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Heterogenous Treatment Effect in Development Policy: A Randomized Experiment in Morocco on Those Who Take up the Microcredit

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Abstract

Randomized experiments are widely used in analyzing policy implementation and evaluation as researchers can estimate the average treatment effect between the control and treated groups. Sometimes, treatment effects are variable in different subgroups. The nonrandom variability defined by heterogeneous treatment effect is not like the random variability which is not correlated with explanatory variables and can be fixed by statistical methods, but it estimates individual treatment effects depending on individuals' characteristics within a subgroup. Using DID estimation, we will uncover treatment effects and heterogeneity in policy evaluation, helping policymakers to evaluate the efficacy of policy implementation. The study is mainly based on the effects of microcredit in 162 villages in Al Amana, a rural area in the Kingdom of Morocco (Crépon et al., 2015).

Keywords

Microcredit, DID Estimation, Heterogenous Treatment Effect,
Policy Implementation

1. Introduction

Inequality is the most general of social facets. John Rawls developed a theory of the GOOD as Justice and Justice conceived as Fairness. He discussed distributive justice in *A Theory of Justice* (Rawls, 1971). The main point of his theory is first that society must pursue justice by choosing what is best for those she treats worst.

That is, each person is to have an equal right to the most extensive total system of equal basic liberties compatible with a similar system of liberty for all. Secondly, social and economic inequalities are to be arranged, so that they are both to the greatest benefit of the least advantaged (Rae, 1975). Rawls opened the way to new non-utilitarian thinking on poverty and antipoverty policy (Ravallion, 2016). Poverty is unacceptable. It results from circumstances beyond control such as unequal circumstances of birth and market-governmental failures. It is also framed as lost chances depending on personal characteristics. It entails the loss of individual freedom, deprivation, vulnerability, and powerlessness which significantly impair people's sense of well-being (Lipton & Ravallion, 1995; Sen, 1999).

As we are not presuming that the developing world's pace of progress against poverty can automatically be sustained, governments and researchers are working hard to implement effective policies that unpack inequality to identify specific dimensions relevant to actions against poverty. In this case, the number of people living in extreme poverty is steadily declining based on data from World Bank for almost 25 years (The World Bank, n.d.). According to Multidimensional Poverty Index (MPI) and the Human Development Index (HDI) supported by the United Nations Development Program, poverty is further broken down into 10 indicators: nutrition, child mortality, years of schooling, school attendance, cooking fuel, sanitation, drinking water, electricity, housing, and assets. Most strategies focus on promoting growth and reducing poverty, but ignore the hazard of inequality. But if there is poverty, there is inequality.

While the origin of poverty differs widely across countries, we will mostly focus on rural poverty and inequality here. Rural poverty accounts for nearly 63 percent of poverty worldwide, reaching 90 percent in China and Bangladesh and between 65 and 90 percent in Sub-Saharan Africa (Banerjee & Duflo, 2011). The significance of alleviating poverty not only brings equal opportunities to these groups of people, but also ensures the pattern and stability of the whole economic growth. Since rural development is crucial to a country's agricultural and ecological development, focusing only on the promotion of development is not enough. The inclusive rural development policy requires promoting access to education, health, land, and other services that stimulate the economy, and a judicious combination of economic and social policies at both local and national levels. The successful lessons from countries addressing rural inequality are focusing on five broad perspectives: investing in infrastructure and public services, promoting inclusive agricultural development, ensuring a fair distribution of and secure access to land and its natural resources, improving social protection coverage in rural areas, and ending all forms of discrimination (Lee & Kind, n.d.). In the case of the People's Republic of China (PRC), it has been constantly fighting against poverty since 1978 by taking a series of agrarian reforms. And in 1980, growth in the rural economy accounts for the majority of China's success.

China's case is of interest because its rural policies are widely merited as a

positive force in promoting economic development. The flagship poverty alleviation program began in 2001 and financed public investments in designated poor villages based on participatory village planning. It has invested heavily in the network infrastructure in rural areas including roads, the telephone system, and the internet, integrating small-scale farms into wider value chains (Kimura et al., 2021). After that, it is widely accepted that eliminating poverty is a legitimate goal of publication. China's improvement corresponds to Rawls's maximin principle that resource flows respond to new opportunities for the worse-off.

Views about how best to fight poverty have evolved over many centuries. A longstanding view saw the solution to poverty as changing individual behavior—either by weaning poor people off their bad behaviors or by encouraging greater generosity by rich people (Ravallion, 2016). Thus, it is necessary to consider the heterogeneity of the worse-off groups when understanding how policies affect these individuals and households for poverty alleviation (Khan, 2000). It is, therefore, important to examine the assets the poor own or have access to, and how these assets are connected to the economy, since the poor's access to the assets directly affects how they develop economically in the future.

