the findings on the main outcomes.

Firstly, the results showed that the beneficiaries of the microcredit were significantly less vulnerable than non-beneficiaries. Looking at the various dimensions through which vulnerability was measured, this result was attributed to significant reductions in both frequency of child labour and food shortage in the household. The remaining three domains made no difference. Whilst the evidence of the impact of microcredit on vulnerability is building up, it remains inconclusive. Results are sensitive to which dimension of the outcomes are observed. For example, a different conclusion could have been reached had overall vulnerability been measured narrowly based on the three of the insignificant domains.

Secondly, beneficiaries of the microcredit were significantly more empowered than non-beneficiaries, and each of the five measurement domains made significant contribution to this result. There was an improvement in their bargaining power and capacity to make joint decisions in the household. The social capital of the beneficiaries increased through enhanced ability to network, undertake community activities as well building their self-confidence. Financial inclusion of the beneficiaries also improved.

The microcredit scheme also generated significant positive indirect effects on the household members of the beneficiaries. On average, household members of treated women benefited from the microcredit more than household members of untreated women, particularly in terms of labour market participation and per capita income, expenditure, and savings. There was no evidence of substitution effect in household labour supply as often feared. Moreover, an extension of the analysis showed association between the key outcomes and some aspects of the microcredit design such as pricing, repayment method, loan duration and use of loan.

A key contribution of this study to the literature relates to the rigorous empirical evidence it provides in a quasi-experimental setting. In the absence of randomised evaluation, the RD design provides an alternative but credible approach to support evidence-based policy-making, involving microcredit interventions specifically targeted at women in rural areas in developing countries. A key policy message from the study is that policy interventions emphasising microcredit for the rural poor should take into account the multiple dimensions in which impact tends to manifest. At a point in time, there may be an impact in some dimensions and no impact in others. For Nigeria, this evaluation study has demonstrated the effectiveness of the rural microcredit scheme, a justification of the resources the government committed to the scheme.

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ANNEXE

Table 2. Probit estimates of non-response

Variables	Non-response
Eligible	-0.0385 (0.596)
Credit score	-0.00157 (0.00776)
Account balance	-1.09e-05 (1.92e-05)
Constant	-1.017*** (0.0382)
Observations	3,397

Note: Robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.10

Figure 3: RD Plots of microcredit data at different number of bins

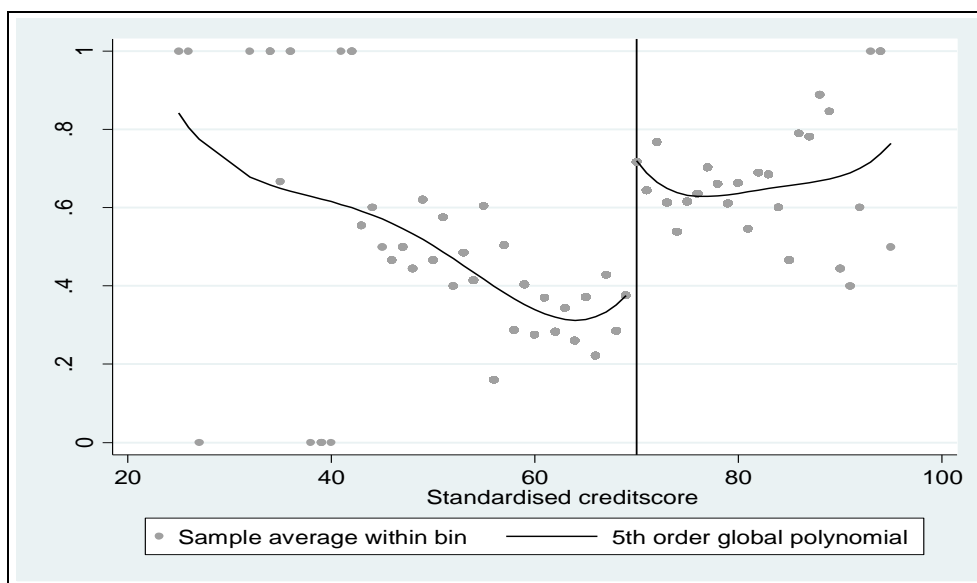


Figure 4: DC density test for the validity of RD design (McCrary 2008)

