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Centre interuniversitaire sur le risque, les politiques économiques et l'emploi

Microfinance and Female Empowerment

Sylvain Dessy
Jacques Ewoudou

Janvier/January 2006

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Dessy: Corresponding author. Department of Economics and CIRPÉE, Université Laval, Local 2176 DeSève, Québec, QC, Canada G1K 7P4
sdes@ecn.ulaval.ca
Ewoudou: Department of Economics, Université de Montréal, Montréal, QC, Canada
jacques.ewoudou@umontreal.ca

Abstract:

In the informal economy of developing countries, female entrepreneurs face a comparative disadvantage for operating high-productivity activities, owing to the prevalence of patriarchal forms of business regulations. Yet, for microfinance institutions (MFIs) to succeed in enhancing female empowerment, increased access to credit must enable female entrepreneurs to tap into the range of high-productivity activities. So when the costs of legality are too high in developing countries, and the informal economy becomes the only affordable venue for operating a business venture, this paper shows that access to microfinance services becomes only necessary, but not sufficient for female empowerment. Based upon a game-theoretic model of activity choices by ex ante homogenous women, we argue that conditioning well-trained women's access to credit to the adoption of high-productivity activities may enable MFIs to induce the emergence of networks of female entrepreneurs large enough to mitigate patriarchal practices that raise the costs of operating such activities in the informal economy.

I. Introduction

This paper offers a new perspective on the empowerment potential of microfinance institutions targeted at women. It develops a theory of female empowerment through access to business loans in an environment where informality is the only affordable venue for operating a business venture. Its aim is to examine the choices of activity informal female entrepreneurs make when faced with patriarchal forms of business regulations that substitute for the absence of legal means for enforcing contracts in the informal economy.

Basic economic theory supporting the empowerment potential of microfinance targeted at women emphasizes access to credit and the resulting opportunity for earning an independent income as the theoretical links to female empowerment through microfinance. In other words, involvement in income-generating activities should translate into greater empowerment for women. But, female empowerment is about improved ability to bring about changes that enhance women's well-being at the household, community, and national levels.[1] Bringing about such well-being requires that women first acquire the power to change their social environment. Whether women can gain such power at individual, community or national levels obviously depends on a number of factors, including social, political, institutional, as well as purely economic, such as access to microfinance services. How these factors interact to affect female empowerment, therefore, warrant due consideration. Here is why.

First, in many developing countries, business formalization in order to access legal means for enforcing contracts is often a privilege available only to politically powerful entrepreneurs, given the prevalence in these countries of high costs of legality.[2] Figure 1

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[1] Esther Duflo (2005) offers an alternative definition. She defines female empowerment as the improvement in the ability of women to access the constituents of development—in particular health, education, earning opportunities, rights, and political participation.

[2] De Soto (1989) finds evidence that the process of legally registering a small business is to expensive for any person of small means in Peru. Fortin, Marceau and Savard (1997) find evidence of high costs of legality in a case study of Cameroon. Johnson and Kaufmann (2000) find that bribes and corruption are reasons why firms hide in the unofficial economy. Djankov et al. (2002) also provide evidence that countries with heavier regulation of entry have larger informal sectors. They argue that such entry barriers are deliberately set by politicians who seek to create extractable rents by restricting entry into formal markets.

below presents a comparative illustration of these costs for a sample of countries, including Sub-Saharan African countries and OECD countries. In terms of days lost dealing with licensing, Figure 1 shows clearly that in average, a potential formal sector entrepreneur in Sub-Saharan Africa loses about three times as many days dealing with licensing as does his counterpart from any advanced industrialized country.

Figure 1. Dealing with licence: Time Spent in Days
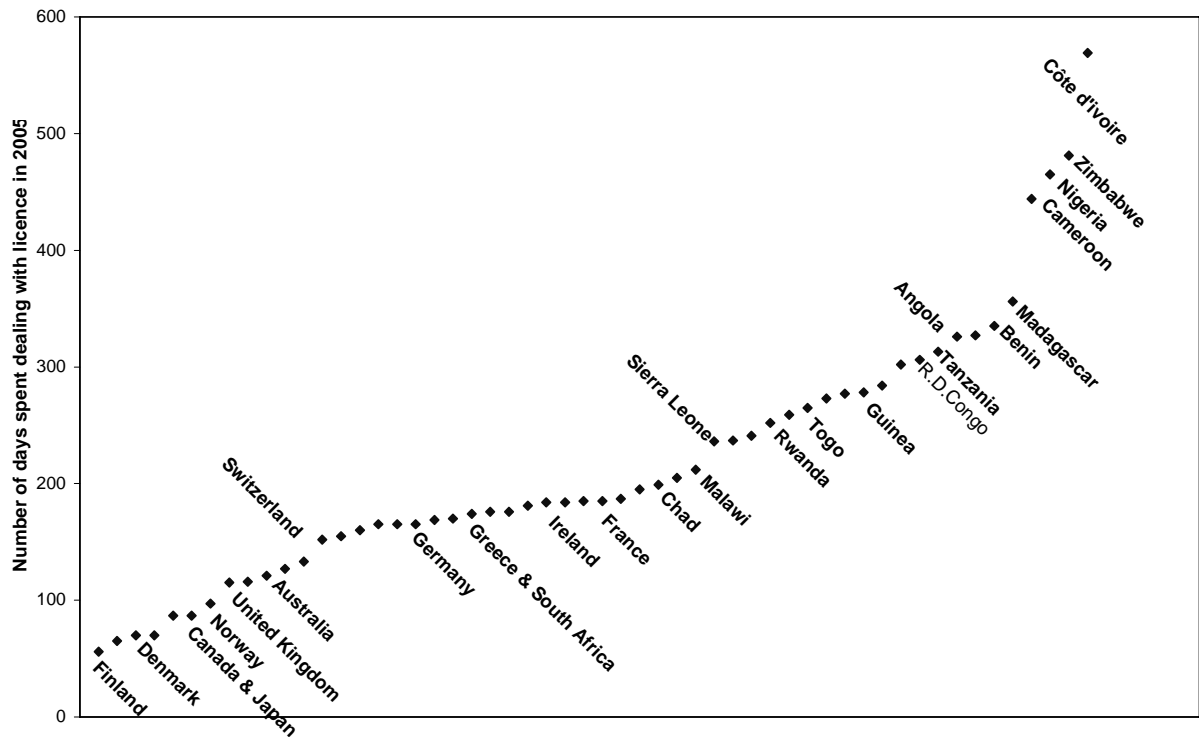
Source: The World Bank 2005