Microcredit, the practice of lending small amounts of money to the poor, quickly rose to global prominence in the 1980s and 1990s and remains an essential part of international development and poverty policy today (*Finance for the Poor: Microcredit, Poverty, and Development,* n.d.). After people take up microcredit, they can invest in physical assets, human assets, infrastructure assets, and institutional assets with greater freedom in participating in the production. The researcher Crépon et al. (2015) implemented their research in 162 villages in Al Amana and the operations were planned by Microfinance Institution (MFI). By collecting data from 7 treatment and 7 control groups and ensuring the entrance of alternative programs before the experiment, they studied the further impact and spillover of microcredit borrowing. The paper evaluates people's average treatment effect after taking up microcredit. It successfully finds that access to microcredit allows households to invest in agriculture and animal husbandry and increases their profit and access to credit enables households to purchase lumpy assets, such as livestock for self-insurance (Banerjee et al., 2015). Microcredit is a powerful financial instrument for the poor, so it is interesting to notice evident heterogeneity in the evaluations. We can expect more benefits from the microcredit policies in future policy implementation to investigate impacts on different groups of people.

The purpose of this paper is to investigate the heterogenous treatment effect in different subgroups after taking microcredit. We will see to what extent a poor village investment program can increase personal assets. We will also see the impacts of microcredit and investment program on household income and consumption growth. Our purpose is to the extent of the possibility of policy implementation by analyzing heterogeneity in treatment effects after taking the

microcredit.

2. Literature Review

Studies have shown varied results when considering microcredit as a mechanism for poverty alleviation. A randomized evaluation of multiple microfinance programs from numerous nations including Mexico provides an effective overview of the positive effects of microcredit (Banerjee et al., 2015). The microcredit's positive effects were found in the areas of female decision-making power and risk management (Banerjee et al., 2015). Some studies found increased business activity, business ownership, and an increase in sales. Some also found microcredit could mitigate the economic shock. Some found microcredit can improve healthcare capacity and health outcomes by educating clients, making referrals to higher levels of skill and resources, and even directly delivering clinical care (Leatherman & Dunford, 2010). To better improve poverty alleviation efforts, researchers wish to understand how microcredit opportunities play a role in the local population by providing adequate assessment (Henry, 2021). CréditoMujer's experiment proves microcredit's impact deviation on households that already enjoyed relatively high business revenues, profits, and household decision-making, which means those "worse-worse-off" have less possibility to break the poverty cycle (Angelucci et al., 2015). Although we can prove that the head ages of the population in the dataset of a randomized experiment from Morocco are normally distributed while the major population is with the low income, which is matched with the purpose of microcredit in order to help almost any poor person who can get a small number of loans from MFI, we should still improve efforts to reach chronically poor people or chronically poor female and ensure that individuals do not fall into over-indebtedness (Women's World Banking, 2015: p. 4; Henry, 2021).

Researchers find it difficult to conduct causal inferences regarding microcredit because measurement errors, fungibility, and heterogeneity complicate the process (Karlan et al., 2015). They point out that heterogeneity can diffuse the treatment effects of microcredit across multiple families, explaining none of the studies finds statistically significant effects at the 10 percent level on even half of the downstream outcomes tested (Banerjee et al., 2015). We also find a similar problem when regressing with a lot of explanatory variables.

DID estimation has been widely used when panel data or repeated cross-sections are available for intervention impact assessments. It can measure the treatment effects of the intervention through pre-treatment effect time and post-treatment effect time. It also offers an alternative by reaching unbiased results while accounting for time-invariant unobserved heterogeneity (Villa, 2016).

3. Data Collection

The data is published on Harvard Database by researchers who wrote the paper "Estimating the Impact of Microcredit on Those Who Take It Up: Evidence from a Randomized Experiment in Morocco" (Crépon et al., 2015, 2016). The research

was based in Al Amana, the largest microfinance institution in Morocco. The main product Al Amana offers in rural areas is a group liability loan. The loan amounts range from 1000 to 15,000 MAD (US$124 to US$1855) per member. It can take 3 to 18 months to reimburse loans, through payments made weekly, twice a month, or monthly. The applicants eligible for the project are between 18 and 70 years old, hold a national ID card, have a residency certificate, and have been running an economic activity other than non-livestock agriculture for at least 12 months.

The research group selected two groups of households: one containing those with the highest probability to become clients of the microfinance institution and one containing a random selection of households from the rest of the population. By using two samples here, we can measure the effect on the whole population of offering access to microcredit. The researchers then made two surveys: baseline surveys and endline surveys. In the baseline survey, researchers sampled 100 households from 14 villages. In villages fewer than 100 households, they surveyed them all. The endline survey was conducted in total 5551 households (Crépon et al., 2015). They measure the likeness of each household to borrow according to baseline surveys. The baseline survey included questions on assets, investment, and production in agriculture, animal husbandry, nonagricultural self-employment activities, labor supply of all household members (hours and sectors), as well as a detailed consumption survey. The baseline survey was conducted between April 2006 and December 2007. The endline survey was conducted two years later with the same instruments as the baseline survey. Additionally, the endline survey updated the dependent variables including clients over the two years and reestimated the coefficients of the model. The baseline survey included questions on assets, investment, and production in agriculture, animal husbandry, nonagricultural self-employment activities, labor supply of all household members (hours and sectors), as well as a detailed consumption survey (Crépon et al., 2015). Table 1 provides the descriptive statistics.

In this paper, we will use Differences-in-Differences estimation to estimate the causal relationships in the microcredit policy. DID estimation consists of identifying a specific intervention or treatment by comparing the difference in outcomes after and before the treatment for groups affected by the treatment to the same difference for untreated groups (Bertrand et al., 2004). DID estimates and their standard errors are most often derived from using ordinary linear regression in repeated panel data on individuals in treatment and control groups for several years before and after a specific intervention. Our estimation models are as follows.

