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, since it decreases intermediaries' capital costs, increasing individuals' access to loans and possibly lowering interest rates. However, the mechanism by which intermediaries administer loans has huge welfare implications. Using an analytical model of microfinance with intermediaries who disburse and service loans, we demonstrate that profit-maximizing intermediaries may have an incentive to increase interest rates because much of the default risk is transferred to lenders. The effects of interest rates on administration costs, borrowers' demand, and lenders' willingness to lend 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, Poverty.

"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 groups or individuals 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 (MFIs) 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]

Kiva, meaning "agreement" or "unity" in Swahili, has emerged as one of the major players at the intersection of microfinance and crowdfunding. Online microfinance platforms such as Kiva 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. Although lenders can loan to borrowers through the Kiva platform, Kiva's field partners (FPs), local lending agencies in the countries of the loan borrowers, actually disburse and administer the loans. These FPs act as intermediaries between lenders and borrowers. And although Kiva is a non-profit organization that does not charge interest or take a cut of any of the lent money, the same cannot be said of the FPs. The FPs do collect interest on the loans (reportedly to cover costs of administration), and these lenders are for the most part for-profit firms. According to the Kiva website, the FPs are "responsible for screening borrowers, posting loan requests to Kiva, disbursing loans and collecting repayments, and otherwise administering Kiva loans."

[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.

The goal of this paper is to analytically demonstrate that the standard loan-repayment mechanisms used on microfinance platforms such as Kiva could lead to a perverse incentive for FPs to charge higher interest rates on loans than they would in the absence of microfinance – a problem of moral hazard. Because much of the default risk of loan repayment is transferred to lenders, FPs have less of an incentive to keep interest rates low to avoid borrower default. The FPs can essentially monetize the altruism displayed by the other agents in the ecosystem who do not account for interest rates in their lending decisions. This upward force on interest rates works against other forces that push rates down and can serve as disciplining devices. Those other forces that push down interest rates include borrowers' demand elasticity, lenders' lending elasticity, and FPs' administration cost elasticity with respect to interest rates.

In this paper, we establish that interest rates set by Kiva's FPs imply they are maximizing profits rather than behaving in an altruistic manner. As an auxiliary exercise to determine whether the assumptions of our analytical model hold, we collect data and estimate the dependencies of borrowers' demand, lenders' lending decisions, and default risk on interest rates. We find that one of the disciplining mechanisms, lenders' lending elasticity, is negligible because loan APRs have no impact on lenders' lending decisions.[3] We find the remaining downward force on interest rates from the demand elasticity, in conjunction with the reduction in FPs' lending costs, likely outweighs the upward force from default-risk transfer for most loans, but this is not necessarily true in all geographic areas or for all loans in a region since there is considerable heterogeneity in default rates across FPs. We show that an alternative repayment mechanism would eliminate the force pushing interest rates higher altogether, mitigating this 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

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

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 Kiva. In section 6, we provide our concluding remarks.

2 Background

Micro-lending has its origin in Bangladesh and was started by economist 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, 2015). 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).[4] 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.

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

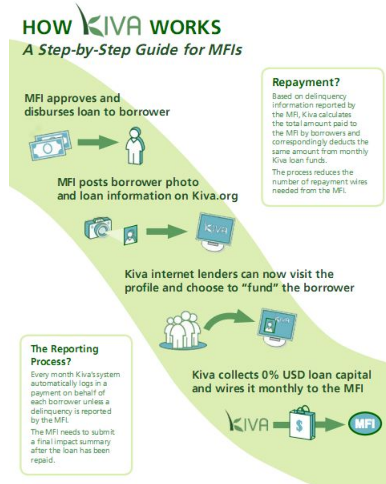
Kiva is the microfinance application we study in this paper. It was founded in 2005, and by mid-2012, almost 800,000 lenders had supplied over $330 million in loans in 62 different countries. Galak et al. (2011), who also study Kiva.org, find lenders are more likely to lend to smaller groups, based on the hypothesis that an individual suffering hardship invokes a stronger emotional response than multiple people (Kogut and Ritov, 2005a,b), and lenders will also be more likely to lend to individuals with whom they have characteristics in common, because research has shown people care more for others with whom they have traits in common (Stotland and Dunn, 1963; Krebs, 1975), 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). 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.

And the altruism of lenders is exactly what Kiva taps 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."[5] 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 is then lent out again to other borrowers. In other words, lenders treat money they lend on Kiva as donations.

The original diagram portraying how Kiva works, shown in the first diagram in Figure 1, makes the role of the lender appear crucial in determining whether a borrower receives the requested loan. 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. This ability to refinance will lead the

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

(a) The Original Financing Diagram



(b) The Updated Financing Diagram

Figure 1: The Financing Diagrams for Lenders

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 in recovering the original capital associated with the default of the loan. This lack of clarity in the process led David Roodman[6] to criticize Kiva in a blog post entitled *Kiva is Not Quite What it Seems* in October 2009.[7] In response to this criticism, on October 15, 2009, Kiva changed the image describing their financing model to represent the true timing, shown in the second diagram in Figure 1.

One aspect of Kiva.org 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 2, an explanatory diagram Kiva now displays on its website. 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 Kiva in increasing access to capital. Specifically, 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

[6]David Roodman follows developments in microfinance at the Center for Global Development.
[7]`http://blogs.cgdev.org/open_book/2009/10/kiva-is-not-quite-what-it-seems.php`.

