Risk Transfer versus Cost Reduction on Two-Sided Microfinance Platforms

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Abstract:

Microfinance can be an important tool for fighting global poverty by increasing access to loans and possibly lowering interest rates. However, 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, which removes one of these disciplining mechanisms. Interest rates are high, around 38% on Kiva. In contrast, on an alternative microfinance platform that does not use intermediaries, Zidisha, interest rates are only around 10%, highlighting the dramatic impact of intermediaries on interest rates. We propose an alternative loan payback mechanism that still allows microfinance platforms to use intermediaries, while removing the incentive to increase interest rates due to the transfer of risk to lenders.

Keywords: Microfinance, Crowdfunding, Two-Sided Platforms, FinTech, 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), 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 commission 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 are divided between the lenders (to cover the initial principal), and the FPs, which receive the interest on the loans.

The fact that microfinance institutions provide free capital for FPs makes lending through microfinance very attractive for FPs, which can lower interest rates due to a reduction in lending

[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.

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 rate can keep interest rates in check.[3] 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 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 online microfinance platforms, almost all of which use local intermediaries, 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 also find that one of the disciplining mechanisms, lenders' lending elasticity, is negligible because loan interest rates have no impact on lenders' lending decisions.[4] The FPs

[3]Despite the high interest rates associated with microfinance, the average default rates (across FPs and time) are relatively low in our data (below 2%). However, the delinquency rates are fairly high at the level of about 11%. The distribution of default/delinquency rates, however, is extremely skewed. In some cases the default rates exceed 20% and the maximum is greater than 50%. The delinquency rates reach 100% for some FPs (see Table 1). One possible reason for the relatively low default rates 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.

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

can essentially monetize the altruism displayed by the other agents in the ecosystem. Although in many geographies the remaining downward force on interest rates from the demand elasticity may outweigh the upward force from default-risk transfer, this is not necessarily true in all geographic areas or for all microfinance platforms. There is considerable heterogeneity in delinquency and default rates across FPs, as well as a huge discrepancy between rates charged on Kiva (an average of 38%), and an alternative microfinance platform that does not use intermediaries, Zidisha, which has rates of only around 10%.[5] Of course not using intermediaries increases the challenges associated with identifying eligible borrowers, disbursing the loans, and collecting payments. We show that an alternative repayment mechanism would still allow the use of intermediaries but eliminate the force pushing interest rates higher, completely mitigating the moral hazard problem.

As financial technologies (FinTech) become more prevalent, understanding the incentives of the market participants is crucial in order to assess the implications for consumers. In particular, the design of two-sided crowdfunding and microfinance platforms must account not only for the incentives of the agents on both sides of the platform, but also all other participants in the ecosystem. This paper provided one example in FinTech, micro-lending, in which the incentives of the intermediaries do not appear to be accounted for in platform design. As a result, consumers who would have been able to receive a loan in the absence of micro-lending can actually be worse off with microfinance due to the altered incentives of these market participants.

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 delinquency 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 in which microfinance is not available, and we find that at the estimated parameters, interest rates are likely to be lower due

[5] Zidisha is the only microfinance platform of which we are aware that connects borrowers directly to lenders without intermediaries. According to their website (`https://www.zidisha.org/why-zidisha`), "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)."

to the presence of microfinance. Next, we demonstrate that an alternative repayment arrangement would eliminate the FPs' incentives to increase interest rates. In section 7, 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 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 still plays a role in lending decisions; local lenders are more likely to lend earlier and to be less influenced by others' lending decisions.

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

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 the literature on charitable giving (Liu and Aaker, 2008; Aaker and Akutsu, 2009; Small and Verrochi, 2009). This 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 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.

Although lenders give money to fund particular loans from specific borrowers, only 5% of Kiva loans are in fact 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

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

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. This mechanism is the norm for microfinance platforms.

[Insert Figure 1 about here.]

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 borrower 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 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 interests rates.

[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.

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 on microfinance platforms such as Kiva 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 microfinance platform (e.g., a local bank). Output q is given by:

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

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-microfinance 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. The stochastic term may be induced by some unobserved factors associated with Kiva loans that affect a borrower's output level. For example, the factor may be some extra costs associated with the loan application. Another example may be some restrictions imposed on the borrower in terms of how the business should be operated.

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 microfinance loan, $y(r)$, decreases as a function of the available outside capital, $\overline{K}_0$.

Proof. See Appendix A. □

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

In other words, if the amount of lower-cost capital $\overline{K}_0$ increases, the borrower is less likely to accept the microfinance loan for any given interest rate, r. The extent to which demand changes with interest rate will be one of the determining factors in the extent to which risk will be transferred to lenders by profit-maximizing FPs.

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 (which can be allowed to vary over time). 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:

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

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

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.

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 by the FPs (cited as a reason for the higher interest rates). 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 on a microfinance platform will be successfully funded. Let $l(r)$ be the probability that a loan is successfully funded by lenders on the platform 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:

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

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.

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 microfinance 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 sets the optimal interest rate for each loan to maximize its profits; accordingly 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:

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

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 through microfinance is higher than if it had not been posted through microfinance 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 expected number of (discounted) payments with respect to interest rate, $F'(r_C)$, is large in magnitude (i.e. low delinquency/default), at the optimal rate in the absence of microfinance, the force pushing rates upward is large because the lenders bear the delinquency 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 microfinance versus using microfinance. The term is positive, or the FP would not post the loan on the platform. With low FP capital costs (low $\widetilde{K}$), low delinquency/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 a 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 through microfinance), to test Proposition 1, we instead assess 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), and let demand satisfy $y > 0.5$ i.e. the borrower will* *accept the loan with at least 50% probability.* $\frac{dr_M}{dz} > 0$*; i.e., the less elastic the demand, the higher the optimal interest rate.*

Proof. See Appendix B. □

The criteria that $y > 0.5$ is a sufficient but not necessary criteria, since demand is concave in that region (if the demand function is too convex, the optimal rate may not be an interior solution). 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 through microfinance platforms 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 demonstrate that the interest rates set by FPs are lower if consumers have more access to capital, providing strong evidence that FPs are indeed setting interest rates to maximize profits. 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 four 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. Third, 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. Finally, we gathered information from another online microfinance platform, Zidisha, from 2010 to 2012.[11] Zidisha has a similar objective as Kiva, which is to use microfinance to support entrepreneurs from developing countries and areas. The most crucial difference between the platforms is that Zidisha does not use intermediaries to disperse loans. Zidisha overlapped with Kiva in 10 countries / areas.[12] We identify the exact entry month of Zidisha in each country, and investigate the impact of this added competition on Kiva FPs' APR levels. We also compare loan APRs across platforms to demonstrate the extent to which intermediaries (the FPs) may lead to higher interest rates.

