Empowering Women through Microfinance in Djibouti

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Empowering Women through Microfinance in Djibouti

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Abstract

Women's empowerment is crucial to improve their political, social, economic, health and sanitary situation. This paper estimates the effect of microfinance on women's empowerment in Djibouti. Using cross-sectional data of 692 households based in Djibouti's six major centres Djibouti-ville, Arta, Ali-Sabieh, Dikhil, Obock and Tadjourah, we construct original measures of women's empowerment index covering three dimensions (economic, social and interpersonal). We examine the extent to which access to microfinance, amount of loans obtained and their duration modifies women's status at home. Employing the instrumental variables (IV) estimations and a number of econometric techniques as robustness checks, we find a significantly positive association between microcredit and women's empowerment. Households with access to loans from MFIs are respectively 35.4%, 30.9% and 10.1% more likely to be economically, socially and interpersonally empowered. The effect of access to microfinance and the number of loans is also significant. However, women who took four or more loans from microfinance institutions are 27.7%, 23.5% and 6.8% less likely to be economically, socially and interpersonally empowered. The results of the study confirm generally positive socioeconomic effects of microfinance programmes.

Keywords: Women's empowerment; Microfinance; Instrumental variables (IV) ; Djibouti.
JEL codes: I3, C8, O1

1. Introduction

Empowering women's role in society has been one of the top priorities of development agencies and governments around the world, and there is no exception for the East African nation like Djibouti. Even in developed countries, women continue to suffer various forms of discrimination in one way or another, specifically gender inequalities. One of the reasons for these inequalities' persistence lies in the gender norms that subject women in developing countries (Agarwal 1994, Sullivan 1994). Patriarchy and traditional cultures in Africa give men more resources and power, resulting in women's lack of access to education, health, and labour markets. Agricultural diversification in Kenya has led to greater male involvement in agriculture, which has eroded women's control over income-generating production and their relative power within the household (Dolan 2001). Women's empowerment in the development process has been seen as achieving a 'better deal' for women, with the main focus being on women's well-being (Sen 2000).

In Djibouti, according to the National Gender Policy in 2011-2021, women are more affected by extreme and relative poverty and more affected by inactivity than men. They are more numerous than men in the informal sector. Women have also faced limited access to financing (from banks and microfinance institutions), mainly due to the lack of bankable projects, the inexistence of financial accounts and the difficulty of providing sufficient guarantees. In response to these challenges, Djibouti's government adopted a ten-year policy to consolidate its commitment to gender equity and equality in all economic and social areas.

Among various mechanisms suggested to promote female empowerment, improving access to microfinance is regarded as a promising policy mechanism in Djibouti. The introduction of microfinance had existed since the 1990s through some associations such as CARITAS, but it was only institutionalized in 2000 with the establishment of the Social Development Fund (SDF). Since 2004, the government has enshrined microfinance development as a critical axis in the Strategic

Framework for the Fight against Poverty (named in French, Cadre Stratégique de Lutte contre la Pauvreté - CSLP). By 2007, the National Initiative for Social Development (INDS) reaffirmed microfinance as a privileged instrument for poverty reduction in 2007. The public authorities aimed to eventually structure an efficient network of local microfinance institutions covering the entire territory and capable of providing financial and non-financial services adapted to the most disadvantaged needs. In 2008, the Djiboutian Social Development Agency (ADDS) entirely dedicated to microfinance in charge of controlling the Caisses Populaires d'Epargnes et de Crédit (CPEC). The latter has benefited from donors such as the Islamic Development Bank (IDB) and the African Development Bank (ADB), who allowed it to create branches in the interior regions and increase the volume of credit granted to its members.

Djibouti's financial system remains dominated by the banking sector. The microfinance sector is growing in Djibouti, but access to financing remains very limited. The non-bank financial corporations sector consists of three microfinance institutions, one specialized credit institution, 19 exchange and money transfer bureaus and two insurance companies. There are two social security and pension funds in Djibouti (the Caisse Nationale de Sécurité Sociale and the Caisse de Retraite Militaire) as national social security entities (IMF 2019). However, developments in the financial sector help diversify the offer of financial products, provide the services to the customers, and facilitate access for disadvantaged populations to local financial products and services suitable for them.

In recent decades, the debate on the effectiveness of microcredit on women's autonomy or empowerment has remained inconclusive. On the one hand, numerous studies have highlighted many negative consequences, both within households and on a larger scale, such as men's control over women's loans and businesses (Montgomery et al. 1996, Garikipati 2008, Goetz and Gupta 1996, Rahman 1999), an increase in domestic violence and patriarchal domination through the control of loan

officers (D'Espallier et al. 2011, Rahman 1999) and increased responsibilities, workload and fatigue among women (Akerly 1995). The failure of microfinance services is also linked to high-interest rates, non-productive use of loans, over-indebtedness, often landless customers and intergenerational migration (Chhorn 2020), disparate treatment of men and women in lending conditions (Agier and Szafarz 2010) and the exacerbation of inequalities between women (Guérin and Palier 2005, Mayoux 2001, Pattenden 2010, Rankin 2002, Rao 2008, Wright 2006). On the other hand, microfinance's careful practice can improve women's empowerment. Some studies have argued that microfinance empowers women, as measured by indicators such as access to consumption, health care, improved decision-making power, increased spatial mobility, access to the property and reduced domestic violence (Pitt and Khandker 1996, Hashemiet al. 1996), while randomized studies yield negligible results (Banerjee and Duflo 2011).

This study aims to provide empirical evidence on the relationship between microfinance and women's empowerment in Djibouti using the household surveys conducted in 2015 among 2,060 households in Djibouti's six major urban centres, including Djibouti city, Arta, Ali-Sabieh, Dikhil, Obock and Tadjourah.

The study contributes to the literature in several ways. Firstly, it investigates whether participation in the microfinance program helps empower women by improving their economic, social and interpersonal status. We created a composite indicator of women's empowerment using three dimensions of autonomy: economic, social and interpersonal. In this regard, microfinance's impact on women's autonomy is analysed in several dimensions: the impact of the acquisition of microcredit by households, the number of loans contracted with microfinance institutions, and the duration since the acquisition of the loan. Secondly, several empirical strategies are employed to deal with problems of selection bias and endogeneity. The microfinance indicator is instrumented using the information on women's membership in a savings and credit cooperative. Although obtaining

microcredit is compulsory, membership is free, widely acquired and open to a broad segment of society, such as households (poor and rich), small businesses and associations. Over half (58 per cent) of women members of credit unions eventually obtain microcredit. Finally, the estimates are structured using alternative estimations as robustness checks, including propensity score matching (PSM), inverse-probability weighting (IPW) and augmented inverse-probability weighting (AIPW).

The next section of the paper presents a brief review of the literature on microfinance and women's empowerment. Section 3 describes the microfinance sector and women's status in Djibouti. Section 4 presents the data and methodology used. The results are presented and discussed in section 5. Robustness measures are described in section 6. The final section concludes the article.

2. Literature review

Al-Mamun et al. (2014) provide a comprehensive survey on the microfinance and women's empowerment literature. They defined women's empowerment in several dimensions, including women's role in the household economic decision, economic security, control over resources, control over the family decision, mobility, and awareness of legal rights. However, the impact of microcredit on women's empowerment remains inconclusive. Kabeer (2001) explores why recent evaluations of the empowerment potential of credit programs for rural women have arrived at very conflicting conclusions.

While some studies point to the positive effect of microfinance on women's roles, see for example, Berger (1989), Naved (1994), Khandker, and Cartwright (2003), Pitt, Khandker and Cartwright (2006), Chhay (2011), other studies confirm that if microfinance is linked to the harmful practice of high-interest rate, non-productive loan, over-indebtedness, landless and migration, its effect is associated with the worse outcome on women's empowerment (Chhorn 2020). Small loans allocated to women are usually controlled by their spouses, which results in more

severe subordination of women and leaves them more vulnerable to the patriarchal system within the household and society (Li, Gan and Hu 2011 239). Using both qualitative and quantitative methods, Goetz and Gupta (1996) suggested that a preoccupation with credit performance, measured primarily in terms of high repayment rates, affects the incentives of fieldworkers dispensing and recovering credit, in ways which may outweigh concerns to ensure that women develop meaningful control over their investment activities. Leach and Sitaram (2002) explained that women's micro-enterprises were unlikely to have been viable commercially. The project insisted that the women operate as a group in a high-risk area of economic activity, with no clear strategy as to how their work could sustain. Garikipati (2008) showed that lending to women benefits their households from the impact evaluation studies. However, it found that It may not empower the women. Loans procured by women often diverted into enhancing the household's assets and incomes. It combined with a woman's lack of co-ownership of the family's productive assets. If empowering women is a crucial objective, then the patriarchal hold on productive assets must be challenged. The most recent study in Bangladesh by Dutta, and Banerjee (2018) argued that easy access to credit through microfinance initiatives could not inculcate the psychological potential to bear risk and bricolage among the borrowers. Without much innovation and risk-taking, self-employment in micro-enterprises has been the characteristics of the overall income-generating process of the model.

On the one side, rising access to microfinance may result in women's higher empowerment. Using fieldwork conducted in the Aoral district of Cambodia in April 2008, Chhay (2011) found this positive relationship. The concept of microfinance through its main component, microcredit, remains an influential tool for income generation, human resource development, poverty reduction and women's empowerment. Access to credit can be an essential tool for the poor to safeguard their food security. Traditional banks and other financial institutions fail

to address the poor's difficulties in general and women (Kessey 2005). Using the data from a survey carried out in rural Bangladesh in 1998-99, it found that women's participation in micro-credit programs increases women's empowerment. Credit program participation leads to women taking a more significant role in household decision-making, and enjoying greater access to financial and economic resources, more outstanding social networks, greater bargaining power than their husbands, and greater freedom of mobility (Pitt, Khandker and Cartwright 2006). Al-Mamun et al. (2014) argue that participation in AIM's microcredit program generated a positive and significant impact on women's empowerment in Urban. It is in accord with many other studies, see, for example, Berger (1989), Naved (1994), Hashemi, Schuler, and Riley (1996), Amin and Pebley (1999), Kabeer (2001), Khandker, and Cartwright (2003).

It is worth noting also that the relationship between microfinance and women's empowerment also comes from the inverse direction, which gender drives microfinance, see, for example, D'espallier, Guerin and Mersland (2013). Using a panel dataset of 398 Microfinance Institutions (MFIs) operating in 73 countries worldwide from 2001 to 2010, the study found that a focus on women is associated with group-lending methods, international orientation, smaller loans, and non-commercial legal status. A focus on women significantly improves repayment but does not enhance overall financial performance because of higher relative costs. Moreover, the higher relative costs do not stem from servicing women per se but from the smaller loans offered to women and the group-lending methodology practised by MFIs focusing on women.