For the vast majority of these countries' micro-entrepreneurs–including women– who cannot afford these high cost of legality (bribes collection by public officials are an example), the informal economy becomes a "getaway"—a framework for producing and/or selling legal goods albeit using illegal means.[3]

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[3]According to a 2002 survey sponsored by the *International Labour Organization* (ILO), excluding South Africa, the share of informal employment in non-agricultural employment is 78 per cent in sub-Saharan Africa.

Second, in the informal economy, patriarchal forms of business regulations substitute for the absence of legal means for enforcing business contracts,[4] and often emphasize the use of threat and violence as an enforcement mechanism (de Soto 1989). Relative to men, this institutional feature of the informal economy put women at a comparative disadvantage for accessing certain lucrative markets (Gibbon 1995; Kabeer 2001). For example, relative to male entrepreneurs, women may face limited access to crucial input markets necessary to effectively operate a high-productivity business venture. Example include labor markets— where lack of legal mechanisms for resolving contract disputes may exposed female micro-entrepreneurs to male employees' violence—, and fertilizers markets—which are often controlled by male-only cooperatives. Due to these patriarchal practices, developing countries women still face trade-off that cause them to make decisions that are arguably disempowering, such as clustering in low-productivity activities, and/or relying on male family members (often their husband) as contract enforcers (Kabeer 2001)[5]

Third, notwithstanding the above, intrahousehold bargaining models have demonstrated that female empowerment is positively associated with the level of a woman's fall-back option, which, in turn, is shown to rise with her relative earned-income (e.g., Anderson and Eswaran 2005; Basu 2005). Yet, in the informal economy of developing countries, women continue to earn less than men, even when controlling for differences in literacy and education. In Bangladesh—a country that pioneered MFIs targeted at women—, there is evidence that self-employed men earn more than three times the income earned by self-employed women, while male informal micro-entrepreneurs earn about

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[4]Business contracts are usually defined as means for organizing and transfering property rights (De Soto 1989).

[5]Lost of bargaining power may, for example, force her to surrender a fraction of her venture capital to her husband in exchange for his services as her informal contract enforcer (Goetz and Sen Gupta 1996). Or, it may take the form of lost of control over her fertility (Kritz and Makinwa-Adebusoye 2000), which may raise the costs of operating a relatively high-risk, high-return business venture, thereby reducing her earned income. In particular, Kritz and Makinwa-Adebusoye (2000) studied women's status and fertility within married couples in five Nigerian ethnic groups (The Hausa, Ibo, Yoruba, Ijaw and Kanuri). They look at several dimensions of women's decision-making and spousal communication on the desire for more children, and wife say on family planning. Among other things, their studies finds that spouses from groups in which women's status is lowest (e.g. Kanuri and the Hausa) have higher disagreement on fertility desires than those from ethnic groups in which women's status is higher (Yoruba, Ibo, and Ijaw).

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four times more than their female counterparts (Dasgupta and Barbattini, 2003). In Figure 2 below, this gender disparity in earnings among self-employed agents is shown to be apparent in other developing countries as well:

Figure 2. Informal Economy: Women's earnings as a % of Men's among Self-Employed, by Country
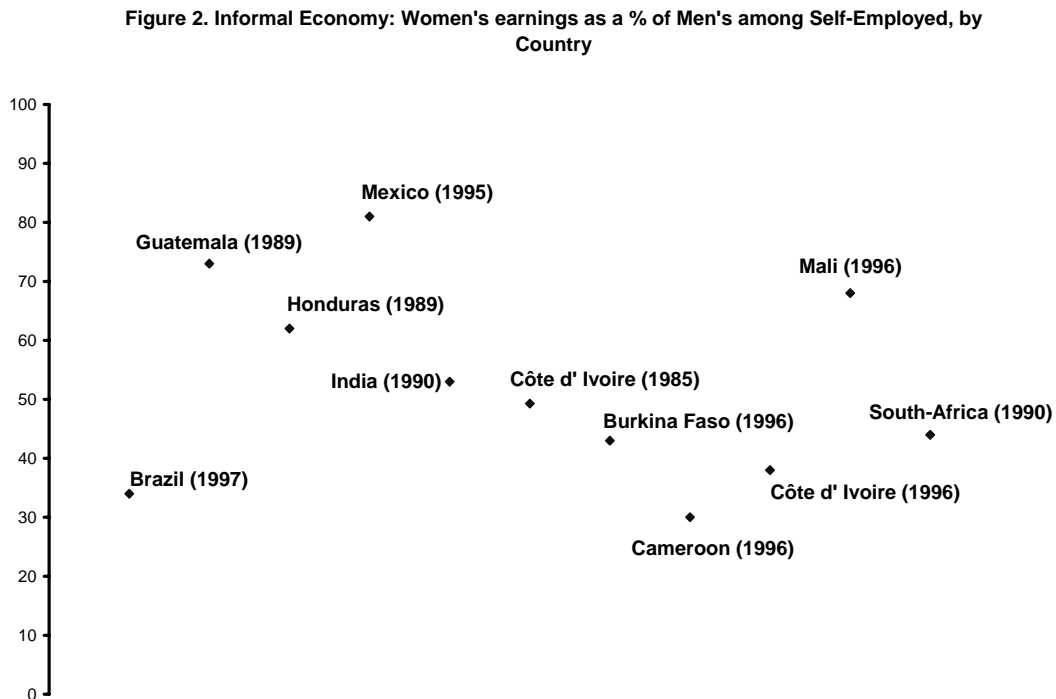
Source: Sethuraman (1998)

Most of this disparity reflects the extent to which women enterprises differ from men's in terms of scale, items sold by traders, extent of diversification, access to effective networking (Kabeer, 2001). Given the prevalence of patriarchal practices in the informal economy, networking among female entrepreneurs may play an essential role in overcoming transaction costs induced by compliance with such practices. Understanding constraints to the emergence of large enough networks of female entrepreneurs can therefore shed light on the issue of female empowerment through microfinance.