4.1.1 Loans

Our Kiva loan data contain 360,575 loans that were listed on Kiva between January 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%) defaulted, but the delinquency rate was over 10%.[13] Table 1 shows the summary statistics of the 360,575 listed loans.[14]

[Insert Table 1 about here.]

4.1.2 Field Partners and Local Financial Markets

We collected the Kiva 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 2 shows

[11] Zidisha started its operations in October 2009.

[12] The overlapping 10 countries and areas are Burkina Faso, Ghana, Guinea, Haiti, Indonesia, Kenya, Mexico, Niger, Senegal, and Zambia.

[13] Note that this percentage of defaulted loans and the delinquency rate are different from the statistics presented in Table 2. The reason is simply that the statistics in these two Tables have different levels of aggregation that lead to rounding differences.

[14] We note that the average APR across all loans is slightly different from the average APR across all FPs as reported in Table 2. This difference is due to differences in weighting when computing the average APRs.

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 relatively low. 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.

[Insert Table 2 about here.]

[Insert Figure 2 about here.]

One thing that is evident from Table 2 is that the average interest rates and default/delinquency 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%. The delinquency rates follow a similar pattern, and are much higher with an average of 10.54%. Furthermore, the relationships between APR and the delinquency and default rates are 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 delinquency and default.[15] Presumably the delinquency/default rates increase 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 delinquency and default rates with respect to interest rate may be sufficiently high to lead to a large risk transfer effect. However, unlike the Middle East, delinquency and 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 3. Only six of the top 20 FPs are non-profit organizations, and only 29% of all 155 FPs are registered non-profit organizations.

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

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.

[Insert Table 3 about here.]

As a case in point, the FPs' APR level on Kiva is 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-year-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.

In comparison, Zidisha, a similar online microfinance platform which entered the market in late 2009 which does not use intermediaries, has a much lower average APR. We collected the APR information from Zidisha for its 7,067 loans during the same time period as the Kiva loans. In Figure 3a, we plot the histograms of distributions of Kiva average APRs and Zidisha average APRs at the FP-market-year level for the countries where the two platforms overlapped.[16] From the figure we can see a stark contrast between the APR levels across the two platforms, which demonstrates the huge effect that the intermediaries (FPs) have on interest rates. One key reason for the interest rates difference is that Kiva's FPs are mostly profit-maximizing entities. Even without microfinance, their baseline return on capital may be at a high level in developing countries. With microfinance, the incentive to raise the rates may become even greater. In contrast, Zidisha's operation does not involve any local capital or profit-maximizing entities, and fully relies on local volunteers to distribute and administer loans. Together, Zidisha's business model results in the much lower rates than Kiva.

In Figure 3b, we focus on the Kiva APR levels before and after the entries of Zidisha. From this graph, it shows that Kiva APR levels dropped considerably after Zidisha entered a specific country / area. The drastic drop in Kiva APRs upon the entry of Zidisha provides strong, descriptive evidence of the role of access to capital access on Kiva APRs. This helps to also rule out cost heterogeneity

[16] We depict another figure only focusing on those Kiva loans issued when Zidisha operates (not reported), which shows similar insights.

across platforms as the reason for the difference in APRs, and shows that the FPs are behaving in a manner consistent with profit-maximization.

[Insert Figure 3 about here.]

4.2 Analysis of Lending Environment

4.2.1 Access to Capital

If the FPs are behaving in a way consistent with profit-maximizing behavior, the local APRs will be lower when borrowers have more access to capital, which then 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 this, we regress the APRs set by FPs on Zidisha entry, as well as on the the number of banks per 100,000 residents (which varies over time), as the two measures of accessibility to alternative capital. Zidisha entered into 10 countries where Kiva operated between 2010 and 2012, and the entry decisions were based on supply side factors, in particular, the personal experiences of Zidisha's CEO (working on the ground after graduate school in Niger and Senegal with the microfinance industry, prior to founding Zidisha), and the availability of on-the-ground volunteers.

According to Corollary 1 and its prediction, APRs decrease in countries with easier access to capital. As a result, with Zidisha's entry into a country, we expect the APRs set by the Kiva FPs to drop. In our analysis, we control for the number of FPs in the country in a given year, the annual GDP per capita of the country, and characteristics of the FPs and loans they grant (such as average loan size and term, fraction of female borrowers, etc.). The unit of observation is a FP-county-year, and the results are shown in column 1 of Table 4. The results show that with easier access to the capital market for borrowers, 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.

We have showed that, when setting rates, 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 lenders.[17] Hence, we next test the dependency of η, γ, and F on the interest rates, r, to help quantify these dependencies.

[Insert Table 4 about here.]

4.2.2 Delinquency Rates

If FPs are maximizing profits, the dependency of delinquency/default rates on interest rates is crucial in determining whether Kiva is likely to lead to higher or lower interest rates (i.e., F', in Proposition 1). Using an FP's yearly average delinquency rates of all loans in a given market, we investigate the factors that affect a loan's risk. We are particularly interested in the effect of APR on delinquency rate. According to Assumption 3, the delinquency probability of a loan should be non-decreasing in its APR. Note that we also consider the same analysis using default rates instead of delinquency rates to measure loan risk and the insights remain the same.

It should be acknowledged, however, that there is an endogeneity concern in the relationship between the risk of a loan and the interest rate due to the FP screening - higher APR loans might only be given to those individuals whom the FP believes to be of high risk. Our data largely avoids this issue by using average APRs at the FP-country-year level rather than loan-specific APRs. Different screening rules across FP, year, and country can be controlled for with the use of fixed effects; identification can then be achieved by within-FP variation across markets and time. That said, to address the potential endogeneity concern, we use two-stage least squares, isolating the part of APR variation that is not driven by default risk. In particular, we use the entry of Zidisha as an instrument for the APRs set by Kiva FPs.[18] Note that our analysis of the effect of Zidisha entry on APRs above in section 4.2.1 is the first stage regression, which has a large F-statistic, ruling out the weak instrument concern. We then use the fitted values for the APRs in our second stage regression, i.e., the analysis of the effect of APRs on delinquency rates. Column 2 of Table 4 shows the second stage of the 2SLS regression results of the analysis of loan delinquency. We again include

[17] 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).

