Risk Transfer versus Cost Reduction on Two-Sided Microfinance Platforms

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Abstract:

Although microfinance can be an important tool for fighting global poverty by increasing access to loans and possibly lowering interest rates, the dominant mechanism used by online microfinance platforms in which intermediaries administer loans has profound implications for borrowers. Using an analytical model of microfinance with intermediaries who disburse and service loans, we demonstrate that profit-maximizing intermediaries have an incentive to increase interest rates because much of the default risk is transferred to lenders. Borrower and lender interest rate elasticities can serve as disciplining mechanisms to mitigate this interest rate increase. Using data from Kiva.org, we find that interest rates do not affect lender decisions at Kiva, which removes one of these disciplining mechanisms. With the low observed default risk in most geographic regions, the estimated demand elasticity of -0.825 is sufficiently large for the downward forces on interest rates to outweigh the upward default-risk transfer force, if administrative costs are small. However, some areas exhibit high default rates and in North America, where default rates are 1.53%, the average loan APR is well above the average, indicating that rates may be higher due to the transfer of risk to lenders.

Keywords: Microfinance, Crowdfunding, Two-Sided Platforms, Lending, Pricing, Risk Transfer

JEL codes: D21, D22, D47, D53, L11, L2, L3

"The engine of the capitalist system is supposed to be fueled by greed . . . We must envision a world which has not only greedy people, but also people with strong feelings for their fellow human beings... Both types of people can be in the same market place, using the same tools and concepts of capitalism but pursuing completely different goals." – Muhammad Yunus, Founder, Grameen Bank

1 Introduction

Public interest in microfinance has rapidly increased in recent years as a potential solution to world poverty. Microfinance is the extension of small loans to high-risk borrowers who usually lack collateral, where each loan provided is a small amount, often by non-traditional lenders. In 2007, a Deutsche Bank report estimated that over 10,000 microfinance institutions existed in 2006, including credit unions, NGOs, cooperatives, government agencies, and private and commercial banks, funding $25 billion in loans in that year alone (Dieckmann, 2007). Meanwhile, crowdfunding has exploded in the past decade and also become an important funding source for microfinance.[1] Crowdfunding, defined as many entities providing funding together to accomplish a specific goal, grew by 350% between 2007 and 2012, and raised $2.7 billion in 2012 alone.[2]

Online microfinance platforms match lenders to borrowers in developing nations with the goal of providing funding to small businesses and individuals who do not have easy access to capital. Nearly all of these platforms utilize local field partners (FPs),[3] lending agencies in the countries of the loan borrowers which actually disburse and administer the loans. These FPs act as intermediaries between lenders and borrowers. The microfinance platforms are usually non-profit organizations that do not charge interest or take a cut of any of the lent money, but the same cannot be said of the FPs. The FPs do collect interest on the loans (reportedly to cover costs of administration), and these FPs are for the most part for-profit firms. As borrowers repay their loans, the payments

[1] Crowdfunding is a specific type of crowdsourcing, a general term that implies a group of people is essential in accomplishing the end goal but does not require the contributions to be monetary in nature.

[2] Source: "Crowdfunding Industry Report: Market Trends, Composition and Crowdfunding Platforms," 2012, www.crowdsourcing.org.

[3] Zidisha is the only microfinance platform of which we are aware that connects borrowers directly to lenders without intermediaries. According to their website, "Zidisha's direct person-to-person connection results in far lower cost for the entrepreneurs, and a more transparent and interesting experience for lenders. Our first-of-its-kind direct lending platform ensures that the profits go to the entrepreneurs (no cut of it goes to a bank or other intermediary)." Interest rates on Zidisha are on the order of 5%, in contrast to rates on Kiva which are over 30%.

are divided between the online lenders (to cover the initial principal) and the FPs, where the latter receive interest on the loans.

The fact that microfinance institutions such as Kiva provide free capital for FPs makes lending through Kiva very attractive, which can lower interest rates due to a reduction in lending costs (and also inject more capital into the ecosystem which can be lent out to other borrowers). The extent to which rates might decline depends on the borrowers' demand elasticity and lenders' lending elasticity. The main contribution of our paper is that we explicitly consider a previously ignored force that can *increase* interest rates. This force exists in the context of microfinance because, without microfinance, FPs receive principal and interest over time and only make a profit on a loan if enough payments are made before the borrower defaults (or if the borrower pays off the loan). The fact that default risk increases with interest rates can keep interest rates in check.[4] However, for loans funded through microfinance platforms, the FPs have no break-even time (ignoring the negligible costs of posting), because the lenders immediately repay the principal. The FPs then receive the interest over time. Because so much of the default risk is transferred to the lenders, the FPs have an incentive to charge higher rates to maximize the expected interest payments (rather than the combined interest and principal payments).

We analytically demonstrate that the standard loan-repayment mechanism used by microfinance sites can lead to a perverse incentive for FPs to charge higher interest rates on loans than they would in the absence of microfinance if this risk-transfer force is sufficiently high – a problem of moral hazard. By modeling the pricing incentives for profit maximizing FPs, we demonstrate the tradeoff between cost reduction and risk reduction. Using data from one of the largest microfinance platforms, Kiva.org, we establish that interest rates set by Kiva's FPs imply they are maximizing profits rather than behaving in an altruistic manner. We find that one of the disci-

[4] Despite the high interest rates associated with microfinance, the average default rates across FPs and time are relatively low in our data (below 2%). The distribution of default rates, however, is extremely skewed. In some cases the default rates exceed 20% and the maximum is greater than 50%. One possible reason is that other disciplining devices may keep interest rates (and thus default rates) in check, including group liability, dynamic incentives (if borrowers plan to borrow in the future), high default costs associated with reputation effects and/or public shaming, and mechanisms of repayment that often involve frequent, small payments and loan collection occurring in group meetings (Banerjee, 2013). Additional disciplining mechanisms which may keep interest rates low include moral hazard on the borrower side if administration costs increase with interest rates (Banerjee and Duflo, 2010) , and FP reputation regarding social outcomes. Finally, because we are in a setting in which FPs have market power (unlike in many finance settings), the demand elasticity itself can serve as the disciplinary device; indeed, in the rare situations in which interest rates are low, such as the case of the Bolivian microfinance industry, the market is highly competitive - more competition increases demand elasticity, which increases the downward force on interest rates.

plining mechanisms, lenders' lending elasticity, is negligible because loan APRs have no impact on lenders' lending decisions.[5] The FPs can essentially monetize the altruism displayed by the other agents in the ecosystem. The remaining downward force on interest rates from the demand elasticity likely outweighs the upward force from default-risk transfer for most loans on Kiva, but this is not necessarily true in all geographic areas or for all microfinance platforms, given the considerable heterogeneity in default rates across FPs. We show that an alternative repayment mechanism would eliminate the force pushing interest rates higher altogether, mitigating the issue.

The rest of this paper is organized as follows: In the next section, we discuss the institutional details and relevant literature. In section 3, we present the analytical model of FP lending to demonstrate the tradeoffs that profit-maximizing FPs face in setting interest rates. In section 4, we provide an empirical analysis to test the assumptions of our analytical model, and show that Kiva's FPs behave in profit-maximizing behavior with respect to interest rates. We further estimate elasticities of demand, lender lending, and default rates with respect to interest rates, to be used in our simulations. In section 5, we use simulations under a range of parameters to show the extent to which FPs increase or decrease interest rates relative to the case with no microfinance, and we find that at the estimated parameters, interest rates are likely to be lower due to the presence of microfinance. In section 6, we provide our concluding remarks.

2 Background

Micro-lending has its origin in Bangladesh and was started by economist and Nobel Peace Prize Laureate Muhammad Yunus who noted that the lack of physical collateral among the poor could be replaced by social capital. The idea behind the Grameen Bank, which he founded in 1976, was that borrowers who joined self-organized groups would apply internal peer pressure on each other to repay their debts. According to Zephyr (2004), "The Bank evolved in a culture where abject poverty and self-employment were both prevalent and connected, leading to readily available human capital in the form of entrepreneurial spirit." The ascendancy of micro-lending has unsurprisingly led to research on the diffusion of microfinance and its efficacy in improving health, education, and business

[5] One reason lenders do not pay attention to interest rates is that they can never receive interest on their loans, and so they must participate for altruistic reasons.

outcomes (Banerjee et al., 2013, 2015a). See Banerjee (2013) for an excellent review of what has been learned over the past 20 years.

To understand the implications of the repayment mechanism on FP behavior, an understanding of why lenders participate in crowdfunding is important because lender decisions affect optimal FP behavior. Whether the decision to lend is a financial investment decision, a charitable act, or some combination of the two is a priori unclear. Not surprisingly, there is a rapidly growing literature across the fields of finance, accounting, economics, and marketing on peer-to-peer lending. This literature examines how lenders make inferences based on information (not always verifiable) posted by borrowers and decisions by other lenders (Michels, 2012; Zhang and Liu, 2012; Iyer et al., 2015), and also studies the drivers of their lending decisions including potential discrimination (Pope and Sydnor, 2011; Ravina, 2012), the role of social networks (Lin et al., 2013; Wei et al., 2016), the appearance of trustworthiness (Duarte et al., 2012), and the perceived features of a loan on its likelihood of being granted (Burtch et al., 2013).[6] Agrawal et al. (2011) find that, despite the geographic dispersion of lenders for specific loans, distance plays a role in lending decisions; local lenders are more likely to lend earlier and to be less influenced by others' lending decisions.

We use data from Kiva.org to test our theoretical predictions. As one of the largest microfinance sites and an early pioneer, Kiva was founded in 2005, and by mid-2012, almost 800,000 lenders had supplied over $330 million in loans in 62 different countries through Kiva. Galak et al. (2011), who also studied Kiva.org, found that lenders are more likely to lend to smaller groups, based on the hypothesis that an individual suffering hardship invokes a stronger emotional response than multiple people (Kogut and Ritov, 2005a,b). They also find that lenders will be more likely to lend to individuals with whom they have characteristics in common, because people care more for others with whom they have traits in common (Stotland and Dunn, 1963; Krebs, 1975), who are within their own group (Flippen et al., 1996; Kogut and Ritov, 2007), or who have suffered similar misfortunes as people to whom they are close (Small and Simonsohn, 2008). All of these findings are consistent with those found in the literature on charitable giving (Liu and Aaker, 2008; Aaker and Akutsu, 2009; Small and Verrochi, 2009). The consistency with the charitable giving literature is not surprising, because on Kiva, none of the interest a borrower pays goes to the lenders - the best the lenders can do financially is to be paid back their original principal. Because the primary

[6] Hulme and Wright (2006) provide a nice history of social lending on the internet.

reason behind lending decisions is likely to be altruism, loan characteristics such as interest rate may only be of second-order importance to lenders, in contrast to characteristics of the borrower.