In this paper, we use a game-theoretic model to highlight coordination failure that hinder the emergence of networks of female entrepreneurs necessary to overcome patriarchal business practices that limit female entrepreneurs' access to high-productivity informal

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activities. In our model, women's entrepreneurship is assisted by an MFI which provides loan and training to all their clients. We focus on women's demand for venture capital and choice of activity as jointly determined by their ability to mitigate the transaction costs that limit their access to more productive business activities. In our model, a female entrepreneur must jointly choose the type of business activity she plans to operate informally and its size as determined by the amount of capital borrowed from the MFI of her choice. Operating a high-productivity informal activity puts a higher demand on a woman to link up with other women operating the same type of activity in order to generate collective resources necessary to overcome obstacles created by patriarchal business practices. The more there are female entrepreneurs operating in such a network, the more able will this network be in enhancing women's success at operating high-productivity activities. Consequently, an essential feature of the environment underlying women's entrepreneurship in the informal economy is the complementarity of their respective business strategies: a female entrepreneur's decision to tap into the range of high-productivity activities increases other female entrepreneurs' marginal gain from following suit. In absence of a mechanism for inducing coordination of women's decision to link up in a such a network, the non-cooperative game these women play admits two pure-strategy Nash-equilibria: a high-income equilibrium where all of them operate high-productivity informal activities, and a low-income equilibrium where they all remain confined into low-productivity ones, despite access to credit. Therefore, when the low-income Nash-equilibrium obtains despite women's improved access to credit, it must be that microfinance assistance to female entrepreneurship has failed to act as a coordination mechanism for the emergence of large enough networks of female entrepreneurs operating high-productivity activities.

From an empirical point of view, there is a case that women's attempt to access high-productivity business activities may be subject to strategic complementarities. Available evidence reveals that most women who receive loans from microfinance institutions tend to be confined into low-productivity, low-capital activities, despite access to credit, and often despite having equal managerial credentials as men. In a case study of Bangladesh, Kabeer

(2001) reports that while access to credit succeeded in increasing the rate at which women participated in economic activities, it failed, however, to increase the range of economic activities they have access to. Lairap-Fonderson (2002), in a case study of Cameroon and Kenya, finds similar evidence. She argues that women micro-entrepreneurs are clustered within a narrow range of activities that offer virtually no opportunity for innovation, or for upgrading to more-lucrative ventures. This includes street-vending, operating food kiosks, selling second-hand clothes and unprocessed food, which are relatively low-capital, low-productivity activities, but which, in addition, face strong competition from cheap imports. She concludes that microfinance fail to lift women out of the confine of such low-capital activities. In a case study of Zimbabwe, Gibbon (1995) finds that rural women business activities tend to remain at a survival level, despite assistance from microfinance institutions.

Our research is related to a growing theoretical literature focusing on women's empowerment through participation in income-generating activities. Anderson and Eswaran (2005) develop an intrahousehold bargaining model which demonstrates the relative ability of earned income to nurture empowerment for women within the household. The model is tested to rural Bangladeshi data, which provides support for their model's prediction. McIntosh and Wydick (2005) develop a model of competition among potential entrants in the microfinance industry that highlights the misgivings of increased competition in terms of the performance and viability of microfinance institutions. Carter and Fletschner (2004) build a model of women's demand for entrepreneurial capital that explicitly incorporates into women's decision-making the effect of social norms prescribing gender behavior. They use this model to argue that microcredit programs that relax women's capital supply constraints may have benefits that extend well beyond the direct beneficiaries. Our research builds around this literature by emphasizing the need to explicitly organize female entrepreneurs in large enough business networks capable of mitigating patriarchal business practices that confine women in low-productivity activities.

The rest of this paper is organized as follows. The model is presented and solved in

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section 2. Section 3 offers concluding remarks.

II. The Environment

There are $N > 0$ ex ante homogenous female entrepreneurs. Each female entrepreneur has a choice between a range of business activities indexed each by its degree of productivity, $p \in [0,1]$.[6] To start up a business venture of any type, women in this environment can borrow venture capital from an MFI of their choice.[7] Borrowed capital determines the size of the venture. Denote as $k \in [\underline{k}, \bar{k}]$ the loan obtained by a female entrepreneur, with $0 < \underline{k} < \bar{k} < +\infty$.

All business operations take place in the informal economy. In that economy, owing to the prevalence of patriarchal forms of business regulations, each female informal entrepreneur may face gender-specific transaction costs, unless she can joint a network of business women large enough to overcome these costs. Let $n \in [0, N]$ denote the cardinality of the subset of female informal entrepreneurs who are connected with one another through a business network (say a cooperative or any business association). Each female entrepreneur member of that network will face a level,

$$t_c = \varphi(n, p) \, pk, \tag{II.1}$$

of transaction costs reflecting the extent to which the network she belongs to is unable to eliminate her comparative disadvantage for being a female informal entrepreneur. These transactions costs are assumed to increase with size, k, and the degree of productivity, p, of the business venture.

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[6]Examples of activities including the vending of perishable goods (such as fruits and vegetables), and the vending of non- perishable goods (such as household appliances, furnitures, and other consumer durables).