3. Women's role and microfinance in the Djiboutian society

3.1. Women's role in Djiboutian society

Following the Millennium Development Goals (MDGs) of the United Nations, Djibouti's government set the women's empowerment as one of the government's

priority policy. The policy also focused on education, particularly the universal primary education, promoting gender equality and improving maternal health. The creation of the Ministry of Women and the Family has contributed to significant progress. For example, we could observe a significant increase in the literacy of women aged 15-24 years old, effective integration into the decision-making sphere and a significant drop in mortality rates. According to the National Gender Policy in 2011-2021, other policies relating to empowering women aim to diversify women's economic domains, facilitating their access to drinking water and energy in rural areas, supporting them in terms of resources and assets (capital and land production techniques, market and transport) and promoting women's entrepreneurship.

Despite these efforts, women's role in Djibouti's society remains much restricted compared to the men in reality. According to the National Gender Policy 2011-2021, Djiboutian women still struggle with poverty, less education, less healthcare, and face inequality in many perspectives. Women are more affected by extreme and relative poverty and more touched by inactivity compared to men. The feminization of poverty is associated with women's disadvantage in education, access to economic opportunities, employment and property ownership. According to the Djibouti survey on employment, informal sector and household consumption (EDESIC) carried out in 2015, women are more numerous in the informal sector and struggle with gender inequality. The informal sector is the leading provider of employment, especially in urban areas. According to the Ministry of Women and the Family of the Government of Djibouti 2019, this situation translates into women's more limited access to accounts in financial institutions and, consequently, to bank credit and micro-financing. The main reasons are the lack of bankable projects, the absence of financial accounts and the difficulty of providing sufficient guarantees.

According to the last update data from the Djibouti household survey on social indicators (EDAM4-IS) and the Djibouti National Statistical Institute in 2017, women suffer nearly twice from unemployment than men. The literacy rate is higher

among men, with 20 points compared to that of women. The study on the evolution of women's situation in Djibouti 2000-2018 shows that, in terms of access to health, women acknowledge that their health status has improved; however, several health service concerns remain. For instance, payment for care and medicines are obstacles for disadvantaged households, and there is a lack of midwives and gynaecologists. The active participation of rural women in Djibouti is also hampered by limited labour force participation, immobility, income disparity and lack of decision-making opportunities. Women in Djibouti are also facing violence, a significant problem in the region and the whole country.

3.2. Microfinance in Djibouti

Djibouti's microfinance sector started in the 1990s, pioneered by associations such as Caritas to reduce poverty and stimulate economic development. The most significant experiences in the field of microfinance in the country are related to 2007. Since then, the sector has experienced remarkable growth and, at the end of 2010, it is entering its expansion phase, due to its amplification in rural areas. The establishment of CPECs in the interior regions has contributed to the consolidation of this initiative to cover the entire country. In addition, their principles, mission is to allow the most destitute excluded from the classic banking system, and to allow has their dispositions of the multiple financial services such as the saving (saving to sight (not remunerated), saving to term), and the credit (microcredit, credit to the consumption, individual or collective credits).

Female beneficiaries have a higher percentage than male beneficiaries in Djibouti, Tadjourah, and Ali-sabieh. Indeed, women's access to credit is higher than men's (Figure 1). At the other end of the spectrum, credit served has seen a strong concentration in the capital Djibouti (Figure 2).

The credit recipient population has mainly composed of women (70.8%) and includes a significant proportion of widows/divorced (18.1%). In 2017, CPECs have collected more than 206 million Djibouti francs (DF) in savings and distributed

outstanding loans equivalent to 107 million Djibouti francs (DF) (Ministry of Women and Family, 2017).

Figure 1: Evolution of CPEC (Credit Unions) members by region at the end of 2016
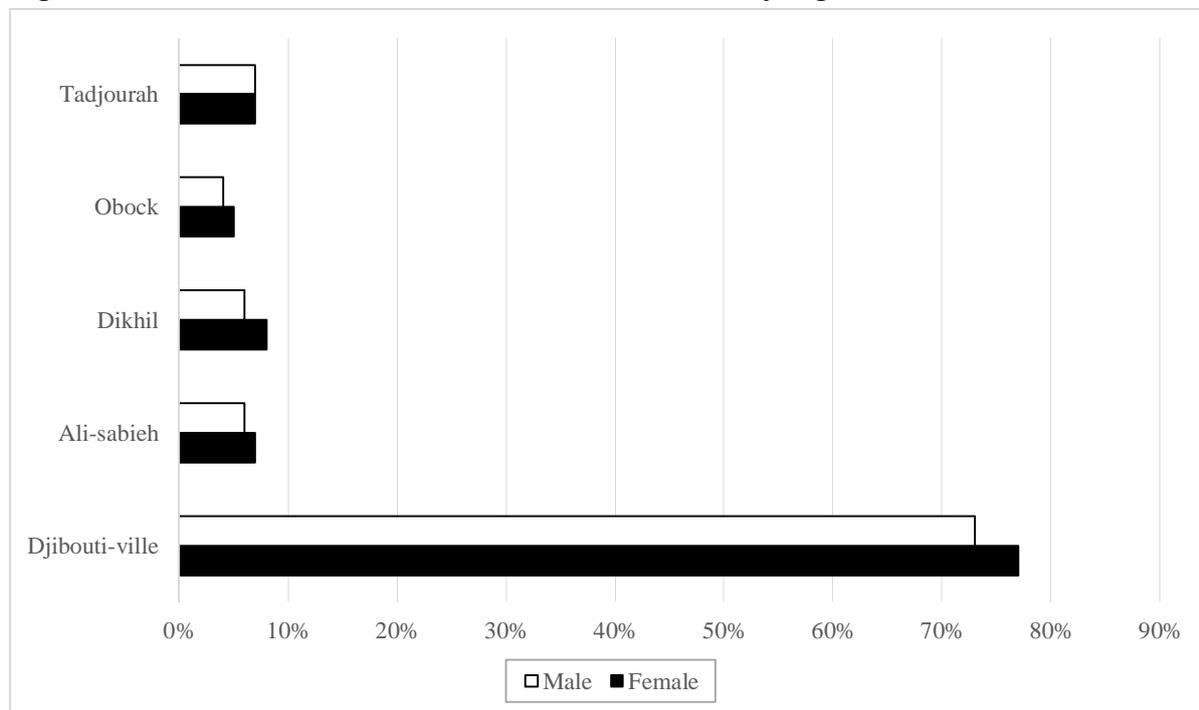

Source: The data set is taken from Djibouti Social Development Agency (ADDS) in 2015

Figure 2: Cumulative credits granted between 2011-2016 (in millions of Djibouti francs)
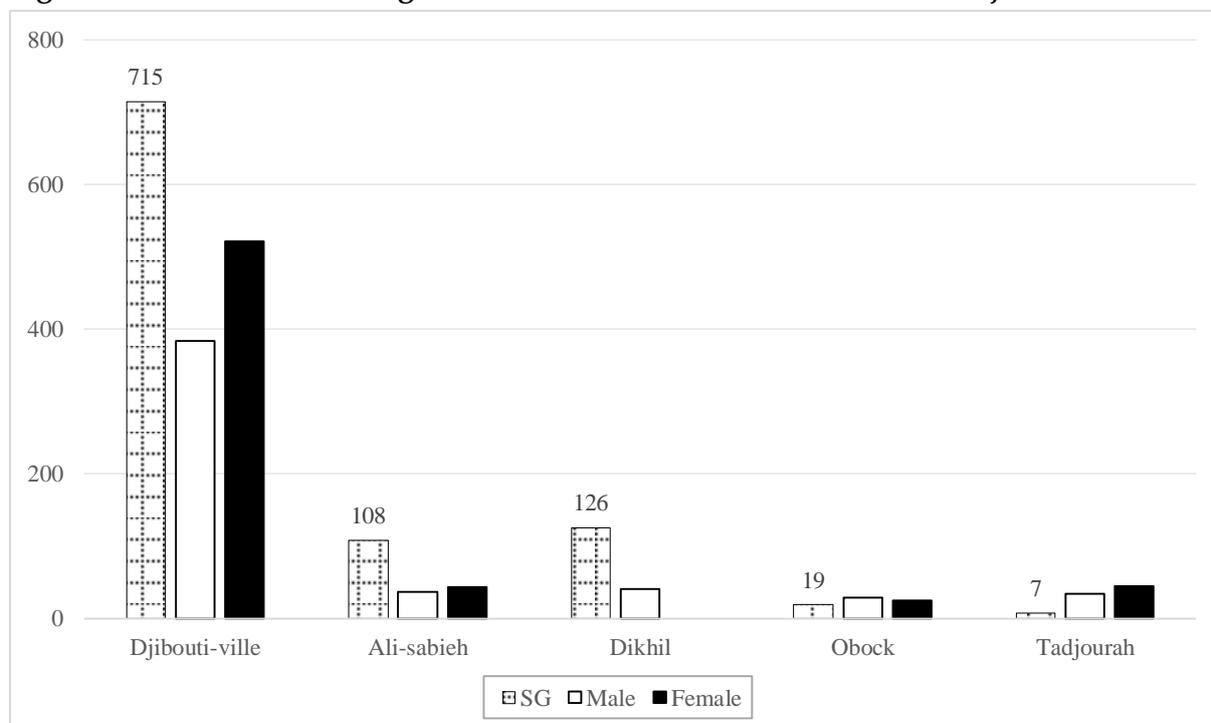
Source: ADDS 2015

4. Data description and empirical methodology

4.1. Data and survey description

This study uses the survey of the PREPUD in 2015, which is conducted by the Djiboutian Agency for Development (ADDS) and the Institute of Statistics of Djibouti (INSTAD). It covers all major regions in the country, including the capital, Djibouti City, and the five regional capitals of Arta, Ali-Sabieh, Dikhil, Obock and Tadjourah.

The survey, covering 2,060 households, contains a wide range of information on education, employment, access to basic social services and microfinance. In this study, we limit the sample to only 692 women, who may or may not have benefited from microcredit or microfinance institutions (women who answered 'Yes or No' to the question 'Is at least one member of the household a beneficiary of a microcredit?'). The detailed information and descriptive statistics of the dependent variable, variable of interest, and controls are presented in Table 3.