The altruism of lenders is exactly what microfinance platforms tap into. As noted by Premal Shah, the president of Kiva, "Banks don't value emotional returns. So they will charge a high interest rate to these microfinance institutions. But people are a little more forgiving. Today, your average person can't actually invest in small businesses in the developing world. We're tapping into this new source of capital, which is ordinary people."[7] At the Tides Momentum Conference in 2008, Shah pointed out that only ten percent of people who get paid on Kiva actually withdraw the money, and that the rest then lend out again to other borrowers. In other words, lenders treat money they lend on Kiva as donations. However, although lenders give money to fund particular loans from specific borrowers, only 5% of Kiva loans are disbursed *after* being fully funded by lenders. In the vast majority of cases, the FP has already lent the money to the borrower using its own funds before posting the request on Kiva. What lenders actually do is to provide refinancing for FPs, as shown in Figure 1. This ability to refinance will lead the FPs to loan more money to higher-risk groups and individuals, especially to those borrowers who will appeal to lenders on Kiva, because once a loan is financed through Kiva, the intermediary FP receives interest payments but bears no risk of losing the original capital associated with the default of the loan.

One aspect of the microfinance mechanism that is absent from Galak et al. (2011) and this stream of research in general is the role of the FPs, the institutions that actually provide and service the loans. As previously mentioned, an FP has already funded a loan *before* it is listed on Kiva, as shown in Figure 1. Only if the FP decides to fund a loan request do lenders have the ability to support the individual or group requesting the loan. Therefore, a model of the FPs' funding decisions is necessary to assess the potential impact of microfinance in increasing access to affordable capital. The FPs have an incentive to grant loans to people who will get funded (in expectation) through Kiva, because only then does it transfer the default risk to lenders, while still obtaining a profit opportunity through interest payments.[8] And that incentive may not fully align with lenders' and Kiva's altruism motive. The current repayment mechanism at Kiva and other microfinance sites is such that the lenders immediately refinance FPs' pre-disbursed principals. The

[7] `http://www.pbs.org/frontlineworld/stories/uganda601/video_index.html`

[8] Factors that alter the FPs' expectation of loans being funded through Kiva, such as social and earned media exposures studied in Stephen and Galak (2012), will influence FPs' decisions to provide loans.

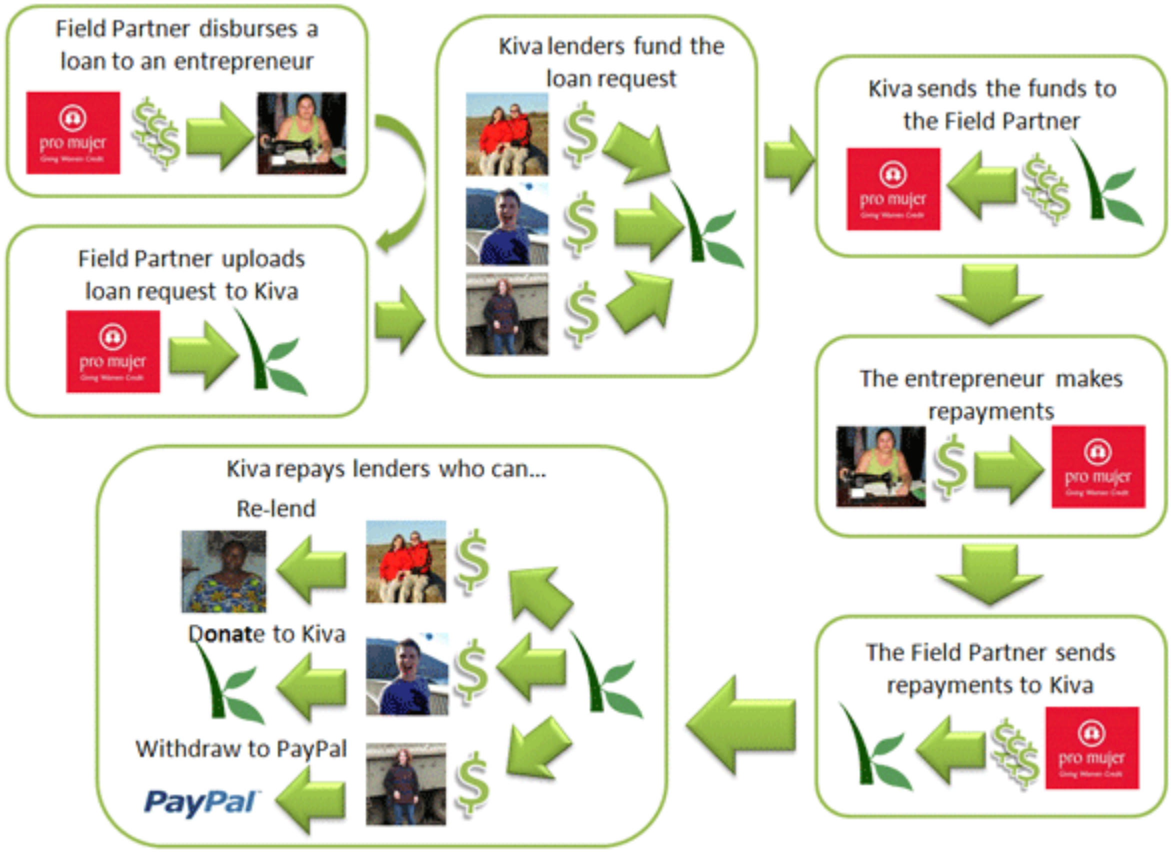


Figure 1: The Kiva Financing Diagram for FPs

FPs then collect principal and interest from borrowers over time, repaying lenders the principal, and keeping the interest. Due to such a repayment mechanism, if FPs are profit-maximizing, the loan agreement will be altered due to FPs' ability to refinance on Kiva. Indeed, the profit-maximizing objective of FPs is what we expect; Kent and Dacin (2013) describe how commercial-banking logic has displaced the foundational goal of poverty alleviation in microfinance over time, and Chu (2007) documents the high rates of return available on microfinance sites.

In the next section, we formally present the model of FP incentives in order to show the tradeoff FPs face when setting up the interests rates.

3 Model of Field Partner Incentives

In this section, we model and solve for an FP's optimal interest rate for any given loan. For an FP, funding loans through microfinance is an opportunity to refinance its outstanding loans. The timing involved in a microfinance loan (and on other microfinance sites) is as follows:

1. A borrower requests a loan from an FP.
2. The FP provides the terms of the loan (or deems the borrower not eligible).
3. The borrower decides whether to accept the terms of the loan.
4. If the loan is granted and accepted, the FP posts the loan on the microfinance platform.
5. Lenders may chose to "lend to the borrower."
6. If the amount of lent money is sufficient to cover the loan amount, the loan is funded through microfinance, which means the lenders pay the FP the principal of the loan.
7. Borrowers submit monthly payments, which are split between the lenders and FP to pay off the principal and interest, respectively.

3.1 Borrower Model

We first present a simple model to outline the basic tradeoff a borrower faces. Let us assume that a borrower has a Cobb-Douglas production function, which can be interpreted as either a small business or household production function. We assume the borrower is a price taker, and hence optimizing the output over the inputs also maximizes profits. Suppose the borrower can access some capital K_0 from some source other than the Kiva's FP (e.g., a local bank). Output q is given by:

$$\begin{aligned} q &= \alpha K_0^{\beta_1} L^{\beta_2} \qquad (1) \\ s.t.\ K_0 p_K + L p_L &\leq B \end{aligned}$$

where B is the borrower's budget constraint. p_K is the input price of capital K_0. L is the input of labor, and p_L is the corresponding price of labor. Solving equation 1, we can see that the optimal levels of capital and labor are $K_0^* = \frac{B\beta_1}{p_K(\beta_1+\beta_2)}$ and $L^* = \frac{B\beta_2}{p_L(\beta_1+\beta_2)}$, respectively.[9]

Now suppose that the borrower can only access non-Kiva capital up to the amount of $\overline{K}_0 < K_0^*$, and also has the option of getting a more expensive loan through the microfinance FP up to the amount of K, at the interest rate level of r, with a duration of T months. Accordingly, the monthly payment $p(r)$ is:

$$p(r) = \frac{Kr}{1 - \frac{1}{(1+r)^T}}. \tag{2}$$

In this formulation, the borrower should borrow K through the FP if doing so increases the output level more than the case of only borrowing up to $\overline{K}_0$, i.e.,

$$\alpha \overline{K}_0^{\beta_1}(L^* + (K_0^* - \overline{K}_0)\frac{p_K}{p_L})^{\beta_2} \quad < \quad \alpha\left(\overline{K}_0 + K\right)^{\beta_1}\left(L^* + (K_0^* - \overline{K}_0)\frac{p_K}{p_L} - K\frac{p(r)}{p_L}\right)^{\beta_2}\exp(\epsilon)$$

where we include a multiplicative stochastic term on the right hand side, which corresponds to the output level when borrowing extra capital from the microfinance FP. We can then write the probability of accepting the microfinance loan as:

$$y(r) = 1 - \Phi_\epsilon\left(\beta_1 \log\left(\frac{\overline{K}_0}{\overline{K}_0 + K}\right) + \beta_2 \log\left(\frac{L^* + (K_0^* - \overline{K}_0)\frac{p_K}{p_L}}{L^* + (K_0^* - \overline{K}_0)\frac{p_K}{p_L} - K\frac{p(r)}{p_L}}\right)\right) \tag{3}$$

where Φ_ϵ is the cumulative distribution function of ϵ, which we assume to be normally distributed.

Claim 1. The probability of accepting the Kiva loan, $y(r)$, is decreasing in the available outside capital $\overline{K}_0$.

Proof. See Appendix A. □

In other words, if the amount of lower-cost capital $\overline{K}_0$ increases, the borrower is less likely to accept the Kiva loan for any given interest rate, r.

[9] The optimal levels can be obtained by maximizing the Lagrangian, $\mathcal{L} = \log\alpha + \beta_1 \log K_0 + \beta_2 \log L + \lambda(B - K_0 p_K - L p_L)$.