[7]Microfinance programs generally foster self-employment.

Assumption 1. *The function φ satisfies the following properties:*

$$\varphi(n,p) = \begin{cases} 0 & \text{if } n > \widetilde{n}(p) \\ \delta & \text{if } n \leq \widetilde{n}(p) \end{cases} \tag{II.2}$$

where $\widetilde{n}(p) \in (1, N]$ denotes the critical mass of connected female informal entrepreneurs above which networking become successful in eliminating gender-specific transaction costs in the informal economy.

Assumption 1 implies that unless the size of the network of female informal entrepreneurs is large enough, transaction costs induced by the prevalence of patriarchal forms of business regulations will not disappear.

Assumption 2. *The function $\widetilde{n}(.)$ is strictly increasing and satisfies the following boundary conditions: (i) $\widetilde{n}(0) = 0$; (ii) $1 < \widetilde{n}(1) < N$.*

That $\widetilde{n}(p)$ is bounded below by 0 means that a female entrepreneur who elects to capitalize a business venture with the lowest degree of productivity (i.e., $p = 0$) faces no transaction cost whether or not she operates in autarky. However that $\widetilde{n}(1) > 1$, means that no female informal entrepreneur acting in autarky can avoid gender-specific transaction costs when she chooses to informally operate a business venture with the highest degree of productivity (i.e., $p = 1$).

Next, denote as $\phi(p, k)$ the gross revenue generated by a female informal entrepreneur who uses her loan, k, to invest in a business activity with degree of productivity, p. We make the following Assumption:

Assumption 3. *The function ϕ satisfies the following properties: for all p, and all k,*

$$(i) \qquad \phi_p > 0, \quad k \text{ given;}$$

$$(ii) \qquad \phi_k > 0, \quad p \text{ given;}$$

$$(iii) \qquad \phi_{pk} = \phi_{kp} > 0$$

$$(iv) \qquad \phi_{kk} < 0.$$

Assumption 3 states that the function ϕ is strictly increasing in p (property i) and in k (property ii). It also states that the function ϕ has increasing differences in (p, k) on the feasible domain (property iii), and that ϕ is strictly concave.

A. Choice of Business Size

In this subsection, we are interested in characterizing female entrepreneurs' choice of business size. Let r denote the rental rate of capital pre-determined by the assisting MFI. Denote as $\pi(k, p, \widetilde{r})$ the residual claimed by a female entrepreneur who operates an informal business venture with degree of productivity, p, and size, k, when the marginal cost of borrowing an additional unit of capital is

$$\widetilde{r} = r + \varphi(n, p)\, p, \tag{II.3}$$

where equation (II.3) makes use of equation (II.1). Therefore we can write $\pi(k, p, \widetilde{r})$ as follows:

$$\pi(k, p, \widetilde{r}) = \phi(p, k) - \widetilde{r}k. \tag{II.4}$$

Next, consider a female informal entrepreneur decision problem. Given the pair (n, r), a typical female informal entrepreneur sequential decision problem is to choose (i) the degree of productivity, p, of the business she plans to run, and (ii) the loan level, $k \in [\underline{k}, \bar{k}]$, necessary to capitalize the venture. Her objective is to maximize her residual claim defined in (II.4). It will be assumed that each female entrepreneur solves her three-stage problem by backward induction.

Let $K(p, \widetilde{r}) \equiv \arg\max_k \pi(k, p, \widetilde{r})$ be the optimal loan size chosen by a female informal entrepreneur when the state of the world is described by the pair $(p, \widetilde{r})$. And suppose that this optimal loan size is interior. The *Implicit function theorem* may be applied to establish the following result:

Lemma 1. *Let Assumption 3 hold. Then*

$$(i) \qquad \frac{\partial}{\partial p} K(p, \widetilde{r}) \; > \; 0.$$

$$(ii) \qquad \frac{\partial}{\partial \widetilde{r}} K(p, \widetilde{r}) \; < \; 0.$$

Part (i) of Lemma 1 states that if a female entrepreneur plans to run a more productive activity, it is optimal for her to increase her demand for capital, otherwise she will not maximize the return to entrepreneurship. Part (ii) states that a return-maximizing female entrepreneur will always reduce her demand for capital as a result of an exogenous increase in the marginal cost of capital. Lemma 1 will prove useful for characterizing a female informal entrepreneur's choice of the degree of productivity of the business venture she plans to operate. Since all women in this environment have access to credit, we characterize this choice as dependent upon relevant socioeconomic characteristics of the environment in which these women live.

B. Choice of Business Activity by Female Informal Entrepreneurs

In this subsection we study a female informal entrepreneur's choice of the degree of productivity, p, of the business venture she plans to operate in an environment where a collective action by women entrepreneurs is necessary to eliminate gender-specific transaction costs that severely constrain this choice. We assume that the objective pursued through such a choice is the maximization of the return to entrepreneurship.

Let $\hat{\pi}(n, p) \equiv \pi[K(p, \widetilde{r}), p, \widetilde{r}]$ denotes the return to entrepreneurship earned by a female entrepreneur who joins a business network of size n when she chooses an activity with degree of productivity, p. Then

$$\hat{\pi}(n, p) = \phi[p, K(p, \widetilde{r})] - \widetilde{r} K(p, \widetilde{r}) \tag{II.5}$$

with $\widetilde{r}$ as defined in (II.3). The following proposition formalizes the incentive for female entrepreneurs to operate business ventures with a high degree of productivity.

