Moral Hindrance
Sub-optimal Risk Under Excessive Liability*

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Abstract. While economists have tended to focus on moral hazard, it is the opposite problem of moral hindrance that is far more likely to plague low-income credit markets. This is the central argument of this paper, supported by a rather straightforward application of economic theory. The total cost of default borne by borrowers, including social, psychological, and other non-appropriable forms of sanction, is likely to be excessive, giving rise to sub-optimal risk-taking and excessive effort on the part of borrowers. Because non-appropriable forms of sanction are strictly less efficient than pledged collateral, sanctions that induce first-best effort are already too high. Unfortunately, public and policy focus on minimizing interest rates has the effect of ratcheting up these sanctions, doing much harm to borrower welfare in the process. Policy should rather promote competition among lenders, encourage broader use of collateral, and allow interest rates to rise as necessary to meet borrower demand for varying loan conditions.

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1 Introduction

Debtors prisons and leg-breaking loan sharks induce powerful *ex ante* incentives. Borrowers will do almost anything to repay, and nobody need fear that moral hazard is causing efficiency losses. Fortunately for borrowers, such incentives – and the deadweight loss from so harshly punishing defaults – are widely recognized as excessive. Still, excessive incentives exist even in the more polite modern world. They are simply less obvious. And just as inadequate incentives induce moral hazard in borrowers' *ex ante* choices, excessive incentives induce what I call *moral hindrance* in those same choices.

Though the economics literature has focused much attention on the problem of moral hazard, it is actually this opposite problem of moral hindrance that may limit efficiency in many settings. This is especially likely to be the case in low-income credit markets typified by the types of unsecured or incompletely-secured loans for which moral hazard is thought most problematic. Rather than taking on too much risk and exerting too little effort (the standard moral hazard result), theory actually indicates that borrowers in these settings are likely to take on too little risk and exert too much effort (the moral hindrance result).

To see the basic argument, consider a borrower who invests in a project that either succeeds or fails. Presuming that the lender cannot observe the project outcome, terms are set such that the borrower has sufficient incentive to repay his loan – at least when his project succeeds (else the lender would face certain default). If these terms provide sufficient incentive to repay when the project succeeds, then already they are sufficient to entirely or almost entirely prevent *ex ante* moral hazard in the borrower's choices of risk and effort.

Still, though, there is likely an inefficiency. Particularly if the borrower is very poor, he may lack the wealth or liquidity to repay when his project fails. He may default involuntarily, bringing the full weight of the repayment incentives down upon his shoulders. Knowing this, he will make inefficient *ex ante* choices over risk and effort whenever the repayment incentives are anything more than the barest minimum necessary to induce repayment. Fearful of the excessive consequences of default, he will exhibit moral hindrance, taking on too little risk and putting in too much effort. If he can help it, he will make sure that his project succeeds so that he will not be forced to default. While repayment would seem to be a good thing, the trouble is that risk is often coupled with reward and effort can come at too high a cost. Both the punishment and the actions taken by the borrower to avoid that punishment generate deadweight loss.

Some of the most prominent models in the literature assume not only that the borrower's liability, on default, is limited to the market value of pledged collateral, but further that this pledged collateral is insufficient to fully secure the loan (e.g., Stiglitz and Weiss, 1981; Innes, 1990; Ghosh et al., 2000; Banerjee, 2004). If this were the extent of borrower liability, however, then it would be a wonder that anybody ever repaid their loans. In fact, borrowers often repay at very high rates. In India, for example, 84% of microfinance institutions (MFI's) report write-off rates less than 1%, and 97% report write-off rates less than 5% (MIX Market, 2011). There, the vast majority of loans are repaid, and case studies of individual MFI's suggest that traditional forms of pledged collateral play little to no role (e.g., Ross and Savanti, 2005; Krishnan, 2006; Schechter, 2007; Feigenberg et al., 2011; Giné et al., 2011).

Limited-liability models from Stiglitz-Weiss (1981) onward have highlighted a particular problem with raising interest rates in order to recover (in expectation) any losses associated with default. Due to adverse selection, moral hazard, or some combination, higher interest rates can actually provoke more defaults, leading to a negative feedback loop. At the extreme, some credit markets could unravel entirely. Economics- and business-savvy lenders are thus keen to keep interest rates as low as possible, and to find additional mechanisms to incentivize borrowers to repay. Both reactions, though reasonable, push toward moral hindrance.

Microcredit is something of a poster child for these additional mechanisms, often achieving extremely low default rates in low-income settings with little to no reliance on traditional collateral (as described in, e.g., Yunus, 1999). In lieu of collateral, social, psychological, and other pressures are brought to bear, inducing repayment by significantly raising the total (utility) cost of default (as discussed in, e.g., Armendáriz and Morduch, 2007; Rahman, 1999). The Grameen-style village banking model, implemented in low-income settings the world over, employs a particularly common mix of features – public oath-taking, joint-liability groups, and public repayment – in order to raise the social and psychological costs of default. Women are generally targeted, partly if not primarily for their "deeper sense of shame" (in Quinones and Seibel, 2000, p. 202), their greater "conscientiousness" (in Yunus, 1999, p. 119), or their greater responsiveness to peer pressure (in Rahman, 1999, pp. 69-71).

Even without the much-lauded joint-liability feature of Grameen-style microcredit, shame and other social pressures to repay are frequently induced via public oath-taking, third-party guarantors, and public repayment (e.g., SEWA, Satin, and VWS in Krishnan, 2006; Daga, 2006; Feigenberg et al., 2011, respectively). Threats to punish relatives can likewise encourage repayment within kin groups (e.g., in Ghana, La Ferrara, 2003). Dynamic incentives, collateral with high private value, and other incentives can further raise default costs and thus encourage repayment (Armendáriz and Morduch, 2007, ch. 5). While most modern lending eschews heavy-handed threats like debtor's prison, indentured servitude (von Lilienfeld-Toal and Mookherjee, 2010), or physical punishment, it is not at the expense of effectiveness.[1] Clearly, the threat of lighter-handed punishments can combine to achieve extremely low default rates.

[1]Though it is true that, for example, the Indian popular press often carries sensational stories with anecdotal cases of more heavy-handed punishment (as in "Agents kidnap girl to punish mother for loan default," Editor, 2010).

It is no wonder that lenders set the total cost of default high enough to incentivize repayment. Otherwise, they would face the realistic prospect of widespread default and the insolvency that would result. Without innovative use of social, psychological, and dynamic incentives, formal credit markets simply might not exist in settings that lack sufficient collateral or external enforcement.

But there is a fine line between high enough and too high. Once default costs exceed the necessary threshold, borrowers begin to face excessive down-side risk. Poor borrowers who cannot help but default on project failure begin to choose inefficiently low levels of risk and inefficiently high levels of effort. Children begin to work in the family shop or field instead of studying, fertilizers are applied beyond the point of negative expected returns. Deadweight loss mounts and overall welfare suffers.

To make matters worse, in many of these settings even the barest minimum repayment incentive is already too strong with respect to *ex ante* incentives. Moral hindrance already obtains whenever incentives are set high enough to avoid *ex post* moral hazard (i.e., to avoid voluntary or strategic default). This is because the efficient levels of risk, effort, and repayment differ depending on the incentives employed. Traditional collateral is a form of appropriable liability; the prospect of its loss incentivizes borrowers, plus it improves the lender's recovery in the actual event of default. Social and psychological costs, dynamic incentives, and the private value of collateral, on the other hand, are all *non-appropriable* forms of liability; in the event of default, the borrower loses utility but the lender gains nothing in increased recovery. Thus, non-appropriable liability is a strictly less efficient incentive mechanism than appropriable liability. Accordingly, it is optimal to use less of it, because its costs more quickly come to exceed its benefits. This further worsens the moral hindrance problem.