[18] One possible channel that may invalidate Zidisha's entry as an instrument is that the platform chose countries with more low-risk borrowers to enter, hence the lower APR was the reason of Zidisha's entry. We think this mechanism is unlikely because Zidisha had fairly high delinquency rates and consequently had to stop its operation for a brief time. Also, we control country and FP fixed effects. The within-FP-country variation related to Zidisha's entry can further mitigate such a concern.

fixed effects for FP, year, and country, as well as characteristics of the loans and market covariates used in the first stage regression. From the results, we see that APR has a significant, positive effect (at the 1% significance level), on the delinquency probability.

4.2.3 The Funding Probability

Next, we evaluate whether the likelihood of a loan being funded on Kiva decreases with the interest rate. We assume (Assumption 2) that the likelihood of the loan being funded does not increase with interest rate, but if it decreases with the rate, then this would serve as a disciplining mechanism by increasing the downward force on the optimal APRs. We again use 2SLS (using the same first stage regression), at the FP-market-year level to test this relationship. The dependent variable is the average percentage of loans being funded for a specific FP during a given year.

In the last column of Table 4, we report the second stage of IV regression results. We find no significant effect of the 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).[19] [20]

4.2.4 Demand Elasticity

Assumption 1 assumes that the demand for a Kiva loan has a negative elasticity with respect to interest rates, which we would expect. To estimate the demand elasticity, we consider a linear regression where the dependent variable is the total amount of loans an FP lent out in a given market during a given year. For each market during a given year, we use the average APR of all loans of an FP as the independent variable, together with the number of competing field partners and the accessibility of local capital. We also include the number of banks per 100,000 residents of

[19] Another potential reason why a loan's APR has inconsequential effect on the funding probability is that Kiva vaguely labeled the APR as the field partner's "portfolio yield." It might be difficult for lenders to perceive it as the interests and fees collected by the FP from borrowers. Recently, Kiva has changed the label to a more transparent "average cost to borrower."

[20] 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).

each country, as well as the Zidisha entry to control for the access the borrowers have to alternatives to Kiva loans. In light of the skewness in APR (see Table 1), and for easy interpretation of the coefficients, we use logarithms of the variables in the regression. The regression also controls for fixed effects of FP, country, and year with standard errors clustered at the FP level. Column 1 in Table 5 presents the results. Of particular interest, the demand for loans of a focal FP dropped when its average APR increased, implying a negative demand elasticity. However, we find the elasticity to be low in magnitude in our setting.[21]

[Insert Table 5 about here.]

One concern, however, is that the APR level of an FP may be endogenous to the market condition in which it operates. Such endogeneity may lead to biased estimates for the demand elasticity. In this case, we cannot use the entry of Zidisha as an IV since it directly affects demand. Consequently, we consider an alternative IV, in light of the fact that an FP may operate in multiple markets. In particular, we use the total amount of loans an FP lent out in markets other than the focal one during the same year. Suppose the FP is subject to some capital constraint, lending in other markets may increase its APR in the local market. The increase in APR is arguably exogenous to the local market's conditions. Accordingly, in Table 5, we consider an IV regression using an FP's loan amount in other markets to separate its local APR variation due to exogenous shocks. As we expected, the loan amount in other markets does significantly increase an FP's APR level (Column 2 in the table). In the second stage of the IV regression (column 3), we again find the demand elasticity estimate to be significantly negative, implying demand for loans drops when the APR rises.

4.3 Discussion

In this section, we established 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 such as Kiva in which lenders lend for altruistic reasons. These two factors together reduce the downward forces on interest rates.

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

We also found a positive relationship between APR and loan risk. Intuitively, the stronger the relationship between delinquency rates and interest rates, the greater the incentive for FPs to charge higher rates on Kiva than they would without Kiva, because the risk is transferred to lenders. In the next section, we use simulations to demonstrate the tradeoff between loan risk and interest rates explicitly.

5 Simulations

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 microfinance's 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 through microfinance 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). We assume that the cost of borrowing for the FP is 10% of the value of the loan (which we later vary). We set demand to be 0.5 for a range of demand elasticities between -0.5 and -1.0. The qualitative relationships are robust to changes in the parameter values, which are used for illustrative purposes.

We assume the probability of making each payment is a time-invariant function of r, $\delta(r)$, so that delinquent payments (which occur with probability $1-\delta(r)$) are not made; the borrower continues to make future payments with probability $\delta(r)$:

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

These assumption are not needed, but they help with the interpretation of the simulations. Because $\delta(r)$ can be easily interpreted (as "1−monthly delinquency probability"), we will vary $\delta(r)$ in the simulations in order to vary $F(r)$.

The FPs' discount rate and the monthly delinquency 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

FPs' discount rate to be $\rho = 0.99$ and alter the delinquency rate function. We specify this function as:

$$\delta(r) = 1 - \kappa_1 \exp((r - .5)\kappa_2). \tag{12}$$

This allows us to modify the level of delinquency rate as well as the curvature of the delinquency rate function by changing κ_1 and κ_2. To show the effect of the two κ parameters on the shape of the delinquency rate function, we plot the delinquency rate function for different values of the κ parameters in Figure 4. The first figure shows the function for a lower initial delinquency rate at $r = 0$ with $\kappa_1 = 0.01$ for $\kappa_2 = 5$ and 10, and the second for a higher initial delinquency rate with $\kappa_1 = 0.02$ for the same values of κ_2. A larger κ_2 results in a greater curvature of the delinquency function (shown in Figure 4 with the dashed line).

[Insert Figure 4 about here.]

Next, we compare the optimal APRs as a function of both demand and demand elasticity. The first derivative of the delinquency 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 delinquency risk. In Figure 5, we show the optimal interest rates with and without microfinance as the magnitude of the first derivative becomes larger, which is achieved by increasing the value of κ_1 or κ_2. In Figure 5, the delinquency rate is set at $\kappa_1 = 0.01$ in the left two graphs, with the bottom graph having the larger κ_2, i.e., delinquency increases more rapidly with interest rate. With a larger effect of rate on delinquency, there is a larger risk transfer effect. Hence the graphs of the optimal APRs with and without microfinance cross at a lower rate. In the right two figures, we use the same value for κ_2, but double κ_1 - the effect is to increase the disparity between the rates with and without microfinance - the rate at which the two curves cross is the same as with the lower κ_1 .

[Insert Figure 5 about here.]