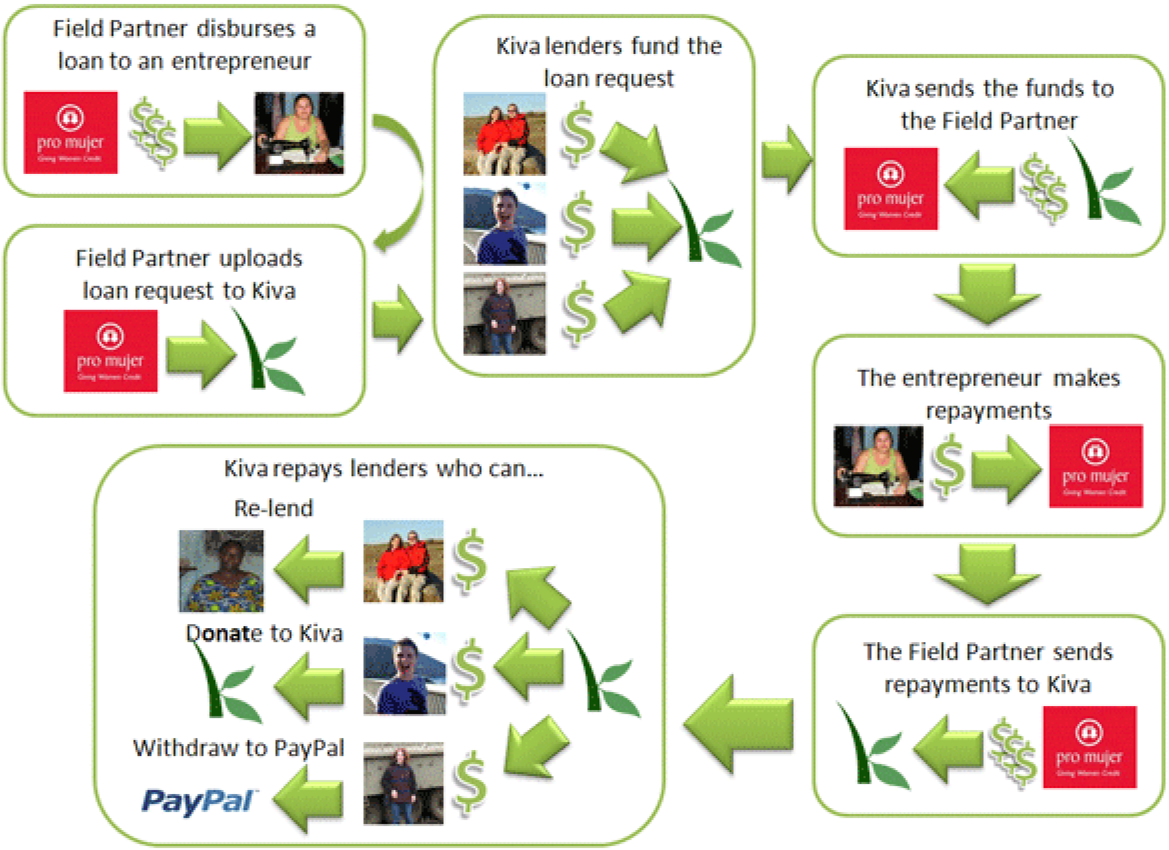


Figure 2: The Kiva Financing Diagram for FPs

lenders, while still providing a profit opportunity through interest payments.[8] And that incentive may not fully align with lenders' and Kiva's altruism motive.

More critically, the current repayment mechanism at Kiva 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, and finds some of the highest rate chargers also make the highest rates of return.

[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.

The fact that Kiva (and similar microfinance institutions) provide free capital for FPs makes lending through Kiva very attractive, which can lower interest rates due to this reduction in lending costs. The extent to which rates might decline depends on the demand elasticity for the loans and whether lenders on Kiva are less likely to lend at higher rates. The unique feature of our model is that we explicitly consider a 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 does not default). The fact that default risk increases with interest rates can keep interest rates in check.[9] 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).

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 FP profits and solve for the FP's optimal interest rate. For an FP, funding loans through microfinance is an opportunity to refinance its outstanding loans. The timing involved in a Kiva 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).

[9] 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 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.

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 Kiva.

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 Kiva, 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.

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. Let us define $F(r)$ as the expected discounted number of payments the borrower makes, which will be a function of the interest rate.[10] Without discounting and if the borrower makes all period-payments with certainty, 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. We assume $F(r)$ is non-increasing in r; in other words, that loan repayment does not become more likely at higher interest rates. However, no specific assumptions are needed on the exact timing of payments or on whether they depend on the principal amount, remaining balance, and so on.

Expected profits for a commercially financed loan (without microfinance) by an FP at rate r are given by

$$\pi^C(r) \quad = \quad F(r)p(r) - L, \tag{1}$$

where p is the monthly repayment from the borrower (a composite of interest and principal). L is the principal amount. Since the interest rate r is a control variable, we write these dependencies on the interest rate explicitly in the model. The tradeoff for an FP in setting the interest rate is that the monthly payment amount increases but the expected discounted number of payments ($F(r)$) will decrease. Note that the FP distributes the principal L upfront.[11]

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

[11] We ignore the minimal cost of posting a loan, and other administrative costs remain the same with or without Kiva.

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

$$\pi^{Funded|M}(r) \quad = \quad F(r)\left(p(r) - \frac{L}{T}\right) - C(r), \tag{2}$$

where the FP receives monthly payments $p(r)$ from the borrower and also pays back the lenders with the monthly contribution to principal, L/T, where T is the loan duration, and $C(r)$ are the extra costs of administering the loan, which could increase with interest rates as discussed in Banerjee and Duflo (2010). In this expression, we ignore the minimal lag time for an FP to receive the funding from lenders if 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).

Of course, not all loans posted at Kiva can be successfully funded. Let $\gamma(r)$ be the probability that a loan is successfully funded by lenders on Kiva conditional on being posted, which depends on the borrower/FP characteristics as well as the interest rate. Hence, the total expected profits for a loan posted are

$$\begin{aligned}
\pi^{M}(r) &= \pi^{C}(r)\,(1-\gamma(r)) + \pi^{Funded|M}(r)\gamma(r) \qquad (3)\\
&= (F(r)p(r) - L)\,(1-\gamma(r)) + \left(F(r)\left(p(r) - \frac{L}{T}\right) - C(r)\right)\gamma(r)\\
&= (F(r)p(r) - L) + \left(L - F(r)\left(\frac{L}{T}\right) - C(r)\right)\gamma(r)\\
&= \pi^{C}(r) + \left(L - F(r)\frac{L}{T} - C(r)\right)\gamma(r).
\end{aligned}$$

Because $L > F(r)\frac{L}{T}$ ($F(r)\frac{L}{T}$ is the expected principal that will be paid back to lenders), posting a loan is always more profitable than not posting if $C(r) = 0$, 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 terms. The borrower may choose the microfinance loan or some outside option to fulfill her capital need. Let $y(r)$ be the probability that the borrower chooses the Kiva loan at the offered terms, that is, the expected demand for the loan, which will also depend on the interest rate (we assume the amount of the requested loan is exogenously determined). The expected profit for a loan the FP offers to a borrower is then:

$$\pi(r) = y(r)\,\pi^M(r). \tag{4}$$

Let us define the elasticity of demand with respect to the interest rate as $\eta(r) = \frac{\partial y(r)}{\partial r}$. We assume the FP maximizes its profits over each loan. This assumption ignores spillover effects of one loan on the expected profitability of another loan, although why such spillovers would exist is not clear. It also assumes FPs do not care about their profit stream being in discrete amounts, which is reasonable given the large number of loans each FP provides and the small size of the loans. Taking the derivative of profits with respect to r, we can write the first-order condition as:

$$\frac{\partial \pi(r^*)}{\partial r} = \quad y(r^*)\frac{\partial \pi^M(r^*)}{\partial r} + \eta(r^*)\pi^{*M}(r^*) \quad = 0. \tag{5}$$

We know the monthly payment as a function of the interest rate is positive and increasing in r:

$$p(r) = \frac{Lr}{1 - \frac{1}{(1+r)^T}}. \tag{6}$$

In what follows, we will also make the following assumptions:

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

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

Assumption 2: $\frac{\partial \gamma(r)}{\partial r} \leq 0$

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: $\frac{\partial C(r)}{\partial r} \geq 0$

This assumes administration costs do not decrease with the interest rate.