3.1. Ordinary Linear Regression

$$Y_i = \alpha + \beta D_i + \gamma T_i + \delta\left(D_i \cdot T_i\right) + Z + \varepsilon_i$$

In this regression model for microcredit treatment effect, α is the constant

Table 1. Sample summary statistics of select variables from the baseline survey and endline survey.

Var Name	Definition	Obs	Mean	SD	Min	Median	Max
expense_total	total expenses of self-employment activitite	9941	20441.18	88089.26	0	4040	3,618,860
expense_agri	agriculture expenses	9986	5032.92	14122.306	0	760	384,000
expense_livestock	animal husbandry expense	10,003	5804.75	19664.222	0	15	801,700
expense_business	total expense of non-agricultural business	9978	9737.67	79854.796	0	0	3,600,000
inv_total	total purchases of assets self-employment activities	9979	1078.56	11097.854	0	0	750,000
profit_total	total profit of self-employment activities	9895	9044.6	51367.656	−537835	160	1,720,942
output_total	total output from self-employment activities	9958	29750.62	1.05E+05	0	6000	3,817,663
Income	total income	10,003	32791.95	72221.123	−537835	18,000	1,720,942
income_assetsales	income from asset sales	10,016	278.81	6387.372	0	0	400,000
consumption	total monthly consumption	9985	2746.42	2922.872	217.25	2320.335	155,452
sale_agri	sales and self-consumption of agriculture	9999	10273.53	42003.722	0	1000	1,808,300
prod_agri	agriculture output	9987	11912.79	43607.384	0	1300	1,808,302
need_fin	share of own activities: need financing	7864	0.88	0.277	0	1	1
need_form	share of own activities: need training	7864	0.01	0.088	0	0	1
need_comm	share of own activities: need marketing	7864	0.02	0.113	0	0	1
land_expl_ha	superficies of land exploited (in hectares)	10,016	2.13	12.264	−99	0.5	500
asset_livestock	current stock of animal husbandry assets	10,003	130.66	750.342	0	0	30,340
asset_business	current stock of non-agricultural business assets	10,003	805	6418.768	0	0	166,480
asset_agri	current stock of agriculture assets	10,003	1537.14	8718.88	0	355	210,850
head_age	head age	9881	49.73	15.236	1	48	120
savings_tree	current stock of tree stock	10,016	793.88	3757.044	0	0	209,700
savings_veg	current stock of vegetables	10,016	3.43	62.044	0	0	4000
savings_agri	current stock of agriculture	10,003	1770.43	5499.563	0	0	211,200
savings_livestock	current stock of livestock	10,003	13040.9	21589.075	0	5781.25	370877.5
assets_total	total current stock of assets of self-employment activities	9969	15383.85	25978.345	0	6825	371637.5
women_act	1 if self-employment activity managed by women	10,016	0.2	0.404	0	0	1

Continued

head_male	1 if male head	10,016	0.93	0.253	0	1	1
Shock 1	1 if shock to agriculture or animal husbandry production	10,016	0.14	0.344	0	0	1
Shock 1 Agri	if 1 prevented to use more than half of the land or lost more than half of	10,016	0.11	0.307	0	0	1
Shock 2	1 if health or house damage incident	10,016	0.24	0.426	0	0	1
head_educ_1	1 if educational attainment: none	10,016	0.64	0.479	0	1	1
head_educ_2	1 if educational attainment: koranic	10,016	0.12	0.32	0	0	1
head_educ_3	1 if educational attainment: 1st grade	10,016	0.02	0.122	0	0	1
head_educ_4	1 if educational attainment: 2nd grade	10,016	0.02	0.127	0	0	1
head_educ_5	1 if educational attainment: 3rd grade	10,016	0.02	0.149	0	0	1
head_educ_6	1 if educational attainment: 4th grade	10,016	0.03	0.171	0	0	1
head_educ_7	1 if educational attainment: 5th grade	10,016	0.05	0.227	0	0	1
head_educ_8	1 if educational attainment: 6th grade	10,016	0.01	0.117	0	0	1
head_educ_9	1 if educational attainment: 7th grade	10,016	0.01	0.088	0	0	1
head_educ_10	1 if educational attainment: 8th grade	10,016	0.01	0.088	0	0	1
head_educ_11	1 if educational attainment: 9th grade	10,016	0.01	0.109	0	0	1
head_educ_12	1 if educational attainment: 10th grade	10,016	0	0.056	0	0	1
head_educ_13	1 if educational attainment: 11th grade	10,016	0	0.065	0	0	1
head_educ_14	1 if educational attainment: 12th grade	10,016	0.01	0.079	0	0	1
head_educ_15	1 if educational attainment: 13th grade	10,016	0.01	0.074	0	0	1
head_educ_16	1 if educational attainment: 14th grade	10,016	0	0.02	0	0	1
selfempl_agri	1 if agricultural self-employment activity	10,016	0.63	0.482	0	1	1
selfempl_livestock	1 if animal husbandry self-employment activity	10,016	0.57	0.494	0	1	1
selfempl_business	1 if non-agricultural self-employment activity	10,016	0.16	0.368	0	0	1
self_empl	1 if self-employment activity	10,016	0.8	0.399	0	1	1

term, β is the treatment effect (to account for average differences between treatment and control), γ is the time trend common to control and treatment groups, δ is the true effect of treatment, Z is the other control variables and coefficients,

and ε_i is the random unobserved "error" term in the regression. $D_i \cdot T_i$ denotes the interaction variable of treatment and post (time).