4.2. Variable description

A- *Dependent variable: women's empowerment index*

Even though women's empowerment is a much-researched topic in development economics, there is no universally agreed definition of the term (Malhotra & Schuler, 2005). For example, Sen (1993) viewed empowerment as ''altering relations of power which constrain women's options and autonomy and adversely affect health and well-being''. Keller and Mbwewe (1991) defined it as ''a process whereby women become able to organize themselves to increase their own self-reliance, to assert their independent right to make choices and to control resources which will assist in challenging and eliminating their own subordination''. According to Kabeer (1999), ''empowerment is the expansion in people's ability to make strategic life choices in a context where this ability was previously denied to them''. The ability needs to improve on three inter-related dimensions: resources

Table 3: Data and variable description

Variable	Definition	Mean
Dependent variable		
Women's empowerment	A composite index measure women's control cover various aspect of their lives and environments. It includes household decision-making, control over income, asset ownership and media exposure, and health domain. From these dimensions, women are grouped into two categories: 1. if the woman is empowered, 0 otherwise.	0.42 0.58
Economic empowerment	Dummy variable, takes the value of 1 if the female is empowered economically, 0 otherwise.	0.39 0.61
Social empowerment	Dummy variable, takes the value of 1 if the female is empowered socially, 0 otherwise.	0.11 0.89
Interpersonal empowerment	Dummy variable, takes the value of 1 if the female is empowered interpersonally, 0 otherwise.	0.41 0.59
Variables of interest		
Loan access	1 if the household has outstanding loan last three year, 0 otherwise.	0.44 0.56
Amount of loan	Continuous variable corresponds to the total of amount of outstanding loan for the last three years.	96,185
Multiple loans	Dummy variables, takes the value of 1 if the female acquired the loan more than four times, 0 otherwise.	0.34 0.66
Numbers of loans	Continuous variable corresponds to the number of loans taken by the households for the last three years.	1.29
Duration	1 if the household has participated in the program more than three years, 0 otherwise.	0.69 0.31
Control variables		
Age	Age of the female (in years).	49.35
Marital status	1 if the female is married, 0 otherwise.	0.74 0.26
Women employed	Dummy variable, takes the value of 1 if the female is employed, 0 otherwise.	0.42 0.58
Women education	Categorical variable, takes the value of 1 if female has primary or no education, 2.secondary level and 3. Higher education.	0.36 0.53 0.11
Region	Categorical variable, takes the value of 1 if the female lives in : 1.Djibouti, 2. Ali-sabieh 3. Arta, 4. Dikhil, 5. Obock and 6.Tadjourah.	0.16 0.25 0.16 0.16 0.13 0.14
Region dummy	Binary variable takes 1 if head lives in Djibouti, 0 otherwise.	0.25 0.75
Household size	Number of household members.	1.68
Dependency ratio	Ratio of household members under age of 15 years or over 60 years to total members.	16.17
Wealth status	Categorical form, takes the value 1 if female in poorest,	0.06

	2 if is poorer,	0.58
	3 if is middle,	0.25
	4 if richest otherwise.	0.10
Instrumental variable		
Membership	1 if the female has membership for at least one month, 0 otherwise.	0.37 0.63

(access to and claims over material, human and social resources), agency (processes of decision making), and achievements (well-being outcomes).

In this study, we construct a composite indicator of women's empowerment that measures women's control over various aspects of their lives and environments, such as participation in household decisions, control over income, asset ownership, media exposure, and health. The constituent indicators of the index are listed in Table A1 in the Appendix. Saha and Sangwan (2020) also include political awareness, attitude towards domestic violence, and family planning in their empowerment index. In our study, however, we could not include these three dimensions due to the limitations of the survey design. The index is generated using Principal Component Analysis (PCA). PCA is a multivariate statistical procedure used to reduce the number of variables in a data set into a smaller number of components so that variations in the data can be accounted with the greatest accuracy (Vyas and Kumaranayake, 2006). PCA transforms original variables into uncorrelated indices, where each component is a linear weighted combination of the original variables. Based on the index, women are grouped into two categories, namely: autonomous and non-autonomous. Women who are classified as autonomous are able to make important decisions such as buying or selling land, repairing houses, participating in, and strengthening income-generating activities. They can also exercise their right to control and benefit from resources while improving their economic status and well-being.

Kabeer (2001) provide a comprehensive concept of women's empowerment, considering three dimensions of autonomy at the economic, social and interpersonal levels. Economic autonomy is the ability of women to participate in and benefit from

growth processes in a way that recognizes the value of their contributions respects their dignity and enables them to negotiate a more equitable distribution of the benefits of growth. It increases women's access to economic resources and opportunities, including jobs, financial services, property and other productive assets, skills development and market information. A woman also needs confidence and social skills to translate options into practical action, which is considered social autonomy. It is closely linked to women's access to public spaces and mobility in the community. To develop and maintain their position in a community, women must engage socially, for example, by participating in community meetings and events and forming their networks. It will improve their social trust, access to public information, and influence social norms, which will ultimately bring a strategic advantage to society. Interpersonal autonomy is a process of internal change, which focuses on a woman's sense of belief in her decision-making abilities. For example, attitudes and perceptions reflect internal transformation and empower women (Kabeer, Mahmud and Tasneem, 2011).

As shown in Map 1, the rate of women's empowerment is high in the regions surrounding Djibouti's capital city, namely Tadjourah and Arta, compared to other regions. These regions provide more access to knowledge, education, and job opportunities. On the top, in Tadjourah, 52.5% of the surveyed women enjoy greater autonomy. This high rate of autonomy has been recognized for a long time. The social organization known as fiqma[1] ensures freedom and autonomy to participate in social events. These women gain more autonomy from the opportunities offered by the public authorities through the microfinance institutions that provide for the most destitute's needs by granting credit. In Arta, 51.5% of the women surveyed enjoy an advantageous degree of autonomy, which can be explained by the fact that the city's

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[1] The term 'figma' means an organization of age groups in women play a crucial role. This organization is not new but has existed for a long time. Their objective is to help women take their 'destiny in hand' while promoting their initiatives such as crafts, entrepreneurship and all other opportunities to participate more in social events.

proximity to the capital (Djibouti City) encourages them to invest in activities such as catering and the sale of khat[2], which remains minimal compared to other regions.

This high rate of empowerment is explained by women's better skills, who also participate in household decisions.

The surveyed women from the capital Djibouti City had a favorable level of autonomy. In Djibouti-City capital, 43% of the surveyed women are self-sufficient. Most of the women in the capital are charcharis[3] who supply Djibouti's markets with various goods from neighboring countries and the Gulf. They are also khat sellers, manual money-changers, and sellers of doughnuts, sweets, and clothing. Many of their activities are facilitated by the microcredit funds of which they are the primary beneficiaries.

In Dikhil and Ali-sabieh, the southern regions, 40% and 41% of the women are empowered. Although these two regions remain landlocked, they are heavily dependent on road traffic from Ethiopia. The two regions in question are also experiencing a significant flow of immigration from neighboring countries (Somalia and Ethiopia) accompanied by strong urbanization of the population. In the south of the country, women are more numerous in trading activities, especially in khat and

non-khat retail. In contrast, only 21% of the women surveyed in Obock are autonomous. It is primarily because not all of them could participate in women's activist organizations, which leads to a lack of awareness and information. Although these women have access to institutional sources of credit, the loans taken out are not for productive purposes but rather for consumption or to meet primary needs.

B- *Variables of interest*

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[2] 'Khat' is a plant widely consumed by the people and heads of states in the Horn of Africa (Djibouti, Somalia and Somaliland), where the leaves are chewed and provide stimulant effects to its consumers. In the European Union, khat is considered a narcotic drug. Ethiopia and Kenya are the two major khat growers in the region.

[3] Shopkeepers in the Somali language.

Figure 3: Empowerment rate of female households by region.

Legend	
■	[51.97 - 52.48]
■	[47.24 - 51.97]
■	[41.94 - 47.24]
■	[40.43 - 41.94]
■	[30.71 - 40.43]
■	[21.43 - 30.71]
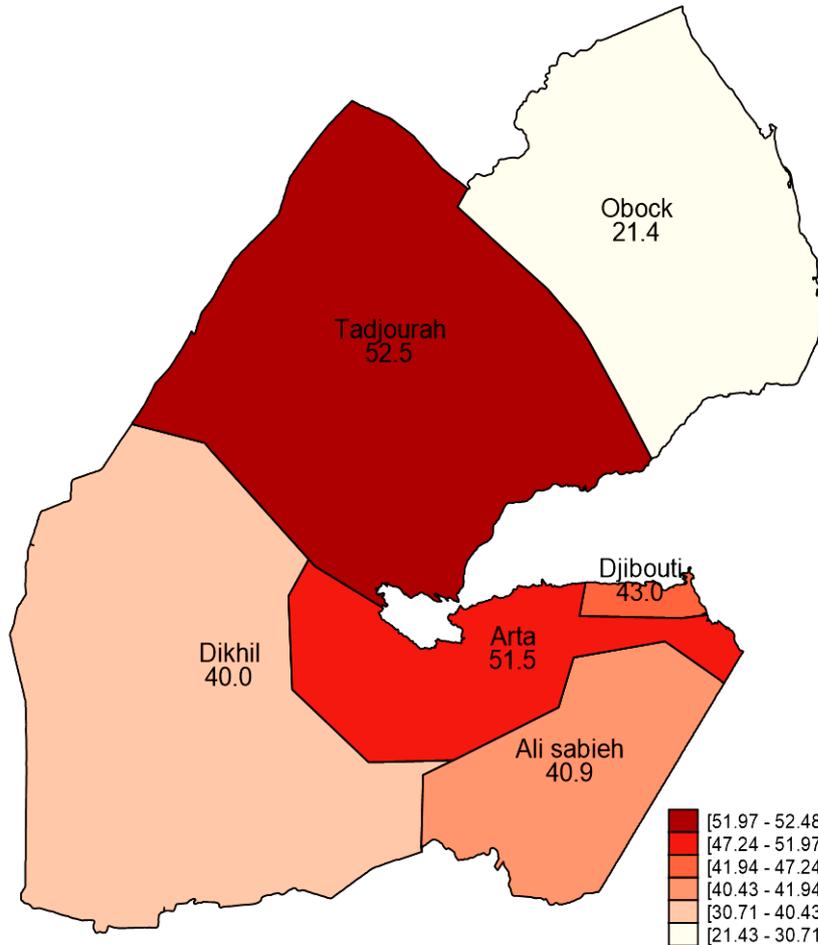
Source: Dataset from the survey of the PREPUD in 2015 by the ADDS and the INSTAD.

We use a set of variables of interest: (i) participation in the microfinance program, a binary variable indicating whether or not the household has received a loan from a microfinance institution, (ii) loan amount, which is the total amount of the outstanding loan, (iii) the number of loans taken out by households in two ways: (a) as a binary variable, i.e. whether or not women take out loans four or more times; (b) as a continuous variable, which corresponds to the number of loans taken out by households in recent years, and (iv) the duration of participation in the microfinance programme is whether or not women have participated in the programme for three years or more.