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Proposition 1. *Let Assumptions 1-3 hold. If $n > \widetilde{n}(p)$, for all $p \in [0,1]$, then $\arg\max_p \bar{\pi}(p) = 1$.*

Proof. Observe that if $n > \widetilde{n}(p)$, for all $p \in [0,1]$, then $\varphi(n,p) = 0$, and, using (II.5), it can be shown that the return to entrepreneurship earned by a typical female informal entrepreneur reduces to

$$\bar{\pi}(p) = \phi[p, K(p,r)] - rK(p,r). \tag{II.6}$$

Therefore, it suffices to establish that $\bar{\pi}'(p) > 0$, for all p. The proof follows directly from the application of the *envelope theorem* to (II.6) given that Assumptions 1-3 hold simultaneously·

Proposition 1 states that if gender-specific transaction costs were to be eliminated (i.e., $n = N$), access to credit would provide female entrepreneurs with an incentive to tap into the range of highly productive informal activities usually controlled by men. In other words, a return-maximizing female informal entrepreneur will always select a business activity with degree of productivity, $p = 1$. Proposition 2 therefore highlights the importance for women, as a group, to overcome patriarchal forms of business regulations that put them at a comparative disadvantage in managing highly productive informal activities. When such forms of business regulations are overcome by women, the optimal return to entrepreneurship is given by

$$\bar{\pi}(1) = \phi[1, K(1,r)] - rK(1,r). \tag{II.7}$$

Now, suppose instead that for some reason, no female entrepreneur can link up with enough other female entrepreneurs in a business network when she chooses to run an activity with degree of productivity, $p \in [0,1]$. In other words, $n \leq \widetilde{n}(p)$, for all $p \in [0,1]$. How would this fact affect her optimal decision on the level of p? The following proposition provides an answer to that question:

Proposition 2. *Let Assumptions 1-3 hold simultaneously. Suppose in addition that for*

all feasible pairs (p, k)

$$\phi_p \leq \delta \underline{k}. \tag{II.8}$$

If

$$n \leq \widetilde{n}(p), \tag{II.9}$$

for all $p \in [0, 1]$, *then* $\arg \max_p \hat{\pi}(n, p) = 0$.

Proof. Observe from (II.5) that if $n \leq \widetilde{n}(p)$, the return to entrepreneurship becomes

$$\underline{\pi}(p) = \phi[p, K(p, r + \delta p)] - [r + \delta p] K(p, r + \delta p). \tag{II.10}$$

It then suffices to show that $\underline{\pi}(.)$ is a strictly decreasing function. The proof follows as an implication of the *envelope theorem,* using condition (II.8). Hence the maximum obtains at the corner $p = 0$.

Condition (II.8) states that, when they exist, gender-specific transaction costs, as measured by the lower bound, $\delta \underline{k}$, are sufficiently high. Proposition 2 formalizes the observed overrepresentation of women entrepreneurs in low-productivity informal activities. It explains this overrepresentation by the prevalence in the informal economy of patriarchal forms of business regulations that substitute for the absence in that economy of legal means for enforcing contracts. A very important remark follows from Proposition 2. As an implication of Proposition 2, the optimal return to entrepreneurship when $\widetilde{n}(p) \geq n$, for all p is

$$\underline{\pi}(0) = \phi[0, K(0, r)] - rK(0, r) \tag{II.11}$$

To highlight the empowerment potential of microfinance, it is important to obtain a ranking of the returns $\bar{\pi}(1)$ and $\underline{\pi}(0)$ as defined by Equations (II.7) and (II.11), respectively. The following result obtained as a corollary to Proposition 1.

Corollary 1. *Given* r *as pre-determined by the microfinance institution, the following inequality obtain:*

$$\underline{\pi}(0) < \bar{\pi}(1). \tag{II.12}$$

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Corollary 1 formalizes female entrepreneurs' incentive to use their access to credit in order to capitalize informal activities with a high degree of productivity. In other words, if all female entrepreneurs knew that enough other female entrepreneurs will choose to capitalize an activity of type $p = 1$—which is the informal activity with the highest degree of productivity—they will each elect to capitalize that activity because it maximizes their return to entrepreneurship: $\bar{\pi}(1) > \underline{\pi}(0)$. However, since each woman is anonymous, she may not know, prior to choosing any activity p, how many other women will link up with her in the business network spanned by that activity. If she chooses $p = 1$, on the basis that $\underline{\pi}(0) < \bar{\pi}(1)$, she may indeed earn a return $\bar{\pi}(1)$, if the total number, n, of female entrepreneurs in the business network spanned by activity $p = 1$ is large enough: $n > \widetilde{n}(1)$. However, if $n \leq \widetilde{n}(1)$, then she will earn a return

$$\underline{\pi}(1) = \phi\left[1, K\left(1, r + \delta\right)\right] - \left(r + \delta\right) K\left(1, r + \delta\right), \tag{II.13}$$

which, by proposition 2, is less than $\underline{\pi}(0)$:

$$\underline{\pi}(1) < \underline{\pi}(0)$$

since $\underline{\pi}(p)$ is a decreasing function of p.

Whether or not $n > \widetilde{n}(1)$ becomes crucial for the optimality of the business strategy of choosing $p = 1$. Thus, a typical female entrepreneur's decision whether or not to capitalize an activity of type $p = 1$ becomes a strategic reaction to what other female entrepreneurs choose as their business strategy. In other words, women's activity choice strategies are complement. How many women will choose to use their access to credit in order to tap into activities of type p can therefore be viewed as the outcome of a non-cooperative game between the N women living in the targeted environment. In what follows, we analyze the women's activity choice game in its normal form.

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C. The Activity Choice Game

Each woman entrepreneur is indexed by i, with $i \in I$, where $I = \{1, ..., N\}$ denotes the set of women living in this environment. On the basis of Propositions 1 and 2, women in this environment have a choice between two types of informal activities: either a low-productivity one indexed by 0, or a high-productivity one indexed by 1. Thus, we can define $P_i = \{0, 1\}$ as the strategy set for woman $i \in I$, with generic element $p_i \in P_i$. We interpret p_i as woman i's activity choice strategy.