3.2. Average Treatment Effect

$$ATET_{it} = E\left(Y_{it1} - Y_{it0} \mid D = 1\right)$$

The treatment variable denoted by D is binary, $d \in \{0,1\}$. In the DID model, we will have variables from two time periods, $T, t \in \{0,1\}$. Period zero indicates the pre-treatment period. Period 1 indicates the post-treatment period. In this case, we are going to discover the mean effect of switching D from zero to one on some outcome variables. Then, we define "potential" outcome variables indexed by the potential states of the treatment, so that Y_{dt} denotes the outcome that would be realized for a specific value of d in period t. In this paper, we assume $d = 1$ if the household gets the treatment and take up the microcredit, and $d = 0$ if the household does not take up the microcredit. We assume $t = 0$ if the data is collected from the baseline survey and $t = 1$ if the data is collected from the endline survey.

3.3. Difference in Difference Estimator

We will not consider the effect of other control variables Z here explaining the DID estimator.

Firstly, we will ensure the true treatment effect estimator is unbiased:

$$E\left[\hat{\delta}_i\right] = \delta$$

Secondly, we will ensure that error term is on average zero.

$$E\left[\varepsilon_i\right] = 0$$

Thirdly, we will ensure the error term is uncorrelated with other variables in the regression model:

$$cov\left(\varepsilon_i, T_i\right) = 0$$

$$cov\left(\varepsilon_i, D_i\right) = 0$$

$$cov\left(\varepsilon_i, T_i \cdot D_i\right) = 0$$

Then, we can get the expectation of the pre-treatment estimator and post-treatment estimator, which is the average difference in outcome Y_i before and after treatment in the treatment group ($D = 1$).

$$E\left[\hat{\delta}_{id=1}^{t}\right] = E\left[Y_{i1}^{t=1}\right] - E\left[Y_{i1}^{t=0}\right] = \left[\alpha + \beta + \gamma + \delta\right] - \left[\alpha + \beta\right] = \gamma + \delta$$

Then, we can get the expectation of the treatment and control estimator, which is the average difference in outcome Y_i in the post treatment group ($T = 1$).

$$E\left[\hat{\delta}_{it=1}^{d}\right] = E\left[Y_{i1}^{d=1}\right] - E\left[Y_{i1}^{d=0}\right] = \left[\alpha + \beta + \gamma + \delta\right] - \left[\alpha + \gamma\right] = \beta + \delta$$

Finally, we can get the Difference in Difference estimator, which is the difference in average outcome in the treatment group before and after treatment mi-

nus the difference in average outcome in the control group before and after treatment.

$$\hat{\delta}_{DD} = \left| E\left[Y_{i1}^{\ d=1} \right] - E\left[Y_{i0}^{\ d=1} \right] \right| - \left| E\left[Y_{i1}^{\ d=0} \right] - E\left[Y_{i1}^{\ d=0} \right] \right| = \delta$$

3.4. Heterogenous Treatment Effect

Grameen Bank Model suggested that the availability of financial services to the poor population can help them deal with vulnerabilities arising from poverty and empower women who can find few business opportunities due to patriarchal systems of control (Bateman & Chang, 2012; Matin et al., 2002). Depending on the Grameen Bank Model, we decide to select some subgroups to investigate the heterogeneous treatment effect.

Heterogeneity of Treatment Effect (HTE) is the nonrandom, explainable variability in the direction and magnitude of treatment effects for individuals within a population. The main goals of HTE analysis are to estimate treatment effects in relevant subgroups and to predict whether an individual might benefit from the treatment (Varadhan & Seeger, 2013).

We will use the same OLS model but with different groups of people to investigate the impact of microcredit on households with various characteristics. Subgroup variables must be true covariates, that is, variables that are defined before an individual is exposed to the treatment or variables that are known to be unaffected by the treatment (Varadhan & Seeger, 2013). In this case, the subgroups are divided based on gender, education, self-employment activities, and economic shock. There are four small groups in the "self-employment" and "education" groups. There are three small groups in the "asset shock" and the "woman" group. Table 2 shows the heterogenous groups with variable explanations.

In addition, although we conduct the subgroup analysis here, we are not able to explain all important questions regarding THE attribute to household characteristics. Therefore, there is a huge demand will be placed on observational studies to produce evidence to inform decisions. In order to ensure the results are valid, it is necessary to design and analyze the corresponding studies in the same way as randomized controlled experiments.

4. Empirical Results

4.1. Average Treatment Effect

In Table 3, there are three key explanatory variables: treatment, post (time), and interaction. 12 selected response variables explain the change in a household's expenditure, investment, profit, production, income, consumption, and sale. The selected variables can reflect households' well-being. According to USDA's Economic Research Service (ERS), key indicators of rural economic well-being include on-farm sources and off-farm sources. The on-farm source is the income from the farm business, determined by farm costs and returns, based on the prices of inputs and outputs. Off-farm sources include wage income, nonfarm

Table 2. Heterogeneous subgroups.