In Figure 6, we plot the profits for the FP and the optimal interest rate as a function of the extra administrative costs, for the values used in Figure (5a). We plot these variables both when using and when not using microfinance, and we use a thick, gray line to designate the profits and optimal interest rate for the option that maximizes profits. As the administrative costs increase, the profits when using microfinance go down for the FPs and the optimal interest rates go up.

Essentially, any additional administrative cost of working with the microfinance platform reduces the downward pressure on rates that resulted from the lower costs of dispersing loans (due to the refinancing), and so the upward force due to risk transfer dominates. If costs become too high, the FP choses not to post the loan because its profits become higher when not using the microfinance site (at which point the optimal APR drops back down to what it would be without microfinance). From a consumer welfare perspective, it is the intermediate level of costs which cause concern, since the FPs still choose 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.

[Insert Figure 6 about here.]

6 An Alternative Mechanism

An alternative payback mechanism could completely mitigate the incentive of FPs to increase interest rates due to their ability to refinance loans using microfinance. The huge benefit from microfinance platforms such as Kiva is the increased availability of capital that comes via the lenders. If lenders were always paid back by the FPs, (i.e. it was not dependent on the borrowers not being delinquent and/or defaulting), then incentives for the FPs would change. This would be equivalent to the lenders granting a loan to the FP (which must then be lent to the borrower) equal to the principal of a borrower's loan. With this mechanism, the upward force on interest rates would be completely removed.

Proposition 2. *If the repayment of microfinance loans to lenders by FPs was not dependent on borrower not being delinquent and/or defaulting (i.e. the loan is to the FP), then the optimal interest rate of a loan that can be funded through microfinance is lower than if it could not be funded through microfinance.*

Proof. See Appendix C. □

With this alternative mechanism, microfinance platforms such as Kiva still provide 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, which is still alleviated with this alternative mechanism.

In Figure 7, we repeat the simulations shown in Figure 5 for $\kappa_1 = 0.01$, but with this alternative payback mechanism. Now the discrepancy in interest rates is driven by the reduction of lending costs, since the risk transfer effect is completely removed. As stated by the proposition, the optimal interest rate is always below that without microfinance. In Figure 8, we show the profits and optimal interest rate given the FP's choice to use microfinance as a function of the additional lending costs - now, if costs with microfinance become high enough, the FP may still decide to not use it, but in all cases, the optimal interest rate remains below the rate without microfinance. In cases with minimal additional costs, rates would be considerably lower. The rates are equivalent at the FP's indifference point, which is intuitive since the only remaining force altering rates is due to the discrepancy in lending costs.

[Insert Figure 7 about here.]

[Insert Figure 8 about here.]

7 Concluding Remarks

As with the study of informal lending markets in Weining et al. (2017) and in other FinTech examples, it is critical to consider the incentives of all the agents in the ecosystem. Because micro-lending intermediaries (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 the altruistic 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 to hold true for other microfinance sites), means one of the downward forces on rates is removed entirely. At Kiva, the low default rates mean interest rates may not be higher due to the presence of Kiva, because the amount of default risk to be transferred to lenders on Kiva is small. However, if this condition fails, the platform will still be subject to the risk of FPs raising interest rates higher than in the absence of microfinance. Furthermore, the large discrepancy between rates on Kiva and Zidisha demonstrates the large reduction in rates that would be possible from lowering lending costs without the associated increase in rates from risk transfer.

Zidisha was able to eliminate the issue by using volunteers that match lenders and borrowers directly, rather than use intermediaries. However, this approach may be more of a challenge to scale, especially in areas where getting volunteer support is not viable. Kiva has recently implemented a different 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. 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. Rather than relying on the lenders to internalize the effect of larger rates on the borrowers, we propose an alternative payback mechanism which completely mitigates the risk transfer force on interest rates, allowing microfinance platforms to still use intermediaries without setting up incentives that are detrimental to borrowers.

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 logistical reasons to achieve socially desirable outcomes, 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:

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

in which profits for a commercially financed loan are:

$$\pi^C(r) = F(r)p(r) - \widetilde{K}, \tag{15}$$

and expected profits for a loan offered through microfinance are:

$$\pi^M(r) = \pi^C(r) + \left(\widetilde{K} - F(r)\frac{K}{T} - C \right) l(r). \tag{16}$$

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:

$$
\begin{aligned}
\Theta_1(r) \equiv\ & p(r) + \\
& \frac{1}{\eta_y F(r) + rF'(r)}\Bigg[-\eta_y \widetilde{K} + rF(r)\frac{\partial p(r)}{\partial r} + \\
& l(r)\left(\eta_y\left(\widetilde{K} - F(r)\left(\frac{K}{T}\right) - C\right) + \eta_l\left(\widetilde{K} - F(r)\left(\frac{K}{T}\right) - C\right) - rF'(r)\frac{K}{T}\right)\Bigg],
\end{aligned}
\tag{17}
$$

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:

$$
\Theta_2(r) \equiv p(r) + \frac{1}{\eta_y F(r) + rF'(r)}\left[-\eta_y \widetilde{K} + rF(r)\frac{\partial p(r)}{\partial r}\right], \tag{18}
$$

which is equal to zero at the optimal interest rate r_C without microfinance.

We can calculate the difference in these two functions as:

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

Here, we make one final assumption:

Assumption 5: Define $\Theta \equiv \Theta_2 - \Theta_1$. Θ is increasing and satisfies the single-crossing condition if $\exists r | \Theta(r) = 0$.

This assumption is benign because the expression is negative at $r = 0$. We know the first term, $-\frac{l(r)}{\eta F + rF'}$, is negative, because from Assumption 3, we have that $F'(r) \leq 0$, η_y is negative from Assumption 1, η_l is negative from Assumption 2, 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 non-negative term, because $F'(r)$ is negative. At the optimal interest rate without microfinance, r^C, we have that $\Theta_2(r^C) = 0$. Therefore $\Theta_2\left(r^C\right) - \Theta_1\left(r^C\right) < 0$, at the optimal interest rate without microfinance if and only if the third (risk-transfer) term is smaller in magnitude than the combined first two terms. By the single crossing property, this means that for all $r < r^C$, $\Theta_2\left(r^C\right) - \Theta_1\left(r^C\right) < 0$, and so for the optimal rate with microfinance, r^M, we have that $r^M < r^C$. Conversely, if the third term is larger in magnitude than the other two terms, we have that $\Theta_2\left(r^C\right) - \Theta_1\left(r^C\right) > 0$, and therefore $r^M > r^C$. □