Figure 1 illustrates the polar case where only non-appropriable sanctions are employed, as in microcredit programs that eschew the use of formal collateral. Even accepting that the use of non-appropriable sanctions always entails some deadweight loss, the need to incentivize repayment *ex post* prevents even minimization of that loss. Thus, *ex ante* moral hindrance is inevitable in these settings.

Policies that cap interest rates – or, worse, apply continuous downward pressure on them – encourage even greater use of excessive liability and inefficient incentive mechanisms in order to drive default rates as close to zero as possible. Such policies likely cause much of the world's moral hindrance. Without them, borrower choices of risk and effort might naturally move closer to optimal levels, particularly in competitive lending environments.

While the possibility of excessive liability has been raised in the literature – for example, in Dewatripont et al. (2003, p. 893) and Ahlin and Townsend (2007, p. F43) – it tends not to be the subject of special focus or concern. My argument here is that it should be of far greater concern to economists, and to development economists in particular. From a theory standpoint, moral hindrance is even more plausible, in many settings, than moral hazard.

The remainder of this paper formalizes and expands upon these basic arguments. In Section 2, I introduce the formal model, discuss the related theoretical literature, and cite illustrative case studies. I then review key results from the model in Section 3, and conclude with a short discussion in Section 4. Finally, three appendices provide additional discussion of project finance models, optimality, and the second-best nature of non-appropriable liability.

2 Model

I demonstrate both the moral hindrance problem and the unlikelihood of moral hazard using a slightly extended version of the model in Ghosh et al. (2000). This model belongs to a broad class of project finance models that contemplate a liquidity-constrained entrepreneur or household faced with a risky but potentially profitable investment opportunity. Such models, typically couched in principal-agent terms, study the form, dynamics, and ultimately the optimality of potential contracts between the source of financing (the principal) and the entrepreneur or household (the agent). At its simplest, a project finance model might feature debt financing for a project that succeeds or fails with some fixed probability, yielding a fixed return on success and nothing on failure.

While some follow Stiglitz and Weiss (1981) in modeling project risk as directly (and unobservably) chosen by the borrower (e.g., Bardhan et al., 2000; Banerjee, 2004), others follow Innes (1990) in modeling project risk as an indirect function of the borrower's costly (and unobservable) choice of effort (e.g., Ghosh et al., 2000; Dewatripont et al., 2003; Besley and Ghatak, 2009). My model falls into the latter camp, for I find it most intuitive to think about borrowers exerting effort to reduce risk. The model's mechanics are substantially the same either way: higher effort simply corresponds to lower risk, lower effort to higher risk.

In such models, "project success" can be broadly conceived as any outcome that allows the borrower sufficient wealth or liquidity to repay, and "borrower effort" can be conceived to include any manner of complementary investments toward success, including financial, reputational, and labor contributions. More broadly still, "effort" can include any borrower choice or action that influences risk, such as which crop to cultivate or which business training to undergo. Viewed in this way, project finance models are quite flexible and can be applied in a great many contexts where funds are borrowed for the purposes of investment toward uncertain returns. More on the project finance literature can be found in Appendix A.

2.1 The borrower side

The model in Ghosh et al. (2000) provides a useful starting point. In the base case of self-financing, an individual invests L in a project that either succeeds with return Q or fails with return 0. He can exert costly effort e to raise the probability p of success ($p'(e) > 0$ and $p''(e) < 0$ assumed), and he chooses a level of effort that maximizes his expected returns. As an example, consider a farmer who can invest in sowing a crop and then exert effort – weeding, applying fertilizers and pesticides, etc. – in order to avoid a crop failure.

$$\max_{e} p(e) \cdot Q - e - L \tag{2.1}$$

The borrower is presumed to be risk-neutral, which simplifies the model and exposition. (Risk aversion only strengthens the moral hindrance results.) Given this set-up, the optimal level of effort – generally characterized as "first-best" – is simply the solution to the following first-order condition:

$$p'(e^*) = \frac{1}{Q} \tag{2.2}$$

When instead the farmer finances L, assume that he has to repay $R = (1+i)L$ in the case of success and lose collateral equal to c in the case of failure. This presumes that he lacks the wealth or liquidity to repay when his project fails. His maximization problem then becomes:

$$\max_e p(e) \cdot (Q - R) + (1 - p(e)) \cdot (-c) - e \tag{2.3}$$

The farmer's new optimum is now characterized by the following condition:

$$p'(e^*) = \frac{1}{Q + c - R} \tag{2.4}$$

When there are diminishing returns to effort (as assumed) and liability is limited ($c < R$), effort under debt financing is strictly less than the first-best level of effort under self-financing. This is the basic moral hazard problem ubiquitous in economic models of credit markets.[2] The limitation on liability shifts some risk onto the lender, thereby reducing the borrower's incentive to exert costly effort to avert failure.

This is where we depart from Ghosh et al. (2000). First, why should borrowers repay at all when $c < R$, even when their projects succeed? Typically, there is no perfect external enforcement, and so repayment must be incentive-compatible. As the model stands, borrowers would only ever repay when the consequences of default were less desirable than the consequences of repayment. In other words, repayment is subject to the following incentive-compatibility constraint (ICC):

$$\begin{aligned} Q - R - e &\geq Q - c - e \\ c &\geq R \end{aligned} \tag{2.5}$$

If $c < R$, then there would be an *ex post* moral hazard problem. Lenders would face widespread default and quickly find themselves insolvent. But if $c \geq R$, then no moral hazard can exist with respect to the *ex ante* effort choice.

[2] This is *ex ante* moral hazard (or involuntary default) because it concerns the *ex ante* effort decision, not the *ex post* repayment decision. "Debt overhang" is closely related. On the other hand, *ex post* moral hazard concerns voluntary or strategic default. (When I do not specify *ex ante* or *ex post*, I mean *ex ante*.)

In truth, however, we know that it is not collateral alone that motivates borrowers to repay. The traditional model is correct in so far as collateral is, in a great many settings, clearly limited. The model is wrong, however, to omit those other factors that do motivate repayment.

To begin with, defaulting borrowers may face the stress of evading loan officers, not to mention the guilt of evading their obligations. Many lenders require borrowers to repeatedly and publicly take oaths to repay their loans, often explicitly witnessed by their God or "home God" (as in, e.g., cases described in Krishnan, 2006; Tiwari et al., 2008; Feigenberg et al., 2011). Such oaths are likely to increase a defaulting borrower's sense of guilt, to say nothing of her sense of social shame. As mentioned earlier, women's greater perceived susceptibility to this guilt or shame may explain why they are so often the preferred targets of unsecured loans in low-income settings.

Defaulting borrowers may also face future consequences when default would negatively affect subsequent access to credit, giving rise to dynamic incentives. This is certainly the case when credit bureaus are put in place, as in the case of Bolivia (Bustelo, 2009). But even individual lenders have had much success motivating borrowers to repay by threatening to withhold future loans (as discussed in, e.g., Armendáriz and Morduch, 2007, pp. 122-129), and both Karlan and Zinman (2009) and Breza (2011) demonstrate that borrowers are indeed responsive to these dynamic incentives. In Schechter (2007), joint-liability group (JLG) members will even cover for one another, at great cost, when one member's default threatens another's future access to credit. Even when borrowers have access to multiple lenders, there may be some cost to finding a new lender and being re-screened, particularly if there is the possibility that the borrower's history of default will be uncovered, as in Hoff and Stiglitz (1997) or the "scarring factor" of Ghosh et al. (2000).

Of course, there may also be some social penalty or forfeiture of social capital associated with default (Besley and Coate, 1995; Besley and Ghatak, 2009). By no accident, this is especially likely to arise in cooperative or group-liability settings, where the consequences of default fall at least partly on others in the borrower's community. Montgomery (1996) and Armendáriz and Morduch (2007, pp. 100-101) discuss the sort of social pressure that community members can bring to bear, providing powerful incentive for borrowers to repay. Along these lines, Giné et al. (2011) report as "common practice" that group members in one Indian state, facing pressure from their loan officers, would "undertake a vigil outside the homes of defaulting clients until payments due were made good." Ross and Savanti (2005) report an anecdotal case of "group members removing defaulter's nose ring and anklets or damaging her house until the member repaid." Clearly, much social pressure can be brought to bear.[3]

[3]Note, however, an interesting possibility not discussed here: peers may observe the borrower's *ex ante* choices and condition their social sanctions accordingly. Thus, the degree of social sanction – and, indeed, the degree of guilt felt by the borrower – may depend on *ex ante* choices even when those choices are unobservable to the lender. In this way, social and psychological sanctions may be adaptive in an efficiency-enhancing way.