Assumption 5: $\frac{\partial^2}{\partial r^2}\pi(r) \leq 0$

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. *The optimal interest rate of a loan posted on Kiva is higher than if it had not been posted on Kiva iff:*

$$\left|yF'\frac{L}{T}\gamma\right| > \left|\eta L\left(1-\frac{F}{T}-\frac{C}{L}\right)\gamma + yL\left(1-\frac{F}{T}-\frac{C}{L}\right)\frac{\partial\gamma}{\partial r} - y\frac{\partial C}{\partial r}\gamma.\right| \tag{7}$$

Proof. See Appendix A. □

In the proposition, we drop the interest rate argument for a clearer exposition. 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 default-rate elasticity with respect to interest rate r, F', is large in magnitude, the force pushing rates upward is large because it is the lenders who bear the default risk rather than the FPs. A large F' 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, $\left(1-\frac{F}{T}-\frac{C}{L}\right)$ is the difference (as a fraction of L) 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 default (large F), low discounting (large F), or high administration cost C, this term gets smaller, leading to weaker forces pushing interest rates down. If administration costs C increase with the interest rate, it will also help to push rates down (through $\frac{\partial C}{\partial r}$, the third term on the right-hand side). Furthermore, lower demand elasticity, η, and lower lenders' lending elasticity, $\frac{\partial\gamma}{\partial r}$, also reduce the downward pressure on interest rates. Higher borrower demand for loans, y, increases the upward force more than the downward forces (if there is non-zero demand elasticity), because y appears in the only left-hand term and not in all of the right-hand-side terms - we can divide both sides of equation 7 by y to get $\left|F'\frac{L}{T}\gamma\right| > \left|\frac{1}{y}\eta L\left(1-\frac{F}{T}-\frac{C}{L}\right)\gamma + L\left(1-\frac{F}{T}-\frac{C}{L}\right)\frac{\partial\gamma}{\partial r} - \frac{\partial C}{\partial r}\gamma\right|$. Now y

only appears through its reciprocal in the first right-side term, so increasing y leads to a reduction in the first downward force (relative to the other forces).

Because we do not observe the counterfactual scenario (i.e., loans that are not posted on Kiva) to test Proposition 1, we instead propose two propositions that predict how demand and demand elasticity will affect interest rates, assuming FPs are profit maximizing. We then test these relationships to confirm FPs are indeed setting interest rates in a manner consistent with profit-maximizing behavior.

Proposition 2. *Let $y(r) = y(r, z_1)$, where z_1 is an exogenous demand shifter and $y(r, z_1)$ is increasing in z_1. We have $\frac{dr^*}{dz_1} > 0$; i.e., the higher the demand, the higher the optimal interest rate.*

Proof. See Appendix A. □

Proposition 3. *Let $\eta(r) = \eta(r, z_2)$, where z_2 is an exogenous shifter of demand elasticity and $\eta(r, z_2)$ is increasing in z_2 (decreasing in magnitude). $\frac{dr^*}{dz_2} > 0$; i.e., the less elastic the demand, the higher the optimal interest rate.*

Proof. See Appendix A. □

Propositions 2 and 3 are not surprising – we would expect interest rates to be higher with more demand and/or lower demand elasticity. And because demand decreases and demand elasticity increases with improved access to capital, Propositions 2 and 3 lead to the following testable corollary to determine whether FPs are behaving in a profit-maximizing way:

Corollary 1. *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. Then we simulate optimal interest rates using the estimated dependencies under a range of demand and FP parameters.

4 Empirical Analysis

4.1 Data

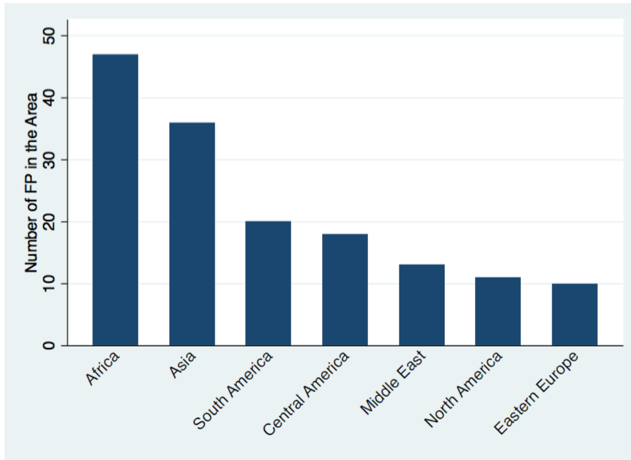
We compile data from three sources. First, we scraped a unique data set directly from Kiva.org, which contains the key components that underpin our empirical analyses, including data regarding field partners and loans such as their locations, loan amount, terms, fund-raising status, repayment status, 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 of each FP between 2008 and 2012 to obtain the respective APR of loans when they were posted. Finally, we gather 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

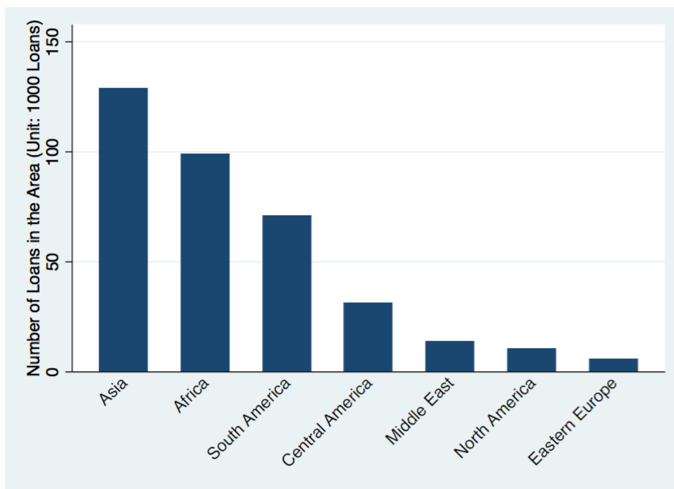
We collected the data about field partners on April 5, 2012, which contain 155 field partners across 63 countries/regions that raised funds at Kiva.org. We supplement the FP data with the Wayback Machine APR data. The 63 countries belong to seven geoeconomic areas. Table 1 shows summary statistics of the FPs across the seven areas. These FP are mainly concentrated among developing countries and areas where the per capita GDPs are at relatively low levels. Figure 4a and Figure 4b show the geoeconomic distribution of FPs and loans, respectively. The FPs on average have been refinancing through Kiva for more than 41 months.

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

Figure 3: Field Partners and Funding by Geoeconomic Areas



(a) Field Partners by Geoeconomic Areas



(b) Fundraising Loans by Geoeconomic Areas

the lowest APRs, also has the highest rate of default.[12] Presumably the default rate elasticity in the Middle East is low enough to reduce the risk transfer effect, and the level of default is high enough to keep 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 default rate elasticity 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 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

[12]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 of 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

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.