As shown in Table 3, approximately 44% of women borrowers use microcredit offered by formal financial institutions (CPECs in Djibouti, North and

South), while the remaining 56% take out microcredit from informal lenders (friends, shopkeepers, employers and others).

Moreover, as shown in Map 2, female borrowers concentrate in the regions outside Djibouti City's capital. Women beneficiaries in the northern regions (Obock and Tadjourah) represent 52% and 47% participation rate in the programmes, which is the highest rate at the national level. The southern regions (Dikhil and Ali-sabieh) have a participation rate of 46% and 41%, which are still far behind the northern regions. Female borrowers from the capital Djibouti City and its neighbouring regional capital represent the lowest. Comparing the empowerment rate, as mentioned above, women from higher empowerment regions seems to less access to microfinance.

C- Control variables

The control variables used in the study cover the household's sociodemographic characteristics: age of the head of the household, marital status, education or schooling levels, geographical regions, household size, economic status (extremely poor, poor, moderately poor and rich) and the ratio of women.

Table 3 shows that 59% of married women have taken out loans from micro-finance institutions, 80% of them benefiting from microcredits are illiterate, 9% having reached primary school level, 11% having secondary school level and above, and 29% benefiting from the loans are from the capital city. The majority of (71%) are from the interior regions, Ali-Sabieh, Arta, Dikhil, Obock and Tadjourah, while 6% of them in the extremely poor categories can benefit from microcredits.

4.3. Empirical methodology

In this study, the relationship between microfinance and women's empowerment, defining the latent variable $Women_i^*$ directly, such that the probit model is structured as follow:

Figure 4: Access to microfinance by region
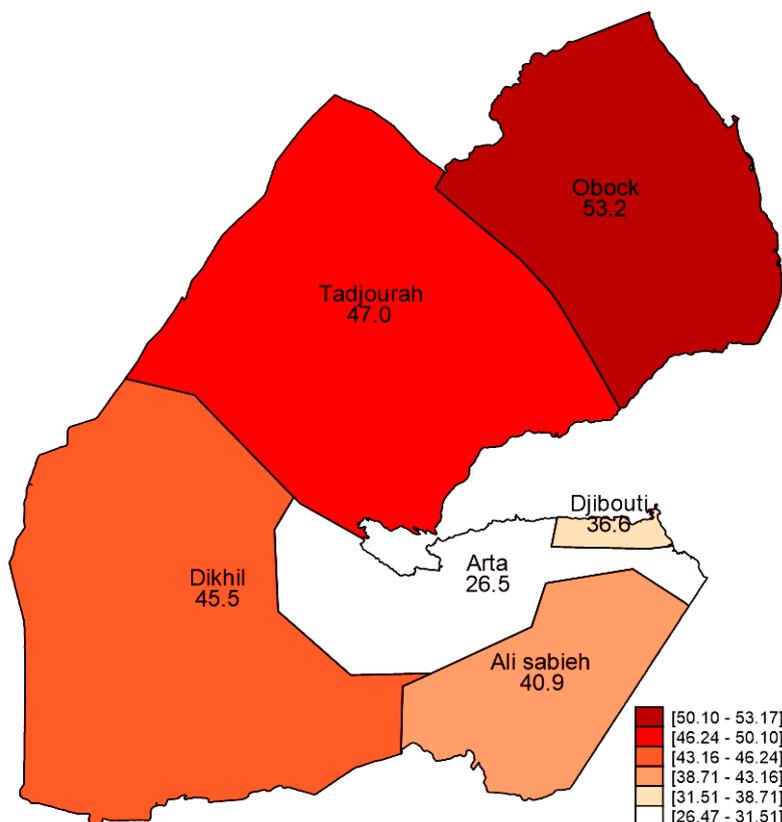
Source: Dataset from the survey of the PREPUD in 2015 by the ADDS and the INSTAD.

$$Women_i^* = MFI_i\beta + X_i\alpha + \varepsilon_i \tag{1}$$

$$\varepsilon_i \sim NID\ (0,1)$$

$$Women_i = 1\ if\ Women_i^* > 0$$

$$Women_i = 0\ if\ Women_i^* \leq 0$$

Where $Women_i^*$ defines the women's empowerment index, taking 1 if the women is empowered and 0 otherwise. We also define in the same way the indices for economic empowerment, social empowerment and interpersonal empowerment. MFI_i is vector of microfinance indicators. X_i is a set of additional controlled variables, which are assumed to be exogenous and may influence the women's empowerment. ε_i is error term and independent of all explanatory variables. In the

probit model, function is a standard normal distribution function. β and α are the coefficients of the parameters, which estimated by the method of maximum likelihood.

According to Verbeek (2004), Amemiya, (1981, 1984), Maddala (1983), Lee (1996), Franses and Paap (2001) and Wooldridge (2002), the likelihood contribution of observation i with $Women_i = 1$ is given by $P\{Women_i = 1|MFI_i\} = 1$ as a function of the unknown parameter vector β, and, similarly for $Women_i = 0$. The likelihood function is estimated as follows:

$$L(\beta) = \prod_{i=1}^{N} P\{Women_i = 1|MFI_i; \beta\}^{y_i} P\{Women_i = 0|MFI_i; \beta\}^{1-y_i} \qquad (2)$$

Then it is estimated with the log likelihood function and substitute $P\{Women_i = 1|MFI_i; \beta\} = F(MFI_i'\beta)$ we obtain:

$$log\ L(\beta) = \sum_{i=1}^{N} Women_i\ logF(MFI_i'\beta) + \sum_{i=1}^{N}(1 - Women_i)\log(1 - F(MFI_i'\beta)) \qquad (3)$$

We then estimate with the first order condition of the maximum likelihood problem. Differentiating with respect to β yields:

$$\frac{\delta log\ L(\beta)}{\delta \beta} = \sum_{i=1}^{N}\left[\frac{Women_i - F(MFI_i'\beta)}{F(MFI_i'\beta)(1 - F(MFI_i'\beta))}F(MFI_i'\beta)\right]MFI_i = 0 \qquad (4)$$

According to Verbeek (2004), the first order conditions say that each explanatory variable should be orthogonal to the generalized residual (over the whole sample). This is comparable to the OLS first order conditions, which state that the least squares residuals are orthogonal to each variable in MFI_i.

The solution of equation (4) is the maximum likelihood estimator β. From this estimation, we then calculate the probability that $Women_i = 1$ for a given MFI_i. The probit model specifies the conditional probability:

$$p = \phi(MFI_i'\beta) = \int_{-\infty}^{MFI_i'\beta} \phi(z)dz \qquad (5)$$

$$p = \int_{-\infty}^{MFI_i'\beta} \frac{1}{\sqrt{2\pi}}exp^{-0.5(MFI_i'\beta)^2}dz \qquad (6)$$

Where $\phi(.)$ is the standard normal cdf, with derivative $\phi(z)$ which is the standard normal density function. The probit model marginal effect are:

$$\frac{\delta p_i}{\delta MFI_{ij}} = \phi(MFI_i'\beta)\beta_j \tag{7}$$

From the equations (1), the estimated results may face the treatment endogeneity effects. We therefore address the treatment endogeneity effects with the instrumental variables. Rationally, the orthogonality of instruments to the error term requires that they be uncorrelated with omitted variables so that, when we are interested in the effect of MFI_i on $Women_i$, and Z_i is an instrument, then Z_i can only affect $Women_i$ through its effect on MFI_i, and not through any other mechanism (Deaton 2019).

In this paper, our instrumental variables include membership in a credit union. Chang and Mishra (2008) use national identity cards, which are required to access formal loans, as the instrument. This instrument's logic is as follows: to be eligible for microcredit, one must be a cooperative credit member such as the CPECs. Members can open a savings account, which is then used to obtain the microcredit. The member can borrow up to one million Djiboutian franc (FD) of which 20% is necessary to be present in the savings account. Membership is free and open to individuals (men, women, poor, non-poor, young people) and legal entities (associations, other groups, small businesses). There is no statistical difference between members according to these criteria, indicating that any association with women's empowerment (if any) can only go through the microfinance indicator, the instrumented variable.

Therefore, we can transform the *probit* model with continuous endogenous regressors, applying with stata commend *ivprobit*, as follows:

$$Women_i^* = \beta X_i + \alpha MFI_i + \varepsilon_i \tag{8}$$

$$MFI_i = \gamma X_i + \xi Z_i + \eta_i$$

Where, Z_i is $1 \times z$ vector of additional instruments. By the assumption, $(\varepsilon_i, \eta_i) \sim N(o, \sigma)$, where σ_{11} is normalized to one to identify the model. ξ is matrice of parameters. (ε_i, η_i) is independent and identically distributed multivariate for all i. The equation $Women_i$ is observed then:

$$Women_i = \begin{cases} 0 & Women_i^* < 0 \\ 1 & Women_i^* \geq 0 \end{cases} \qquad (9)$$

For the equation (9), the Wald test of the exogeneity of the instrumented variables is applied. If the test statistic is not significant, there is not sufficient information in the sample to reject the null that there is no endogeneity. Then a regular *probit* regression may be appropriate. The point estimates from *ivprobit* are consistent, though those from *probit* are likely to have smaller standard errors (StataCorp 2013). Finally, the minimum chi-squared estimator with the two-step estimators of Newey (1987) will be computed for the endogenous *probit* model.

Besides, three matching techniques, namely PSM, IPW and AIPW are used to account for the possibility that households who benefited from the microcredit differ from those who did not could be considered non-random. The mean treatment effects (ATE) and the mean treatment effects on treated persons (ATT) are obtained. After the PSM estimations, we check the balance of the treatment groups and the sensitivity. Finally, we also perform a variety of robustness measurements.

According to StataCorp (2013), the PSM estimator uses a treatment model, $\rho(z_i, t, \gamma)$ to model the conditional probability that observation i receives treatment t given covariates z_i. When matching on the estimated propensity score, the set of nearest-neighbor indices for observation $i, i = 1; \ldots ; n$, is:

$\Omega_m^p(i) = \{j_1, j_2, \ldots, j_{mi} | t_{jk} = 1 - t_i, |\hat{p}_i(t) - \hat{p}_{jk}(t)| < |\hat{p}_i(t) - \hat{p}_l(t)|, t_l = 1 - t_i, l \# j_k\}$ (10)

where $\hat{p}_i(t) = \rho(z_i, t, \hat{\gamma})$. m_i is the smallest number such that the number of elements in each set, $m_i = \left|\Omega_m^p(i)\right| = \sum_{j \in \Omega_m^p(i)} w_j$, is at least m, the desired number of matches.