Even when a borrower's default does not directly affect others, the borrower can suffer a loss of "reputational capital" (Tirole, 2006, pp. 121-122) when default is in some way public (see also Rahman, 1999; Armendáriz and Morduch, 2007, pp. 137-138). Many lenders, in fact, require even individual-liability borrowers to repay (and likewise default) in very public fashion (as in, e.g., Feigenberg et al., 2011).

Collateral can also entail an outsized influence over borrower behavior once the private value of that collateral is considered (Tirole, 2006, pp. 167-170). When this private value is especially high, as with jewelry, land, or other property with sentimental value, borrowers may repay even when the value of the collateral is negligible to the lender (Armendáriz and Morduch, 2007, p. 135). Because this kind of private value drives a wedge between the value lost by the borrower on default and the value gained (recovered) by the lender, a single collateral term is insufficient to model such cases.

All of these other consequences of default, beyond the simple market value of collateral, share this same property: they are fundamentally *non-appropriable*. The private value of collateral, guilt and stress, social and dynamic penalties, and other default sanctions all have the property that they represent a loss to the borrower in the case of default – but not a gain to the lender. In this sense, they are pure punishment. They provide *ex ante* incentives to the borrower, but *ex post* they are pure deadweight loss.[4]

As in Rai and Sjostrom (2004), a single reduced-form sanction term, s, can be used to parsimoniously represent all of these non-appropriable default sanctions. The borrower's maximization problem in (2.3) then becomes:

$$\max_{e} p(e) \cdot (Q - R) + (1 - p(e)) \cdot (-c - s) - e \tag{2.6}$$

The associated ICC in (2.5) likewise becomes:

$$\begin{aligned} Q - R - e &\geq Q - c - s - e \\ c + s &\geq R \end{aligned} \tag{2.7}$$

None of this actually solves the mystery of why moral hazard should be suspected in the face of widespread repayment, but it does set us up to better explore both moral hazard and moral hindrance in Section 3 below.

This very simple model, of course, presumes that all borrowers are homogeneous. Clearly this is only an approximation. However, note that one key source of heterogeneity, gender, tends to be controlled when different products and terms are offered to women versus men (an extremely common practice). Likewise,

[4]Note that risk-averse borrowers (Dowd, 1992) and those with sufficient bargaining power (Genicot and Ray, 2006) may actually prefer such sanctions to exist as a kind of commitment device – particularly when there are practical or legal constraints on financial liability.

joint-liability groups are thought to self-sort in a way that yields approximately homogeneous risk within individual groups (Armendáriz and Morduch, 2007, pp. 88-93). Particularly at the village level, where much low-income lending occurs, community members are thought to know each other's "types." In more anonymous settings, credit exchanges can help lenders to price-discriminate. All of this helps to mitigate the effects of adverse selection within discrete "markets" (which may be as small as a single group).

The model used here also presumes that the borrower's chosen level of effort or risk is not observable, or that it is at least not contractible. This unobservability or noncontractibility is fundamental to the literature from Stiglitz-Weiss (1981) onward. Without this source of information asymmetry, moral hazard is no longer any concern, and neither is moral hindrance. Sadly, debt contracts in the real world rarely if ever condition on borrower choices, despite obvious welfare gains in theory.

Another implicit assumption is that lenders cannot observe or contract on project outcomes. If they could, then that would enable them to punish default on project success arbitrarily harshly, more than enough to guarantee 100% repayment on success (i.e., they could easily eliminate the *ex post* moral hazard problem). They would still, though, be left with the question of how much to punish default on failure. Anticipating the results of the next section, too little punishment would entail losses via *ex ante* moral hazard and too much would entail losses via moral hindrance instead. The moral hindrance problem would become easier to manage, but would not go away altogether.

The model embodies many other simplifications. For example, it is assumed that borrowers who repay face no default sanctions. However, this is clearly not the case for borrowers who repay only after suffering some degree of sanction, as in the "vigils" of Giné et al. (2011) or the more physical harassment in Ross and Savanti (2005) (both discussed above). Schechter (2007) reports the case of Angarika, who has trouble repaying a loan during an unexpected hospitalization. Though her son eventually repays her debt, it is only after she experiences the stress of default and the social pressure to repay. Even after repayment, she bears lingering reputational and social costs. In the model, however, punishment and default are discrete, all-or-nothing events.

Of course, borrowers will only take loans when a participation or individual rationality constraint has been met. The borrower's expected utility (here simply the expected return) must meet or exceed some reservation utility $\bar{U}$:

$$\max_{e} EU(e) \geq \bar{U} \tag{2.8}$$

Finally, to round out the borrower side of the model, graphs and simulated equilibria require a specific success function for $p(e)$. I use the following function, which exhibits positive but diminishing returns and asymptotes to a probability of success α:

$$p(e;\alpha,\beta) = \alpha\left[1 - \frac{1}{(1+e)^{\beta}}\right] \tag{2.9}$$

In this formulation, $\alpha < 1$ can be used to constrain projects to some minimum level of risk. β indicates the relative efficacy of effort (in conjunction with how effort e figures negatively into the borrower's objective function, as in Equation (2.6) above). Presuming that borrowers exert non-zero but non-infinite effort in practice, I calibrate β such that there is an internal solution to the borrower's maximization problem.[5]

2.2 The lender side

The lender side of the model is comparatively straightforward. With loan principal L, repayment R, proportional overhead cost ω (which includes the cost of capital et al.), probability of repayment $p(e)$, and market value of collateral c, per-borrower profit is:

$$\pi = p(e)\cdot R + (1 - p(e))\cdot c - L - \omega L \tag{2.10}$$

Risk neutrality is presumed, as is typically the case for firms. (Even an underlying degree of owner risk aversion would be mitigated by the ability to diversify risk across many projects.)

2.3 Equilibrium

If the credit market of interest is characterized by free entry and perfect competition among lenders – a common baseline approximation for many economic models – then lenders should be held to zero profit in equilibrium. Equation (2.10) can be set to 0, rearranged, and evaluated at the equilibrium effort level e^*:

$$R^* = \frac{(1+\omega)\cdot L - (1 - p(e^*))\cdot c}{p(e^*)} \tag{2.11}$$

Because the borrower's equilibrium effort choice e^* itself depends on the interest rate, equilibrium interest and effort must be solved jointly. Equilibrium effort must satisfy the first order condition of the borrower's maximization problem in Equation (2.6):

$$p'(e^*) = \frac{1}{Q + c + s - R^*} \tag{2.12}$$

[5] Note that a simple linear success function leads trivially to an all-or-nothing effort choice (as in Armendáriz and Morduch, 2007, pp. 78-80), and quadratic and other mathematically simple forms lack the intuitively-compelling feature of positive but diminishing returns.

Jointly solving (2.11) and (2.12) yields solutions for equilibrium interest and effort both.[6] When multiple equilibria exist, one can follow Banerjee (2004, p. 16) in presuming that the lower-interest equilibrium prevails. Often this is the only equilibrium that satisfies the participation constraint.

When solving, collateral and sanction levels might be presumed exogenous. However, in most settings they are likely to be endogenous in the medium-to-long-run at least. Of all possible collateral-sanction combinations leading to all possible equilibria, certain ones might be expected to prevail.