3.2 FP Model

The profits for an FP of posting a loan mainly depend on the probability that the loan will be successfully funded by microfinance lenders, the interest rate and fees charged to the borrower, and the expected timing and number of payments the borrower makes. We follow Phillips (2013) by specifying the FP's net present value (NPV) of profits from future loan payments as:

$$p(r)\sum_{m=1}^{T}(\rho\delta(r))^m - p(r_0)\sum_{m=1}^{T}\rho^m, \tag{4}$$

where r is the interest rate the FP charges the borrower, and $p(r)$ is the corresponding monthly payment the FP receives from the borrower. ρ is the FP's discount factor, and $\delta(r)$ is the probability that the borrower will make the monthly payment. r_0 is the rate at which the FP can borrow money, so $p(r_0)$ is the monthly cost at which the FP borrows.

For notational convenience, let us define $F(r)$ as the expected discounted number of payments the borrower makes, i.e. $F(r) \equiv \sum_{m=1}^{T}(\rho\delta(r))^m$, which will be a function of the interest rate.[10] If there is no discounting (i.e., $\rho = 1$) and the borrower makes all monthly payments without uncertainty (i.e., $\delta(r) = 1$), this value would be equal to the duration of the loan, T; and if the borrower immediately defaults on the loan, it is equal to zero. Let us also define $\widetilde{K} \equiv p(r_0)\sum_{m=1}^{T}\rho^m + s(r_0)$ as the total cost of making a loan without refinancing through microfinance, which is a function of r_0. The shadow price, $s(r_0)$, reflects the added cost in granting the loan on the future cost of capital for the FP.

We can now rewrite expected profits for a commercially financed loan (without microfinance) by an FP at rate r as:

$$\pi^C(r) = F(r)p(r) - \widetilde{K}. \tag{5}$$

The main tradeoff for an FP in setting the interest rate r is that the monthly payment amount increases, but the expected discounted number of payments ($F(r)$) will decrease.

[10] We suppress the subscript for indexing FPs to avoid cluttering the notation.

In comparison, profits for a microfinance-funded loan are:

$$\pi^{Funded|M}(r) \quad = \quad F(r)\left(p(r) - \frac{K}{T}\right) - C, \tag{6}$$

where K is the loan amount. The FP receives monthly payments $p(r)$ from the borrower and also pays back the lenders with the monthly contribution to principal, K/T. C includes any extra costs of administering the loan. In this expression, we ignore the minimal lag time for an FP to receive the funding from lenders when the loan becomes funded through microfinance (in actuality, the FP supplies the loan amount to the borrower but the lenders pay back that amount as soon as the loan is funded, which happens within a month). When the loan is successfully refinanced through microfinance, the FP does not incur the cost of capital for the current loan or the shadow price that results from increasing its borrowing costs (i.e., $\widetilde{K}$).

Not all loans posted at Kiva can be successfully funded. Let $l(r)$ be the probability that a loan is successfully funded by lenders on Kiva conditional on being posted, which depends on both the borrower and FP characteristics as well as the interest rate r. We also define the lending elasticity as $\eta_l = \frac{\partial l(r)}{\partial r}\frac{r}{l(r)}$. Hence, the total expected profits for a loan posted are:

$$\begin{aligned} \pi^{M}(r) &= \pi^{C}(r)\left(1 - l(r)\right) + \pi^{Funded|M}(r)l(r) \\ &= \left(F(r)p(r) - \widetilde{K}\right)\left(1 - l(r)\right) + \left(F(r)\left(p(r) - \frac{K}{T}\right) - C\right)l(r) \\ &= \left(F(r)p(r) - \widetilde{K}\right) + \left(\widetilde{K} - F(r)\left(\frac{K}{T}\right) - C\right)l(r) \\ &= \pi^{C}(r) + \left(\widetilde{K} - F(r)\frac{K}{T} - C\right)l(r), \end{aligned} \tag{7}$$

where $F(r)\frac{K}{T}$ is the expected principal that will be paid back to lenders. Because $\widetilde{K} > F(r)\frac{K}{T}$, posting a loan is always more profitable than not posting if $C = 0$, even without re-optimizing over the interest rate.

We have not yet addressed the fact that once an FP offers a loan to a borrower, the borrower has the choice of whether or not to accept the loan. The borrower may choose the microfinance loan or some outside option to fulfill her capital need. We previously defined $y(r)$ as the probability that the borrower chooses the Kiva loan at the offered terms and now further define $\eta_y(r)$ as the demand elasticity of a borrower with respect to r. The expected profit for a loan the FP offers to a borrower is:

$$\pi(r) = y(r)\,\pi^M(r). \tag{8}$$

We assume the FP maximizes its profits over each loan; we do not include the loan specific subscript for readability. The impact across loans is captured by the shadow price. Taking the derivative of profits with respect to r, we can write the first-order condition as:

$$\frac{\partial \pi(r^*)}{\partial r} = \quad y(r^*)\left[\tfrac{\partial \pi^M(r^*)}{\partial r} + \tfrac{1}{r^*}\eta_y(r^*)\pi^{*M}(r^*)\right] \quad = 0. \tag{9}$$

It should be noted again that the optimal interest rates can be set for each individual loan.

In what follows, we will make the following assumptions:

Assumption 1: $\eta_y(r) < 0$

This assumes borrowers have a negative demand elasticity with respect to price (interest rate).

Assumption 2: $\eta_l(r) \leq 0$

This assumes the likelihood of a loan being funded through microfinance does not increase with the interest rate.

Assumption 3: $\frac{\partial F(r)}{\partial r} \leq 0$

This assumes the repayment probability does not increase with the interest rate.

Assumption 4: $\frac{\partial^2}{\partial r^2}\pi(r) \leq 0$

Here we assume profits are concave in r and therefore have a global maximum.

These assumptions are all standard and what we would expect a priori. In addition, we test the validity of the first three assumptions in our empirical analysis (section 4) and find they all hold in practice.

Proposition 1. *Let r_C be the optimal interest rate for a commercially funded loan. The optimal interest rate of a loan posted on Kiva is higher than if it had not been posted on Kiva iff:*

$$r_C \left| F'(r_C)\frac{K}{T} \right| > \left| \eta_y(r_C)\left(\widetilde{K} - F(r_C)\left(\frac{K}{T}\right) - C\right) + \eta_l(r_C)\left(\widetilde{K} - F(r_C)\left(\frac{K}{T}\right) - C\right) \right|. \tag{10}$$

Proof. See Appendix B. □

This proposition makes the tradeoffs clear between the upward force (left side of the inequality) and the downward forces (right side of the inequality) on interest rates. On the left-hand side, if the change in default rate with respect to interest rate at the optimal rate in the absence of microfinance, $F'(r_C)$, is large in magnitude, the force pushing rates upward is large because the lenders bear the default risk for the FPs with microfinance. A large $F'(r_C)$ will lead to higher interest rates if and only if it exceeds the forces pushing rates down, which are on the right side of the inequality. On the right-hand side, $\left(\widetilde{K} - F(r_C)\left(\frac{K}{T}\right) - C\right)$ is the difference in the FP's expected lending costs of not using Kiva versus using Kiva. The term is positive, or the FP would not post the loan. With low FP capital costs (low $\widetilde{K}$), low default and/or discounting (large F), or high administration cost C, this term gets smaller, leading to weaker forces pushing interest rates down. A lower demand elasticity, $\eta_y(r_C)$, and lower lending elasticity, $\eta_l(r_C)$, both reduce the downward pressure on interest rates.

Because we do not observe the counterfactual scenario (i.e., loans that are not posted on Kiva) to test Proposition 1, we instead calculate how demand elasticity will affect interest rate with microfinance, r_M, assuming FPs are profit maximizing, leading to the following corollary:

Corollary 1. *Let $\eta_y(r) = \eta_y(r, z)$, where z is an exogenous shifter of demand elasticity and $\eta_y(r, z)$ is increasing in z (decreasing in magnitude). $\frac{dr_M}{dz} > 0$; i.e., the less elastic the demand, the higher the optimal interest rate.*

Proof. See Appendix B. □

From our borrower model, we know that demand elasticity will be higher in areas with greater access to capital, which leads to the following testable prediction to determine whether FPs are behaving in a profit-maximizing way:

Prediction: If FPs are profit-maximizing, interest rates will be lower in areas with more access to capital. If this prediction holds, we have evidence that the FPs are maximizing profits, in which case our model predicts they are potentially setting interest rates higher on Kiva due to their ability to transfer default risk to lenders. To test whether the assumptions hold for the model, especially whether the risk-transfer effect may exist, we next test the dependency of F, γ, and y on r, using field data collected from Kiva. We then simulate optimal interest rates using the estimated dependencies under a range of demand and FP parameters.

4 Empirical Analysis

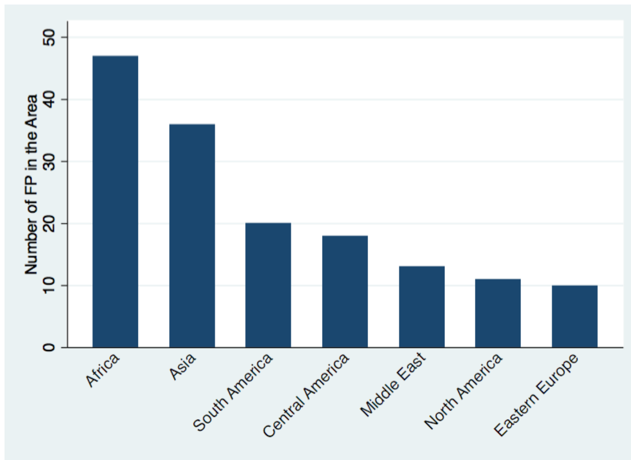
4.1 Data

We compiled data from three sources. First, we scraped a unique data set directly from Kiva.org, which contains the key components that underpin our empirical analyses, including data regarding field partners and loans such as their locations, loan amount, terms, fund-raising status, repayment status, etc. These scraped data, however, lack certain crucial information. Kiva only posts the then-current interest rates in the format of the annual percentage rate (APR) of each FP at the time of the data scraping. Accordingly, our second set of data comes from Wayback Machine, an online archive of webpages since the 1990s. We accessed Kiva's webpages for each FP between 2008 and 2012 to obtain the respective APR of loans when they were posted. Finally, we gathered the local financial market data from the World Bank's Global Financial Development Database, including the average number of banks per 100,000 residents and the annual average return on equity of banks in each country. Next, we detail the compiled data.