Self-employment	Asset Shock	Woman	Education
Total Activities	fear of not being able to reimburse and agriculture or animal husbandry production shock	self-employment	uneducated
Agriculture Activities	poor, health or house damage incident, agriculture or animal husbandry production shock	self-employment and primary education	koranic and fear to loan because of religion
Animal Husbandry Activities	self-employment activities, agriculture or animal husbandry production shock, and lose half of the land	self-employment and college education or above	primary
Business Activities			junior high

Table 3. Main regression without dependent variables.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	expense_total	expense_agri	expense_livestock	expense_business	inv_total	profit_total	output_total	Income	income_assetsales	Consumption	sale_agri	prod_agri
Treatment	−1282.408	394.680	441.470	−1925.315	80.222	−877.342	−2210.600	3704.995*	140.241	32.113	−115.331	374.788
	(2653.30)	(422.24)	(587.87)	(2398.95)	(333.20)	(1557.42)	(3146.80)	(2161.07)	(191.08)	(86.86)	(1259.63)	(1308.99)
Post	10012.322***	2248.828***	1916.615***	5571.339**	1111.925***	4506.379***	13827.864***	−6035.936***	587.640***	894.751***	1276.201	2692.595**
	(2492.88)	(397.49)	(554.08)	(2258.63)	(313.71)	(1461.36)	(2962.80)	(2037.39)	(180.23)	(81.91)	(1187.60)	(1233.86)
Interaction	4230.815	734.928	1463.522*	1839.122	54.389	475.895	4757.560	−5377.466*	−723.472***	−180.832	866.392	493.103
	(3550.65)	(566.31)	(789.14)	(3216.26)	(446.74)	(2079.36)	(4214.76)	(2900.97)	(256.67)	(116.61)	(1690.57)	(1755.77)

Standard errors in parentheses, $*p < 0.1$, $**p < 0.05$, $***p < 0.01$.

business earnings, dividends, and transfers (USDA ERS, n.d.). We will not consider the off-farm sources due to the lack of substantial data.

Then, we will see the statistical significance distributed in Table 3. Firstly, the treatment effect of selected variables is not significant. The insignificant result indicates that the treatment and control groups are randomly assigned to the group, validating the authenticity of the experiment design. We may suspect the random distribution of the income here but the scatter histogram in Figure 1 indicates people who take up the microcredit are mainly from low-income groups. While Crépon declared the existence of pure chance although randomization was already well carried out in their office by computer, the research group then attributed the deviation to the households in the baseline survey, that is those people have on average slightly larger access to the financial institution and a larger probability to have large assets and income in treatment villages (Crépon et al., 2015).
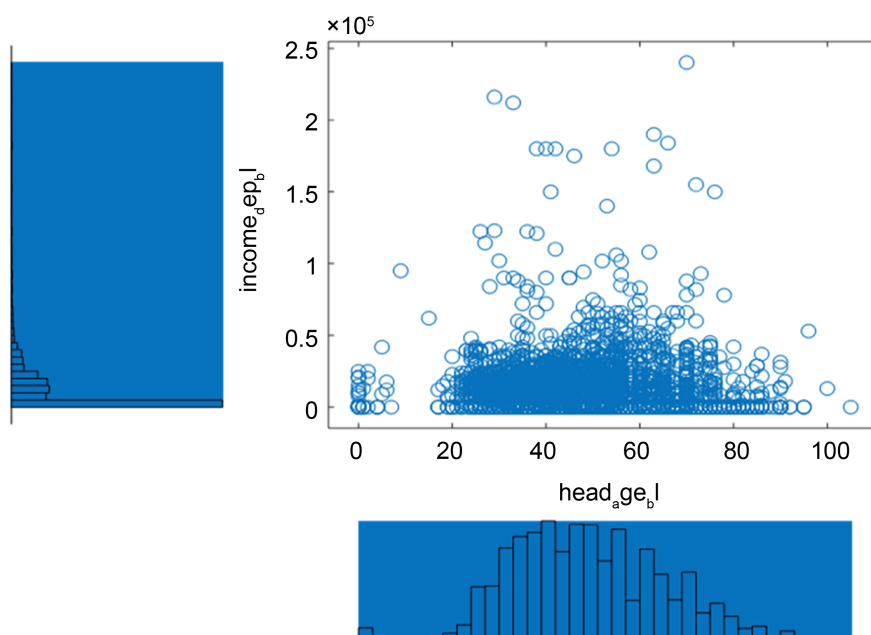
Figure 1. Scatterhist chart for the data distribution of income quantity and head age in the population.

Second, the significant post indicates that the experiment was performed at different times. We speculate the insignificance result comes from the variable itself. For example, people's self-consumption behavior in agriculture may not change with time. This needs further research evidence.

Thirdly, we will focus on the interaction effect on "livestock expenditure", "income", "income asset sales", and "consumption" in Table 3 and Table 4. The insignificant interaction effect in "livestock" expenditure reflects a shift of behavior in households coping with risk. Households tend to buy more lumpy assets, such as livestock, for self-insurance (Crépon et al., 2015). The saving behavior study in the low-income area finds a larger proportion of animals are held as a proportion of total liquid wealth and speculate households are risk-averse by holding more livestock in hardship because next-period selling prices are higher and maintenance costs are cheaper (Rosenzweig, 2001). Although the speculation needs further evidence, we can still find microcredit changes an individual's financial consideration and purchase behavior.