If information is presumed to flow completely and freely, all expectations and behavior are rational, and all of the other requirements for perfect competition among lenders obtain, then the first fundamental welfare theorem should hold and the welfare-maximizing equilibrium should be the one to prevail. Though lenders are held to zero profit in the long-run, the invisible hand of short-run profit opportunities should guide them toward arrangements that maximize borrower surplus. For the model developed thus far, the "price" of a loan is effectively the triplet $P = \{R, c, s\}$, which includes the repayment amount R (or interest rate, given that $R = (1+i)L$), collateral amount c, and degree of non-appropriable default sanction s. This price should adjust so as to maximize surplus – subject, of course, to any practical or legal constraints on collateral.

In the case of a monopolistic lender, on the other hand, it is the profit-maximizing price that will prevail in equilibrium. With profit described by Equation (2.10), the lender's problem becomes:

$$\max_{R,c,s} \pi = p(e) \cdot R + (1 - p(e)) \cdot c - L - \omega L \tag{2.13}$$

Here, the lender can take full account of the borrower's response function, implicitly defined by Equation (2.12). The primary pricing constraint is the borrower's participation constraint (as in Equation (2.8)), which lender maximization will generally drive to binding. Certain settings may also place constraints on the amount of collateral.

With this simple set-up, welfare inference is straightforward. There is no difficulty with interpersonal comparisons of utility since borrowers are assumed to be homogeneous. A single "representative borrower" may be considered. Increases and decreases to this borrower's utility are unambiguous from a welfare perspective. And when perfect competition drives lender profits to zero, all surplus accrues purely on the borrower side. Thus, gains for the representative borrower are efficiency gains, and losses are efficiency losses.

In the case of monopolistic lenders, borrowers are driven to their reservation utilities and all surplus flows to lender profit. Thus, welfare and efficiency comparisons are equally straightforward. See Appendix B for more on the optimality of different equilibria.

[6] If commitment were possible with respect to effort, then Equation (2.11) could be used to substitute for the R in (2.6) and the borrower could maximize utility while factoring in the effect of effort on interest rates. However, it is typically assumed that the borrower cannot commit, and thus will choose effort to maximize expected utility given an interest rate, without concern for dynamic equilibrium consequences.

Of course, homogeneous borrowers and perfectly competitive or monopolistic markets lack realism. They are simplifications, approximations. They may well be sufficient, however.[7]

[7]The simplifying assumption that all surplus accrues to borrowers (or lenders), for example, makes it straightforward to determine when the overall pie is largest. Such conclusions may well hold even if, in reality, the surplus is shared to some extent between borrowers and lenders (as it is in, e.g., Genicot and Ray, 2006).

3 Results

Figure 2 plots an equilibrium that exhibits moral hazard. It presents the classic situation described at the beginning of Section 2.1, where there are positive but diminishing returns to effort ($p'(e) > 0$ and $p''(e) < 0$) and total liability is limited ($c + s < R$). Equilibrium effort is below the first-best level, and therefore risk is above first-best. This is the standard moral hazard result.

Some suspension of disbelief is required, however. One must presume that the borrower defaults only on project failure and repays faithfully on project success. If liability is limited such that $c + s < R$, however, then it is hard to see why the borrower should ever repay at all. Her ICC in Equation (2.7) is clearly violated by the same condition that gives rise to the moral hazard to begin with. In other words, in this model the existence of *ex ante* moral hazard implies also *ex post* moral hazard. Should any of this actually transpire in the real world, it is the *ex post* problem – that nobody repays their loans – that is likely to be the first-order concern.[8]

On the other hand, consider what happens when liability is instead excessive ($c + s > R$). In this case, effort is actually above first-best (and risk below). This is the moral *hindrance* result. Figure 3 plots an example of such an equilibrium.

Note that under both moral hazard and moral hindrance, borrowers respond to incentives at the margin. Increases and decreases in collateral or non-appropriable default sanctions are met by corresponding increases and decreases in repayment. Karlan and Zinman (2009) ingeniously establish the working of such incentives and conclude that it empirically demonstrates the presence of moral hazard. It could equally have been moral hindrance, however, as their research design cannot distinguish the two.

Whether moral hazard or moral hindrance obtains, the question becomes: what are the circumstances that would allow these phenomena to exist in equilibrium? After all, neither is optimal. Market forces, guided by prospective welfare gains, should mitigate or eliminate both phenomena.

In the case of moral hazard, the story is a simple and familiar one. Practical or legal limitations to liability are generally presumed to be exogenous. Constrained by these limitations, competitive markets arrive at a second-best optimum that falls necessarily short of first-best.

A similar argument can be made for moral hindrance. Excessive collateral or non-appropriable default sanctions may be exogenous features of a given setting. For example, physical collateral may be lumpy in practice, as when indivisible physical equipment is pledged as collateral even though its market value exceeds

[8] Adding borrower risk aversion into the model introduces non-zero scope for *ex ante* moral hazard without violating the borrower's repayment ICC. However, incentives would need to be balanced on a knife's edge, and even still there would be only minimal scope for moral hazard. Alternatively, contractibility over project outcome would allow greater punishment of default on project success, opening the door to the possibility that liability is limited only when projects fail.

the face value of the loan, or when a farmer pledges the title to a one-hectare plot of land when, in reality, the loan's value is only worth 0.79362 hectares. Non-appropriable default sanctions may be similarly lumpy, with the additional difficulty that they may be difficult to quantify and very slow to change. In a given setting, for example, the shame of defaulting on a loan may be intensely felt and, at least in the short-run, culturally fixed. In such settings, non-appropriable default sanctions may be stuck at an inefficiently high level, over-inducing effort and under-inducing risk.

This is particularly likely to be the case given that lenders face consequences of under-shooting on liability that are far more severe (widespread default) than the consequences of over-shooting (borrowers working too hard and taking too little risk, so that they can ensure repayment). In fact, the consequences of over-shooting are likely to sound positively appealing to most lenders (and maybe even to some economists). That it can be inefficient for borrowers to face too much liability is a subtle point. For lenders, making sure that borrowers repay at all is likely to be the first-order concern.

In the long-run, however, non-appropriable sanctions should be endogenous, more smoothly adjustable, and generally subject to market forces. In a competitive environment, lenders and borrowers should bargain their way to the welfare-maximizing outcome, lowering excessive sanctions in exchange for higher interest rates. If existing lenders leave potential surplus on the table, then new lenders should spring up with new product offerings that split that surplus with borrowers. This would preclude there being "too much" or "too little" risk or effort in the long-run equilibrium.

Monopolists may, of course, employ more than the efficient level of sanction in equilibrium, accepting some deadweight loss in order to extract greater surplus from borrowers (maximizing, for example, as in Equation (2.13), perhaps with a constraint on the level of physical collateral). Fortunately, the resulting inefficiency will be tempered by the monopolist's desire not to bleed away too much surplus in the form of deadweight loss.

Government policy may also have an important influence over the equilibrium that prevails, as when interest rates are capped or the subject of continuous downward pressure. This is clearly the case in India, where there have been recent efforts to more firmly control interest rates at the national level (Reserve Bank of India, 2011; Kline and Sadhu, 2011), and even individual states have traditionally dabbled in interest rate controls (as in, e.g., Orissa, Page, 2006). Such policies are common practice throughout the developing world (as discussed in, e.g., Meagher et al., 2006; Timberg et al., 2010).

Over time, successful policies might have the cumulative effect of pushing interest rates as low as they will go, under the (mistaken) impression that lower interest rates are better – particularly for low-income borrowers. Such policies would be devastating to social welfare by construction, for they would squeeze all surplus from the borrower and lender sides of the market in service of lower interest rates. In settings where physical collateral is limited, it would be non-appropriable sanctions that would adjust upward, pushing lenders and borrowers all the way to their participation constraints. In such an equilibrium, moral hindrance would be extreme. Effort would be far too high and risk far too low. The resulting deadweight loss would be substantial.