The IPW implements a smooth treatment-effects estimator, which then developed to the AIPW. According to StataCorp (2013), the AIPW estimating functions for the treatment parameters include terms from a conditional probability model and from a conditional mean model for the outcome. The sample-estimation-equations vector has three parts for the AIPW estimators:

$$S_{aipw,i}(x_i, z_i, \hat{\theta})' = \left[S_{aipw,e,i}(x_i, z_i, \hat{\theta})', \ S_{aipw,tm,i}(z_i, \hat{\gamma})', S_{aipw,om,i}(x_i, w_i(t), \hat{\beta})'\right] \quad (11)$$

Where $S_i(x_i, z_i, \hat{\theta})'$ are the sample realizations of the estimating functions. The $aipw, e, tm, om, i$ and $x_i, z_i, \hat{\theta}, \hat{\gamma}, w_i(t), \hat{\beta}$ are the parameters of smooth treatment-effects estimators.

5. Results and discussions

This section discusses the analysis and estimations as follows. First, it shows the results of female characteristics of access to microfinance. Second, it shows the results of Probit estimation with the IV approach. Finally, it shows the results of sensitivity using many alternative techniques as robustness measures.

We begin by presenting some descriptive statistics showing the difference between the borrower and non-borrower households. Table 5 presents bivariate statistics for female characteristics by access to microfinance program. We observe that non-borrower and borrower households differ little in ages and education. However, non-borrower and borrower households are significantly different in terms of their geographic, dependency ratio, household size, and wealth status. For example, the number of borrower household are significantly lower than non-borrowing households in Arta but higher in Obock, and Tadjourah. On average, the borrower households have a lower dependency ratio. Borrower households, on

average, have a larger family size. In term of wealth, borrower households are at a lower percentage of being poor.

Table 5: Female characteristics by access to microfinance program

Variables	Total sample (1)		Non-borrower (2)		Borrower (3)		t-Test of Means dif. (4) = (2) minus (3)
	Mean	SE	Mean	SE	Mean	SE	ln Mean
Dependent variable							
WEI (ref: Empowerment)	0.419	(0.019)	0.414	(0.025)	0.427	(0.028)	-0.013
Household characteristics							
Age of female	48.366	(0.553)	48.806	(0.802)	47.785	(0.727)	1.021
Marital status (ref = married)	0.414	(0.019)	0.362	(0.024)	0.480	(0.029)	-0.118
Education level of female							
Less and primary	0.417	(0.042)	0.389	(0.056)	0.452	(0.064)	-0.062
Secondary and above	0.583	(0.042)	0.610	(0.056)	0.548	(0.064)	0.062
Region (ref : Djibouti)							
Ali-Sabieh	0.135	(0.013)	0.141	(0.018)	0.126	(0.019)	0.016
Arta	0.098	(0.011)	0.128	(0.017)	0.059	(0.014)	0.069***
Dikhil	0.159	(0.014)	0.154	(0.018)	0.166	(0.021)	-0.011
Obock	0.182	(0.015)	0.152	(0.018)	0.222	(0.024)	-0.070***
Tadjourah	0.291	(0.017)	0.272	(0.023)	0.315	(0.027)	-0.042***
Dependency ratio	23.126	(0.489)	24.411	(0.586)	21.471	(0.816)	2.940***
Household size	1.682	(0.028)	1.679	(0.036)	1.685	(0.044)	-0.007***
Wealth status (ref : Hpoor)							
Poor	0.253	(0.166)	0.293	(0.023)	0.202	(0.203)	0.091***
Middle	0.582	(0.019)	0.514	(0.025)	0.669	(0.027)	-0.155***
Rich	0.059	(0.009)	0.044	(0.010)	0.079	(0.016)	-0.036**

SE = standard error; ref = reference; Hpoor = poor households
Source: Authors' calculations
Notes: Standard errors (SE) given in parentheses. *** p< 0.01; **p<0.05; *p<0.1

5.1. Probit estimation with IV approach

This section discusses the estimated results of microfinance services on women's empowerment index. Table 6 estimated the effect of access to microfinance empowerment using Probit estimation. Table 7 and 8 estimated the effect of amounts of loans using Probit estimation and with IV approaches. Table 9 and 10 estimated the effect of numbers of loans using Probit estimation and with IV approaches. This analysis defines the number of loans from microfinance institutions into two groups: households taking out loans up to four times and less and those taking out loans more than four times. More than 65% of households in the data set took out microcredit four times and less. Table 11, and 12 estimated the effect of duration of loans using Probit estimation and IV approaches along with the Walt test of

exogeneity. We analyze the length of time (duration) that households have participated in the microfinance program by dividing households into two groups: those who participated in the program three years and less and those who participated more than three years. More than 27% of the households in the data set could participate in the microfinance program for up to three years or less. At the bottom of the table, the marginal effects are shown.

The relationship between access to microfinance and women's empowerment (shown in Table 6) is statistically and positively significant at the 1% level for the three dimensions. Households with access to the microfinance program are broadly empowered at the socio-economic and interpersonal levels. The marginal effects of the microfinance indicators, presented at the bottom of Table 6, show that households with access to loans from MFIs are 35.4%, 30.9% and 10.1% more likely to be economically, socially and impersonally empowered.

This result is valid for the Probit and IV-Probit model estimates, with the interest variable as the amount of loans (shown in Tables 7 and 8). This indicates that the use of microcredit allows for greater empowerment for women. The marginal

Table 6: Access to Microfinance and women's empowerment – Probit estimation

	Economic empowerment	Social empowerment	Interpersonal empowerment	All components
Variables	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
Access to microfinance	1.359***	1.089***	0.317***	1.023***
	(0.146)	(0.135)	(0.154)	(0.151)
Age of female	0.009	0.104**	0.009*	0.018**
	(0.006)	(0.005)	(0.005)	(0.005)
Married female	0.499	0.369***	0.298**	0.630***
	(0.149)	(0.131)	(0.125)	(0.136)
Education level of female				
Primary	0.002	0.542**	0.591***	0.467**
	(0.201)	(0.238)	(0.164)	(0.227)
Secondary	-0.129	0.902***	0.966***	0.625***
	(0.229)	(0.182)	(0.169)	(0.229)
Employed				
Yes	-0.404***	-0.301**	-0.068**	-0.409***
	(0.143)	(0.135)	(0.178)	(0.131)
Region (ref: Djibouti)				
Ali-sabieh	-0.179	0.196	0.319**	0.143
	(0.224)	(0.152)	(0.137)	(0.226)

Arta	-0.307	0.116	0.204	-0.18
	(0.293)	(0.190)	(0.164)	(0.242)
Dikhil	0.435	-0.416*	-0.335	0.333
	(0.287)	(0.243)	(0.269)	(0.304)
Obock	0.01	0.447**	0.358	0.296
	(0.261)	(0.196)	(0.272)	(0.255)
Tadjourah	0.171	-0.504**	-0.504*	-0.347
	(0.295)	(0.254)	(0.303)	(0.319)
Economic status (ref: Poorest)				
Poorer	-0.135	0.202	0.662**	0.237
	(0.211)	(0.269)	(0.309)	(0.251)
Middle	0.324**	0.528**	0.964***	0.734**
	(0.193)	(0.265)	(0.297)	(0.256)
Rich	0.809***	0.692**	1.083***	0.935*
	(0.193)	(0.316)	(0.399)	(0.371)
Dependency ratio	-0.004	0.007*	0.005	0.002
	(0.004)	(0.004)	(0.004)	(0.005)
Household size	0.187	0.285***	0.249***	0.332***
	(0.093)	(0.084)	(0.088)	(0.095)
Marginal Effect	0.354***	0.309***	0.101**	0.279***
	(0.025)	(0.031)	(0.049)	(0.032)
Constant	-0.423	-1.061***	-2.220***	-0.954**
	(0.435)	(0.377)	(0.402)	(0.462)
Observation	626	625	625	625

Source: Authors' calculations

Notes: Standard errors given in parentheses. *** p< 0.01; **p<0.05; *p<0.1

Table 7: Amounts of loans and women's empowerment – Probit estimations

	Economic empowerment	Social empowerment	Interpersonal empowerment	All components
Variables	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
Amount of loans	1.860***	0.228***	0.783***	0.403***
	(0.337)	(5.180)	(0.003)	(0.754)
Age of female	0.007	0.010**	0.008	0.011**
	(0.005)	(0.005)	(0.005)	(0.005)
Married female	0.562	0.453***	0.325**	0.667***
	(0.124)	(1.125)	(0.121)	(0.133)
Education of female (ref: none)				
Primary	0.079	0.437	0.564***	0.412**
	(0.200)	(2.202)	(0.194)	(0.213)
Secondary	0.378	0.723	0.899***	0.541***
	(0.197)	(0.209)	(0.194)	(0.221)
Employed				
Yes	-0.642	-0.489	-0.096	-0.513***
	(0.118)	(0.120)	(0.118)	(0.128)
Region (ref: Djibouti)				
Ali-sabieh	-0.371	0.053	0.257**	0.028
	(0.170)	(0.167)	(0.160)	(0.180)
Arta	-0.236	0.137	0.218	-0.12

	(0.205)	(0.203)	(0.203)	(0.212)
Dikhil	-0.084	-0.591*	-0.393	-0.124
	(0.210)	(0.219)	(0.218)	(0.221)
Obock	-0.111	0.338**	0.329	0.21
	(0.191)	(0.189)	(0.182)	(0.201)
Tadjourah	0.038	-0.531**	-0.524*	-0.395
	(0.230)	(0.241)	(0.249)	(0.242)
Economic status (ref: Poorest)				
Poorer	0.028	0.285	0.674**	0.313
	(0.228)	(0.218)	(0.243)	(0.220)
Middle	0.49	0.636**	0.986***	0.781**
	(0.208)	(0.202)	(0.227)	(0.203)
Rich	0.994	0.859**	1.117***	0.967*
	(0.294)	(0.307)	(0.306)	(0.324)
Dependency ratio	-0.006	0.005*	0.004	0.001
	(0.005)	(0.005)	(0.005)	(0.005)
Household size	0.154	0.266***	0.246***	0.322***
	(0.085)	(0.087)	(0.083)	(0.093)
Marginal Effect	0.063***	0 .070***	0.025**	0.114***
	(0.958)	(0.136)	(0.942)	(0.203)
Constant	0.968	1.613***	2.389***	0.166**
	(0.369)	(0.370)	(0.383)	(0.387)
Observation	626	625	625	625