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

$$\frac{dr_M}{dz} = -\frac{\frac{\partial}{\partial z}\frac{\partial \pi(r_M)}{\partial r}}{\frac{\partial}{\partial r}\frac{\partial \pi(r_M)}{\partial r}} = -\frac{\frac{\partial \eta_y}{\partial z}\pi^M}{r\frac{\partial^2 \pi^M}{\partial r^2} + \frac{\partial \eta_y}{\partial r}\pi^M} > 0$$

The numerator is positive by definition, and the first term in the denominator is negative by Assumption 4. The second term in the denominator is negative above the inflection point in the choice probability expression since $\frac{\partial - \phi(r)}{\partial r} > 0$ for $y > .5$ (see equation 3). Thus the entire expression is positive and the optimal interest rate increases with less elastic demand. □

Appendix C: Alternative Mechanism

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

$$\pi^{Funded|A}(r) \quad = \quad F(r)\left(p(r)\right) - N\frac{K}{T} - C, \tag{19}$$

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:

$$\begin{aligned}
\pi^A(r) &= \left(F(r)p(r) - \widetilde{K}\right)(1 - l(r)) + \left(F(r)\left(p(r)\right) - N\frac{K}{T} - C\right) l(r) \\
&= \left(F(r)p(r) - \widetilde{K}\right) + \left(\widetilde{K} - N\frac{K}{T} - C\right) l(r) \\
&= \pi^C(r) + \left(\widetilde{K} - N\frac{K}{T} - C\right) l(r).
\end{aligned} \tag{20}$$

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

$$\pi(r) = y(r)\,\pi^A(r). \tag{21}$$

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:

$$\begin{aligned}
\Theta_3(r) \equiv\; & p(r) + \qquad (22) \\
& \frac{1}{\eta_y F(r) + rF'(r)}\left[-\eta_y \widetilde{K} + rF(r)\frac{\partial p(r)}{\partial r} + \right. \\
& \left. l(r)\left(\eta_y\left(\widetilde{K} - N\left(\frac{K}{T}\right) - C\right) + \eta_l\left(\widetilde{K} - N\left(\frac{K}{T}\right) - C\right)\right)\right]. \qquad (23)
\end{aligned}$$

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 (23) 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 inside the braces 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.

Tables and Figures

Table 1: Summary Statistics of Loans

	Mean	S.D.	Minimum	Maximum
APR%	38.11	15.00	2.00	109.00
Delinquency Rate% (FP-Year)	10.68	19.29	0.00	100.00
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

Table 2: 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 % across FP (S.D.)*	Average Delinquency Rates % across FP (S.D.)*	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)	18.97 (22.23)	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)	0.22 (0.73)	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)	2.00 (3.45)	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)	3.77 (2.04)	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)	45.26 (27.11)	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)	5.68 (8.19)	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)	0.44 (1.18)	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)	10.54 (17.06)	35.59 (14.31)	16.25 (8.28)	1502.40 (2582.67)

* The unit for measuring the distributions in this column is at the FP level. To be specific, we first regress FP-country-year default or delinquency rates on year and country fixed effects. We then compute the statistics of the regression residuals, which capture the variations of default or delinquency rates at the FP level.

** Four countries have missing values on Return on Equity Percentage.

Table 3: 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%

Table 4: The Effect of APR on Delinquency and Funding Probabilities of Loans

Variables	(1) Log (Avg. APR Perc.) IV 1st Stage	(2) Log (Perc. of Loans Delinquent) IV 2nd Stage	(3) Log (Perc. of Loans Funded) IV 2nd Stage
Log (Avg. APR Perc.)		0.874***	-0.076
		(0.153)	(0.054)
Zidisha Entry Dummy	-0.096***		
	(0.014)		
Log (Number of Banks per 100K Residents)	-0.008*** (0.001)	-0.039** (0.014)	-0.003** -0.001
Log (Number of FPs in the Country during that Year)	0.018 (0.018)	0.141 (0.303)	0.001 (0.006)
Log (Avg. Loan Terms (Months))	-0.014 (0.039)	0.254*** (0.018)	-0.009 (0.011)
Log (Avg. Loan Size ($1000))	0.263***	0.418***	0.051*
	(0.068)	(0.008)	(0.027)
Log (Avg. Loan Size/ GDP per Capita)	-0.125 (0.078)	3.012** (1.217)	-0.025 (0.019)
Log (Avg. Number of Borrowers)	-0.106*** (0.034)	0.775 (0.553)	-0.018** (0.008)
Log (Avg. Female Borrower Perc.)	0.027 (0.028)	0.399 (0.480)	0.003 (0.008)
Log (Perc. Loans with English Description)	-0.032 (0.029)	0.019 (0.462)	-0.005 (0.004)
Log (GDP per Capita ($1000))	-0.077* (0.042)	-1.723*** (0.650)	-0.015 (0.010)
F-stat. on Zidisha entry dummy	48.17		
Field Partner FEs	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes
Observations	771	771	771

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

Table 5: The APR Elasticity of Loans

Variables	(1) Log Annual Amount of Kiva Loans (US$1000)	(2) Log FP Avg. APR (%)	(3) Log Annual Amount of Kiva Loans (US$1000)
Log FP Avg. APR (%)	-0.727***		-0.805***
	(0.076)		(0.091)
Log Total Loans in Other Markets		0.040***	
		(0.006)	
Zidisha Entry Dummy	-1.272***	-0.101***	-1.187***
	(0.472)	(0.015)	(0.275)
Log Num. of Banks per 100K Residents	-0.310	-0.039	-0.940
	(0.562)	(0.024)	(0.638)
Log Num. of FPs	0.240	0.011	0.521**
	(0.662)	(0.018)	(0.230)
Constant	6.070***	0.382***	4.157***
	(1.152)	(0.060)	(1.218)
F-stat of IV (Loans in Other Markets)		8.96	
Field Partner FEs	Yes	Yes	Yes
Country FEs	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes
Observations	771	771	771