By way of example, Figure 4 plots simulated equilibria under perfect competition (C), monopoly pricing (M), and interest-minimizing regulation (I). For each setting, equilibria are plotted according to varying degrees of exogenous collateral limitation (from zero collateral to collateral that fully secures the principal). The monopolistic and interest-minimizing equilibria drive borrowers to their participation constraints, represented by the dashed curves. The perfect-competition equilibria are welfare-maximizing by construction, given the constraints on information, contracts, and collateral. The monopolistic equilibria transfer all surplus from borrowers to lenders – with some deadweight loss. The interest-minimizing equilibria are welfare-*minimizing* by construction, since all surplus is sacrificed to lower interest rates; extremely high default sanctions are employed, causing extreme moral hindrance in borrowers' *ex ante* choices and significant deadweight loss from severe *ex post* punishment of default.

The higher-collateral equilibria are strictly preferred because collateral is a strictly more efficient incentive mechanism than non-appropriable sanctions. This explains why both monopolistic and competitive equilibria shift from sanctions to collateral whenever the exogenous limitation on collateral is eased (i.e., why the C's and M's march from right to left in Figure 4). An implication is that using sanctions to push effort or risk to first-best levels is actually welfare-harming with respect to *ex ante* incentives. See Appendix C for a detailed discussion of this second-best optimality result.

Unfortunately, all of the competitive and monopolistic equilibria do just that: they push borrowers to exert first-best effort, even though that level of effort is excessive from a welfare standpoint. The reason is that sanctions need to be set high enough to incentivize repayment *ex post*. Thus, perfect competition in the absence of collateral (the C_0 point in Figure 4) can lower sanctions only so far as the intersection of the deadweight loss curve with the right-most dashed line in Figure 1. This is a kind of third-best social optimum since lowering sanctions any further would result in an unraveling due to *ex post* moral hazard.[9]

If the project outcome is observable and contractible, however, then *ex post* moral hazard can be averted by harshly punishing voluntary or strategic default (default on project success). In such cases, both competitive and monopolistic lenders will employ considerably less sanctions to punish involuntary default (default on failure) in the long-run equilibrium, even in the absence of collateral. Welfare will be considerably higher, and competitive lenders will be able to achieve the second-best optimum described in Appendix C (i.e.,

[9]As more collateral becomes available, the bottom of the loss curve in Figure 1 converges toward 0, as do the levels of sanction that induce first- and second-best effort. Once enough collateral is available to fully secure loans, first- and second-best effort are induced at $s = 0$ and there is no deadweight loss.

they will set sanctions for involuntary default at the second-best point indicated in Figure 1, minimizing deadweight loss).

Not plotted are hybrid cases such as those that feature monopolists operating under tight interest rate controls. In India, for example, rural lenders are likely to exercise market power since providers prefer to extend services to areas not yet served by competitors, and for many years Indian regulation in fact required them to expand to otherwise unserved areas (Burgess and Pande, 2005). At the same time, interest rates are controlled at the national level (Reserve Bank of India, 2011; Kline and Sadhu, 2011). When monopolists cannot extract surplus by means of a higher interest rate, they increase collateral requirements to the extent possible and dial up other forms of sanction in order to reduce default rates. Borrowers remain pegged at their participation constraints, and the interest rate controls limit the monopolists' profits (since they are forced to employ DWL-inducing sanctions). Moral hindrance is rampant in such settings, and overall welfare is far lower than under either perfect competition or even unrestrained monopoly.

When it comes to empirics, two classes of evidence might support a diagnosis of moral hindrance in a given setting. First, there should be evidence of involuntary default, some indication that punishment is severe and yet borrowers default nonetheless. For example, borrowers may in some cases lose collateral with market value in excess of their loan obligations, a clear case of excessive punishment and involuntary default. Public oaths, joint liability, and other loan features may indicate considerable use of non-appropriable sanctions, though it may be difficult to tell when such sanctions are excessive. Certainly, qualitative and circumstantial evidence may exist, such as extremely high levels of distress – even suicide – among delinquent borrowers.

Second, the investment behavior of borrowers may indicate moral hindrance. For example, agricultural borrowers may use fertilizer, labor, or pesticides beyond the point of technical efficiency. Since many such inputs can reduce the variance of output, borrowers over-fearful of the possibility of default may use them beyond the point of negative expected returns. When information has been ruled out as an explanation for an otherwise puzzling over-use of inputs, moral hindrance may be one of few remaining explanations. Likewise, borrowers subject to moral hindrance may systematically choose lower-risk, lower-return crops and business activities, beyond what would be explained by reasonable levels of baseline risk aversion.

4 Discussion

In settings where successful borrowers repay their loans, there is little reason to fear moral hazard in those borrowers' *ex ante* choices. Repayment incentives are clearly sufficient. The greater worry is that they may actually be excessive.

There is much reason to suspect a world rife with moral hindrance, particularly in low-income settings. Lenders, naturally fearing default and taught to fear moral hazard, ratchet up the consequences of default in any way they can. Mission-driven NGO's do the same, under the impression that sustainably lower interest rates are in the poor's best interest, or in order to prove that the poor can be trusted to repay loans. Politicians and policymakers, likewise, use policy to push aggressively downward on interest rates, convinced that it is in the best interest of borrowers. Default rates fall, interest rates fall, and all appears well on the surface. But meanwhile deadweight loss mounts and welfare suffers.

The economics yields clear and contrary policy prescriptions. Allow borrowers to pay higher interest rates in exchange for other terms they deem more favorable (for example, "shame-free" loans should be available to low-income borrowers who are willing to pay to avoid the possibility of public default and social sanction). If monopoly pricing is feared, promote competition. If nontransferable credit histories are hindering competition, require participation in a public credit bureau. Because collateral is more efficient than the alternative (non-appropriable sanctions), promote collateralization of assets so that even the poorest borrowers can pledge collateral. Provide a legal framework in which collateral can be seized so that threats are credible and pledged collateral serves as an effective commitment device. Be willing to tolerate non-zero default among liquidity-constrained borrowers.

While such reforms hardly appear to be pro-borrower, the underlying economics suggest that they are. Appearances can be deceiving.

Of course, moral hindrance will only exist in the second-best world of information asymmetry. If the underlying observability and contractibility constraints were relaxed, then the scope for moral hindrance would diminish. The existence of moral hindrance also depends on borrowers not having the ability to repay on project failure. After all, when the consequences of not repaying are high enough to generate moral hindrance, they are by definition high enough to induce repayment – if borrowers are able. Thus, insufficient liquidity to repay is a necessary condition.

In practice, however, true inability to repay need only be a legitimate fear. As mentioned earlier, the definition of "borrower effort" can include anything the borrower does to ensure his ability to repay. At the extreme, this could include the commission of heinous crimes, selling daughters into prostitution, and more. For moral hindrance to obtain, the prospect of involuntary default need only be sufficient to induce inefficient *ex ante* choices. Even when borrowers almost always repay, moral hindrance may be in play.

Unfortunately, moral hindrance is guaranteed when (a) borrowers do fear a potential inability to repay, (b) lenders cannot distinguish between voluntary and involuntary default, and (c) non-collateral sanctions are used to incentivize repayment. Since all three of these conditions are very likely to hold in many microcredit and other low-income lending environments, we should not be surprised to see borrowers exerting too much effort, taking too little risk, and generally getting too little out of their investments.

This problem is difficult enough under the simplifying assumption of homogeneous borrowers. To make matters worse, there is bound to be heterogeneity in how deeply borrowers feel the social and psychological costs of default. So long as such costs exist, some borrowers may be subject to moral hazard while others are subject to moral hindrance – even when seemingly similar borrowers face the very same contractual terms. This will be particularly the case for settings in which lenders try hard to distinguish cases of involuntary default and lower sanctions in a conscious attempt not to overshoot (i.e., not to induce moral hindrance). The closer sanctions are to the boundary between moral hazard and moral hindrance, the more likely it will be that heterogeneity causes some borrowers to fall on either side. Some will exert too little effort and default too much while others will exert too much effort and default too little. The problem may be sufficiently intractable to warrant attempts to eliminate social and psychological costs altogether, though such recommendations should only follow from a more concerted study of heterogeneity in social and psychological sanctions.