Source: Authors' calculations

Notes: Standard errors given in parentheses. *** p< 0.01; **p<0.05; *p<0.1

Table 8: Amounts of loans and women's empowerment – IV – Probit estimations

	Economic empowerment	Social empowerment	Interpersonal empowerment	All components
Variables	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
Amounts of loans	0.450***	0.414***	0.157***	0.460***
	(0.306)	(0.518)	(0.578)	(0.528)
Age of female	0.002	0.005**	0.007	0.007**
	(0.005)	(0.005)	(0.005)	(0.005)
Married female	0.401	0.347***	0.310**	0.580***
	(0.116)	(1.125)	(0.121)	(0.129)
Education of female (ref:none)				
Primary	0.088	0.359	0.550***	0.337**
	(0.179)	(2.202)	(0.193)	(0.202)
Secondary	0.386	0.494	0.861***	0.342***
	(0.386)	(0.209)	(0.195)	(0.210)
Employed				
Yes	0.141	0.119	-0.006	-0.227***
	(0.123)	(0.128)	(0.131)	(0.138)
Region (ref: Djibouti)				
Ali-sabieh	-0.466	-0.134	0.204**	-0.15
	(0.153)	(0.156)	(0.163)	(0.170)
Arta	-0.104	0.137	0.245	-0.044
	(0.189)	(0.190)	(0.202)	(0.201)

Dikhil	0.169	-0.457*	-0.371	-0.079
	(0.190)	(0.205)	(0.217)	(0.207)
Obock	-0.113	0.263**	0.318	0.165
	(0.174)	(0.178)	(0.181)	(0.189)
Tadjourah	-0.038	-0.473**	-0.517*	-0.36
	(0.209)	(0.226)	(0.248)	(0.228)
Economic status (ref: Poorest)				
Poorer	-0.053	0.199	0.655**	0.242
	(0.206)	(0.207)	(0.242)	(0.210)
Middle	0.21	0.405**	0.933***	0.596**
	(0.192)	(0.197)	(0.230)	(0.202)
Rich	0.494	0.489**	1.029***	0.714*
	(0.274)	(0.291)	(0.310)	(0.312)
Dependency ratio	-0.003	0.005*	0.004	0.001
	(0.004)	(0.004)	(0.004)	(0.005)
Household size	0.114	0.212***	0.239***	0.268***
	(0.077)	(0.081)	(0.083)	(0.088)
Marginal Effect	0.450***	0.414***	0.157***	0.460***
	(0.306)	(0.518)	(0.942)	(0.528)
Constant	0.978	1.494***	2.417***	0.1487**
	(0.336)	(0.349)	(0.382)	(0.369)
Observation	626	625	625	625
Wald test of exogeneity				
Chi2 (1)	72.91	36.92	2.37	20.18
Prob > chi2	0.000	0.000	0.124	0.000

Source: Authors' calculations

Notes: Standard errors given in parentheses. *** p< 0.01; **p<0.05; *p<0.1

effects from IV-Probit model estimates show 45.0%, 41.4% and 15.7% more likely to empower women.

We also looked at whether there is a link between the number of loans received and women's empowerment in binary term (1 for the number of loans equal or less than four times and 0 otherwise). The results from Table 9 using the Probit model estimates show that it appears to be statistically significant at the 1% level for the three empowerment dimensions. When we retain the binary interest variable of the numbers of loans received, we note that women who have taken out four or more loans from microfinance institutions are 27.7%, 23.5% and 6.8% less likely to be economically, socially and interpersonally empowered. The results, estimated by the IV-probit model (shown in Table 10), follow the same direction as

the previous results. Women who are already relatively more autonomous may tend to participate in the program more than others.

In short, the positive and significant coefficients of the variables of interest, access to credit and number of loans, may suggest that the microfinance program can empower women. The woman's autonomy level is likely to increase as she becomes more involved in the program (reflected in the increase in loan size), compared to the initial level (i.e., the level of autonomy in non-recipient status). In other words, a good program effect may reflect in this trend towards increased autonomy for women, in parallel with their participation in the program. It should also note that our empowerment index shows that three dimensions, economic, social and interpersonal, are more important than others in determining women's empowerment.

Does the duration of participation play a role? The estimates of program participation duration, that aim at answering this question, using the Probit and IV-Probit model, are shown in Table 11 and 12. The coefficient for participation in the

Table 9: Numbers of loans (ref: less than 4 loans) and women's empowerment – Probit estimations

	Economic empowerment	Social empowerment	Interpersonal empowerment	All components
Variables	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
Number of loan (ref: less than 4 loans)				
More than 4 loans	0.956***	0.776***	0.212***	0.727***
	(0.146)	(0.149)	(0.156)	(0.147)
Age of female	0.007	0.009*	0.008	0.011**
	(0.006)	(0.005)	(0.005)	(0.005)
Married female	0.494***	0.369***	0.305***	0.642***
	(0.141)	(0.119)	(0.124)	(0.130)
Education of female (ref : none)				
Primary	0.005	0.542**	0.584***	0.451**
	(0.206)	(0.236)	(0.165)	(0.228)
Secondary	0.155	0.815***	0.943***	0.579***
	(0.213)	(0.169)	(0.169)	(0.211)
Employed				

Yes	0.628***	0.493***	0.127	0.577****
	(0.136)	(0.133)	(0.174)	(0.140)
Region (ref: Djibouti)				
Ali-sabieh	0.353	0.035	0.279*	0.004
	(0.335)	(0.203)	(0.145)	(0.304)
Arta	0.43	0.009	0.168	0.275
	(0.363)	(0.224)	(0.167)	(0.305)
Dikhil	0.142	0.596***	0.39	0.151
	(0.381)	(0.240)	(0.258)	(0.359)
Obock	0.068	0.326	0.334	0.193
	(0.359)	(0.231)	(0.277)	(0.325)
Tadjourah	0.132	0.483	0.504	0.34
	(0.411)	(0.309)	(0.310)	(0.397)
Economic status (ref: Poorest)				
Poorer	0.033	0.274	0.679**	0.304
	(0.193)	(0.258)	(0.309)	(0.245)
Middle	0.401**	0.596**	0.987***	0.784***
	(0.187)	(0.254)	(0.297)	(0.251)
Rich	0.960***	0.868***	1.145****	1.107***
	(0.290)	(0.328)	(0.411)	(0.372)
Dependency ratio	0.003	0.008**	0.005	0.003
	(0.005)	(0.004)	(0.004)	(0.005)
Household size	0.172**	0.275***	0.249***	0.314***
	(0.091)	(0.081)	(0.089)	(0.094)
Marginal Effect	0.277***	0.235***	0.068***	0.210***
	(0.035)	(0.042)	(0.050)	(0.041)
Constant	1.242***	1.745***	2.242***	1.625***
	(0.517)	(0.440)	(0.422)	(0.524)
Observation	626	625	625	625

Source: Authors' calculations
Notes: Standard errors given in parentheses. *** p< 0.01; **p<0.05; *p<0.1

Table 10: Number of loans (ref: less than 4 loans) and women's empowerment – IV–Probit estimations

	Economic empowerment	Social empowerment	Interpersonal empowerment	All components
Variables	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
Number of loan (ref: less than 4 loans)	0.400***	0.338***	0.118***	0.335***
	(0.030)	(0.034)	(0.044)	(0.037)
Age of female	0.009	0.011**	0.009**	0.020**
	(0.005)	(0.005)	(0.005)	(0.005)
Married female	0.512	0.402***	0.319***	0.640***
	(0.112)	(1.122)	(0.120)	(0.129)
Education of female (ref: none)				
Primary	0.041	0.46	0.570**	0.409**
	(0.192)	(0.197)	(0.193)	(0.206)
Secondary	0.198	0.737	0.928***	0.509***
	(0.190)	(0.199)	(0.193)	(0.208)
Employed				
Yes	-0.193	-0.148	-0.018***	-0.251***

	(1)	(2)	(3)	(4)
	(0.129)	(0.130)	(0.129)	(0.137)
Region (ref: Djibouti)				
Ali-sabieh	0.105	0.381	0.391	0.326
	(0.166)	(0.162)	(0.162)	(0.174)
Arta	-0.148	0.304	0.272	0.032
	(0.205)	(0.199)	(0.204)	(0.209)
Dikhil	0.506	-0.241*	-0.279	0.154
	(0.206)	(0.215)	(0.221)	(0.216)
Obock	0.165	0.548**	0.402	0.421
	(0.189)	(0.186)	(0.182)	(0.196)
Tadjourah	0.045	-0.525**	-0.402	-0.398
	(0.227)	(0.238)	(0.182)	(0.237)
Economic status (ref: Poorest)				
Poorer	-0.111	0.169	0.645	0.201
	(0.225)	(0.216)	(0.242)	(0.217)
Middle	0.312	0.489**	0.951**	0.684**
	(0.208)	(0.203)	(0.228)	(0.206)
Rich	0.528	0.476**	1.005*	0.714*
	(0.295)	(0.304)	(0.310)	(0.329)
Dependency ratio	-0.01	0.003*	0.003	0.714
	(0.004)	(0.004)	(0.005)	(0.323)
Household size	0.138	0.236***	0.240***	-0.289***
	(0.083)	(0.084)	(0.082)	(0.089)
Marginal Effect	0..450	0.414***	0.118***	0.118***
	(0.306)	(0.518)	(0.044)	(0.044)
Constant	1.666	2.054***	2.566**	1.946**
	(0.365)	(0.363)	(0.388)	(0.374)
Observation	626	625	625	625
Wald test of exogeneity				
Chi2 (1)	44.98	28.73	3.97	20.21
Prob > chi2	0.000	0.000	0.046	0.000

Source: Authors' calculations

Notes: Standard errors given in parentheses. *** p< 0.01; **p<0.05; *p<0.1

On the other hand, there is an insignificant effect when we estimated with households having participated in the programmes for three years or less than three years. Overall, we find that duration is a significant factor in enhancing the role of women. When program participation is more long-term, it tends to generate better results.