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

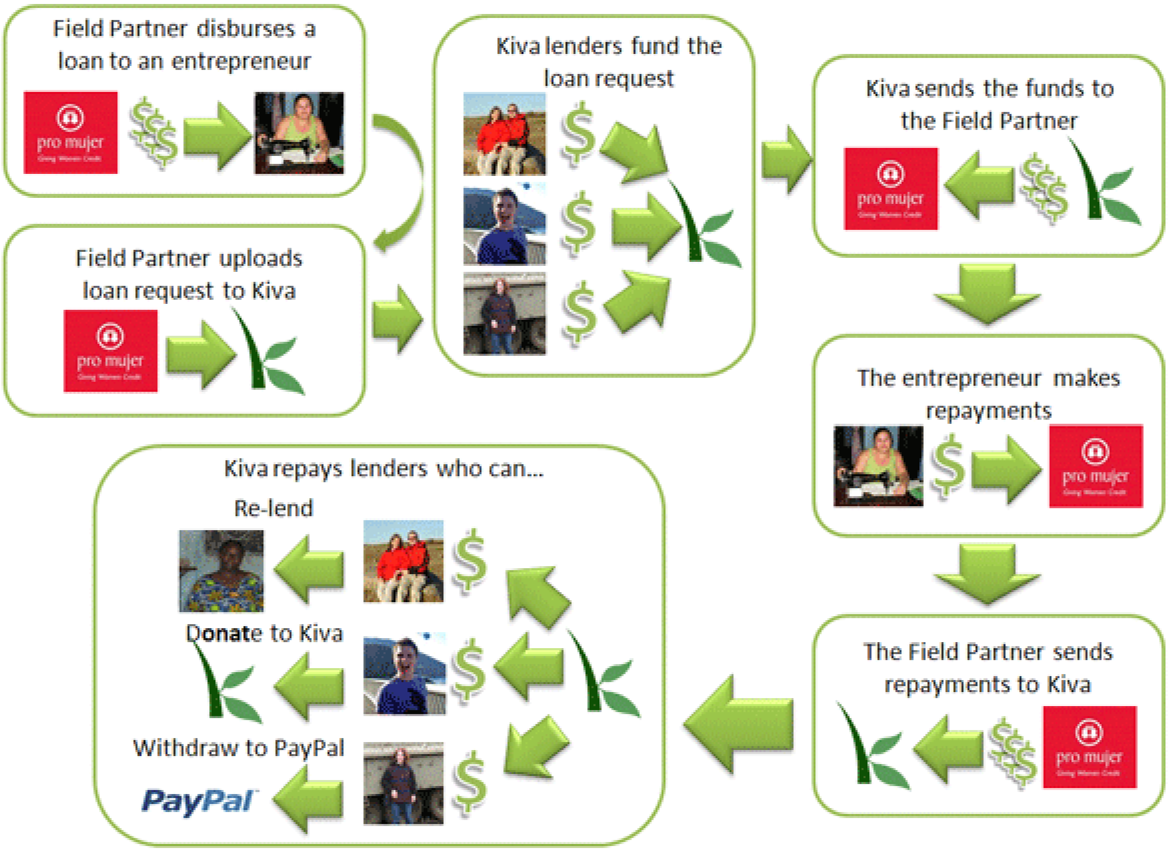
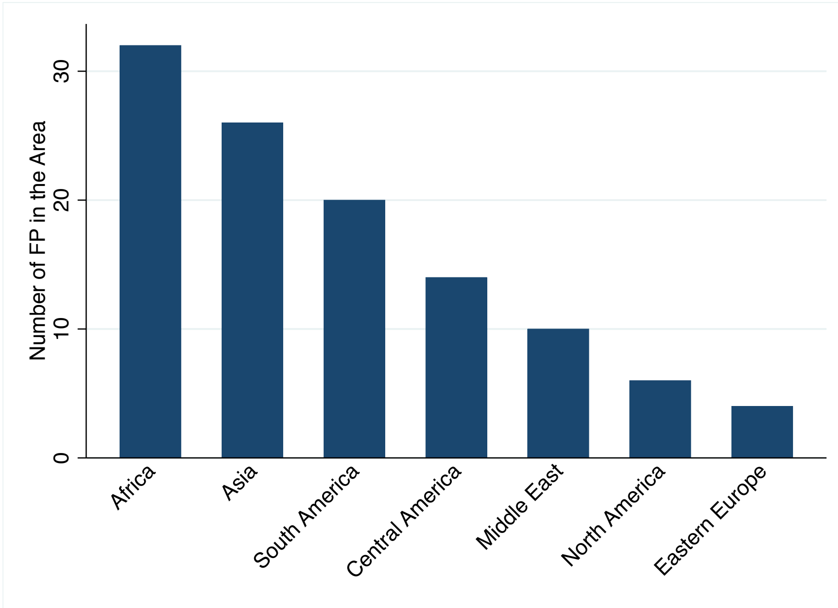
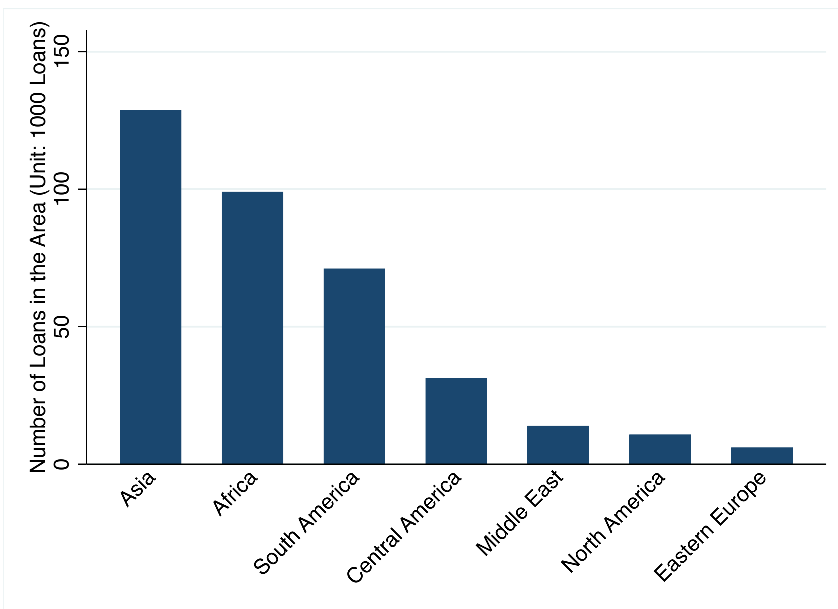