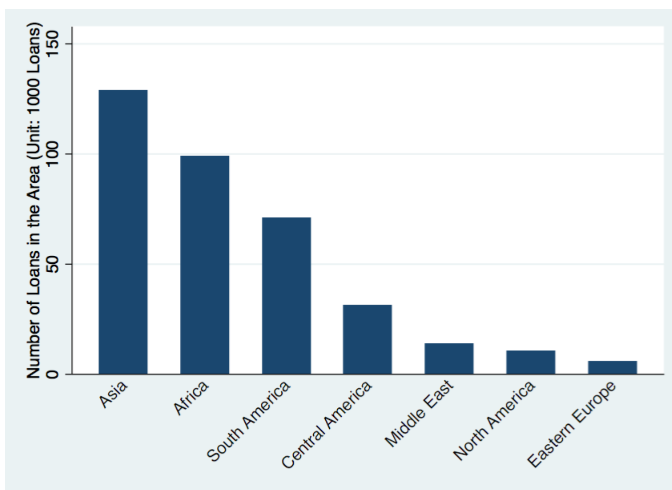
4.1.1 Field Partners and Local Financial Markets

We collected the data about field partners on April 5, 2012, which contain 155 field partners across 63 countries/regions that raised funds at Kiva.org. We supplement the FP data with the Wayback Machine APR data. The 63 countries belong to seven geoeconomic areas. Table 1 shows summary statistics of the FPs across the seven areas. These FPs are mainly concentrated among developing countries and areas where the per-capita GDPs are at relatively low levels. Figure 2a and Figure 2b show the geoeconomic distribution of FPs and loans, respectively. On average, the FPs have been refinancing through Kiva for more than 41 months.

Figure 2: Field Partners and Funding by Geoeconomic Areas



(a) Field Partners by Geoeconomic Areas



(b) Fundraising Loans by Geoeconomic Areas

One thing that is evident from Table 1 is that the average interest rates and default rates vary considerably both across regions and within regions. The average default rates range from 0.09% in Eastern Europe (with average APRs of 35.59% on Kiva), to 5.21% in the Middle East (with average APRs of 29.58% on Kiva). The 95th percentile for default rate in the Middle East is a staggeringly high 51.21%. Furthermore, the relationship between APR and default rate is not monotonic. In Eastern Europe the APRs are relatively low. The APRs are then higher (as expected) in areas with higher default rates such as North America and Africa, but then the Middle East, which has the lowest APRs, also has the highest rate of default.[11] Presumably the default rate increases enough with interest rate in the Middle East to reduce the risk transfer effect, and the level of default is high enough to keep interest rates relatively low. In contrast, North America is an outlier in terms of the average APR, which is much higher than the other regions, indicating that the change in default rate with respect to interest rate may be sufficiently high to lead to a large risk transfer effect, but unlike the Middle East, default levels are not high enough to serve as an effective disciplining mechanism to keep interest rates low.

To get a better sense of the identities of the FPs, we tabulate the top 20 FPs (by amount of loans disbursed on Kiva) at the end of our data period in Table 2. Only six of the top 20 FPs are non-profit organizations, and only 29% of all 155 FPs are registered non-profit organizations. Therefore, the FPs are highly likely to be trying to maximize profits, rather than maximizing the poor's access to capital, which is the mission of Kiva.

As a case in point, the FPs' APR level on Kiva was rather high, with an average APR higher than 35% across countries. For the 63 countries/areas in our data, we were able to collect the annual return rates on equity for 59 of them. We compare these country-level APRs against the Kiva return rates of these 59 countries from 2008 to 2012. A t-test indicates Kiva's APR level is significantly ($p<0.001$) higher than the return rates on equity, with a mean difference of 16%. Assuming the country-level return rate on equity reflects the regular return rate of a country's banking industry on its capital, it is significantly lower than the yield on loans refinanced through Kiva.

4.1.2 Loans

Our loan data contain 360,575 loans that were listed on Kiva between 2008 and June 2012. These loans all completed their listing periods by July 2012. About 0.87% (3,136) of loans failed to raise the amounts requested during their listing periods. Among the loans that were successfully funded, 271,656 loans passed their maturity dates. Among these matured loans, only 2,506 (0.92%)

[11] We note that the high default rates of the Middle East may be due to its political instability in the past decade.

Table 1: Summary Statistics of Field Partners and Local Financial Markets

Geoeconomic Area (Number of FPs; Number of Countries/Areas)	Average Outstanding Loan in Million US$ per FP (S.D.)	Average Months at Kiva (S.D.)	Average Number of FP from the Same Country (S.D.)	Average Number of Banks per 100K Residents of the Same Country (S.D.)	Average Default Rates % (S.D.)	Default Rates % 95th percentile	Average APR% of FP of the Same Country (S.D.)	Average Return on Equity of a Country's Banking Industry % (S.D.)*	Average Annual Number of Kiva Loans in the Same Country (S.D.)
Africa (47; 20)	1.85 (1.62)	40.68 (21.14)	1.79 (1.19)	3.30 (1.44)	1.95 (5.56)	23.50	39.89 (16.36)	20.34 (6.65)	1319.80 (1919.58)
Asia (36; 12)	2.56 (2.18)	42.56 (19.80)	2.51 (1.75)	12.31 (14.83)	0.06 (0.27)	0.12	35.53 (10.63)	13.10 (6.41)	2523.84 (4111.22)
South America (20; 6)	3.44 (2.77)	41.30 (16.30)	2.78 (1.89)	17.92 (14.30)	0.43 (0.66)	1.49	30.85 (9.95)	22.52 (8.02)	2631.44 (3091.93)
Central America (18; 5)	1.39 (1.19)	40.61 (16.89)	2.50 (1.32)	20.98 (9.02)	1.15 (1.62)	2.27	29.58 (6.31)	16.94 (8.31)	1302.79 (1517.62)
Middle East (13; 8)	1.57 (1.55)	29.69 (19.29)	1.47 (0.51)	15.11 (11.45)	5.21 (14.27)	51.21	28.37 (7.49)	12.45 (3.91)	533.31 (566.27)
North America (11; 4)	1.76 (1.73)	34.55 (25.33)	1.84 (0.96)	12.65 (13.11)	1.53 (1.98)	3.19	45.13 (23.50)	6.91 (6.38)	563.21 (703.37)
Eastern Europe (10; 8)	0.96 (1.11)	36.90 (26.52)	1.22 (0.55)	18.88 (22.03)	0.09 (0.20)	0.38	32.58 (11.67)	8.73 (8.28)	332.83 (249.32)
Overall (155; 63)	2.08 (1.97)	41.54 (17.05)	2.05 (1.41)	12.45(13.60)	1.60 (6.42)	7.98	35.59 (14.31)	16.25 (8.28)	1502.40 (2582.67)

*Four countries have missing values

Table 2: Top 20 Field Partners

FP's ID on Kiva	APR	Total Loans Posted (US$)	Nonprofit Status
58	0.40	10,270,050	No
71	0.38	8,435,175	No
84	0.50	7,952,975	No
100	0.38	7,623,475	No
9	0.27	6,261,875	Yes
109	0.36	6,100,450	No
119	0.37	5,919,925	No
116	0.20	5,751,175	No
133	0.32	4,936,400	No
44	0.43	4,929,025	Yes
123	0.38	4,887,225	Yes
137	0.22	4,729,475	No
106	0.27	4,702,300	Yes
77	0.32	4,690,050	Yes
130	0.56	4,577,200	No
60	0.38	4,569,025	No
20	0.83	4,273,850	Yes
70	0.60	4,103,575	No
115	0.21	3,958,225	No
93	0.46	3,917,075	No
Max	0.83	10,270,050	
Min	0.20	3,958,225	
Median	0.38	4,929,025	

Note: The percentage of nonprofits among all FP is 29%

defaulted and the remaining were paid off in full.[12] Table 3 shows the summary statistics of the 360,575 listed loans.[13]

4.2 Analysis of Lending Environment

The main tradeoff an FP faces is between the effect of the interest rate on the loan being successfully created and funded by lenders on Kiva (through both demand elasticity η and lending elasticity γ), and the effect on default risk, F', which determines the amount of risk that is transferred to these

[12] Note that this percentage of defaulted loans is lower than the statistics presented in Table 1. The reason is simply that the statistics in that Table are computed at the FP and year level, and then aggregated to each geoeconomic area. The 0.92% is the average across all loans, independent of the FPs, years, and areas.

[13] We note that the average APR across all loans is slightly different from the average APR across all FPs as reported in Table 1. This difference is potentially due to some aggregation errors when Kiva computed the average APR of each FP and then aggregated them across all FPs.

Table 3: Summary Statistics of Loans

	Mean	S.D.	Minimum	Maximum
APR%	38.11	15.00	2.00	109.00
Loan Terms (Months)	11.68	4.96	2	62
Loan Amounts (US$)	786.25	766.96	25	10,000
Loan Amount/National GDP per Capita	0.61	1.06	0.004	30.46
Number of Borrowers (per Loan)	1.98	3.22	1	79
Female Borrower Percentage (per Loan)	74.45	42.70	0	100
The Loan Was Listed without English Description (1/0)	0.04	0.20	0	1

lenders.[14] Hence, we test the dependency of η, γ, and F on the interest rates, r, to see whether interest rates are likely to be higher with Kiva.

4.2.1 Default Rates

First of all, we want to demonstrate the relationship between default risk and interest rates. If FPs are maximizing profits, the dependency of default rates on interest rates is crucial in determining whether Kiva is likely to lead to higher or lower interest rates (i.e., the default rate derivative, F', in Proposition 1). Among the 360,575 observed loans in our data set, 216,565 loans reached their maturity dates, either fully paid off (269,150, 99.08%) or defaulted (2,506, 0.92%) by the time of our data collection. Using these 216,565 loans, we investigate the factors that affect a loan's default probability. We are particularly interested in the effect of APR on default rate. According to Assumption 3, the default probability of a loan should be non-decreasing in its APR. Table 4 shows the regression results of a linear probability model. We divide the countries into three equal-sized groups based on their default rates. The model also controls for industry sector and year fixed effects. Furthermore, because each field partner administered the repayment of its loans, we include FP fixed effects and cluster standard errors at the FP level. From the results, we see that APR has a significant, positive effect (at the 10% level) on the default probability for countries with high

[14] If costs $C(r)$ also increase with r, another disciplining mechanism would exist, but we have no cost data to test this relationship. However, this effect is documented in Banerjee and Duflo (2010).

default rates. The average effect is also positive for countries with medium and low default rates, though insignificant.

It should be acknowledged that there is an endogeneity concern in the relationship between default probability and interest rate due to the FP screening - higher APR loans might only be given to those individuals whom the FP believes to be high default risk. Our approach largely avoids this issue by using average APRs at the FP-year level rather than loan-specific APRs. Different screening rules across FPs are controlled for with the use of FP fixed effects; identification is driven by within-FP variation across markets and time. Because FPs operate in multiple markets we also incorporate market fixed effects to control for heterogeneity in costs or in the quality of the borrower pool (in terms of credit risk). That said, if an endogeneity issue remained from selection, it would bias our estimates downwards.