Such a study would need to unpack the s term in order to better understand the dynamics of particular sanctions. Some of these dynamics may be readily observable to empiricists. For example, borrower expectations over the likely intensity of social sanction and value of dynamic incentives are sometimes subject to exogenous shocks. In cases of widespread, government-sanctioned default, for example (as in Giné et al., 2011; Breza, 2011; Kline and Sadhu, 2011), social, dynamic, and legal sanctions may have been eliminated, leaving those who repay motivated primarily by personal feelings of duty or guilt.

From a theory standpoint, moral hindrance is at least as plausible as moral hazard; in particular settings, it is far more plausible. A next logical step might be for future research to establish unambiguous signs of excessive effort or sub-optimal risk-taking, thus empirically demonstrating moral hindrance. One approach would be to look at the direct effect of debt burden on effort and risk-taking. As an example, Robert (2011) and Kanz (2011) consider a massive agricultural debt relief program in India. Both authors had hoped to isolate the effect of an exogenous reduction in debt burden on agricultural investment, crop choice, and other indicators of effort and risk-taking, in order to provide evidence of moral hazard. Unfortunately, the evidence turned out to be ambiguous due to insufficient statistical power and a sizable income effect. In principle, however, such investigations can provide direct evidence of either moral hazard or moral hindrance.

In the end, it is unlikely that moral hindrance can be entirely eradicated. Lenders must set repayment incentives sufficiently high and they will often over-shoot; collateral limitations will force them to employ less efficient incentive mechanisms. As economists, however, we should work to encourage greater use of collateral and to temper the popular enthusiasm for less efficient, non-appropriable default sanctions. We should likewise work to encourage a preference for competition over interest rate controls. At the very least, we should refrain from encouraging the flawed notion that lower interest rates are necessarily better for borrowers.

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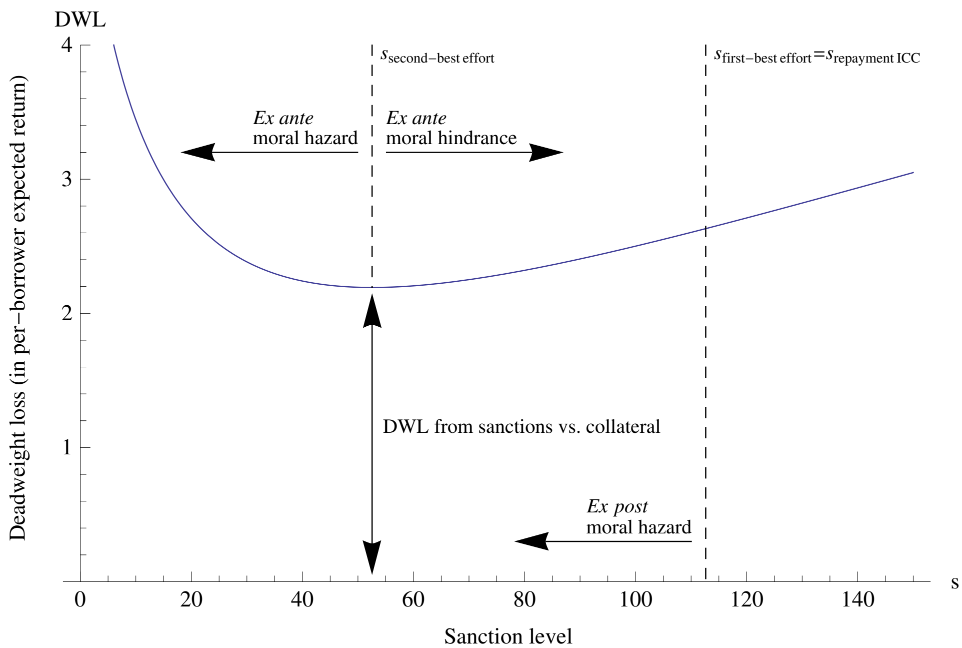
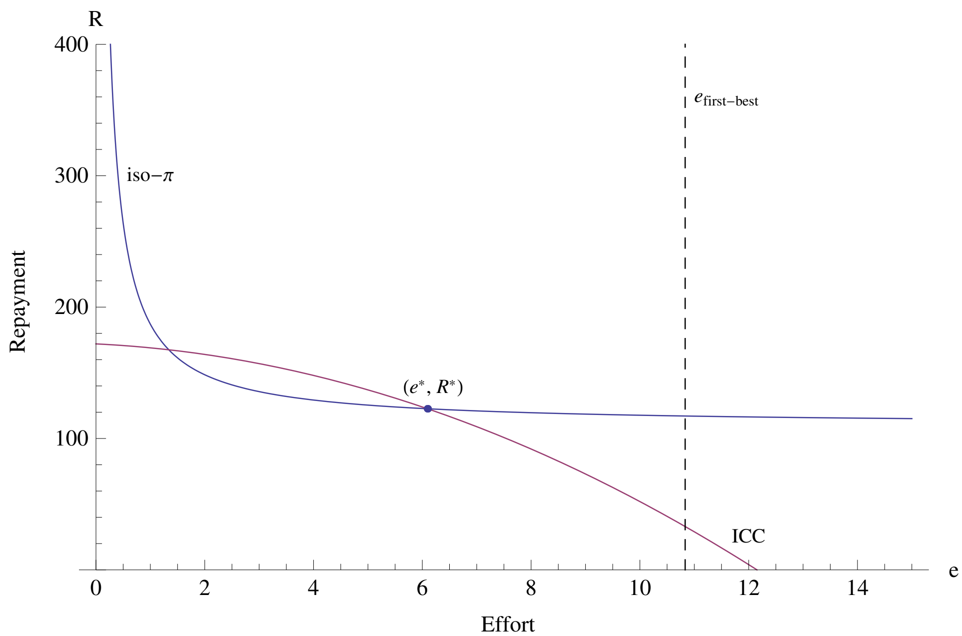
5 Figures

Figure 1: Deadweight loss from use of non-appropriable sanctions in lieu of collateral



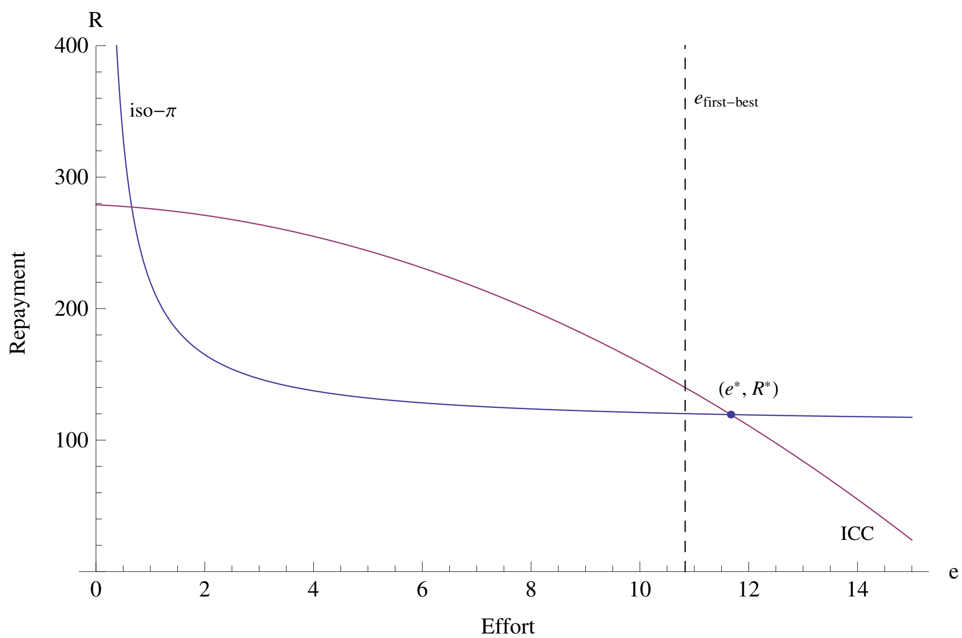
The solid line plots per-borrower deadweight loss in equilibrium for varying levels of non-appropriable default sanction s (assuming no collateral). This DWL, relative to the first-best case where collateral fully secures loans, is in terms of per-borrower expected returns since (a) here borrowers are assumed risk-neutral, and (b) the equilibria are competitive so all surplus gains and losses accrue to borrowers. The dashed lines represent the sanction levels that induce second-best (i.e., welfare-maximizing, given use of sanctions in lieu of collateral) and first-best effort. The arrows indicate the *ex ante* moral hazard, *ex ante* moral hindrance, and *ex post* moral hazard domains, as well as the minimum level of DWL from use of sanctions in lieu of collateral. Employs success function in Equation (2.9), lender zero-profit condition in (2.11), borrower effort choice in (2.12), and borrower repayment ICC in (2.7). Parameters: $\alpha = 1$, $\beta = 2$, $L = 100$, $Q = 140$, $\omega = 0.10$, and $c = 0$.