Figure 1: The Kiva Financing Diagram for FPs

Figure 2: Field Partners and Funding by Geoeconomic Areas

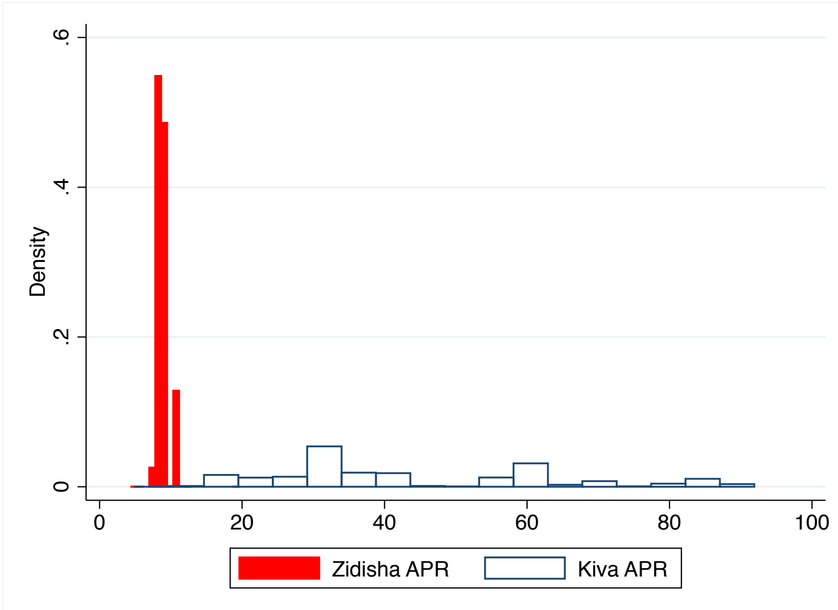


(a) Field Partners by Geoeconomic Areas

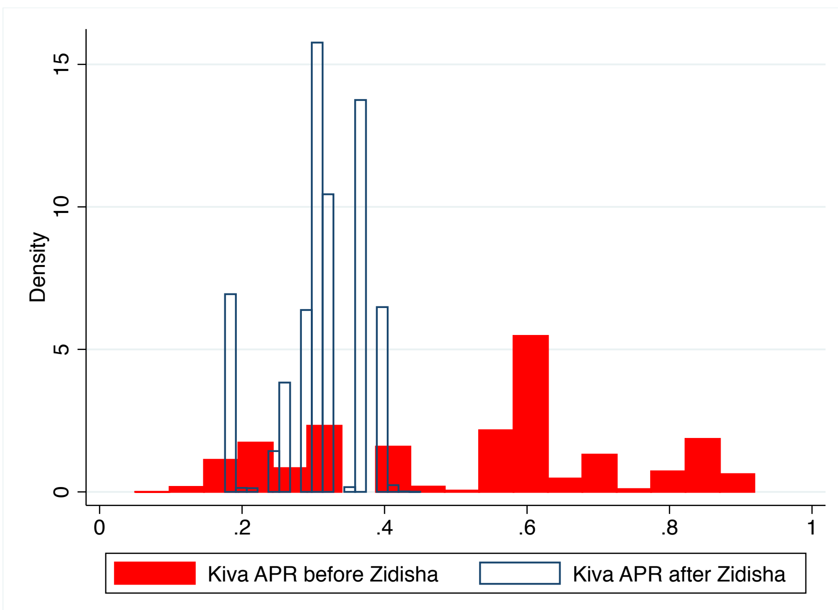


(b) Fundraising Loans by Geoeconomic Areas

Figure 3: APR of Kiva and Zidisha



(a) APRs of Kiva and Zidisha of the Same Countries



(b) Kiva APRs before and after the Entries of Zidisha

Figure 4: Comparison of APRs between Microfinance Loans and Non-Microfinance Loans

(a) Lower default rate

(b) Higher default rate

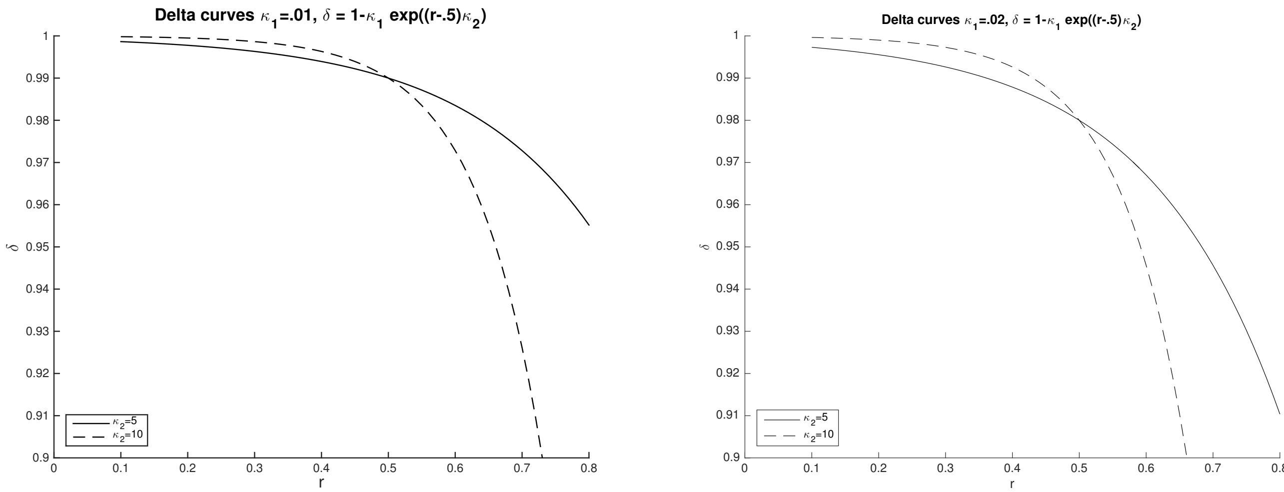
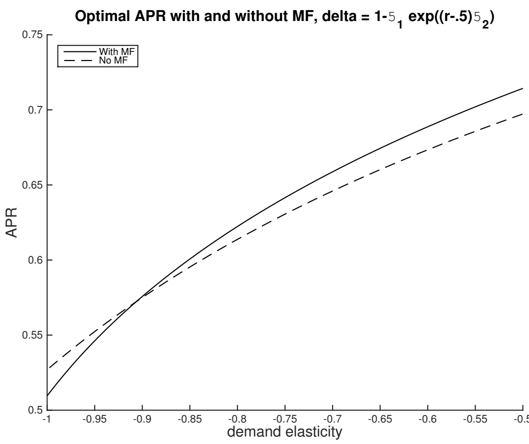


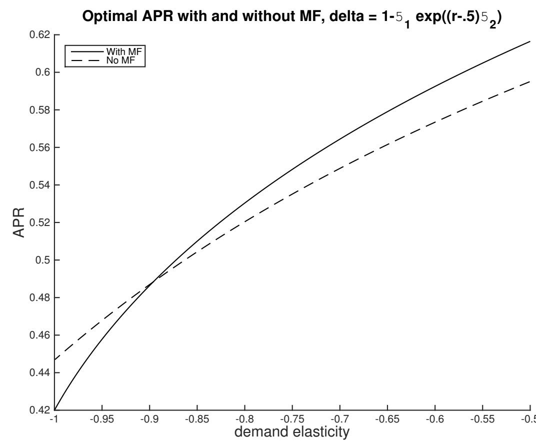
Figure 5: Comparison of APRs between Microfinance Loans and Non-Microfinance Loans, High Default Rate