Next, the interaction effect on "income" as well as "income from asset sales" is among the most interesting, however, it is hard to explain the overall income depending on our research because Crépon finds that there is no significant impact on the overall income. There is also an insignificant income decrease here. The Morocco study has more rigorous consideration when explaining the income change than ours. It divides income into the home and salary income, which is based on individual expenditure as well as the labor market related to employment and self-employment activities. It also investigates the income diversification with a household's ability to borrow, which is too complex, so we will not elucidate the income effect based on Table 3 and Table 4 here.

Table 4. Main regression with dependent variables.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	expense_total	expense_agri	expense_livestock	expense_business	inv_total	profit_total	output_total	Income	income_assetsales	Consumption	sale_agri	prod_agri
Treatment	310.162	212.933	178.698	228.602	−14.795	−1266.439	−1186.883	3187.666	156.726	10.957	−391.039	−391.039
	(3187.28)	(460.46)	(677.00)	(2953.51)	(428.19)	(1937.00)	(3671.89)	(2646.87)	(249.74)	(108.65)	(1488.15)	(1488.15)
Post	10417.666***	1761.856***	−157.710	8763.429***	936.559**	3634.888*	13785.745***	−7704.500***	697.543***	920.978***	−547.449	−547.449
	(3301.96)	(478.42)	(704.77)	(3067.86)	(444.68)	(2003.47)	(3815.91)	(2755.75)	(260.14)	(113.08)	(1548.23)	(1548.23)
Interaction	4035.005	404.375	1301.844	2010.937	−190.833	−31.845	4259.829	−5832.018*	−813.008**	−248.991*	−339.426	−339.426
	(4195.06)	(607.51)	(894.17)	(3894.55)	(564.58)	(2543.97)	(4839.15)	(3496.90)	(330.02)	(143.47)	(1964.34)	(1964.34)

Standard errors in parentheses, $*p < 0.1$, $**p < 0.05$, $***p < 0.01$.

Lastly, we find an insignificant consumption decrease, compatible with the Morocco study, and may be caused by the following reasons: first, most borrowers in the sample are working hard to pay back the initial loans; second, the composition of consumption may need potentially important but not transformative explanations. The measures of consumption may need to focus more on durable stocks rather than expenditures because increases in the latter may indicate an increased churn of assets from the strain of the debt service (Angelucci et al., 2015). While a lot of Microcredit studies in low-income areas find mixed impacts microcredit access can either increase or decrease the stock of household durables (Attanasio et al., 2015; Augsburg et al., 2015). We may need to reconsider collecting and processing related data. The results of the lack of consumer spending can also be interpreted with the prediction model. Maybe some households already gained from the consumption while others are consuming less but may consume more in the future so that there is no next effect (Banerjee et al., 2015). That is, heterogeneous treatment effect may play a role here.

4.2. Heterogeneous Treatment Effect[1]

1) Self-Employment

Microentrepreneurial activity is one of the key research parts of the microcredit policy. The premise of the microcredit policy is to give opportunities to the poor, which helps them engage in self-employment activities. We need to find increases in business likelihood, size, or profitability to prove the transformative force of microcredit or it is not likely to reduce poverty by relaxing credit constraints that inhibit business growth.

Unluckily, in Table 5 and Table 6, we did not observe any significant increase in self-employment profit, which may be undermined by the decrease in income. We observe a weird significant decrease in income for all households with

[1]All the tables in THE study only include part of the regression results.

self-employment activities. Crépon et al. (2015) emphasized that the increase in self-employment income is small and insignificant as a result of the reduction in wage earnings. This may explain the significant decrease in income in households with self-employment activities and animal husbandry self-employment activities. We observe a significant decrease in income from selling assets. In rural areas, household vulnerability due to shocks requires families to use available resources as mechanisms to deal with them. They have to sell their assets to get enough income for more health care and buy more food for storage. The significant decrease here indicates microcredit provides a cushion for self-employed households, so they are protected under the risk. In this case, the assets not sold can help households extend their business and develop their self-employment activities peacefully.

The increase in the expense of livestock is slightly significant and may be due to people's risk-seek behavior rather than self-insurance behavior (Banerjee et al., 2015). Households can confer a high tolerance of losing livestock during

Table 5. Regression on self-employment subgroup.

	$(1)^2$	(1)	(1)	(3)	(3)	(1)	(3)
	Income	income_assetsales	expense_livestock	Income	income_assetsales	Consumption	Consumption
Treatment	5467.822**	179.679	764.487	10897.834***	280.471	76.320	173.889
	(2678.32)	(239.79)	(738.47)	(3726.17)	(406.86)	(108.38)	(158.33)
Post[3]	−6891.876***	629.076***	2249.515***	−2617.016	738.766**	976.188***	1135.825***
	(2475.85)	(221.74)	(682.24)	(3076.25)	(336.18)	(100.17)	(130.81)
Interaction	−7057.954**	−798.011**	1651.790*	−1.27e+04***	−958.301**	−238.616*	−312.913*
	(3541.92)	(317.26)	(976.27)	(4401.27)	(480.75)	(143.29)	(186.95)

Standard errors in parentheses, *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Table 6. Regression on asset shock subgroup.