Table 11: Number of loans and women's empowerment (Duration) - Probit estimations

Variables	Economic empowerment		Social empowerment		Interpersonal empowerment		All components	
	(Duration≤3)	(Duration>3)	(Duration≤3)	(Duration>3)	(Duration≤3)	(Duration>3)	(Duration≤3)	(Duration>3)
Number of loans	-0.255 (0.266)	1.004*** (0.192)	-0.144 (0.307)	0.926*** (0.309)	-0.242 (0.439)	0.250*** (0.201)	-0.252 (0.344)	1.172*** (0.386)
Age of female	-0.008 (0.011)	0.014* (0.008)	-0.013 (0.013)	0.015*** (0.006)	-0.006 (0.009)	0.014** (0.006)	-0.017 (0.014)	0.016** (0.006)
Married female	0.644** (0.285)	0.419*** (0.159)	0.477 (0.291)	0.344** (0.344)	0.446** (0.236)	0.262* (0.153)	0.843*** (0.321)	0.568*** (0.144)
Women education (ref: none)								
Primary	-0.140 (0.360)	0.002 (0.233)	0.444 (0.581)	0.543** (0.283)	0.503 (0.370)	0.660*** (0.223)	0.259 (0.514)	0.431* (0.258)
Secondary	-0.177 (0.378)	-0.280 (0.318)	0.734 (0.501)	0.820*** (0.201)	1.085*** (0.421)	0.912*** (0.215)	0.299 (0.514)	0.581** (0.259)
Employed								
Yes	-0.401** (0.196)	0.685*** (0.204)	-0.061 (0.149)	0.650 (0.174)	0.197 (0.228)	0.340** (0.168)	-0.242 (0.181)	-0.635*** (0.189)
Region (ref: Djibouti)								
Ali-sabieh	-0.229 (0.213)	0.085*** (0.354)	0.073 (0.263)	0.186 (0.203)	0.267 (0.190)	0.394** (0.202)	0.004 (0.231)	0.202 (0.318)
Arta	-0.758* (0.422)	0.079*** (0.356)	-0.533 (0.454)	0.324* (0.203)	-0.591 (0.381)	0.554 (0.211)	-0.966** (0.433)	0.092 (0.284)
Dikhil	-0.677* (0.411)	0.582** (0.415)	-1.087*** (0.357)	0.291 (0.279)	-1.128* (0.580)	0.033** (0.254)	-0.856*** (0.263)	0.211 (0.379)
Obock	-0.252 (0.216)	0.115 (0.430)	-0.043 (0.356)	0.544** (0.256)	-0.423 (0.509)	0.832*** (0.254)	-0.210 (0.340)	0.494 (0.351)
Tadjourah	-0.244 (0.424)	0.401*** (0.509)	-0.589 (0.388)	0.452 (0.360)	-0.432 (0.733)	0.551 (0.357)	-0.911** (0.363)	-0.125 (0.480)
Economic status (ref: Poorest)								
Poorer	-0.853 (0.617)	0.206 (0.285)	-0.604 (0.548)	0.421 (0.361)	1.308** (0.637)	0.555 (0.357)	-0.490 (0.633)	0.448 (0.340)
Middle	-0.456 (0.499)	0.764*** (0.246)	-0.401 (0.491)	0.791** (0.338)	1.356** (0.613)	0.953*** (0.324)	-0.274 (0.547)	1.013*** (0.326)
Rich	-0.232 (0.649)	1.319*** (0.311)	-0.430 (0.642)	1.256*** (0.461)	1.297* (0.727)	1.457*** (0.399)	-0.338 (0.710)	1.563*** (0.535)
Dependency ratio	0.008 (0.007)	-0.014** (0.007)	0.001 (0.009)	0.013** (0.006)	-0.003 (0.009)	0.012* (0.007)	0.009 (0.009)	-0.002 (0.007)
Household size	0.307 (0.207)	0.115 (0.114)	0.186 (0.139)	0.352*** (0.099)	0.070 (0.120)	0.422*** (0.103)	0.286 (0.184)	0.362*** (0.102)
Marginal Effect	0.077 (0.080)	0.249*** (0.041)	0.040 (0.040)	0.266*** (0.082)	0.079 (0.145)	0.072 (0.057)	0.057 (0.076)	0.335*** (0.985)
Constant	1.081* (0.625)	1.765** (0.699)	1.406** (0.619)	2.549*** (0.504)	1.180 (0.932)	3.202*** (0.485)	1.543** (0.667)	2.252*** (0.631)
Observation	172	454	172	453	172	453	172	453

Source: Authors' calculations

Notes: Standard errors given in parentheses. *** p< 0.01; **p<0.05; *p<0.1

Table 12: Numbers of loans and women's empowerment (Duration) – IV- Probit estimations

Variables	Economic empowerment		Social empowerment		Interpersonal empowerment		All components	
	(Duration≤3)	(Duration>3)	(Duration≤3)	(Duration>3)	(Duration≤3)	(Duration>3)	(Duration≤3)	(Duration>3)
Numbers of loans	0.113 (0.826)	0.343*** (0.048)	0.069 (0.555)	0.350*** (0.526)	0.007 (0.832)	0.120*** (0.056)	0.106 (0.128)	0.379*** (0.053)
Age of female	0.010 (0.369)	0.016* (0.006)	0.014 (0.039)	0.018*** (0.006)	0.006 (0.426)	0.015** (0.006)	0.018 (0.655)	0.018** (0.005)
Married women	0.677** (0.331)	0.427*** (0.160)	0.498 (0.231)	0.325** (0.150)	0.430** (0.330)	0.258* (0.150)	0.884*** (0.507)	0.516*** (0.152)
Women education (ref: none)								
Primary	0.172 (0.199)	0.025 (0.241)	0.453 (0.122)	0.584** (0.234)	0.496 (0.200)	0.670*** (0.232)	0.268 (0.307)	0.470* (0.237)
Secondary	0.250 (0.920)	0.095 (0.251)	0.726 (0.599)	0.994*** (0.239)	1.111*** (0.926)	0.979*** (0.235)	0.269 (0.142)	0.741** (0.242)
Employed								
Yes	0.402** (0.209)	0.268*** (0.180)	0.048 (0.139)	0.257 (0.177)	0.206 (0.209)	0.203** (0.174)	0.230 (0.321)	0.213*** (0.176)
Region (ref: Djibouti)								
Ali-sabieh	0.182 (0.972)	0.142*** (0.226)	0.097 (0.654)	0.387 (0.206)	0.226 (0.980)	0.458** (0.206)	0.021 (0.151)	0.400 (0.208)
Arta	0.683* (0.120)	0.093*** (0.275)	0.489 (0.793)	0.498* (0.250)	0.624 (0.121)	0.612 (0.255)	0.929** (0.186)	0.282 (0.251)
Dikhil	0.651 (0.562)	0.860** (0.259)	1.087*** (0.354)	0.003 (0.260)	1.139* (0.569)	0.058** (0.261)	0.861*** (0.876)	0.488 (0.247)
Obock	0.212 (0.300)	0.352 (0.272)	0.082 (0.204)	0.793** (0.243)	0.409 (0.304)	0.916*** (0.245)	0.172 (0.467)	0.730 (0.242)
Tadjourah	0.179 (0.105)	0.132*** (0.298)	0.563 (0.690)	0.731 (0.309)	0.428 (0.106)	0.624 (0.324)	0.885** (0.163)	0.380 (0.281)
Economic status (ref: Poorest)								
Poorer	0.787 (0.984)	0.030 (0.309)	0.590 (0.649)	0.220 (0.263)	1.285** (0.996)	0.498 (0.282)	0.456 (0.153)	0.222 (0.252)
Middle	0.425 (0.636)	0.606*** (0.281)	0.396 (0.419)	0.620** (0.247)	1.329** (0.643)	0.897*** (0.268)	0.246 (0.989)	0.795*** (0.242)
Rich	0.240 (0.110)	1.120*** (0.401)	0.459 (0.643)	0.959*** (0.413)	1.295* (0.113)	1.364*** (0.414)	0.357 (0.173)	1.120*** (0.423)
Dependency ratio	0.006 (0.034)	0.014** (0.006)	0.001 (0.228)	0.013** (0.007)	0.002 (0.343)	0.012* (0.007)	0.008 (0.053)	0.009 (0.006)
Household size	0.306 (0.108)	0.119 (0.110)	0.184 (0.696)	0.337*** (0.107)	0.073 (0.111)	0.419*** (0.107)	0.289 (0.171)	0.335*** (0.107)
Marginal Effect	0.113 (0.826)	0.343*** (0.048)	0.069 (0.554)	0.350*** (0.052)	0.007 (0.832)	0.120 (0.056)	0.106** (0.128)	0.379*** (0.053)
Constant	0.657* (0.237)	2.276** (0.493)	1.143 (0.157)	3.047*** (0.461)	1.368 (0.239)	3.403 (0.487)	0.111** (0.368)	2.645*** (0.453)
Observation	172	454	172	453	172	453	172	453

Source: Authors' calculations

Notes: Standard errors given in parentheses. *** p< 0.01; **p<0.05; *p<0.1

Table 12.1: Numbers of loans and Women's empowerment (Duration) - IV- Probit estimations

	Economic empowerment		Social empowerment		Interpersonal empowerment		All components	
Variables	(Duration≤3)	(Duration>3)	(Duration≤3)	(Duration>3)	(Duration≤3)	(Duration>3)	(Duration≤3)	(Duration>3)
Wald test of exogeneity								
Chi2 (1)	47.15		26.63		22.17		20.15	
Prob > chi2	0.000		0.000		0.000		0.000	

Source: Authors' calculations

Notes: Standard errors given in parentheses. *** p< 0.01; **p<0.05; *p<0.1

5.2. Sensitivity and robustness measures

A- *Matching estimations*

To address the problem of endogeneity, we estimate our model using three propensity score methods: PSM, IPW, and AIPW. Matching estimates are based on Rubin's causal model (Rosenbaum and Rubin 1983). The PSM matches treated and untreated individuals based on a propensity score for participation given observable characteristics of the individual. Nevertheless, the idea of the IPW gives greater weight to those who are unlikely to receive treatment. The aim is to obtain a pseudo-sample (or weighted sample) in which the distribution of covariates is identical between exposed and unexposed individuals. Finally, AIPW combines regression fitting aspects and inverse probability weighted methods to estimate the means of potential outcomes and average treatment effects. This method is 'doubly robust' (Cao, Tsiatis, and Davidian 2009). The use of propensity score methods gives both the most common estimates, namely: mean treatment effect on treated individuals' (ATT), which is the effect on individuals in the treatment group, and mean treatment effect (ATE), which is the effect on all individuals (treatment and control).

Table 13 presents the PSM estimation results, which gives a similar picture to our baseline, probit, and IV-probit estimates. In women from the autonomous categories, the mean effect (ATT) for economic, social and interpersonal autonomy is significant at least at the 1% and 5% level. The average effects for autonomous women compared to non-autonomous women are 15.9%, 32.9% and 32.4% for the respondent's relative economics, social and interpersonal autonomy, respectively. These average effects are consistent with the effects observed with the probit model's estimates and are even more significant. The aggregate indicator of women's autonomy is also significant, with an average effect of 42%.