Table 4: The Default Probability of a Loan

Variables	Loan Defaulted
APR Percentage/100 (High Default Rates Countries)	0.0437*
	(0.024)
APR Percentage/100 (Medium Default Rates Countries)	0.0425
	(0.043)
APR Percentage/100 (Low Default Rates Countries)	0.0150
	(0.048)
Loan Terms (Months)	0.0020**
	(0.001)
Loan Amounts (1000 US$)	-0.0036
	(0.002)
Loan Amount/National GDP per Capita	0.0004
	(0.002)
Number of Borrowers of a Loan	0.0006
	(0.0004)
Female Borrower Percentage of a Loan	0.000006
	(0.00002)
The Loan Was Listed with English Description (1/0)	0.0074
	(0.0082)
Constant	-0.0443
	(0.0290)
Field Partner FEs	Yes
Country FEs	Yes
Borrower's Industry Sector FEs	Yes
Year FEs	Yes
Observations	271,656

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

4.2.2 Demand Elasticity

Assumption 1 states that the demand for a Kiva loan has a negative elasticity with respect to interest rates. To estimate the demand elasticity, we consider a linear regression where the dependent variable is the total amount of loans in a market. For each market, we use average APR as an independent variable, together with the number of competing field partners and the accessibility to local capital markets. In particular, we treat each country as a market and aggregate the amount of loans, the number of field partners, and the average APR up to the yearly level for each country. We also include the number of banks per 100,000 residents of each country, to control for the access the borrowers have to alternatives to Kiva loans. In light of the skewness in APR (see Table 3), and for easy interpretation of the coefficients, we use logarithms of the variables in the regression. The regression also controls for fixed effects of country and year with standard errors clustered at the country level. Table 5 presents the results. Of particular interest, the demand for loans in a local market dropped when the average APR increased, implying a negative demand elasticity. However, we find the elasticity to be low in magnitude in our setting.[15]

Table 5: The APR Elasticity of Loans

Variables	Log Annual Amount of Kiva Loans (US$1000)
Log Average Kiva Local APR (%)	-0.825***
	(0.307)
Log Number of Banks per 100,000 Residents	-0.297
	(0.405)
Log Number of FPs	1.838***
	(0.411)
Constant	7.647***
	(1.572)
Country FEs	Yes
Year FEs	Yes
Observations	204

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

4.2.3 The Funding Probability

Next, we use a linear probability model to evaluate the probability of a loan being funded on Kiva, depending on its APR and other factors. Using this binary model, we explore which factors are

[15] An alternative specification with the number of loans as the dependent variable gives similar results.

crucial for the successful refinancing of a loan on Kiva. In particular, we are interested in whether the likelihood of a loan being funded on Kiva decreases with the interest rate (Assumption 2). Table 6 presents the results, in which we control field partner, country, industry sector, and year fixed effects, and cluster the robust standard errors at the FP level. The results show that loans with more female members, more borrowers, shorter term, and smaller amount are more likely to be funded. We find no significant effect of loan APR on the loan's probability of being funded. This means the second force pushing interest rates lower in the inequality shown in equation (10) is completely removed. We would expect this non-dependency of lending on interest rates to be a unique feature of microfinance sites since lenders participate for altruistic reasons, rather than to make financial investments. This finding highlights the challenges of designing a platform when some agents are not profit-maximizing (lenders and Kiva) and some are (FPs).[16]

Table 6: The Funding Probability of a Loan

Variables	Funded
APR Percentage/100	0.0007
	(0.023)
Loan Terms (Months)	-0.0010***
	(0.000)
Loan Amounts (1000 US$)	-0.0169***
	(0.003)
Loan Amount/National GDP per Capita	0.0001
	(0.002)
Number of Borrowers for the Loan	0.0021***
	(0.001)
Female Borrower Percentage for the Loan	0.0001***
	(0.00002)
The Loan Was Listed with English Description (1/0)	0.0048**
	(0.002)
Constant	1.0059***
	(0.0100)
Field Partner FEs	Yes
Country FEs	Yes
Borrower's Industry Sector FEs	Yes
Year FEs	Yes
Observations	360,575

*** p<0.01, ** p<0.05, * p<0.1

[16] A full understanding of lender incentives is tangential to this paper's goals, and there has been significant work in understanding these decisions in microfinance and crowdfunding applications Galak et al. (2011); Agrawal et al. (2011); Stephen and Galak (2012); Kawai et al. (2014).

4.2.4 Access to Capital

Finally, we test whether the FPs are indeed behaving in a way consistent with profit-maximizing behavior. We predict that the local APRs will drop when borrowers have easier access to capital, which decreases their demand for Kiva loans. This is the key test that determines whether the risk transfer effect should be accounted for in platform design and FP incentives. To test the prediction, we regress the APR of a given country during a year on the level of accessibility to the capital market, namely, the number of banks per 100,000 residents for a given year, controlling for the annual amount of loans given on Kiva. The results are shown in Table 7. The results show that with easier access to the capital market, the average APR of Kiva loans drops, which is aligned with Corollary 1 and shows FPs are behaving in a manner consistent with profit maximization.[17] As before, we include country fixed effects, using the time-series variation in the number of banks within a county to identify the effect of interest, namely how the interest rates through microfinance change with access to capital.

Table 7: The Effect of Local Capital Access on Local APRs

Variables	Log Average Kiva Local APR (%)
Log Number of Banks per 100,000 Residents	-0.182*
	(0.093)
Log Number of FPs	0.090
	(0.079)
Log Annual Amount of Kiva Loans (US$1000)	-0.030*
	(0.015)
Constant	4.050***
	(0.214)
Country FEs	Yes
Year FEs	Yes
Observations	204

*** p<0.01, ** p<0.05, * p<0.1

4.3 Discussion

In this section, we establish that demand elasticity is low and lenders do not depend on interest rates in order to make their decisions. This latter finding is a unique feature of microfinance platforms

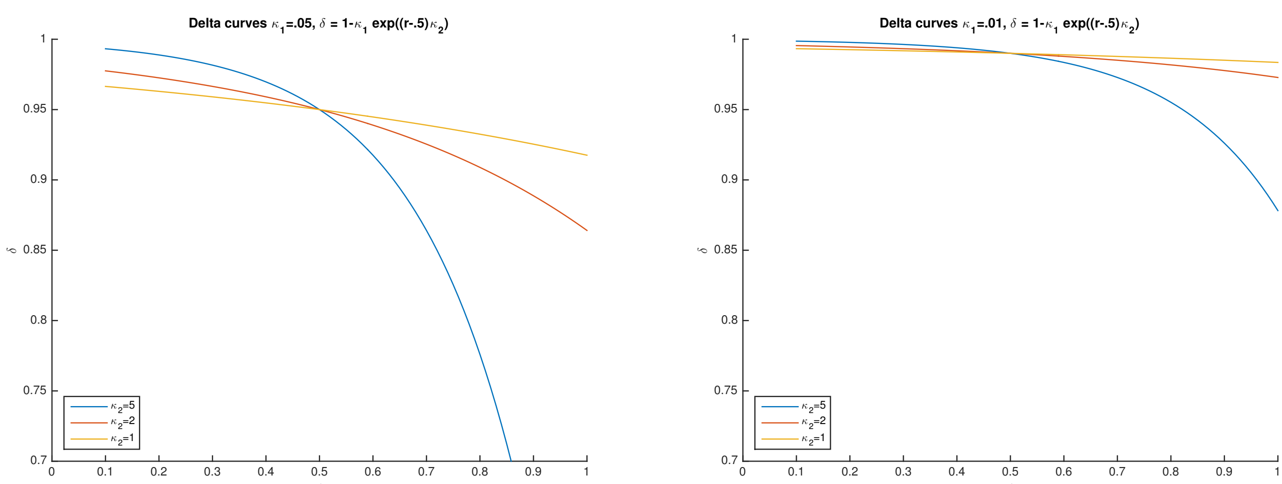
[17] A regression of individual FPs' APR level leads to a similar conclusion.

such as Kiva in which lenders lend for altruistic reasons. These two factors together reduce the downward forces on interest rates.

We also find a positive relationship between APR and default rate. Intuitively, the stronger the relationship between default rates and interest rates, the greater the incentive for FPs to charge higher rates on Kiva than they would without Kiva, because the default risk is transferred to lenders. Although the positive effect is insignificant for countries with medium and low default rates, it is significant in areas with high default. We should also be very cautious in generalizing such an empirical finding to other similar platforms, especially since the lack of an effect of APR on default does not necessarily imply the platforms will be free from the risk of FPs raising interest rates considerably for the borrowers. In the next section, we use simulations to demonstrate the tradeoff more explicitly.

5 Simulations

Figure 3: Comparison of APRs between Kiva Loans and Non-Kiva Loans, High Default Rate



In this section, we use numerical simulations to demonstrate the dependence of the interest rate on the demand and demand elasticity with and without the presence of microfinance, in order to demonstrate its effect on the optimal interest rate. For these simulations, we set the loan duration to be one year and loan amount of 0.61, which is the average loan size relative to the country's GDP per capita in our data. For the first set of simulations, we assume that additional loan disbursement costs on Kiva are low, 10% of the loan amount and that they do not increase with interest rates (if costs increased with interest rates, this would further push rates down). In one set of simulations, we set the demand elasticity to be -0.825, consistent with our estimates, over a range of demand between 0.25 and 0.75; in another set of simulations, we set demand to be 0.5 for a range of demand elasticities between -0.5 and -1.0.

We assume the probability of each monthly payment is a constant, $\delta(r)$, so that

$$F(r) \equiv \sum_{m=1}^{T} (\rho\delta(r))^m \quad = \tfrac{1-(\rho\delta(r))^{T+1}}{1-\rho\delta(r)} - 1 = \tfrac{-(\rho\delta(r))^{T+1}+\rho\delta(r)}{1-\rho\delta(r)} \quad = \frac{\rho\delta(r)\left(1-(\rho\delta(r))^{T}\right)}{1-\rho\delta(r)}. \qquad (11)$$

Defining $\delta(r)$ helps with the intuition - because $\delta(r)$ can be easily interpreted (as "1−monthly default probability"), we will vary $\delta(r)$ in the simulations in order to vary $F(r)$.