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%

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%) defaulted and the remaining were paid off in full.[13] Table 3 shows the summary statistics of the 360,575 listed loans.[14]

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

4.2 Analysis of Lending Environment

The main tradeoff an FP faces is between the effect of the interest rate on borrower demand, the loan being successfully fulfilled by lenders on Kiva (through both demand elasticity η and lending elasticity γ), and the effect on default risk (which enters through F), and therefore the amount of risk that is transferred to these lenders.[15] 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.

[13]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 is computed at FPs and Year level, and then aggregated to each geoeconomic area. The 0.92% is the average across all loans, independent of their FPs, Years, or Areas.

[14]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.

[15]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 well documented in Banerjee and Duflo (2010).

4.2.1 Price (APR) Elasticity

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 4 presents the results. Of particular interest, the demand of loans of a local market dropped when the average APR increased as expected, but we find low demand elasticity as expected in this environment.[16]

Table 4: 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

4.2.2 The Funding Probability

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 crucial for the successful refinancing of a loan on Kiva. In particular, we are interested in whether

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

the likelihood of a loan being funded on Kiva decreases with the interest rate. Table 5 presents the results, in which we use country, industry sector, and year fixed effects, and cluster the robust standard errors at the country level. The results show that loans with more female members, more borrowers, short 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 7 is completely removed. We would expect this non-dependency of lending on interest rates to be a unique feature of microfinance sites such as Kiva in which lenders participate for altruistic reasons, rather than to make financial investments. This finding highlights the potential issue when some agents are not profit-maximizing (lenders and Kiva) and some are (FPs). We next test whether the FPs are indeed behaving in a way consistent with profit-maximizing behavior.

Table 5: The Funding Probability of a Loan

Variables	Funded
APR Percentage/100	-0.0016
	(0.015)
Loan Terms (Months)	-0.0012***
	(0.000)
Loan Amounts (1000 US$)	-0.0160***
	(0.003)
Loan Amount/National GDP per Capita	0.0013
	(0.002)
Number of Borrowers for the Loan	0.0020***
	(0.001)
Female Borrower Percentage for the Loan	0.0001***
	(0.000)
The Loan Was Listed with English Description (1/0)	0.0068***
	(0.002)
Constant	1.0062***
	(0.0073)
Country FEs	Yes
Borrower's Industry Sector FEs	Yes
Year FEs	Yes
Observations	360,575

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

4.2.3 Access to Capital

In Corollary 1, we predict the local APRs will drop when borrowers have easier access to capital market, which decreases their demand for Kiva loans. To test this 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. The results are shown in Table 6. 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]

Table 6: The Effect of Local Capital Market on Local APR

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

4.2.4 Default Rates

Because FPs are maximizing profits, the dependency of default rates on interest rates is also crucial in determining whether Kiva likely leads to higher or lower interest rates (i.e., the default-rate elasticity 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 2, the default probability of a loan should be non-decreasing in its APR. Table 7 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

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

and year fixed effects. Furthermore, because each field partner administered the repayment of each loan, we include FP fixed effects and cluster standard errors at the FP level. From the results, we may see APR has a significantly positive effect on the default probability of a loan at the 10% level for countries with high default rates. The average effect is positive for countries with medium and low default rates, though insignificant.

Table 7: 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
	(0.000)
Female Borrower Percentage of a Loan	0.0000
	(0.000)
The Loan Was Listed with English Description (1/0)	0.0074
Constant	
Field Partner FEs	
Borrower Industry Sector FEs	
Year FEs	
Observations	

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

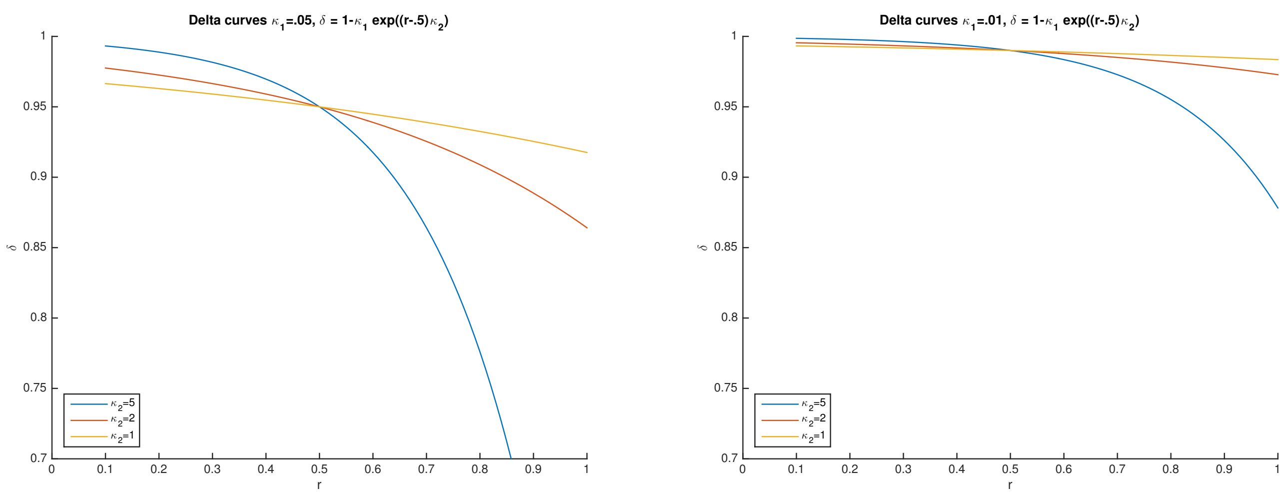
4.3 Discussion

In the previous subsections, 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.

We also find a positive relationship between APR and default rate. Intuitively, the stronger the relationship between default rates and interest rates, the larger 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, we should be very cautions in generalizing such an empirical finding to other similar platforms, especially when the lack of such an effect does not necessarily imply the platforms will be free from the risk of FPs raising interest rates for the borrowers. In the next section, we use simulations to demonstrate the tradeoff more explicitly.

5 Simulations

Figure 4: 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 Kiva, in order to demonstrate the effect of Kiva 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. 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

$$F(r) \equiv \sum_{m=1}^{T} (\rho\delta(r))^m \quad = \tfrac{1-(\rho\delta(r))^{T+1}}{1-\rho\delta(r)} - 1 = \tfrac{-(\rho\delta(r))^{T+1}+\rho\delta(r)}{1-\rho\delta(r)} \quad = \frac{\rho\delta(r)\left(1-(\rho\delta(r))^{T}\right)}{1-\rho\delta(r)}. \tag{8}$$

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 $F(r)$.