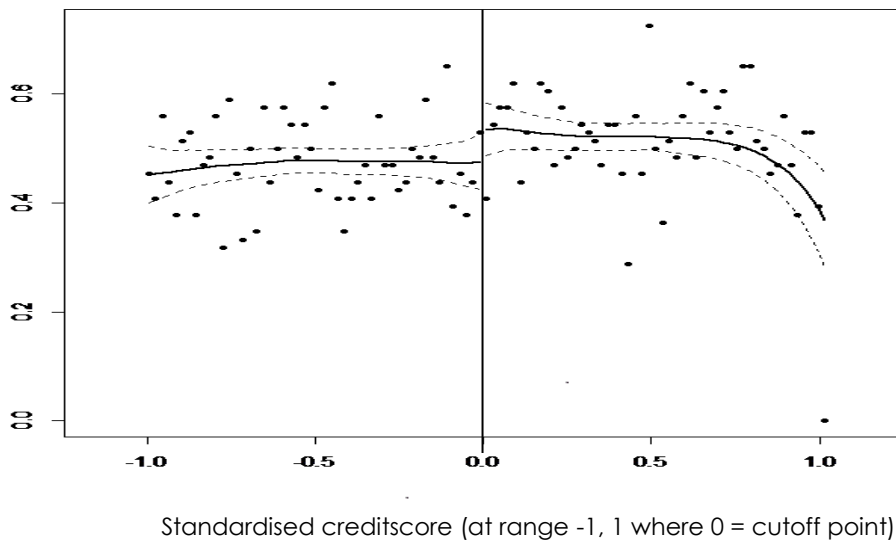


Figure 5: Plots of RD treatment effects for some outcome variables

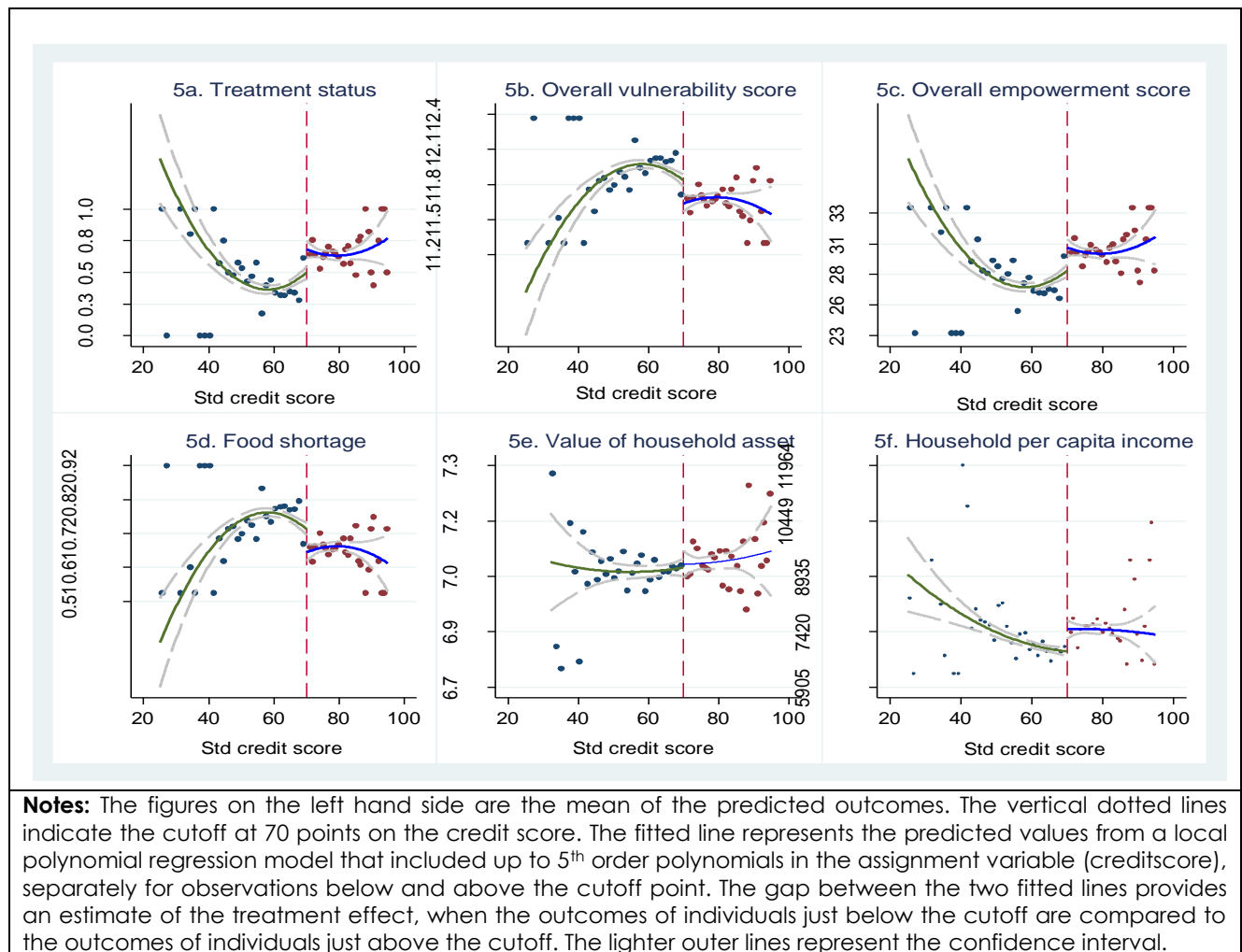


Table 6: IV-2SLS estimates of LATE on household vulnerability and associated domains

Variables	Overall household vulnerability score	Value of household assets	Frequency of child labour	Food shortage in household	Health service demand	Shocks
	(1)	(2)	(3)	(4)	(5)	(6)
First-stage: ⁱ						
Eligible	0.4295*** (0.0428)	0.4411*** (0.0448)	0.4412*** (0.0442)	0.4293*** (0.0428)	0.4289*** (0.0426)	0.4423*** (0.0534)
R ²	0.564	0.568	0.569	0.563	0.564	0.591
Reduced-form:						
Eligible	-0.334*** (0.0332)	-0.0847*** (0.00859)	-0.238*** (0.0243)	-0.113*** (0.0113)	-0.0175*** (0.00175)	-0.0211*** (0.0025)
IV-2SLS:						
Debtor	-0.777*** (0.268)	0.192 (0.139)	-0.541*** (0.145)	-0.263** (0.109)	-0.0407 (0.109)	-0.0473 (0.142)
Constant	12.48*** (2.234)	7.734*** (1.258)	2.199* (1.136)	1.301** (0.6803)	1.538* (0.897)	0.490 (0.894)
Sample size (n)	2,145	2,145	2,145	2,145	2,145	2,145
Poly order (p)	2	2	2	2	2	2
CCT BW	12.0	11.0	12.0	12.0	12.0	8.0

Notes: ⁱ The dependent variable was the treatment status (*Debtor*), which takes the value of 1 if the individual received the microcredit and value 0, otherwise. *Debtor* was the instrumented variable. Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. Models were estimated by IV-2SLS estimator. Estimates are Huber-White robust to heteroscedasticity. Estimates are from local polynomial specification, using CCT (2014) bandwidth selection method, and controls for customer characteristics, including: age, marital status, education level completed, and occupational status. The excluded instruments include *Eligible*, which takes a value of 1 if the credit score is greater than or equal to the 70 point cut-off and a value of 0 otherwise; quadratic of the standardised assignment variable and their interactions with the treatment status. These controls constituted the included instruments.