Let $P = \times_{i \in I} P_i$ denote the strategy space, whose elements $p = (p_i, p_{-i}) \in P$ define a strategy profile of the activity choice game. Let $P_{-i} = \times_{\{j \in I; \ j \neq i\}} P_j$ be the set of feasible joint strategies for all women other than woman i, with generic element $p_{-i} \in P_{-i}$. Observe that since P_i is finite for all i, P is also finite and contains a total of 2^N elements.

C.1. The Payoff Function

To construct each player's payoff function, we make use of expressions (II.7), (II.11), and (II.13). On the basis of Propositions 1 and 2, if player i selects the activity choice strategy $p_i = 0$, she will earn a payoff $\underline{\pi}(0)$ as specified by (II.11), irrespective of the activity choices of other players, because $\underline{\pi}(0) = \bar{\pi}(0)$. In contrast, if she plays the strategy $p_i = 1$, she will earn a return $\Pi(n)$ depending upon the strategy profile selected by her rivals, where

$$\Pi(n) = \begin{cases} \bar{\pi}(1) & \text{if } n > \widetilde{n}(1) \\ \underline{\pi}(1) & \text{if } n \leq \widetilde{n}(1) \end{cases} \tag{II.14}$$

Observe that since $\underline{\pi}(1) < \underline{\pi}(0) < \bar{\pi}(1)$, clearly playing the strategy $p_i = 1$ is never a dominant strategy for any player of this game.

Now, let $V_i : P \to \Re$ denote woman i's payoff function. Therefore, we can define a typical woman-entrepreneur payoff as follows:

$$V_i(p_i, p_{-i}) = p_i \Pi(n) + (1 - p_i) \underline{\pi}(0) \tag{II.15}$$

where

$$n = \sum_{j=1}^{N} p_i \qquad \text{(II.16)}$$

denotes the size of the network of female entrepreneurs who choose to play the activity choice strategy $p_i = 1$. Thus, if woman i plays the strategy $p_i = 0$, she will gain a payoff

$$V_i(0, p_{-i}) = \underline{\pi}(0),$$

irrespective of what other women do. However, if she plays $p_i = 1$, she will gain a payoff

$$V_i(1, p_{-i}) = \Pi(n),$$

which is dependent upon the level of n as determined by the the strategy profile p_{-i} selected by players other than player i, where $\Pi(n)$ is as defined in (II.14).

A *non-cooperative normal-form game* is the triple $\Omega = \langle I, P, \{V_i : i \in I\} \rangle$, consisting of a non-empty set of players I, a set P of feasible joint decision strategies, and a collection of payoff functions $\{V_i : i \in I\}$. Since all players have identical strategy spaces ($P_1 = P_2 = ... = P_N$) and for all $i, j \in \{1, ..., N\}$, $V_i(p) = V_j(p)$, for all $i \neq j$, the normal-form game Ω is symmetric.

C.2. Nash-equilibria.

In this sub-section, we characterize the set of Nash equilibria when all women make their business-activity decision simultaneously. We define a pure-strategy Nash equilibrium in terms of the payoffs players receive from various strategy profiles:

Definition 1. *A pure-strategy profile $p^* \in P$ is a Nash equilibrium of Ω if and only if*
$$V_i(p^*) \geq V_i(p_i, p_{-i}^*) \text{ for all } p_i \in P_i \text{ and all } i \in I.$$

Let $\aleph_\Omega$ denote the set of Nash equilibria of the game. Let $p^L \in P$ and $p^H \in P$ be feasible strategy profiles, where p^L (respectively p^H) is the strategy profile such that each woman

$i \in I$ chooses an activity of type $p_i = 0$ (respectively $p_i = 1$). The following proposition is proved in Appendix A.

Proposition 3. *Let Assumptions 1-3. Then,* $\left\{ p^L, p^H \right\} \in \aleph_\Omega$.

Proposition 3 states that the strategy profile where all women elect to stay within the confine of low-capital, less productive economic activities (i.e., the profile p^L) and the one where all of them elect to tap into high-capital, high-productivity activities (i.e., the profile p^H) belong to the set of Nash-equilibria of the women's business-decision game, Ω.

Before we proceed to derive further policy implications from the above result, we must address the question of whether the strategy profiles p^L and p^H are indeed the only stable equilibria of the symmetric game, Ω. To address this issue, we first show that Ω is a supermodular game (Milgrom and Roberts, 1990), also known as a game characterized by strategic complementarities.

Definition 2. *(Milgrom and Roberts* [1990]*)* Ω *is a supermodular game, if for all* i,

(i) P_i *is a compact subset of* $\Re$;

(ii) V_i *is upper semi-continuous in* p_i, *for each fixed* p_{-i};

(iii) V_i *is continuous in* p_{-i}, *for each fixed* p_i;

(iv) V_i *has a finite upper bound*;

(v) V_i *has increasing differences in* (p_i, p_{-i}) *on* $P_i \times P_{-i}$.

In particular, property (v) of Definition 2 implies that for a player i, the incremental gain from taking her highest action is higher, when players other than herself also take their highest action: for all $p_i' > p_i$ and all $p_{-i}' > p_{-i}$,

$$V_i \left(p_i', p_{-i}' \right) - V_i \left(p_i, p_{-i}' \right) \geq V_i \left(p_i', p_{-i} \right) - V_i \left(p_i, p_{-i} \right).$$

Our interest in supermodular games stems from several crucial properties these games have. First, the main characteristic of models with strategic complementarities is the

possible presence of multiple equilibria, creating the possibility for coordination failures (Diamond, 1982; Cooper and John, 1988). Second, with a supermodular game, there is no need to rely on mixed-strategies for the existence of a Nash equilibrium, as existence of equilibrium of such game does not require continuity of best response functions (i.e., application of Tarski's *fixed point theorem*). Third, as an implication of supermodularity, we can restrict the search for equilibria to pure-strategy Nash-equilibria. only, since mixed-strategies equilibria, when they exist, are unstable (Echenique and Edlin, 2004).