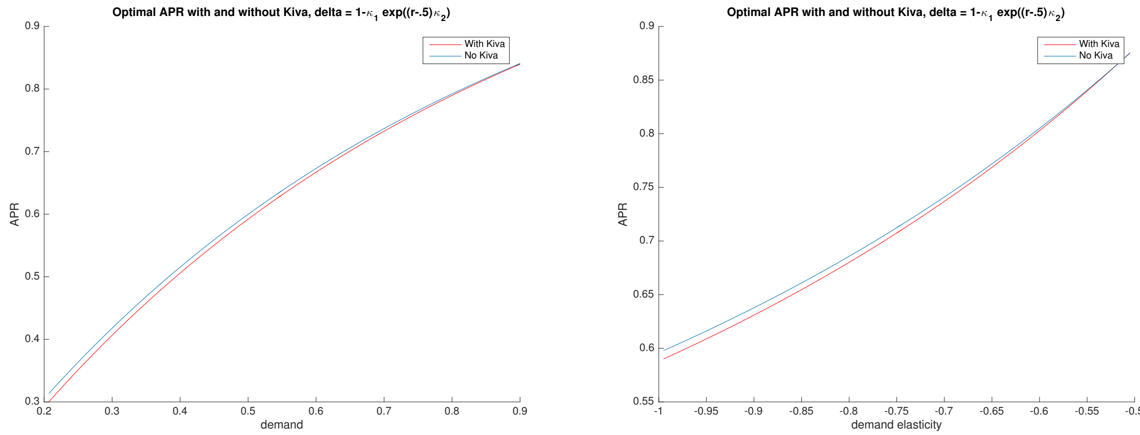
The FPs' discount rate and the monthly default probability have the same effect because a higher value of either will lower the present value of the loan. For the simulations, we set the discount rate as $\rho = 0.99$ and alter the default-rate function, which is defined as

$$\delta(r) = 1 - \kappa_1 \exp((r - .5)\kappa_2). \tag{9}$$

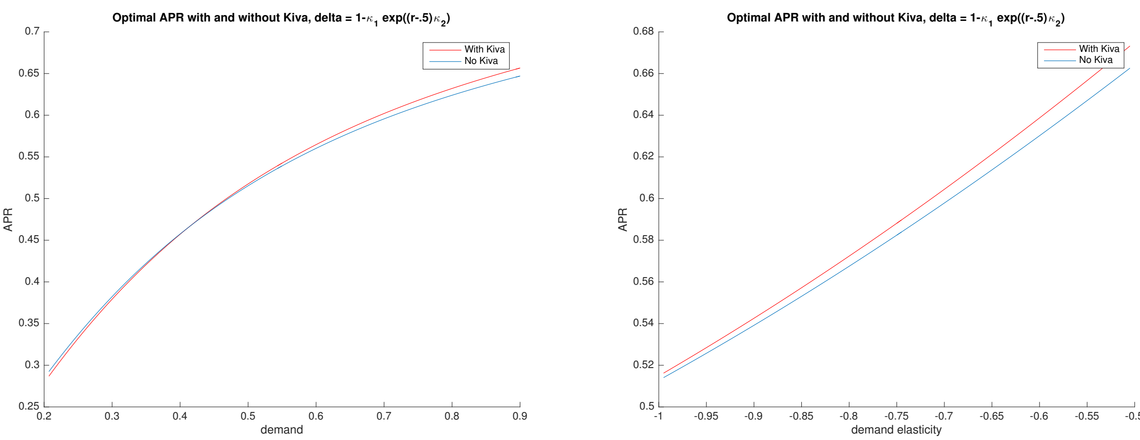
We modify the level of default rate as well as the curvature of the default-rate function by changing κ_1 and κ_2. We chose the function parameters so the default rates would be the same at $r = .5$ but the slopes of the default rate function would be different. To show the effect of κ on the shape of the default rate function, we plot the default-rate function for different values of the κ parameters in Figure 4. 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 9) 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 5 and 6, 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 5, where 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

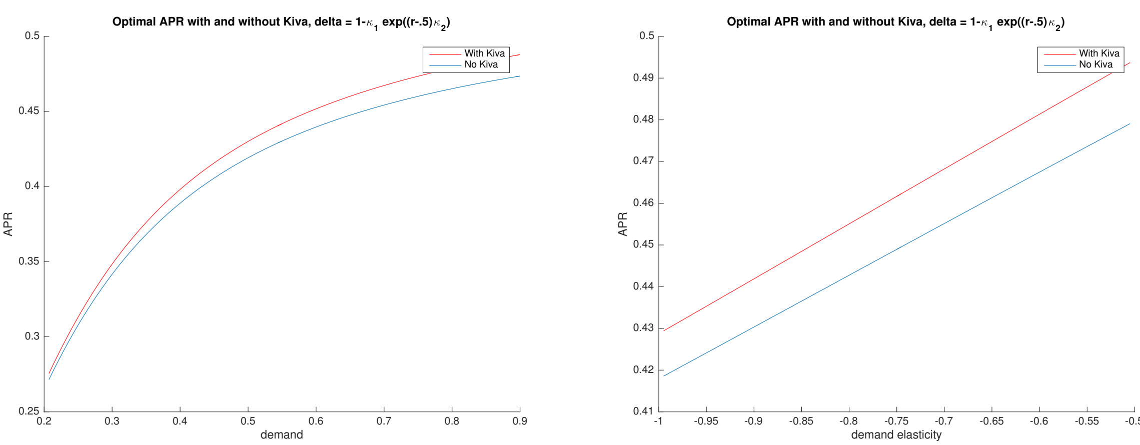
Figure 5: Comparison of APRs between Kiva Loans and Non-Kiva Loans, High Default Rate