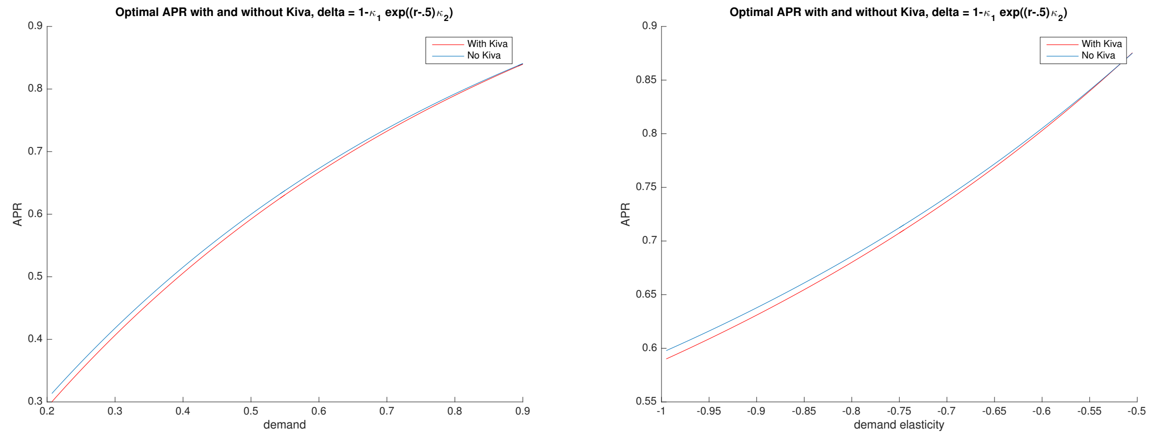
The FPs' discount rate and the monthly default probability have the same effect because a higher value of either will lower the net present value of the loan. For the simulations, we set the discount rate as $\rho = 0.99$ and alter the default rate function. We specify this function as:

$$\delta(r) = 1 - \kappa_1 \exp((r - .5)\kappa_2). \qquad (12)$$

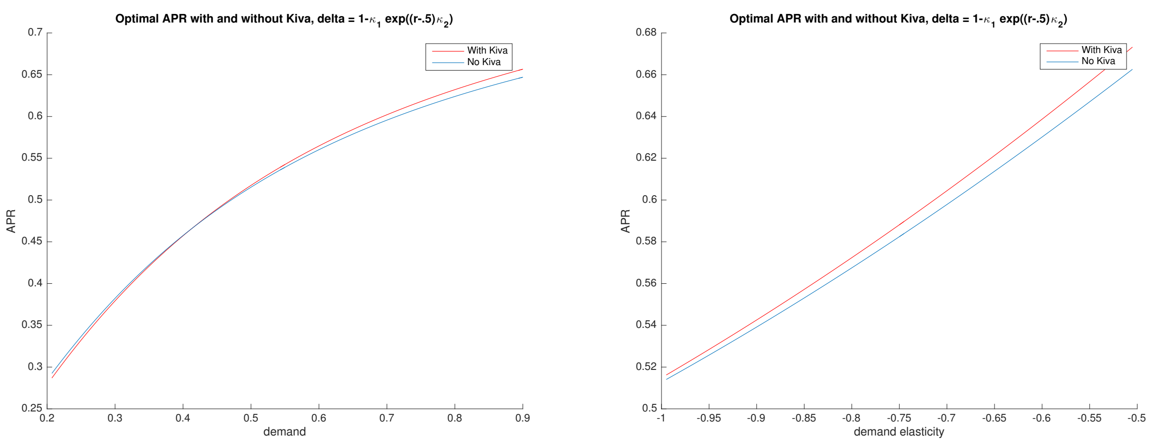
This allows us to modify the level of default rate as well as the curvature of the default rate function by changing κ_1 and κ_2. We chose the function parameters so the default rates would be the same at $r = .5$ but the slopes of the default rate function would be different. To show the effect of κ on the shape of the default rate function, we plot the default rate function for different values of the κ parameters in Figure 3. The first figure shows the function for a higher default rate level from $\kappa_1 = 0.05$ (5% monthly default when $r = 0.5$), and the second for a lower default rate level with $\kappa_1 = 0.01$ (1% monthly default when $r = 0.5$). In particular, with κ_1 fixed, a larger κ_2 results in a greater default risk when interest rates increase.

Next, we compare the optimal APRs as a function of both demand and demand elasticity. The first derivative of the default rate function (equation 12) with respect to interest rates is $-\kappa_1\kappa_2 \exp((r - .5)\kappa_2)$, which measures the impact of interest rates on the level of default risk. In Figures 4 and 5, we show the optimal interest rates with and without Kiva as the magnitude of the first derivative becomes larger, which is achieved by increasing the value of κ_2. In Figure 4, where

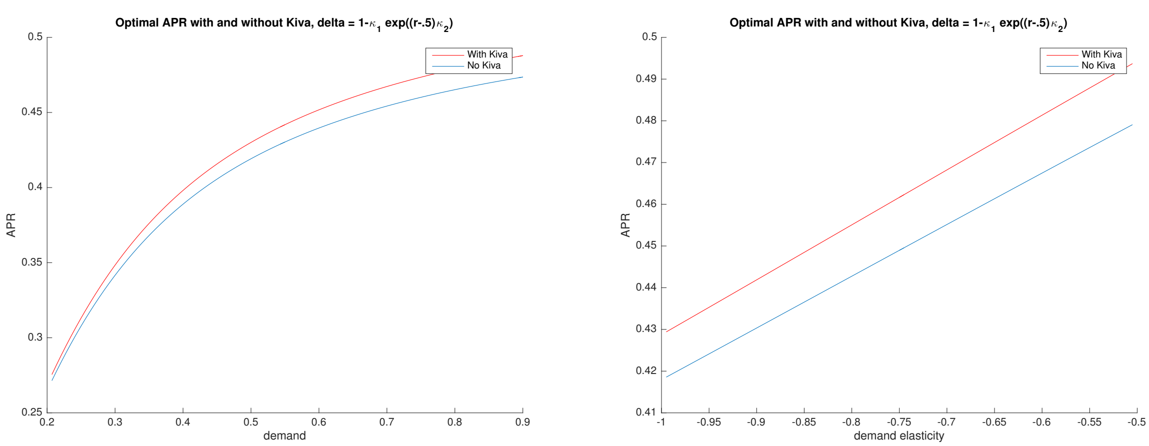
Figure 4: Comparison of APRs between Kiva Loans and Non-Kiva Loans, High Default Rate



A: Low curvature in $\delta(r)$, $\kappa_2 = 1$

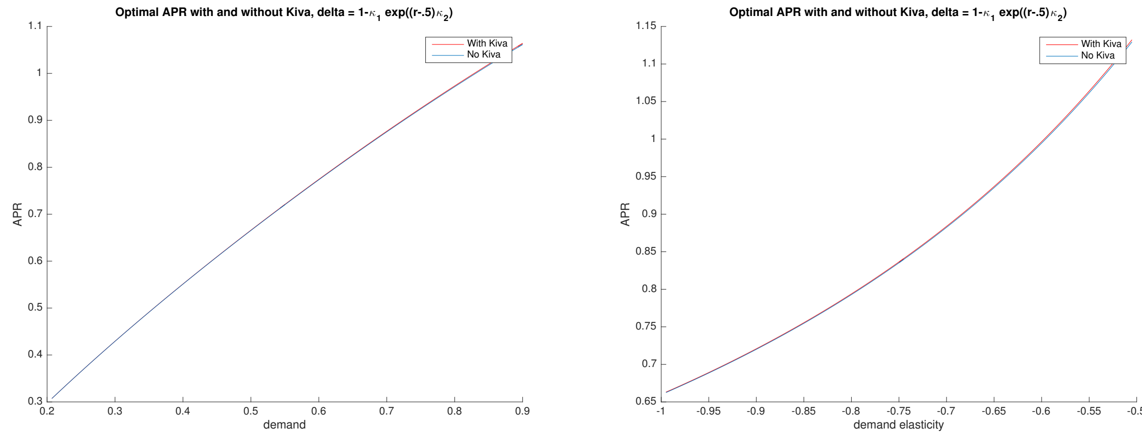


B: Mid curvature in $\delta(r)$, $\kappa_2 = 2$

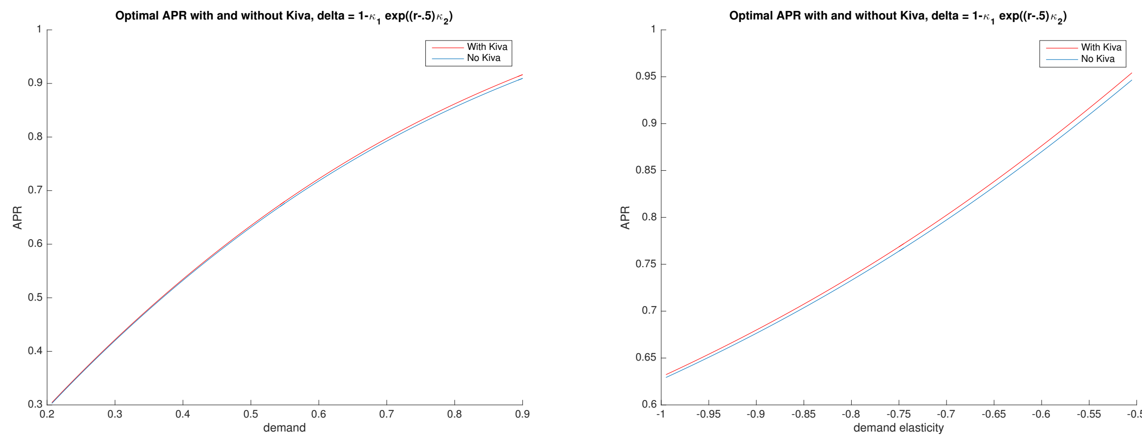


C: High curvature in $\delta(r)$, $\kappa_2 = 5$

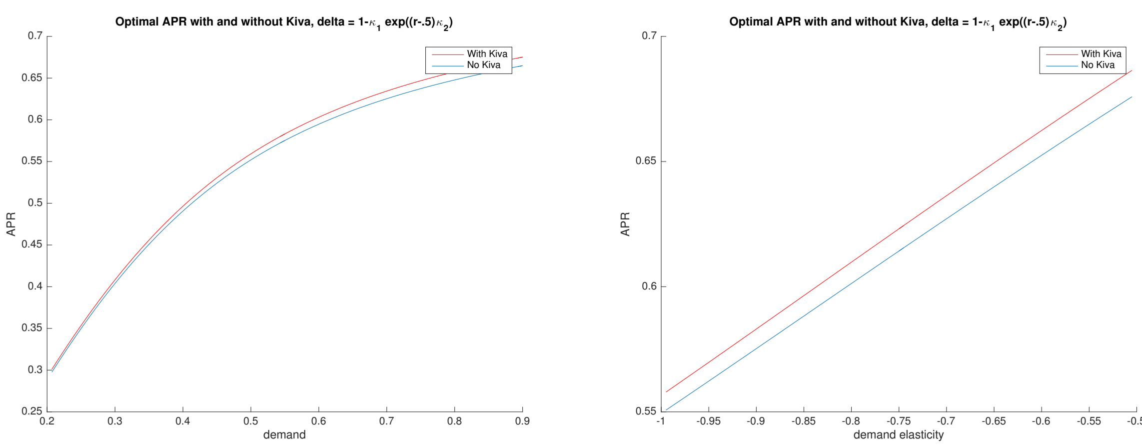
Figure 5: Comparison of APRs between Kiva Loans and Non-Kiva Loans, Low Default Rate