	(1)	(2)	(3)	(3)	(3)	(3)	(2)	(3)	(1)	(3)
	expense_livestock	expense_livestock	expense_livestock	Consumption	profit_total	output_total	assets_total	asset_agri	asset_business	asset_business
Treatment	530.792	−5599.229	215.624	−482.248	932.718	−2186.376	−2.04e+04***	−1291.566	−2287.427**	−724.406
	(4122.31)	(3448.97)	(2676.41)	(495.09)	(7289.92)	(11759.39)	(5883.88)	(885.78)	(1116.24)	(558.31)
Post	−288.966	−5084.762	280.039	1203.831***	12757.852*	26979.452**	−1.90e+04***	−1643.514**	−2287.436**	−401.010
	(3376.00)	(4064.65)	(2487.08)	(459.48)	(6765.24)	(10949.44)	(6934.22)	(823.58)	(914.15)	(519.47)
Interaction	534.848	10049.784*	4809.526	102.621	−4746.169	−2094.336	28503.776***	2217.435*	2708.012**	1394.146*
	(4473.61)	(5583.03)	(3517.09)	(650.62)	(9518.78)	(15421.56)	(9524.56)	(1162.29)	(1211.36)	(733.65)

Standard errors in parentheses, *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

[2]For group numbers on each outcome variable, please see Table 2 for reference.

[3]When observing the heterogenous treatment effect, we will no longer look at the treatment and post. When the post is controlled, treatment and control groups may have differences within the policy implementation. When the treatment is controlled, post groups will have the same effect then.

drought because they think microcredit can compensate for the contemporary loss to some degree. The consumption also has a slight insignificant decrease. We speculate that borrowers may have a lumpy expenditure opportunity that would generate benefits both in the present and the future, which can explain the expense of livestock increase. Some self-employed households may cut their leisure consumption in the short run by spending more time on expanding business, and some may permanently decrease the consumption of temptation goods, reaction, or celebrations. The individual behavior is discretional and may need further psychological and economic evidence to investigate the behavior change. Some political phenomena or natural hazards can also make important. We can compare and contrast more microcredit experiments in other low-income countries to observe the change in behaviors.

2) Asset Shock

Unfortunately, we do not observe any significant results on the interaction effect of expenditure and consumption. There is a slightly significant increase in the expense of livestock for poor people, who have health or house damage incidents and have agriculture or animal husbandry production shock. This proves that microcredit works for people who lose livestock recently. Microcredit helps them to buy livestock to cover the loss. We observe significant changes in consumption and total output if the treatment is controlled in the asset shock subgroup 3, indicating that people rely on solid assets such as houses, livestock, and land.

There is significant growth in the assets total for people who are poor and have a shock on both agriculture and livestock loss. They can largely recover from the shock by buying more assets. There is also a significant increase in business assets for people who have asset loss and fear of not being able to reimburse. There is an insignificant increase in agriculture and business asset for people who are self-employed and have agriculture shock.

3) Women

Women constituted only less than 1 percent of the total number of borrowers. Until the founder of Mohammad Yunus who won the 2006 Nobel Peace Prize gave preference to women in the Grameen Bank, more financial institutions started to provide microcredit to women. The Morocco study did not restrict loans to women exclusively and it did generally require credit agents to have at least 35 percent of women among their clients (Crépon et al., 2015). Economic empowerment was also measured from five domains, financial inclusion, ownership and control of productive assets; household decision making; networking/community activities and perception of self-confidence; and contribution to household expenses (Olajide et al., 2016). The Morocco dataset only provides the expenditure variable so we will consider women's contribution to household expenses as an indicator of female economic empowerment.

In Table 7, there is an insignificant agriculture expenditure decrease in women with self-employment activities and with college or above background. Sub-

group 3 has a really big decrease in agriculture expenditure. There is also an insignificant decrease in agriculture sales and agriculture production for self-employed women with college or above background. We may ignore subgroup 3's insignificant decrease as there are only 15 useful samples for this group of women. Most of the results are insignificant. The female members in the sample age range contribute significantly to the household work, like agricultural work, rearing poultry, and livestock. Thus, variables that have significant meaning are related to agriculture and livestock activities. We observe most sales and expense decreases in women's group varying from being educated or self-employed, this may relate to women's overall social status in Morocco Study.

However, the total assets for the women subgroup do not have any significant change maybe because the empowerment score for women is low as ownership of the assets still resides with husbands. Whatever the wife owns belongs to the husband in Morocco's Muslim culture. Thus, the husband may take away his wife's microcredit and participate in the purchasing behavior by themselves, which can explain the significant drop in female expenditure and the lack of significant change in asset growth in Table 8.

4) Education

In Table 9, total output significantly increases for people who get junior high

Table 7. Regression on women subgroup.

	(1)	(3)	(3)	(2)	(3)	(3)
	expense_agri	expense_agri	expense_livestock	profit_total	sale_agri	prod_agri
Treatment	1010.163	902.500	−0.000	29869.926**	1610.000	2976.250
	(900.54)	(7386.71)	(407.57)	(12069.10)	(2082.43)	(4997.69)
Post	2953.207***	28750.000**	−0.000	18289.973*	6930.000**	17430.000**
	(783.91)	(9449.12)	(521.37)	(10198.07)	(2663.85)	(6393.07)
Interaction	−2058.660*	−2.97e+04*	1825.000**	−3.70e+04***	−8540.000*	−2.04e+04*
	(1116.84)	(13908.72)	(767.44)	(14031.53)	(3921.08)	(9410.34)

Standard errors in parentheses, $*p < 0.1$, $**p < 0.05$, $***p < 0.01$.