To show that the women's business-decision game, Ω, is supermodular, it suffices to prove that properties $(i) - (v)$ above are satisfied. The following Proposition, which is proved in Appendix B, establishes this result.

Proposition 4. *Under Assumptions 1-3, the symmetric game Ω, is supermodular.*

Proposition 4 implies that conditions underlying *Topkis' theorem* apply so that for the game Ω, women's best replies are increasing in opponents' actions: for each

$$\beta_i \left(p_{-i} \right) \in \arg \max_{p_i} V_i \left(p \right),$$

and for all $p'_{-i} > p_{-i}$, $\beta_i \left(p'_{-i} \right) \geq \beta_i \left(p_{-i} \right)$, all i.

Now since the $\beta_i \left(p_{-i} \right)$ are increasing, to rule out asymmetric pure-strategy Nash equilibria, we show in the following Lemma—which we prove in Appendix C—, that women's best reply are single-valued correspondences (i.e., each β_i is a function):

Lemma 2. *Let $\beta_i \left(p_{-i} \right) = \{p_i : p_i \in \arg \max_{p_i \in P_i} V_i \left(p_i, p_{-i} \right)\}$, for all i, given p_{-i}. Then, under Assumptions 1-3, $\beta_i \left(p_{-i} \right)$ is a singleton.*

Lemma 2 states that players best replies are single-valued. This result, combined with our above application of Topkis' theorem rules out the existence of asymmetric pure-strategy Nash equilibria for the women's occupational choice game. Hence the following Proposition:

Proposition 5. *Under Assumptions 1-3, $\left\{ p^L, p^H \right\} = \aleph_\Omega$.*

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Proposition 5 states that the strategy profile where all women elect to stay within the confine of low-productivity economic activities and the one where all of them elect to tap into high-productivity activities are the only pure-strategy Nash-equilibria of the activity-choice game, Ω. This multiplicity of equilibria suggests a potential role for a deliberate action to select one of the equilibria. Such deliberate action is desirable, however, only if the two equilibria can be ranked according to the Pareto principle. The following Proposition establishes this ranking.

Proposition 6. *Under Assumptions 1-3, the symmetric pure-strategy profile p^H Pareto dominates the profile p^L.*

Proof. To prove this Proposition, it suffices to show that for all $i \in I$, and for all $p_i \in P_i$, $V_i\left(p^H\right) - V_i\left(p^L\right) > 0$. Let $\Delta_i \equiv V_i\left(p^H\right) - V_i\left(p^L\right)$. From the definition of the payoff function V_i, the difference Δ_i reduces to

$$\Delta_i = \bar{\pi}\left(1\right) - \underline{\pi}\left(0\right)$$

Since $\widetilde{n}\left(1\right) \in (1, N)$, by Assumption 2, the result simply follows from Corollary 1. This completes the proof.

Proposition 6 states that the strategy profile where all women elect to operate high-productivity business ventures in the informal economy is strictly preferred to the one where all women elect to stay within the confine of low-productivity activities. Because the high-income equilibrium (i.e., p^H), is counter-intuitive in many poor countries where women are generally confined to low-productivity business activities, our analysis therefore suggests that in these societies, coordination failures in women's activity choice decisions are to be blamed. Such a coordination failure prevents women from creating large enough business networks likely to enable them to overcome patriarchal forms of business regulations that put them at a comparative disadvantage, relative to men, at managing high-productivity business ventures in the informal economy.

III. Concluding Remarks

This paper had two important related goals. The first was to explore the implications for women's choice of activity and demand for capital, of the interaction between economic and social factors. Improved access to credit and informality were the main economic factors underlying women's business decision in our model, while the prevalence in the informal economy of patriarchal forms of business regulations highlights the social context underlying this decision. The second goal was to investigate necessary and sufficient conditions for microfinance to nurture empowerment for women. We drew from the existing literature in assuming that women's earned income from entrepreneurship was a determining factor of their empowerment. For that purpose, we use a game-theoretic framework featuring a supermodular game of activity choice between ex ante homogenous female entrepreneurs. We demontrated that this game admits two pure-strategy, Pareto-ranked, symmetric Nash-equilibria as its only possible outcomes. The equilibrium where all women elect to operate high-productivity business ventures in the informal economy was shown to be strictly preferred to the one where all of them elect to stay within the confine of low-productivity activities. Therefore, whereever microfinance has failed to empower women—in the sense of enhancing their involvement in high-productivity activities—, we concluded that it may be because of coordination failure that prevent women from creating business networks large enough to mitigate patriarchal forms of business regulations that put them at a comparative disadvantage, relative to men, at managing high-productivity business ventures. We found that a sufficient condition for MFIs to succeed in nurturing female empowerment is that women's access to credit be conditioned to their adoption of high-productivity informal activities. Such conditionality will act as a coordination mechanism, allowing female entrepreneurs to organize in large enough networks that raise women's gains from operating high-productivity activities in the informal economy. The role of these networks will be to mitigate patriarchal practices that raise the costs of operating such activities. Finally, our analysis shows the importance of including the social context underlying the implementation of development projects targeted at women.

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Appendix

A. Proof of Proposition 3.

The proof is divided in two claims:

Claim 1 *The strategy profile $p^L = \left(p_1^L, ...p_i^L, ...p_N^L \right)$ such that $p_i = 0$ for all $i \in I$, is a pure-strategy Nash equilibrium of Ω.*

Proof: Using (II.15) and the definition of a Nash-equilibria, it follows from definition 1 that, the profile p^L is a pure-strategy SNE of Ω if and only if the following condition is always satisfied for all i:

$$\underline{\pi}\left(0\right) - \Pi\left(1\right) \geq 0 \tag{III.1}$$

Since $\widetilde{n}\left(1\right) > 1$, the result then clearly follows from the strictly decreasing property of the function $\underline{\pi}$ (as an implication of proposition 2), i.e., $\underline{\pi}\left(0\right) > \underline{\pi}\left(1\right)$. Hence the result

Claim 2. *The strategy profile $p^H = \left(p_1^H, ...p_i^H, ...p_N^H \right)$ such that $p_i = 1$ for all $i \in I$, is a pure strategy NE of Ω*

Proof: With inequality (II.12) in hands, the proof follows in the same manner as in claim 1. This completes the proof of proposition 3.