Table 7: IV-2SLS estimates of LATE on women empowerment and associated domains

Variables	Overall empowerment score	Financial inclusion	Ownership of productive assets	Household decision making	Networking, community & self confidence	Contribution to household expenses
	(1)	(2)	(3)	(4)	(5)	(6)
First-stage:						
Eligible	0.4358*** (0.0507)	0.4423*** (0.0534)	0.4277*** (0.0473)	0.4411*** (0.0448)	0.4408*** (0.0448)	0.4425*** (0.0444)
R ²	0.576	0.591	0.574	0.569	0.569	0.569
Reduced form:						
Eligible	4.475*** (0.521)	0.876*** (0.106)	0.565*** (0.0625)	1.608*** (0.164)	1.047*** (0.106)	0.179*** (0.0180)
IV-2SLS:						
Debtor	10.28*** (0.593)	1.985*** (0.173)	1.323*** (0.257)	3.656*** (0.348)	2.359*** (0.173)	0.405*** (0.0955)
Constant	33.65*** (5.061)	1.184 (1.569)	20.39*** (2.248)	3.629 (3.111)	7.237*** (1.435)	1.927** (0.938)
Sample size (n)	2,184	2,184	2,184	2,184	2,184	2,184
Poly order (p)	2	2	2	2	2	2
CCT BW	10.0	8.0	11.0	11.0	11.0	11.0

Notes: as in Table 6.

Table 8: IV-2SLS estimates of local treatment effects on household member indicators

Variables	Labour share in total income	Working	Hrs worked per week	Household expenditures per capita	Household income per capita	Savings per capita
	(1)	(2)	(3)	(4)	(5)	(6)
Debtor	0.0554*** (0.0149)	0.104*** (0.0152)	2.395*** (0.431)	678.2*** (128.0)	1,728*** (288.5)	774.4*** (242.3)
Constant	0.290*** (0.0366)	0.685*** (0.0394)	38.55*** (1.067)	5,192*** (337.0)	8,724*** (741.2)	2,630*** (638.6)
Order of polynomials (p)	2	2	2	2	2	2
CCT BW	13	10	13	8	9	10
Clusters	1,610	2,042	1,610	2,042	2,042	2,042
Sample size (n)	3,203	6,081	3,203	6,079	6,079	6,079

Notes: As in Tables 6 and 7. Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table 9: IV-2SLS estimates of the effects of institutional factors on the impact of microcredit

Variables	Household vulnerability	Women Empowerment
	(1)	(2)
Debtor	-3.354(1.615)**	6.036(2.339)***
<i>Interactions with Debtor</i>		
Pricing (interest on loan)	0.928 (1.442)	1.194 (3.655)
Repay through cooperative	0.487 (0.246)**	0.112 (0.613)
Repay through bank officials	-0.113 (0.072)	0.940 (0.328)***
Loan duration (months)	-0.0430 (0.0194)**	0.106 (0.0454)**
Log of loan amount	0.0421 (0.0639)	-0.0807 (0.163)
Use of loan - asset purchase	-0.396 (0.521)	-2.101 (1.240)**
Use of loan - children education	0.0984 (0.235)	0.0328 (0.550)
Use of loan - marriage/funeral	-0.809 (1.013)	-3.993 (2.931)
Use of loan – new business	-0.0776 (0.025)***	1.088 (0.574)*
Use of loan – own business	-0.368 (0.230)**	-1.274 (0.557)**
Use of loan – family business	-0.449(0.236)*	0.846 (0.366)**
Constant	15.00 (2.828)***	26.41 (2.886)***
Sample size (n)	2,145	2,145

Notes: Notes as in Table 6 and 7. Robust standard errors in brackets: *** p<0.01, ** p<0.05, * p<0.1. Model was estimated by IV-3SLS estimator to address potential endogeneity of institutional factors.