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

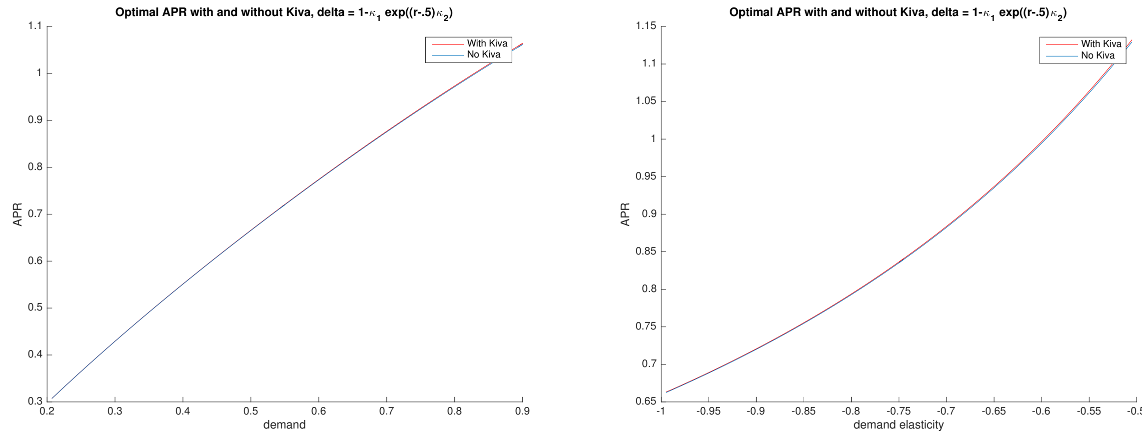


B: Mid curvature in $\delta(r)$, $\kappa_2 = 2$

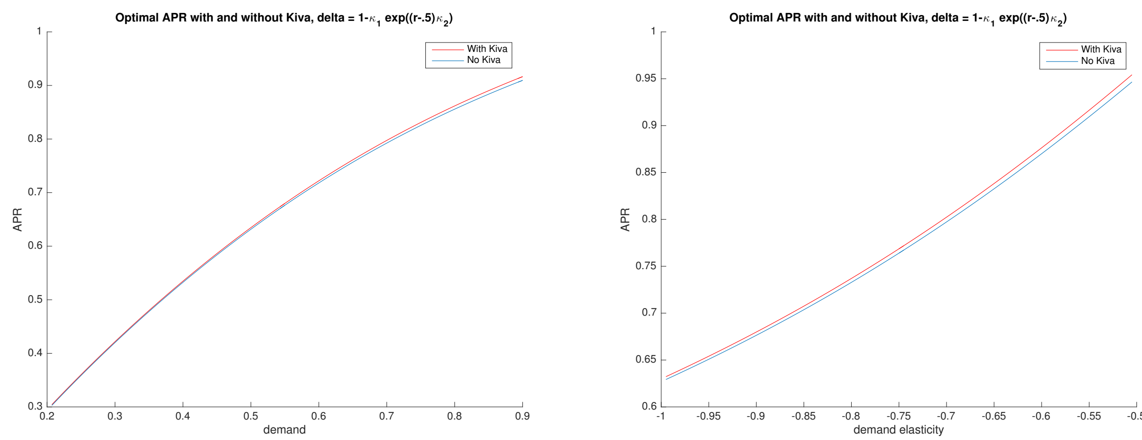


C: High curvature in $\delta(r)$, $\kappa_2 = 5$

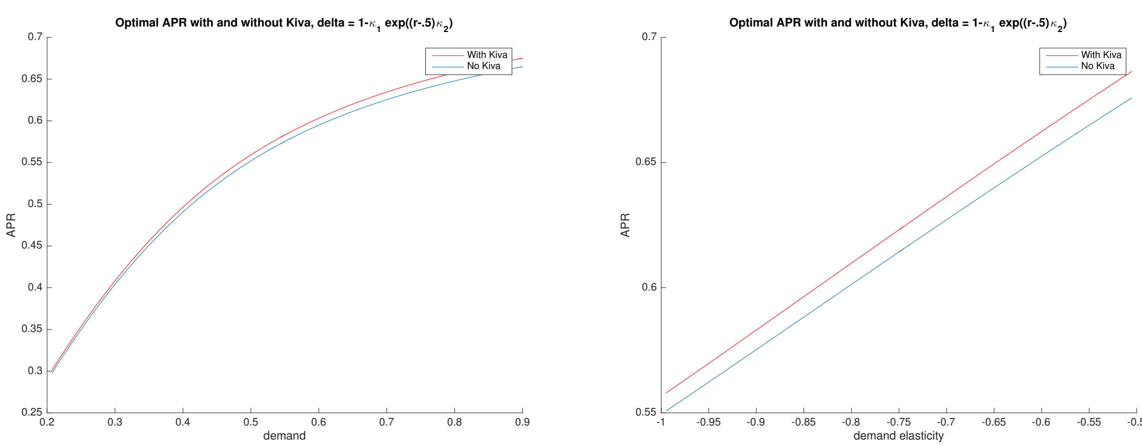
Figure 6: Comparison of APRs between Kiva Loans and Non-Kiva Loans, Low Default Rate



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



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



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

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 6, 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 (κ_2 being small), a higher interest rate does not lead to higher-level default risk being transferred to lenders.

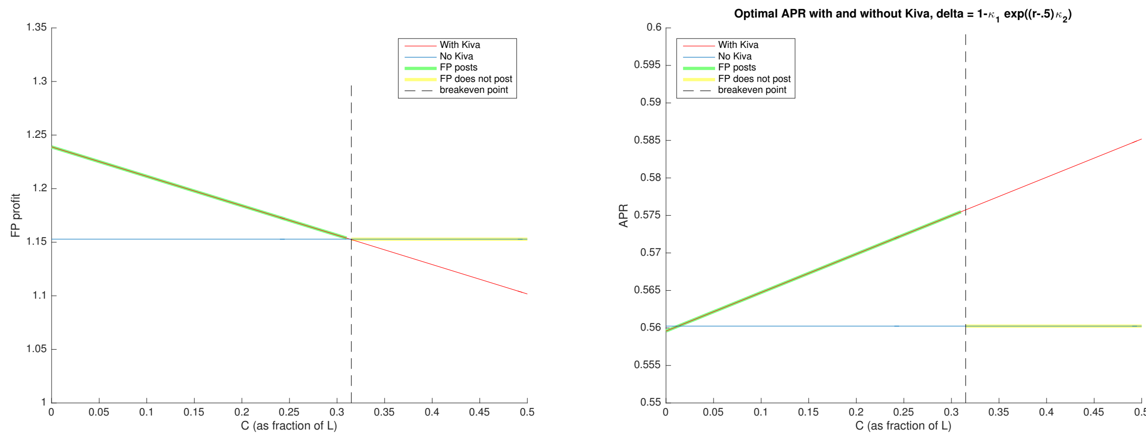
In our data, many loans on Kiva have even smaller default rates, similar to the case where both κ_1 and κ_2 have small values (Subfigure A in Figure 6). For these loans, interest rates will be largely unaffected because of Kiva if administrative costs are low. This is not true in the areas in our data where the default rates elasticity is higher, and it is not true if administrative costs were higher. In both these cases, the upward force on interest rates due to risk transfer may dominate.

In Figure 7, 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 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 rates are higher when doing so. It is thus essential that microfinance sites keep administrative costs to a minimum for the FPs, else rates may become higher than in the absence of microfinance.

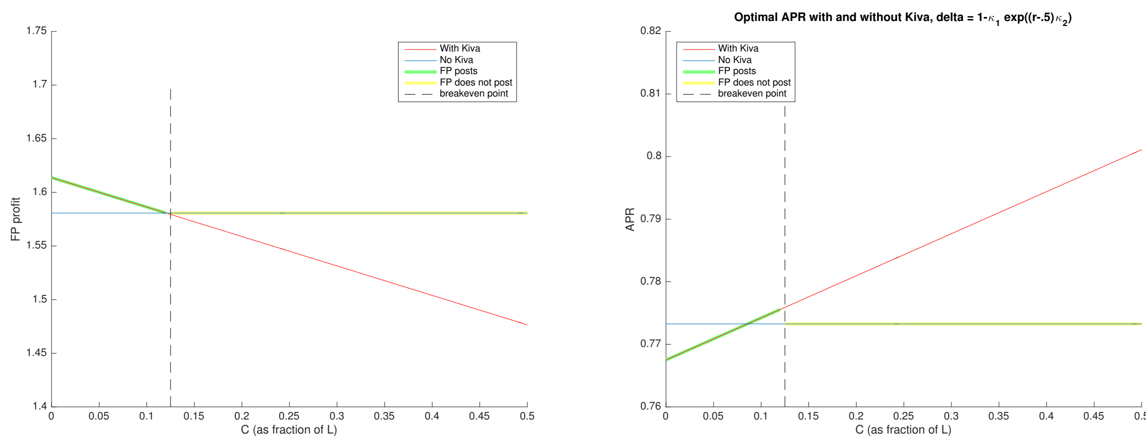
6 Concluding Remarks

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

Figure 7: 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 $\delta(r)$, $\kappa_1 = 0.01$ $\kappa_2 = 1$

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 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 the lenders being paid back was not dependent on the borrower not defaulting, the incentives for the FP 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 effectiveness of this alternative mechanism in Appendix B. With this alternative mechanism, Kiva still provides a benefit by injecting interest-free capital (from the lenders) into the system, freeing up FPs' capital to be used to grant more loans. Because default rates are so low, the biggest constraint on the system is the availability of this capital, which can be supplied without changing the incentives of FPs in setting interest rates (relative to the case without microfinance).