Table 8. Regression on women subgroup (asset).

	(1)	(2)	(3)	(1)	(2)	(3)
	assets_total	assets_total	assets_total	asset_agri	asset_agri	asset_agri
Treatment	279.289	−564.749	−0.000	−526.914	−837.446	50.000
	(1869.66)	(4701.47)	(2232.61)	(624.42)	(2167.62)	(60.92)
Post	3352.620**	−440.676	5206.250*	−158.369	−2209.562	387.500***
	(1626.73)	(3942.64)	(2577.99)	(543.57)	(1817.76)	(77.93)
Interaction	−100.066	3956.498	1088.750	272.891	3373.268	−250.000*
	(2317.59)	(5492.54)	(3866.99)	(775.14)	(2532.34)	(114.71)

Standard errors in parentheses, $*p < 0.1$, $**p < 0.05$, $***p < 0.01$.

Table 9. Regression on education subgroup.

	(4)	(1)	(1)	(2)	(4)
	output_total	income_assetsales	Income	inv_total	expense_business
Treatment	−1.69e+04	30.501	4619.706*	0.000	−8784.441
	(11474.19)	(261.60)	(2729.90)	(733.22)	(9173.41)
Post	−7343.101	582.492**	−4865.051*	0.000	−4259.414
	(10522.68)	(240.88)	(2512.31)	(597.84)	(8420.80)
Interaction	30094.528**	−619.295*	−6685.530*	1966.250*	20844.741*
	(15077.71)	(344.65)	(3593.44)	(989.90)	(12028.47)

Standard errors in parentheses, $*p < 0.1$, $**p < 0.05$, $***p < 0.01$.

schooling. Most borrowers go to middle school in the sample, so they respond well to the microcredit policy. People's expenditure on business also significantly increases. While there is no significant evidence to show there is a relationship directly between an increase in assets and the education level.

An increase in household business expenses is associated with a household's education level. It may indicate that the household can invest more in business if they are highly educated. As the total amount of productive assets increases the total amount of business capital of households, the higher total production indicates that that household has more capital to invest in business activities.

5. Conclusion

In this paper, we measure the impact of access to microcredit in remote rural areas in Morocco. We identify the DID estimation to evaluate the average household average treatment effect and treatment effect in heterogeneous treatment groups. We provide a possible explanation for an individual's behavior change after taking up microcredit. We also investigate the transformative force behind the heterogeneous subgroups.

In the average treatment effect study, we find that income and consumption have an insignificant decrease in the overall group. There is an expansion in the agriculture and animal husbandry self-employment activities. In the heterogeneous treatment effect study, we also find an insignificant decrease in income and consumption. We do not find any significant increase in income and consumption in the selected heterogeneous subgroups. But Crépon's Morocco study shows that there is an income increase in some percentile of households, so our heterogenous subgroups are not able to explain all heterogeneity that existed in the whole experiment population.

While we do find some interesting results in the subgroup study. In the case of self-employed people, they are less risk-averse when confronted with shocks resulting in vulnerability. Their consuming behavior is less stable as they tend to save more currently and invest more in the future or vice versa. As a result of microcredit, self-employment activities can be developed with greater freedom

in a variety of situations; in the case of asset shock, we fail to find any significant evidence maybe due to the data collection. Having a comprehensive study of how microcredit improves people's lives after suffering a shock may require more consideration of the availability of natural resources in the processed data. But we find that these groups of people are able to recover from the loss; as a result of women's decline in expenditure and profit, we find that the underlying unequal decision power may be due to the religious reason. For some self-employed women, their expenditure on agriculture decreases maybe because they invest more time and effort in the business environment rather than agriculture or animal husbandry production. Finally, in the case of education, we find that higher educated people are more sensitive to business activities. Although there is an insignificance impact, we can still conclude that educated people know how to finance the microloan well and mostly utilize it in assets investment or business so that their total output grows largely.

As our results can not exactly explain microcredit on targeted groups of people, we need to adapt the simple OLS model, the heterogeneous subgroup, and conduct the robustness check on independent variables in the future. We can also include Instrumental Variable (IV) estimation in the Difference in Difference (DID) model to evaluate when a treatment is not successfully delivered to individuals.

Regardless, microcredit is a powerful financial instrument for the poor although it has limited transformative force to help households exit from poverty, at least in the medium run (two years after the introduction of the program) (Banerjee et al., 2015). We should also observe the impact in the longer term. Rawls proposed that there can be no social justice in a society unless all institutions operate fairly. However, people are born unequal. To reduce inequality, we can try to open up fair and just opportunities to people just like most Marxists have given support to redistributive policies in the capitalist economy. In light of the aforementioned findings, we could provide free education and healthcare, and ensure the rights of women and children in order to increase the impact of microcredit on this group. The significance of heterogeneity reminds us of the flaw of the average utility in the social justice system, according to Rawls. That is, the necessity of conducting heterogeneous treatment effects will play an important role to efface the antipoverty policy. Policymakers should work hard to the unequal discrepancy by considering the impact on different groups of people.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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