Figure 2: Simulated market equilibrium for the moral hazard case



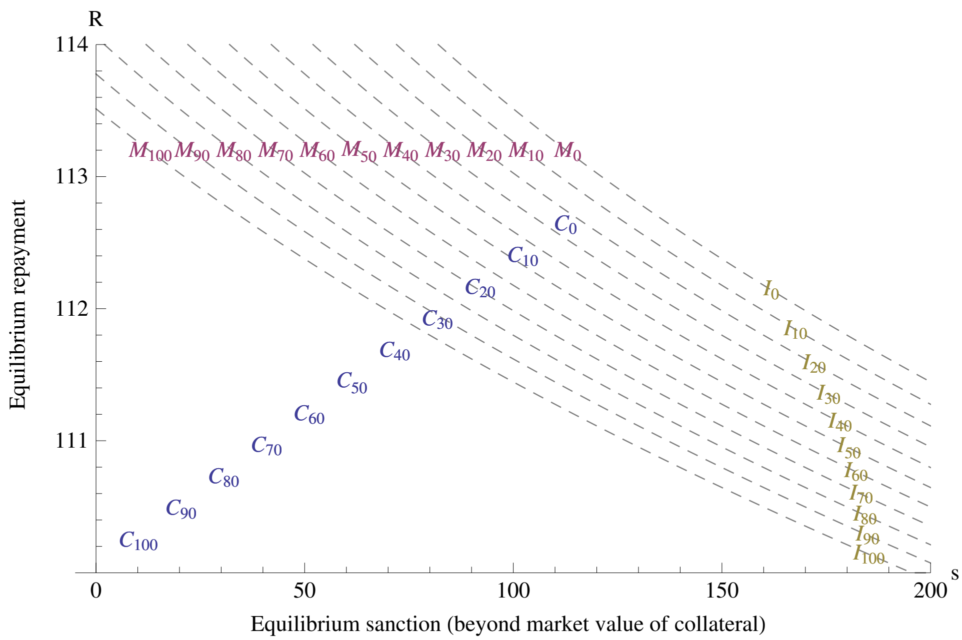
The solid lines plot the lender's iso-profit curve (based on Equation (2.10)) and the borrower's incentive-compatibility constraint (w.r.t. effort, based on Equation (2.12)); equilibrium is where these lines intersect (here, the lower-interest intersection since the higher-interest one violates the borrower's participation constraint). The dashed line represents the first-best level of effort. Employs success function in (2.9); presumes that borrowers repay on success and default on failure. Parameters: $\alpha = 1$, $\beta = 1$, $L = 100$, $Q = 140$, $\omega = 0.10$, $c = 33$, and $s = 0$.

Figure 3: Simulated market equilibrium for the moral *hindrance* case



The solid lines plot the lender's iso-profit curve (based on Equation (2.10)) and the borrower's incentive-compatibility constraint (w.r.t. effort, based on Equation (2.12)); equilibrium is where these lines intersect (here, the lower-interest intersection since the higher-interest one violates the borrower's participation constraint). The dashed line represents the first-best level of effort. Employs success function in (2.9); presumes that borrowers repay on success and default on failure. Parameters: $\alpha = 1$, $\beta = 1$, $L = 100$, $Q = 140$, $\omega = 0.10$, $c = 0$, and $s = 140$. (Only c and s differ from Figure 2 above.)

Figure 4: Simulated equilibrium pricing scenarios



Equilibrium pricing bundles are shown for perfect competition (C), monopoly pricing (M), and interest rate minimization (I). In all three cases, bundles are shown for exogenously-fixed collateral levels $c \in [0, 100]$ in increments of 10, for a loan principal of 100. Gray dashed lines represent the borrower participation constraints at each level of collateral, with $c = 0$ at the upper-right. Employs borrower maximization problem in Equation (2.6), borrower participation constraint in (2.8), success function in (2.9), and profit function in (2.10). Parameters: $\alpha = 1$, $\beta = 2$, $L = 100$, $Q = 140$, $\omega = 0.10$, and $\bar{U} = 18$.

Appendix

A Project finance models

Project finance models, introduced in Section 2 above, have been employed for a wide variety of purposes. These include broad attempts to understand the workings of credit markets (Ghosh et al., 2000; Banerjee, 2004) or to provide foundations for textbook treatments of contract theory or corporate finance (Bolton and Dewatripont, 2005; Tirole, 2006). These also include more narrow attempts to understand, for example, the relative optimality of different financing arrangements (Innes, 1990; Dowd, 1992; Dewatripont et al., 2003), how the distribution of wealth might affect risk-taking and allocative efficiency (Bardhan et al., 2000), the costs and benefits of particular limitations to liability (von Lilienfeld-Toal and Mookherjee, 2010), and why adverse selection might lead to over-investment (vs. the under-investment result in Stiglitz and Weiss) (de Meza and Webb, 1987). Such models often are used as the foundations for empirical investigations (as in, e.g., Rai and Sjostrom, 2004; Karlan and Zinman, 2009).

Information asymmetries lie at the heart of all of these models, leading to problems of selection (adverse selection), incentive (moral hazard or, more specifically, *ex ante* moral hazard), and enforcement (*ex post* moral hazard). On a continuum from abstraction to specificity, these models lie somewhere near the middle, with more general household finance or lifecycle models closer to abstraction and particular microcredit or cooperative models closer to specificity.

At the more abstract end of the continuum, Attanasio and Weber (2010) provide a recent review of lifecycle models of consumption, in which debt is used for intertemporal trades, thus relaxing constraints on lifetime utility maximization. Rosenzweig and Wolpin (1993) and Dercon (1996), for example, use these sorts of intertemporal models as the basis for empirical investigations into consumption-smoothing and risk-taking in rural, developing-country contexts; Genicot and Ray (2006) consider the welfare effects of changes in enforcement technology when credit contracts are used for consumption smoothing; Eswaran and Kotwal (1990) discuss the implications of differential access to credit on risk-taking, again by virtue of borrowers' ability to smooth consumption; and Kaboski and Townsend (forthcoming) consider the effect of microcredit in Thailand with a buffer stock household model extended to allow for borrowing, investment, and growth. This class of models, in general, takes a broader view of credit and household finance than does the class of more specific project finance models.

On the more specific end of the continuum, models are more closely tailored to particular contexts or contractual forms, as with models of cooperatives (e.g., Banerjee et al., 1994), rotating savings and credit associations (ROSCAs) (e.g., Besley et al., 1993), or group lending (e.g., Stiglitz, 1990; Besley and Coate, 1995; Ghatak, 1999; Rai and Sjostrom, 2004; Armendáriz and Morduch, 2007; Madajewicz, 2011; Fischer, 2011). Other models focus more precisely on just one aspect of debt contracts (such as term structure, as in, e.g., Fischer and Ghatak, 2010; Field et al., 2011).