A: Low curvature in $\delta(r)$, $\kappa_2 = 1$



B: Mid curvature in $\delta(r)$, $\kappa_2 = 2$



C: High curvature in $\delta(r)$, $\kappa_2 = 5$

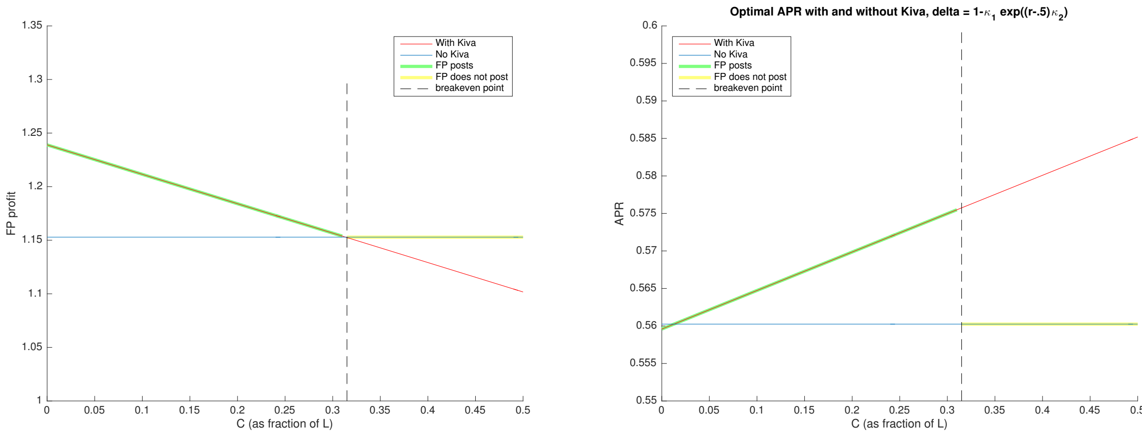
the default rate is fixed at a higher level ($\kappa_1 = 0.05$), in the top graph with a small first derivative, the optimal rate is lower due to Kiva, because changing the interest rate has little effect on default risk and hence the amount of risk transferred to the lenders. However, in the bottom graph, the opposite is true. Without Kiva, interest rates were kept lower due to the downward pressure of default risk, but with Kiva, this force is reduced and the optimal rate goes up.

When default rates are at a lower level ($\kappa_1 = 0.01$), as shown in Figure 5, these qualitative results remain the same, but the difference in interest rates with and without Kiva become negligible, especially for Subfigure A. Intuitively, with a low default rate on average, Kiva's effect on raising interest rates due to transferring the default risk to lenders is small overall. Furthermore, with small curvature (small κ_2) a higher interest rate does not lead to higher-level default risk being transferred to lenders.

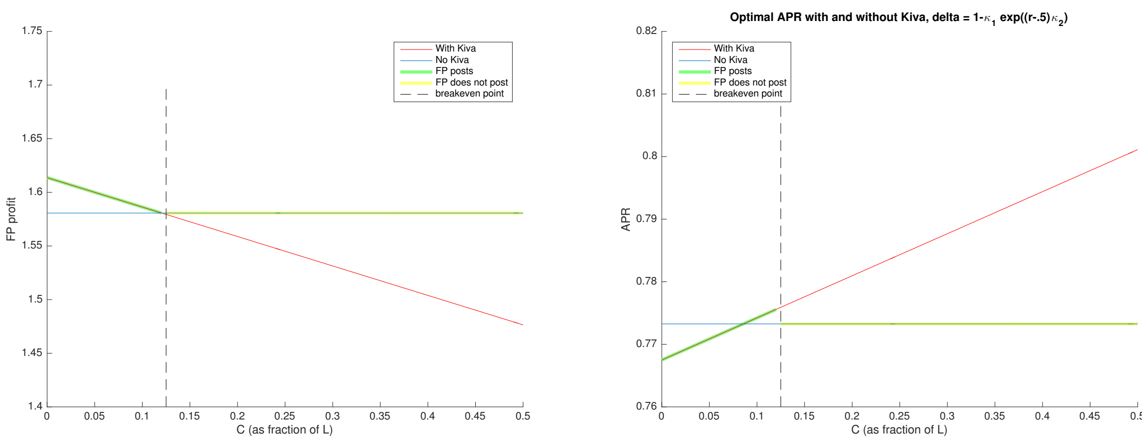
In our data, many loans on Kiva have even smaller default rates, similar to the case where both κ_1 and κ_2 have small values (Subfigure A in Figure 5). For these loans, interest rates will be largely unaffected because of Kiva if administrative costs are low. This is not true in the areas in our data where the effect of interest rates on default rates is higher, and it is not true if administrative costs are higher. In both these cases, the upward force on interest rates due to risk transfer may dominate.

In Figure 6, we plot the profits for the FP and the optimal interest rate as a function of the extra administrative costs, for relatively low default rates and default elasticity. As the administrative costs increase, the profits go down for the FPs and the optimal interest rates go up. Essentially, the administrative costs of working with the microfinance site reduce the downward pressure on rates from the lower costs of dispersing loans (due to the refinancing), and so the upward force due to risk transfer can dominate, even at low default rates. If costs become too high, the FP choses not to post the loan because its profits become higher without using the microfinance site. From a consumer welfare perspective, it is the intermediate level of costs which might be a concern, since the FPs still chose to use the microfinance platform but the interest rates are higher when doing so. It is thus essential that microfinance sites keep administrative costs to a minimum for the FPs, otherwise rates may become higher than in the absence of microfinance.

Figure 6: Comparison of FP Profit and APRs between Kiva Loans and Non-Kiva Loans as Administrative Costs Increase



A: High default rate and curvature in $\delta(r)$, $\kappa_1 = 0.05$ $\kappa_2 = 2$



B: Low default rate and curvature in $\delta(r)$, $\kappa_1 = 0.01$ $\kappa_2 = 1$

6 Concluding Remarks

Because FPs are profit-maximizing, the presence of microfinance leads to both upward and downward forces on interest rates. Our paper is the first to model the upward force on rates due to the transfer of default risk to lenders. Whether interest rates increase or decrease depends on the default and discount rates and the effect of interest rates on demand, the probability of a loan being funded through microfinance, and FP administration costs. The fact that on Kiva lenders do not depend on interest rates when making lending decisions (a phenomenon we would expect across other microfinance sites), means one of the downward forces on rates in removed entirely. At Kiva, the low default and low dependency of default on interest rates means interest rates are unlikely to be higher due to Kiva, because the amount of default risk to be transferred to lenders on Kiva is minimal. However, if either one of the conditions fails, the platform may still be subject to the risk of FPs raising interest rates.

An alternative payback mechanism could completely mitigate the incentive of FPs to increase interest rates due to their ability to refinance loans on Kiva. The huge benefit from microfinance platforms such as Kiva is the increased availability of capital that comes via the lenders. If lenders being paid back was not dependent on the borrowers not defaulting, the incentives for the FPs would change. If the lenders essentially granted a loan to the FP equal to the principal of a borrower's loan, which the FP needed to pay back regardless of default, the upward force on interest rates would be completely removed. We demonstrate the effect of this alternative mechanism in Appendix C. With this alternative mechanism, Kiva still provides a benefit by injecting interest-free capital (from the lenders) into the system, reducing the shadow price of lending, allowing the FPs to grant more loans. Because default rates are low, the biggest constraint on the system is the availability of this capital.

Recently, Kiva implemented an approach that could help partially mitigate the potential problem of higher interest rates. Kiva now evaluates its FPs along multiple social performance dimensions such as anti-poverty focus, family and community empowerment, entrepreneurship, and so on. FPs with sufficiently high social performance ratings are awarded "social performance badges," which are shown in the FPs' description that accompanies each posted loan. This approach may help address this issue if lenders alter their lending behavior in response to the FPs' badges (which must be accurate and up-to-date), especially if these badges make the interest rates more of a factor in their decision to lend. However, whether this approach will work depends on the lender response, whereas changing the FP incentives through the lender payback mechanism would not. It is possible that simply informing lenders about FPs charging excessively high interest rates could partially mitigate the problem, but again, only if lenders start accounting for the interest rates the FPs charge when making their own lending decisions.

Across six field studies, Banerjee et al. (2015b) found microfinance loans only lead to modest increases in business activity and household consumption. We hope this paper sheds light on one potential issue when not-for-profit organizations such as Kiva partner with for-profit entities for social reasons, particularly when the effect on such partnerships on the incentives of the for-profit entities are not fully accounted for. In areas with low default rates, the risk transfer force on rates may be minimal, but this would not be true in other regions, in which case the default-risk-transfer effect on higher interest rates would potentially become a first order concern. We demonstrate that further value could be created for borrowers if the incentives of the FPs are accounted for in the payback mechanism, ensuring that the transfer of default risk to altruistic lenders is not driving up the interest rate, which would hopefully lead to further improvement in welfare outcomes for borrowers as a result of microfinance. We believe that further exploring the effect of microfinance platform design on interest rates and the resulting social outcomes is a promising area for future research.