Low curvature in $\delta(r)$, $\kappa_2 = 5$

(b) $\kappa_1 = 0.01$

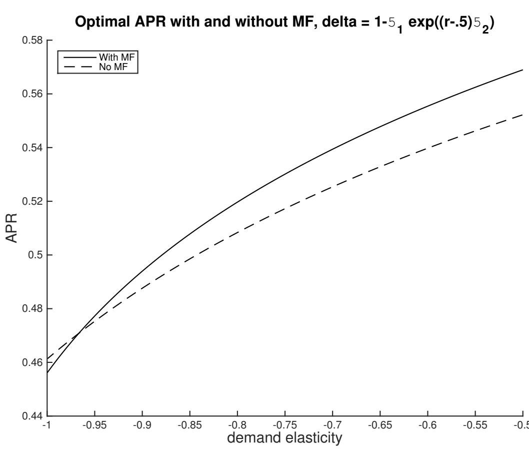


(c) $\kappa_1 = 0.02$



High curvature in $\delta(r)$, $\kappa_2 = 10$

(e) $\kappa_1 = 0.01$



(f) $\kappa_1 = 0.02$

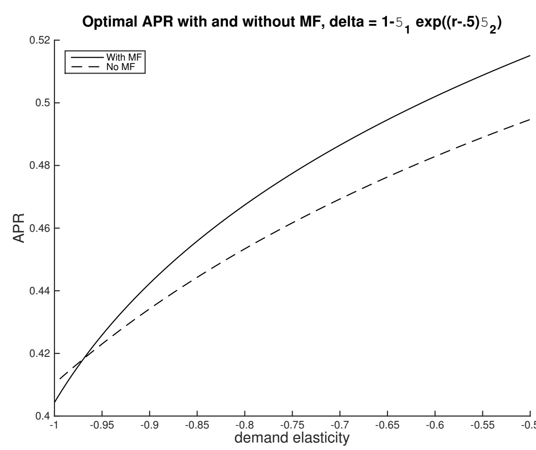


Figure 6: Comparison of FP Profit and APRs between Microfinance Loans and Non-Microfinance Loans as Administrative Costs Increase

Profits and APR charged by FP, $\kappa_1 = 0.01$ $\kappa_2 = 5$

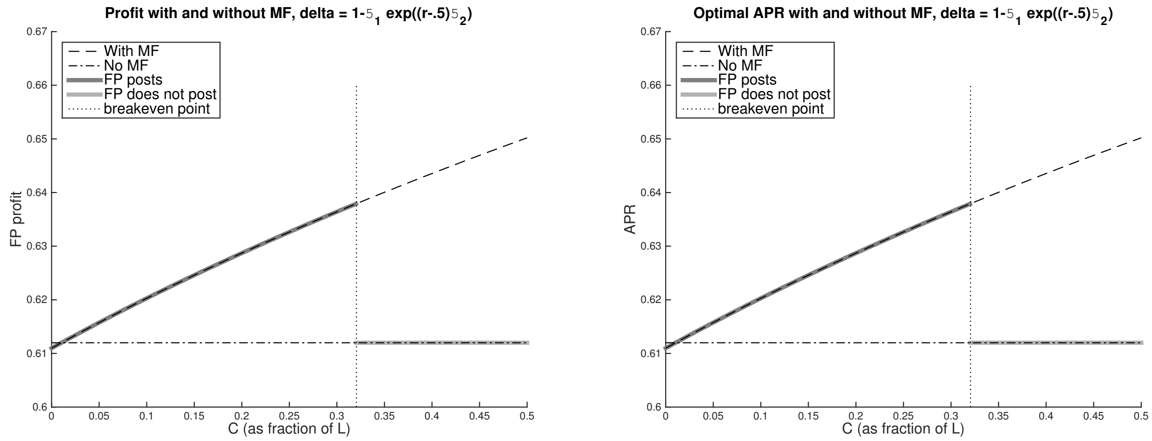
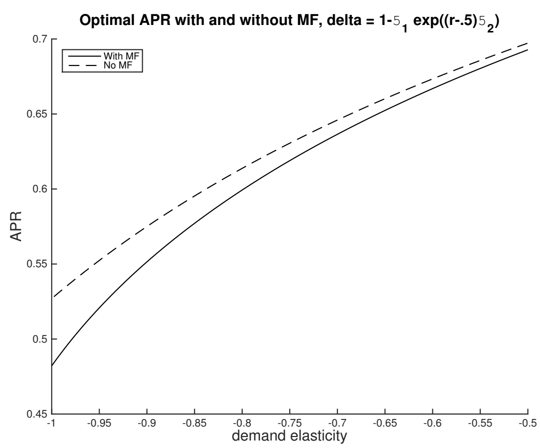


Figure 7: Comparison of APRs between Microfinance Loans and Non-Microfinance Loans, Alternative Mechanism

High curvature in $\delta(r)$, $\kappa_2 = 10$

(b) $\kappa_1 = 0.01$



(c) $\kappa_1 = 0.02$

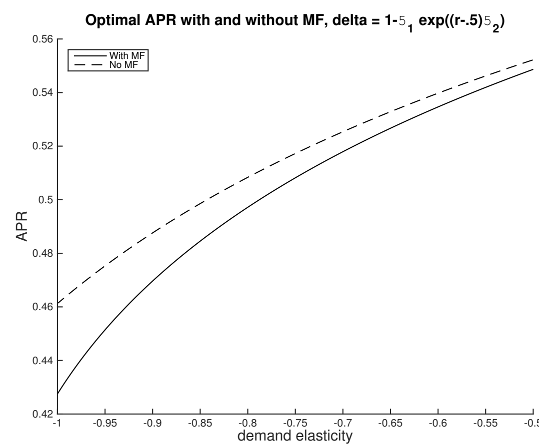


Figure 8: Comparison of FP Profit and APRs between Microfinance Loans and Non-Microfinance Loans as Administrative Costs Increase, Alternative Mechanism

Alternative Payback Mechanism, Profits and APR charged by FP, $\kappa_1 = 0.01$ $\kappa_2 = 5$