B. Proof of Proposition 4.

To prove proposition 4, first, observe that for all i, $P_i = \left\{ 0, 1 \right\}$, is clearly a compact subset of $\Re$, since p_i is closed and bounded. Therefore property (i) of a supermodular game is trivially satisfied. Second, to establish property (ii) and (iii), it suffices to prove the following claim:

Claim 1. *For all $i \in I$, the function $V_i : P \to \Re$, is continuous on P, where $P = \times_{i \in I} p_i$.*

Proof. Since p_i is finite for all i, therefore P is also finite, as the Cartesian product of a finite number of finite sets. Indeed, P has cardinal equal to 2^N, which is finite, since N is a finite number. Therefore, by theorem[8], V_i is continuous on P. This establishes property (ii) and (iii) of a strictly supermodular game.

Third, to establish property (iv), it suffices to prove the following claim:

Claim 2. *For all $i \in I$, the function $V_i : P \to \Re$, attains a maximum on P.*

Proof. Since the set of feasible joint strategies reduced to P is finite and has no more than 2^N elements, we also have that $V_i(P) \subset \Re$ is also finite; and finite subsets of $\Re$ always contain their upper and lower bounds. It therefore follows that, V_i has a finite upper bound on P. This completes the proof of this claim.

Fourth, the following claim establishes property (v).

Claim 3. *Under assumptions 1-3, the function $V_i : P \to \Re$ has increasing differences in (p_i, p_{-i}) on $P_i \times P_{-i}$: for all $i \in I$, for all $p'_i > p_i$ and $p'_{-i} > p_{-i}$,*

$$V_i\left(p'_i, p'_{-i}\right) - V_i\left(p_i, p'_{-i}\right) \geq V_i\left(p'_i, p_{-i}\right) - V_i\left(p_i, p_{-i}\right) \tag{III.2}$$

Proof. Let $p'_i > p_i$ and $p'_{-i} > p_{-i}$ and suppose,

$$V_i\left(p'_i, p'_{-i}\right) - V_i\left(p_i, p'_{-i}\right) < V_i\left(p'_i, p_{-i}\right) - V_i\left(p_i, p_{-i}\right). \tag{III.3}$$

Observe that inequality (III.3) can also be written as follow:

$$V_i\left(p'_i, p'_{-i}\right) - V_i\left(p'_i, p_{-i}\right) < V_i\left(p_i, p'_{-i}\right) - V_i\left(p_i, p_{-i}\right). \tag{III.4}$$

all $i \in I$.

Since $p_i \in \{0, 1\}$, take $p'_i = 1$ and $p_i = 0$. Then, using the definition of $V_i(.)$, it can be shown that the strict inequality (III.4) reduces to

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[8]**Theorem** (continuity with opened sets): Any function defined on a finite set is continuous.

$$\Pi\left(n'\right) - \Pi\left(n^*\right) < 0. \tag{III.5}$$

where

$$
\begin{aligned}
n' &= 1 + \sum_{j \neq i} p'_j \\
n^* &= 1 + \sum_{j \neq i} p_j
\end{aligned}
$$

Since $p'_{-i} > p_{-i}$, its follows that $n' > n^*$ by construction. Now, if $n^* < n' < \widetilde{n}\left(1\right)$, then from (II.14), it follows that $\Pi\left(n'\right) - \Pi\left(n^*\right) = 0$ and we reach a contradiction. If $n^* < \widetilde{n}\left(1\right) \leq n'$ instead, then (III.5) reduces to

$$\bar{\pi}\left(1\right) - \underline{\pi}\left(1\right) < 0. \tag{III.6}$$

By using the *Envelope theorem,* one can easily show that inequality (III.6) leads to a contradiction, since $\delta > 0$ (i.e., since $r < \widetilde{r}$, by construction). Hence the result. This completes the proof of proposition 4.

C. Proof of Lemma 2.

To prove Lemma 2, it suffices to show that given $p_{-i} \in P_{-i}$, and for all pairs $\left(p_i^L, p_i^H\right) \in P_i \times P_i$ such that $p_i^L \neq p_i^H$, $V_i\left(p_i^L, p_{-i}\right) \neq V_i\left(p_i^H, p_{-i}\right)$. Suppose by way of contradiction that for some $i \in I$ and for some $\widehat{p}_{-i} \in P_{-i}$, we have

$$V_i\left(p_i^L, \widehat{p}_{-i}\right) = V_i\left(p_i^H, \widehat{p}_{-i}\right). \tag{III.7}$$

Since $P_i = \{0, 1\}$, take $p_i^L = 0$ and $p_i^H = 1$. Then, we can rewrite (III.7) as follows:

$$V_i\left(0, \widehat{p}_{-i}\right) = V_i\left(1, \widehat{p}_{-i}\right),$$

which, using the definition of function V_i, reduces to

$$\underline{\pi}(0) = \Pi(\widehat{n}), \tag{III.8}$$

where

$$\widehat{n} = 1 + \sum_{j \neq i} \widehat{p}_j$$

Now, if $\widehat{n} < \widetilde{n}(1),$ then equality (III.8) reduces to

$$\underline{\pi}(0) = \underline{\pi}(1), \tag{III.9}$$

which is a contradiction since by Proposition 2, $\underline{\pi}(.)$ is a decreasing function, i.e., $\underline{\pi}(0) > \underline{\pi}(1)$. If $\widehat{n} \geq \widetilde{n}(1)$, then (III.8) reduces

$$\underline{\pi}(0) = \bar{\pi}(1),$$

which contradicts inequality (II.12). Hence the result.

IV. References

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