Table 14 shows the results of IPW and AIPW estimations. The average effects for the two techniques' aggregate autonomy are 12.5% compared to 42% for the propensity score method and a marginal effect of 27.9% for the base estimate. Being

from the categories of autonomous women leads to 12.5% greater autonomy in at least one household autonomy type in three compared to non-autonomous women.

Table 13: Microfinance and women's empowerment – PSM estimations

Propensity score match	Economic empowerment	Social empowerment	Interpersonal empowerment	All
Unmatched	0.159***	0.329***	0.324**	0.420***
	(0.685)	(0.774)	(0.176)	(0.831)
ATT	0.159***	0.3294***	0.3244**	0.4201***
	(0.154)	(0.713)	(0.132)	(0.791)
Observation	691	625	625	690

Source: Authors' calculations

Notes: Standard errors given in parentheses. *** $p < 0.01$; **$p<0.05$; *$p<0.1$.

Table 14: Microfinance and women's empowerment – IPW and AIPW estimation.

| Inverse-Probability score match	(1)		(2)		(3)		(4)	
	Economic empower.	POmean	Social empower.	POmean	Interpersonal empower.	POmean	All Components	POmean
ATE	0.145***	0.620***	0.086***	0.722***	0.082**	0.467***	0.125***	0.775***
	(0.052)	(0.039)	(0.046)	(0.035)	(0.054)	(0.038)	(0.040)	(0.032)
ATET	0.135***	0.644***	0.739***	0.739***	0.083**	0.490***	0.118***	0.800
	(0.055)	(0.043)	(0.038)	(0.038)	(0.057)	(0.045)	(0.039)	(0.033)
Observation	302	302	302	302	302	302	302	302
Augmented IPW								
ATE	0.145***	0.620***	0.086***	0.722***	0.082**	0.467***	0.125**	0.775***
	(0.052)	(0.039)	(0.046)	(0.035)	(0.054)	(0.038)	(0.040)	(0.032)
Observation	302	302	302	302	302	302	302	302

Source: Authors' calculations.

Notes: Standard errors given in parentheses. *** $p < 0.01$; **$p<0.05$; *$p<0.1$

We graphically assessed the support common to the treatment and control groups used in the mean effect estimates (Figure 4). The four estimates' graphs are more or less similar and show satisfactory scores for both self-sufficient and non-self-sufficient households.

B- *Testing multiple hypotheses*

We performed a multivariate analysis of variance (MANOVA) using our four female empowerment variables and the binary microcredit access variable. The results of the four statistics (Wilks 'Lambda, Trace de Pillai, Laweley-Hotelling and Roy) given in

Figure 4: Density distribution for the estimated propensity scores for access to microfinance.
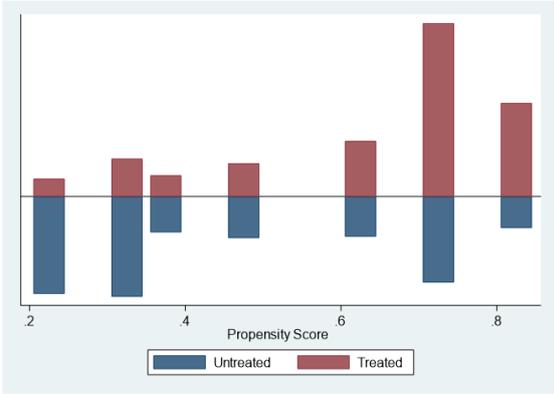

(Outcome-Economic empowerment)
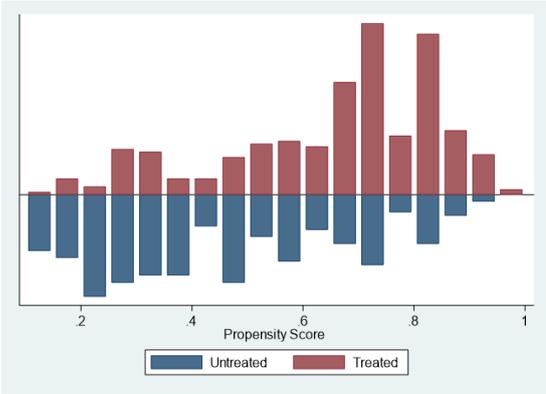
(Outcome-Social empowerment)
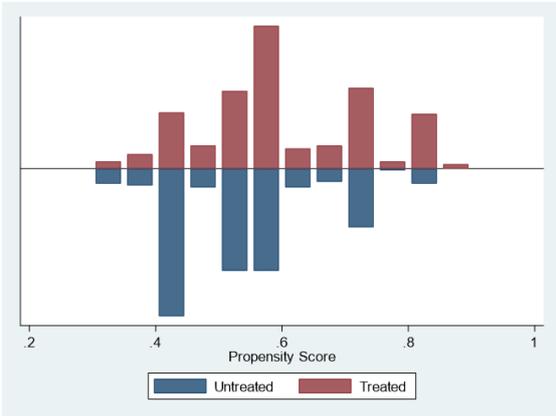
(Outcome-Interpersonal empowerment)
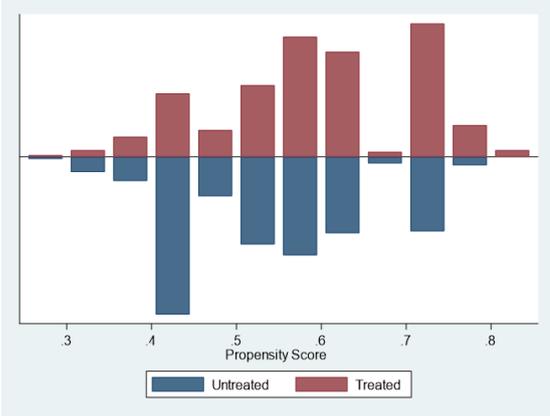
(Outcome-All Components)

Source : Author's calculations

Table 15 all show that the null hypothesis of equality of means of access to microcredit is rejected at the 1% threshold.

We also use Boneffroni's correction to test the statistical significance of our covariates' regression coefficients of interest. This method makes it possible to correct the values of p-value when several tests are carried out simultaneously on the same data. Table 16 shows Boneffroni's corrections for four pairwise comparisons taking the economy-related autonomy estimate first. We find that the four pairs are significantly different at the 1% level according to the indicated p-values.

Table 15: Multivariate analysis of variance and covariance

Source		Statistic	Df	F (df1, df2)		F	Prob>F
Access to	W	0.6210	1	4.0	685.0	104.53	0.0000e
microfinance	P	0.3790		4.0	685.0	104.53	0.0000e
	L	0.6104		4.0	685.0	104.54	0.0000e
	R	0.6104		4.0	685.0	104.55	0.0000e
Residual			688				
Total			**689**				

Source: Authors' calculations. Note: W = Wilks' lambda, L = Lawley-Hotelling trace, P = Pillai's trace R = Roy's largest root. e = exact, a = approximate, u = upper bound on F.

Table 16: Bonferroni correction

Equations	Contrast	Std.Err.	Bonferroni	
			T	P>|t|
2 vs 1	0.426	0.000	-16.60	0.000
3 vs 1	0.810	0.000	-12.65	0.000
3 vs 2	0.176	0.000	-4.83	0.000
2 vs 3	0.782	0.000	-12.01	0.000

Source: Authors' calculations. Note: 4 number of comparisons

6. Conclusion

The international studies have stressed the disappointment of microfinance facilities as a tool for social and economic development due to high interest rates, non-productive use of loans, over-indebtedness, often landless customers and intergenerational migration. This study uses the household survey data on microfinance services carried out in 2015 in the six major regions of Djibouti, including Djibouti City, Arta, Ali-Sabieh, Dikhil, Obock and Tadjourah. The study seeks to determine whether participation in the microfinance programme is linked to women's greater autonomy. We construct a composite indicator of women's empowerment that measures women's control over various aspects of their lives and their environments, such as participation in household decisions, control over income, ownership of property and exposure to the media, and their health. The index is then used in three dimensions: economic, social and interpersonal.

The empirical results suggest that microfinance not only has positive and significant effects on women's autonomy, but these effects increase as the number of

loans taken out increases and as the length of time spent in the program rises. The results of the study are robust regardless of the specifications and econometric techniques used. Both beneficial and harmful impact of microfinance found in the study is in addition to the growing literature of microfinance development as a tool for women's autonomy. The results of the study confirm positive socioeconomic effects of microfinance programmes.

We estimated the effect of amounts of loans using Probit estimation and with IV approaches, the effect of numbers of loans using Probit estimation and with IV approaches, the effect of duration of loans using Probit estimation and IV approaches along with the Walt test of exogeneity. We also used a number of the estimation techniques, namely the IV-Probit estimations, and perform a range of robustness measures, namely PSM, IPW and AIPW estimations. From the marginal effects analysis, the results suggest that households with access to loans from MFIs are 35.4%, 30.9% and 10.1% more likely to be economically, socially and impersonally empowered. The effect of microfinance, counting from access to microfinance and the number of loans, also has a significant relationship on women's empowerment index in three dimensions. The estimations confirm that women who have taken out four or more loans from microfinance institutions are 27.7%, 23.5% and 6.8% less likely to be economically, socially and interpersonally empowered. The results of the study confirm, therefore, positive socioeconomic effects of microfinance programmes.

Despite many noteworthy outcomes delivered in this study, there is ample area for further advancement. First, to examine the influence of microfinance services on women's empowerment, this paper uses only access to credit as an explanatory variable, ignoring other indicators such as payments, money transfers, savings and insurance. The introduction of these variables would provide further understandings. Second, the analysis is based on a one-off survey conducted in 2015, so it cannot capture dynamic effects. Thus, supplementary works are necessary to understand the complete story.

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Appendix

Table A1: Empowerment indicator

Ei (i=1,2,…18)	Abbrev	Description of indicator
Control over financial assets		
E1	CINC	Control over own income
E2	PMIA	Female who most often in the activity
Involvement in decision making		
E3	LAND	purchase or sale of land
E4	HOUS	house repairing
E5	IIGA	involvement in IGA
E6	SIGA	Strengthen IGA
E7	IGAOH	involvement in IGA outside the home
Women asset ownership		
E8	TELIN	Telephone internet subscription
E9	LAPT	Independently purchase laptop
E10	REFRE	Independently purchase refrigerator and freezer
E11	STOV	Independently purchase stove
E12	KSTOV	Independently purchase Kerosene stove
Health Domain		
E13	EXPH	Health expenditure
Media exposure		
E14	RADA	Access to radio
E15	ATV	Access to TV
E16	AMUC	Access to music channel
E17	APAA	Access to parabolic antenna

Abbrev = Abbreviation

Source: Dataset from the survey of the PREPUD in 2015 by the ADDS and the INSTAD.