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, 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.

We hope this paper sheds light on potential issues 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 the case of Kiva, default rates are so low that the upward force on interest rates will be small, and so the problem is not of first-order concern for this particular application. However, on many microfinance sites with much larger default rates or when the default rate strongly depends on the interest rate, this problem would become a primary concern. We demonstrate that further value could be created for borrowers if the incentives of the FPs are accounted for in the payback mechanism, thus ensuring the current transfer of default risk to altruistic lenders is not driving up the interest rates.

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Appendix A: Proofs of Propositions and Corollary

Proof of Proposition 1. Taking the first-order condition on 4, we have

$$\begin{aligned}
\frac{\partial \pi}{\partial r} &= \eta\pi^K + y[F'p + F\frac{\partial p}{\partial r} + L\frac{\partial \gamma}{\partial r} - F\frac{L}{T}\frac{\partial \gamma}{\partial r} - C\frac{\partial \gamma}{\partial r} - \frac{\partial C}{\partial r}\gamma - F'\frac{L}{T}\gamma] \\
&= \eta[(Fp - L) + \left(L - F\left(\frac{L}{T}\right)\right)\gamma] + y[F'p + F\frac{\partial p}{\partial r} + \left(L - F\left(\frac{L}{T}\right) - C\right)\frac{\partial \gamma}{\partial r} - \frac{\partial C}{\partial r}\gamma - F'\frac{L}{T}\gamma] \\
&= \eta Fp - \eta L + \eta\left(L - F\left(\frac{L}{T}\right)\right)\gamma + yF'p + yF\frac{\partial p}{\partial r} + y\left(L - F\left(\frac{L}{T}\right) - C\right)\frac{\partial \gamma}{\partial r} - y\frac{\partial C}{\partial r}\gamma - yF'\frac{L}{T}\gamma.
\end{aligned}$$

Setting this equal to zero and solving for the optimal price on kiva, p^K, we have

$$\begin{aligned}
&p^K(r) \qquad (10) \\
= \quad &\frac{-1}{\eta F + yF'}[-\eta L + \eta\left(L - F\left(\frac{L}{T}\right)\right)\gamma + yF\frac{\partial p}{\partial r} + y\left(L - F\left(\frac{L}{T}\right) - C\right)\frac{\partial \gamma}{\partial r} - y\frac{\partial C}{\partial r}\gamma - yF'\frac{L}{T}\gamma].
\end{aligned}$$

Here, we make one final assumption. We assume for any admissible funding function $\gamma(r)$ that

Assumption 6:

$p(r)$ and $\frac{-1}{\eta F + yF'}[-\eta L + \eta\left(L - F\left(\frac{L}{T}\right)\right)\gamma + yF\frac{\partial p}{\partial r} + y\left(L - F\left(\frac{L}{T}\right) - C\right)\frac{\partial \gamma}{\partial r} - \frac{\partial C}{\partial r}\gamma - yF'\frac{L}{T}\gamma]$ satisfy the single-crossing condition.

This assumption means a unique solution r^* to equation (10) exists for the support of the parameters. This assumption is benign because $p(r)$ increases from 0 (at $r = 0$) to infinity, whereas the right side of equation 10 cannot increase indefinitely. This assumption allows us to compare the situations with and without Kiva, because without Kiva, we can solve for the optimal price for a commercially funded loan, p^C, by setting γ and its derivative to 0. This yields the following equation, which needs to hold for the optimal payment without microfinance:

$$p^C(r) = \frac{-1}{\eta F(r) + yF'}[-\eta L + yF\frac{\partial p}{\partial r}]. \qquad (11)$$

Accordingly, the difference in the terms on the right side of equations 10 and 11 are

$$\begin{aligned} & \frac{-1}{\eta F + yF'}[\eta\left(L - F\left(\frac{L}{T}\right) - \frac{C}{L}\right)\gamma + yL\frac{\partial\gamma}{\partial r} - yF'\frac{L}{T}\gamma - y\frac{\partial C}{\partial r}\gamma - yF\frac{L}{T}\frac{\partial\gamma}{\partial r}] \\ = \quad & \frac{-1}{\eta F + yF'}[\eta L\left(1 - \frac{F}{T} - \frac{C}{L}\right)\gamma + yL\left(1 - \frac{F}{T} - \frac{C}{L}\right)\frac{\partial\gamma}{\partial r} - y\frac{\partial C}{\partial r}\gamma - yF'\frac{L}{T}\gamma]. \end{aligned}$$

We know the first term, $\frac{-1}{\eta F + yF'}$, is positive, because from Assumption 3, we have that $F'(r) \leq 0$, and we also know η is negative and $F(r)$ and $y(r)$ are positive. Next, we also know $0 \leq \frac{F}{T} \leq 1$, and so the first term in the square brackets is negative. The second term is also negative, because $\frac{\partial\gamma}{\partial r}$ is negative. The third term is negative because administration costs are non-decreasing with interest rates (Assumption 4). The fourth term is the only positive term, because F' is negative. If the fourth term is larger in magnitude than the combined first three terms, Kiva leads to higher interest rates because of Assumption 6, which ensures the payment increases at a faster rate with r than the right-hand side of equation 10, and so interest rates r must be higher for the equality to hold. If the opposite is true, Kiva leads to lower interest rates.