Table 10: Two-step estimate of LATE at varying estimation window and order of polynomials: Household vulnerability

	(CCT-BW±12%) ^a	(BW±10%) ^b	(BW±20%) ^c	(BW±50%) ^d
At order of poly.= 2				
Debtor	-0.777 (0.268)***	-1.652 (1.012)	-1.197 (0.572)**	-1.163 (0.342)***
Constant	12.48 (2.234)***	14.30 (7.269)**	13.01 (4.253)***	10.79 (2.807)***
At order of poly.= 3				
Debtor	-0.760 (0.267)***	-1.652 (1.012)	-1.137 (0.467)**	-1.163 (0.342)***
Constant	12.46 (2.233)***	14.30 (7.269)**	12.97 (4.235)***	10.79 (2.807)***
At order of poly.= 4				
Debtor	-0.720 (0.249)***	-1.652 (1.012)	-1.371 (0.436)***	-1.164 (0.335)***
Constant	12.42 (2.225)***	14.30 (7.269)**	13.14 (4.236)***	10.79 (2.803)***
At order of poly.= 5				
Debtor	-0.727 (0.248)***	-1.652 (1.012)	-1.353 (0.438)***	-1.277 (0.304)***
Constant	12.43 (2.225)***	14.30 (7.269)**	13.13 (4.236)***	10.92 (2.796)***
Sample size(n) ^e	1,530	187	420	923

Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; ^a Estimation window (BW) based on CCT (2014) optimal BW selection=12% on each side of the cutoff; ^b BW=10% on each side of the cutoff; ^c BW=20% on each side of the cutoff; ^d BW=50% on each side of the cutoff; ^e sample size is the same for each BW at varying order of polynomial.

Table 11: Two-step estimate of LATE at varying estimation window and order of polynomials: Empowerment

	(CCT-BW±12%) ^a	(BW±10%) ^b	(BW±20%) ^c	(BW±50%) ^d
At order of poly.= 2				
Debtor	10.28 (0.593)***	12.26 (1.788)***	12.04 (1.155)***	10.37 (0.725)***
Constant	33.65 (5.061)***	47.69(11.55)***	41.78(8.418)***	40.46 (6.191)***
At order of poly.= 3				
Debtor	10.27 (0.597)***	12.26 (1.788)***	12.16 (0.993)***	10.37 (0.641)***
Constant	33.66 (5.061)***	47.69 (11.55)***	41.72 (8.401)***	40.47 (6.220)***
At order of poly.= 4				
Debtor	10.13 (0.504)***	12.26 (1.788)***	11.98 (0.923)***	10.24 (0.639)***
Constant	33.81 (5.086)***	47.69 (11.55)***	41.81 (8.380)***	40.62 (6.219)***
At order of poly.= 5				
Debtor	10.10 (0.502)***	12.26 (1.788)***	11.81 (0.931)***	10.29 (0.613)***
Constant	33.85 (5.082)***	47.69 (11.55)***	41.90 (8.372)***	40.56 (6.219)***
Sample size(n) ^e	1,156	161	366	806

Notes: As in Table 10.

Table 12: Summary of empirical results*

Domains of household vulnerability score	Domains of women empowerment score	Household member level outcomes
Value of household assets: (positive, not significant)	Financial inclusion: (positive, significant)	Labour share of total household income: (positive, significant)
Frequency of child work: (negative, significant)	Ownership of productive assets: (positive, significant)	Number of household member working: (positive, significant)
Food shortage in household: (negative, significant)	Decision making in household: (positive, significant)	Hours of work per week: (positive, significant)
Health services demand: (negative, not significant)	Networking, community activities, and perception of self-confidence: (positive, significant)	Expenditures per capita: (positive, significant)
Experience and coping with shocks: (negative, not significant)	Contribution to household expenses: (positive, significant)	Income per capita: (positive, significant)
		Savings per capita: (positive, significant)

Note: * the italics within brackets show the empirical results; sign and whether statistically significant.