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Appendix A: Proof of Claim 1

Proof. The probability of borrowing Kiva loan up to the amount of K is given by

$$y(r) = 1 - \Phi_\epsilon \left(\beta_1 \log \left(\frac{\overline{K}_0}{\overline{K}_0 + K} \right) + \beta_2 \log \left(\frac{L^* + (K_0^* - \overline{K}_0)\frac{p_K}{p_L}}{L^* + (K_0^* - \overline{K}_0)\frac{p_K}{p_L} - K\frac{p(r)}{p_L}} \right) \right). \tag{13}$$

Taking the derivative of $y(r)$ with respect to $\overline{K}_0$, we have

$$\frac{\partial y(r)}{\partial \overline{K}_0} = \left(\frac{-\phi_\epsilon \left(\beta_1 \log \left(\frac{\overline{K}_0}{\overline{K}_0+K} \right) + \beta_2 \log \left(\frac{L^*+(K_0^*-\overline{K}_0)\frac{p_K}{p_L}}{L^*+(K_0^*-\overline{K}_0)\frac{p_K}{p_L} - K\frac{p(r)}{p_L}} \right) \right)}{1 - \Phi_\epsilon \left(\beta_1 \log \left(\frac{\overline{K}_0}{\overline{K}_0+K} \right) + \beta_2 \log \left(\frac{L^*+(K_0^*-\overline{K}_0)\frac{p_K}{p_L}}{L^*+(K_0^*-\overline{K}_0)\frac{p_K}{p_L} - K\frac{p(r)}{p_L}} \right) \right)} \right) \cdot \left(\beta_1 \frac{K}{\overline{K}_0(\overline{K}_0 + K)} + \beta_2 \frac{K\frac{p_K}{p_L}\frac{p(r)}{p_L}}{[L^* + (K_0^* - \overline{K}_0)\frac{p_K}{p_L}][L^* + (K_0^* - \overline{K}_0)\frac{p_K}{p_L} - K\frac{p(r)}{p_L}]} \right)$$

The first term $(\frac{-\phi_\epsilon(.)}{1-\Phi_\epsilon(.)})$ is negative, and the second and third terms in the brackets are non-negative. Hence, the derivative is negative. □

Appendix B: Proofs of Proposition and Corollary

Proof of Proposition 1. Total expected profits were given in 8 as:

$$\pi(r) = y(r) \left[F(r)p(r) - \widetilde{K} + \left(\widetilde{K} - F(r)\frac{K}{T} - C \right) l(r) \right], \tag{14}$$

and profits for a microfinance-funded loan are:

$$\pi^M(r) = \pi^C(r) + \left(\widetilde{K} - F(r)\frac{K}{T} - C \right) l(r). \tag{15}$$

For readability, we omit the function arguments in the proof. Taking the derivative of total expected profits yields:

$$\begin{aligned}
\frac{\partial \pi}{\partial r} &= \eta_y \frac{y(r)}{r}\pi^M + y(r)[F'(r)p(r) + F(r)\frac{\partial p(r)}{\partial r} + \widetilde{K}\frac{\partial l(r)}{\partial r} - F(r)\frac{K}{T}\frac{\partial l(r)}{\partial r} - C\frac{\partial l(r)}{\partial r} - F'(r)\frac{K}{T}l(r)] \\
&= \frac{y(r)}{r}\Bigg[\eta_y\left(\left(F(r)p(r) - \widetilde{K}\right) + \left(\widetilde{K} - F(r)\left(\frac{K}{T}\right) - C\right)l(r)\right) \\
&\quad + \left(rF'(r)p(r) + rF(r)\frac{\partial p(r)}{\partial r} + \left(\widetilde{K} - F(r)\left(\frac{K}{T}\right) - C\right)\eta_l l(r) - rF'(r)\frac{K}{T}l(r)\right)\Bigg].
\end{aligned}$$

Setting this partial derivative to zero, we can define:

$$\begin{aligned}
\Theta_1(r) &\equiv p^K(r) + \\
&\frac{1}{\eta_y F(r) + rF'(r)}\Bigg[-\eta_y\widetilde{K} + rF(r)\frac{\partial p(r)}{\partial r} + \\
&l(r)\left(\eta_y\left(\widetilde{K} - F(r)\left(\frac{K}{T}\right) - C\right) + \eta_l\left(\widetilde{K} - F(r)\left(\frac{K}{T}\right) - C\right) - rF'(r)\frac{K}{T}\right)\Bigg],
\end{aligned} \tag{16}$$

such that $\Theta_1(r_M) = 0$ at the optimal interest rate r_M.

Without microfinance, we can set $l(r)$ and η_l to 0. This yields:

$$\Theta_2(r) \equiv p^C(r) + \frac{1}{\eta_y F(r) + rF'(r)}\left[-\eta_y\widetilde{K} + rF(r)\frac{\partial p(r)}{\partial r}\right], \tag{17}$$

which is equal to zero at the optimal interest rate r_C without microfinance. Here, we make one final assumption:

Assumption 5: $\Theta \equiv \Theta_1 - \Theta_2$ is increasing and satisfies the single-crossing condition.

This assumption means that there is a single optimal interest rate both with and without microfinance. This assumption is benign because $p(r)$ increases from 0 (at $r = 0$) to infinity, whereas the rest of the expression in both equations is negative at $r = 0$, and (16) cannot increase indefinitely. We can calculate the difference in these two functions as:

$$\Theta_1 - \Theta_2 = \frac{l(r)}{\eta_y F(r) + rF'(r)}\left[\eta_y\left(\widetilde{K} - F(r)\left(\frac{K}{T}\right) - C\right) + \eta_l\left(\widetilde{K} - F(r)\left(\frac{K}{T}\right) - C\right) - rF'(r)\frac{K}{T}\right].$$

We know the first term, $\frac{l(r)}{\frac{\eta}{r}F+F'}$, is negative, because from Assumption 3, we have that $F'(r) \leq 0$, and we also know η_y is negative and $F(r)$ is positive. Next, we know $\widetilde{K} - F\left(\frac{K}{T}\right) - C$ is positive, otherwise the FP would not post the loan and so the first and second terms in the square brackets are negative. The third term is the only positive term, because $F'(r)$ is negative. At the optimal interest rate without microfinance (r^C), $\Theta_2 = 0$. Therefore, $\Theta_1\left(r^C\right) > \Theta_2\left(r^C\right)$ at the optimal interest rate without microfinance if and only if the third term is smaller in magnitude than the combined first two terms. By the single crossing property, this means that for all $r > r^C$, $\Theta_1 > \Theta_2$ and so the optimal rate with microfinance, $r^M < r^C$. Conversely, if the third term is larger in magnitude than the other two terms, we have $\Theta_1\left(r^C\right) > \Theta\left(r^C\right)$ and therefore $r^M > r^C$. □

Proof of Corollary 1. From (9), and by the implicit function theorem, we have that

$$\pi^K(r^*)\frac{d\eta_y}{dz}dz + \frac{\partial^2\pi(r^*)}{\partial r}dr = 0. \tag{18}$$

Solving for $\frac{dr}{dz}$ yields:

$$\frac{dr^*}{dz} = -\frac{\pi^K(r^*)\frac{\partial\eta_y}{\partial z}}{\frac{\partial^2\pi(r^*)}{\partial r^2}} > 0. \tag{19}$$

The denominator is negative by Assumption 4 and the numerator is positive, so the left-hand side of the equation is positive. □

Appendix C: Alternative Mechanism

Profits for a microfinance-funded loan under our alternative payment mechanism A are

$$\pi^{Funded|A}(r) \quad = \quad F(r)\left(p(r)\right) - N\frac{K}{T} - C, \tag{20}$$

where the FP receives monthly payments $p(r)$ from the borrower but pays back the lenders with the monthly contribution to principal, L/T, regardless of whether the borrower defaults. N is the total discounted number of payments (equal to T if there is no discounting by FPs). Note that

$T \geq N \geq F$. The total expected profits for a loan posted under this alternative are:

$$\begin{aligned} \pi^A(r) &= \left(F(r)p(r) - \widetilde{K}\right)(1 - l(r)) + \left(F(r)\left(p(r)\right) - N\frac{K}{T} - C\right) l(r) \\ &= \left(F(r)p(r) - \widetilde{K}\right) + \left(\widetilde{K} - N\frac{K}{T} - C\right) l(r) \\ &= \pi^C(r) + \left(\widetilde{K} - N\frac{K}{T} - C\right) l(r). \end{aligned} \tag{21}$$

The expected profit for a loan the FP offers to a borrower is:

$$\pi(r) = y(r)\,\pi^A(r). \tag{22}$$

Taking the derivative of profits with respect to r, we have:

$$\begin{aligned} \frac{\partial \pi(r)}{\partial r} &= \eta_y \frac{y(r)}{r}\pi^A + y(r)\left[F'(r)p(r) + F(r)\frac{\partial p(r)}{\partial r} + \widetilde{K}\frac{\partial l(r)}{\partial r} - N\frac{K}{T}\frac{\partial l(r)}{\partial r} - C\frac{\partial l(r)}{\partial r}\right] \\ &= \frac{y(r)}{r}\left[\eta_y\left(\left(F(r)p(r) - \widetilde{K}\right) + \left(\widetilde{K} - N\left(\frac{K}{T}\right) - C\right) l(r)\right)\right. \\ &\quad \left. + \left(rF'(r)p(r) + rF(r)\frac{\partial p(r)}{\partial r} + \left(\widetilde{K} - N\left(\frac{K}{T}\right) - C\right)\eta_l l(r)\right)\right]. \end{aligned}$$

Similar to before, we can define:

$$\begin{aligned} \Theta_3(r) \equiv\; & p^K(r) + \\ & \frac{1}{\eta_y F(r) + rF'(r)}\left[-\eta_y \widetilde{K} + rF(r)\frac{\partial p(r)}{\partial r} + \right. \\ & \left. l(r)\left(\eta_y\left(\widetilde{K} - N\left(\frac{K}{T}\right) - C\right) + \eta_l\left(\widetilde{K} - N\left(\frac{K}{T}\right) - C\right) - rF'(r)\frac{K}{T}\right)\right]. \end{aligned} \tag{23}$$

(24)

Assumption 6: $\Theta \equiv \Theta_3 - \Theta_2$ is increasing and satisfies the single-crossing condition.

This assumption yields a unique solution r^A to equation (24) over the support of the parameters. This assumption allows us to compare the situations with and without microfinance with the alternative mechanism.

We can again calculate the differences in the Θ functions:

$$\Theta_3 - \Theta_2 \quad = \quad \frac{l(r)}{\eta_y F(r) + rF'(r)} \left[\eta_y \left(\widetilde{K} - N\left(\frac{K}{T}\right) - C \right) + \eta_l \left(\widetilde{K} - N\left(\frac{K}{T}\right) - C \right) \right].$$

These terms are the same as with the current microfinance payment mechanism with the exception that N appears on the right-hand side instead of F, and the term that includes F', which was the risk-transfer term, is absent. Because both terms inside the brackets are negative in value, the interest rate must be lower due to Kiva, from the single-crossing assumption. The intuition is that by having the FPs pay back lenders irrespective of default, the upward force on rates from risk transfer has been removed.