Assuming higher interest rates lead to higher default rates, the ability of the FP to shift risk to lenders puts upward pressure on the optimal interest rate. Therefore, whether a microfinance platform leads to higher or lower rates depends on both the demand function and the probability that lenders fill the loan. The concern with microfinance platforms is that we expect (1) demand to be inelastic and (2) lenders to possibly not care about the interest rate. These factors reduce the value of lowering the interest rate, which stems from the value of making sure the loan is granted and filled on Kiva, because FPs essentially get an interest-free loan from Kiva lenders. Ultimately, whether rates increase or decrease depends on the relationship between $\left(1 - \frac{F}{T} - \frac{C}{L}\right)$, which is the difference in expected lending costs to the FP of not using Kiva versus using Kiva, as well as any increase in administration costs with rates $\frac{\partial C}{\partial r}$, relative to the value of transferring risk to lenders, which is determined from the slope of the expected discounted number of payments, given by F'. $\square$

Proof of Proposition 2. From 5, because $\frac{\partial\pi(r^*)}{\partial r\partial y} = \frac{\partial\pi^K(r^*)}{\partial r}$, and by the implicit function theorem, we have that

$$\frac{\partial \pi^K(r^*)}{\partial r}\frac{dy}{dz_1}dz_1 + \frac{\partial^2 \pi(r^*)}{\partial r}dr = 0.$$

A small increase in demand due to the exogenous demand shifter is offset by a profit-maximizing firm with an adjustment in the interest rate, dr. Solving for $\frac{dr}{dy}$ yields

$$\frac{dr^*}{dy} = -\frac{\frac{\partial \pi^K(r^*)}{\partial r}\frac{dy}{dz_1}}{\frac{\partial^2 \pi(r^*)}{\partial r^2}}. \tag{12}$$

The denominator is negative by Assumption 5. We also know

$$\frac{\partial}{\partial r}\pi(r^*) = y(r^*)\frac{\partial}{\partial r}\pi^K(r^*) + \eta(r^*)\pi(r^*) = 0,$$

or re-written,

$$\frac{\partial}{\partial r}\pi^K(r^*) = -\frac{\eta(r^*)\pi(r^*)}{y(r^*)}.$$

Because $\eta \leq 0$ by Assumption 1, $\frac{\partial}{\partial r}\pi^K(r^*) > 0$. Hence, the numerator in equation 12 is positive. Therefore, $\frac{dr^*}{dy} > 0$. The intuition is that raising rates would be more profitable when the demand for loans is strong. Finally, by chain rule, we have $\frac{dr^*}{dz_1} > 0$. □

Proof of Proposition 3. Similar to the proof of Proposition 2, from 5, we have that

$$\pi^K(r^*)\frac{d\eta}{dz_2}dz_2 + \frac{\partial^2 \pi(r^*)}{\partial r}dr = 0. \tag{13}$$

Solving for $\frac{dr}{dy}$ yield:

$$\frac{dr^*}{dz_2} = -\frac{\pi^K(r^*)\frac{\partial \eta}{\partial z_2}}{\frac{\partial^2 \pi(r^*)}{\partial r^2}} > 0. \tag{14}$$

The denominator is the same as in proposition 2, and the numerator is positive, so the left-hand side of the equation is positive. □

Appendix B: Alternative Mechanism

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

$$\pi^{Funded|A}(r) \quad = \quad F(r)\,(p(r)) - N\frac{L}{T} - C(r), \tag{15}$$

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 are

$$\begin{aligned}
\pi^A(r) &= (F(r)p(r) - L)\,(1-\gamma(r)) + \left(F(r)\,(p(r)) - N\frac{L}{T} - C(r)\right)\gamma(r) \\
&= (F(r)p(r) - L) + \left(L - N\frac{L}{T} - C(r)\right)\gamma(r) \\
&= \pi^C(r) + \left(L - N\frac{L}{T} - C(r)\right)\gamma(r).
\end{aligned} \tag{16}$$

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

$$\pi(r) = y(r)\,\pi^A(r). \tag{17}$$

Taking the derivative of profits with respect to r, we can write the first-order condition as:

$$\frac{\partial \pi(r^*)}{\partial r} = \quad y(r^*)\tfrac{\partial \pi^A(r^*)}{\partial r} + \eta(r^*)\pi^{*A}(r^*) \quad = 0. \tag{18}$$

Proof. Taking the first-order condition on 17, we have

$$\begin{aligned}
\frac{\partial \pi}{\partial r} &= \eta\pi^A + y[F'p + F\frac{\partial p}{\partial r} + L\frac{\partial \gamma}{\partial r} - N\frac{L}{T}\frac{\partial \gamma}{\partial r} - C\frac{\partial \gamma}{\partial r} - \frac{\partial C}{\partial r}\gamma] \\
&= \eta[(Fp - L) + \left(L - N\frac{L}{T}\right)\gamma] + y[F'p + F\frac{\partial p}{\partial r} + \left(L - N\frac{L}{T} - C\right)\frac{\partial \gamma}{\partial r} - \frac{\partial C}{\partial r}\gamma] \\
&= \eta Fp - \eta L + \eta\left(L - \frac{L}{T}\right)\gamma + yF'p + yF\frac{\partial p}{\partial r} + y\left(L - N\frac{L}{T} - C\right)\frac{\partial \gamma}{\partial r} - y\frac{\partial C}{\partial r}\gamma.
\end{aligned}$$

Setting this equal to zero and solving for the optimal price on kiva, p^K, we have

$$p^A(r) \quad = \quad \frac{-1}{\eta F + yF'}[-\eta L + \eta \left(L - N\frac{L}{T}\right)\gamma + yF\frac{\partial p}{\partial r} + y\left(L - N\frac{L}{T} - C\right)\frac{\partial \gamma}{\partial r} - y\frac{\partial C}{\partial r}\gamma]. \tag{19}$$

Similar to before, we assume for any admissible funding function $\gamma(r)$ that

Assumption 7:

$p(r)$ and $\frac{-1}{\eta F+yF'}[-\eta L + \eta\left(L - N\frac{L}{T}\right)\gamma + yF\frac{\partial p}{\partial r} + y\left(L - N\frac{L}{T} - C\right)\frac{\partial\gamma}{\partial r} - \frac{\partial C}{\partial r}\gamma]$ satisfy the single-crossing condition.

This assumption means a unique solution r^* to equation (19) exists for the support of the parameters. This assumption is benign because $p(r)$ increases from 0 (at $r = 0$) to infinity, whereas the right side of 19 cannot increase indefinitely. This assumption allows us to compare the situations with and without Kiva, because without Kiva, we can solve for the optimal price for a commercially funded loan, p^C, by setting γ and its derivative to 0. This yields the following equation, which needs to hold for the optimal payment without microfinance:

$$p^C(r) \quad = \quad \frac{-1}{\eta F(r) + yF'}[-\eta L + yF\frac{\partial p}{\partial r}]. \tag{20}$$

Accordingly, the difference in the terms on the right side of equations 19 and 20 are

$$\begin{aligned} & \frac{-1}{\eta F + yF'}[\eta\left(L - N\frac{L}{T} - \frac{C}{L}\right)\gamma + yL\frac{\partial\gamma}{\partial r} - y\frac{\partial C}{\partial r}\gamma] \\ = \quad & \frac{-1}{\eta F + yF'}[\eta L\left(1 - N\frac{1}{T} - \frac{C}{L}\right)\gamma + yL\left(1 - N\frac{1}{T} - \frac{C}{L}\right)\frac{\partial\gamma}{\partial r} - y\frac{\partial C}{\partial r}\gamma] \\ & . \end{aligned}$$

These terms are the same as with the current 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 all three terms on the right-hand side are negative in value, the interest rate must be lower due to Kiva, from our 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. $\square$