Project finance models strike a balance between the abstraction of household finance models and the specificity of cooperative or microcredit models. Given that many household investments can be characterized as discrete "projects," and that there is a particularly keen interest in the use of finance for income-generating activities in developing-country contexts, this balance is appropriate for many purposes.

B Optimality

Underlying information asymmetries lead credit market outcomes to be, at best, second-best (Bolton and Dewatripont, 2005, p. 19). These outcomes – as well as the results of potential interventions – are frequently compared to the first-best optimum that prevails absent any market imperfections. This first-best is most often modeled as the self-financing borrower (as in, e.g., Ghosh et al., 2000; Banerjee, 2004), though it is important to note that the risk-averse borrower may not optimally self-finance – unless given access to perfect insurance markets so that he can, in effect, invest as if risk-neutral (see, e.g., Attanasio and Weber, 2010, section 4.1, for a perfect-insurance case).

As in the theory of the second-best (Lipsey and Lancaster, 1956), though, first-best choices may not be optimal in second-best settings. Thus, first-best yardsticks may be of limited use. For example, when a loan is fully secured by collateral, the first-best level of effort is optimal. However, when repayment is instead induced via an equivalent amount of non-appropriable default sanction, the optimal level of effort is strictly less than first-best. Trying to force first-best effort in such a setting would only reduce efficiency and harm welfare. (See Appendix C below.)

When considering government intervention in particular, Besley (1994) argues against the use of unconstrained, first-best yardsticks (also see Besley and Ghatak, 2009). If certain information asymmetries will continue to constrain the market, then efficiency should be assessed relative to the best achievable benchmark. Besley considers that benchmark "constrained Pareto efficiency" (Besley, 1994, p. 30). Dewatripont et al. (2003) likewise consider constrained efficiency, and others (e.g., Stiglitz, 1990; Armendáriz and Morduch, 2007) leave aside what is optimal in an absolute sense and focus instead on which arrangements offer welfare improvements over others. Bardhan et al. (2000, pp. 543-545) use a "productivity enhancement criterion" that focuses on aggregate output, rather than Pareto efficiency or the "cardinalist" approach of aggregate utility.

Whatever the yardstick for optimality, welfare effects can be round-about and counter-intuitive. Examples abound. Hoff and Stiglitz (1997) find that rural credit subsidies can yield perverse effects on interest rates and the availability of credit when moneylenders are engaged in monopolistic competition. Kranton and Swamy (1999) provide another example of how increasing moneylender competition can ultimately hurt borrowers; in their case of enforcement-related reform in colonial India, they argue that decreased monopoly power led to lenders having less stake in the long-term welfare of their borrowers, and thus in helping them to maintain assets in bad states of the world (before the increase in competition, lenders were "forgiving monopolists"). From another historical Indian case study, von Lilienfeld-Toal et al. (2010) show

how improvements in enforcement ability can, counter-intuitively, have a negative effect on small borrowers when there is an inelastic supply of loans (because a negative general equilibrium effect outweighs a positive partial equilibrium effect) (see also Genicot and Ray, 2006, for the welfare effects of improved enforcement). Aghion and Hermalin (1990) and von Lilienfeld-Toal and Mookherjee (2010) consider specific cases where tying the borrower's hands can either improve or harm borrower welfare. Indeed, one benefit of rigorous analysis is that intuition alone can often lead policy astray.

C Second-best optimality with non-appropriable sanctions

When borrowers must exert costly effort to promote project success, default on failure, and borrow from lenders that use collateral to induce effort, the collateral level that induces the first-best level of effort is welfare-maximizing. This is not generally the case when non-appropriable default sanctions, as introduced in Section 2.1, are used instead of collateral. The reason is that non-appropriable sanctions are a strictly less efficient method of effort inducement.

In equilibrium, collateral induces borrower effort for both direct and indirect reasons. Directly, it makes failure less attractive since the borrower stands to lose the pledged collateral. Indirectly, the equilibrium interest rate falls, making success more attractive. The interest rate falls for two reasons: because greater borrower effort makes repayment more likely, and because lenders recover the value of the collateral on default. Non-appropriable sanctions induce effort in all the very same ways – except this latter effect on the interest rate is absent: while borrowers lose the value of non-appropriable sanctions in the case of default, lenders do not recover that value. The sanctions, when applied, are pure deadweight loss; their only value is in *ex ante* effort inducement. This is the reason, in this case, why the optimality of effort is sensitive to the means of inducing that effort. The remainder of this appendix formalizes this result.

Assume that borrowers repay on success and default on failure. Assume also that borrowers are risk-neutral, so that the representative borrower's maximization problem is as follows:

$$\max_{e} p(e) \cdot (Q - R) + (1 - p(e)) \cdot (-c - s) - e \tag{C.1}$$

As before, $p(e)$ is the probability of project success ($p'(e) > 0$ and $p''(e) < 0$ assumed), which depends on the effort choice e; Q is the return to success; R the repayment amount (a direct transformation of the interest rate); c the market value of pledged collateral; and s the degree of non-appropriable default sanction. Borrowers therefore optimize by choosing effort according to the following condition:

$$p'(e^*) = \frac{1}{Q + c + s - R} \tag{C.2}$$

The first-best level of effort – characterized by $p'(e^*) = \frac{1}{Q}$ (established in Section 2.1) – is achieved when $c + s = R$. For simplicity, I will consider only all-collateral or all-sanction alternatives, so first-best effort will be achieved with either $c = R$ or $s = R$.

Assume that lenders earn profit as in Section 2.2, where ω is a measure of the lender's overhead:

$$\pi = p(e) \cdot R + (1 - p(e)) \cdot c - L - \omega L \tag{C.3}$$

When perfect competition drives profits to zero, the zero-profit condition, evaluated at the equilibrium level of effort e^*, yields the equilibrium interest rate:[10]

$$R^* = \frac{(1 + \omega) \cdot L - (1 - p(e^*)) \cdot c}{p(e^*)} \tag{C.4}$$

At this point, it is useful to note several important comparative statics regarding the behavior of equilibrium effort levels and interest rates. First, consider the change in equilibrium effort resulting from a change in collateral:

$$\frac{de^*}{dc} = \frac{-1 + \frac{dR^*}{dc}}{p''(e^*)(Q - R^* + c + s)^2} \tag{C.5}$$

This effort response includes the direct response of the borrower (the -1 term), plus the direct and indirect effects on the equilibrium interest rate, $\frac{dR^*}{dc}$, to which the borrower further responds. Because $p''(e^*) < 0$ and $Q > R^*$ by assumption, the borrower's direct response is unambiguously positive. When $\frac{dR^*}{dc} < 0$ – which it is for non-pathological parameter choices – the interest rate effects magnify this positive response, driving equilibrium effort yet higher. The response of equilibrium effort to changes in non-appropriable default sanction looks identical:

$$\frac{de^*}{ds} = \frac{-1 + \frac{dR^*}{ds}}{p''(e^*)(Q - R^* + c + s)^2} \tag{C.6}$$

This too features an identical direct effect, also magnified by an interest rate effect. To understand the equilibrium interest rate responses, consider first the response to collateral:

$$\frac{dR^*}{dc} = 1 - \frac{1}{p(e^*)} + \frac{de^*}{dc}\left[\frac{p'(e^*)[c - (1 + \omega)L]}{p(e^*)^2}\right] \tag{C.7}$$

Here, the initial $1 - \frac{1}{p(e^*)}$ term is the direct response to collateral, by virtue of greater recovery in the case of default. This effect is unambiguously negative since $p(e^*) \in (0, 1)$: as collateral rises, the equilibrium interest rate falls. The remainder is the effect of the effort response, which serves to magnify the direct negative effect whenever loans are less than fully secured by collateral (i.e., whenever $c < (1 + \omega)L$). In the special case where a loan is fully secured ($c = (1 + \omega)L$), the equilibrium response includes only the direct

[10] There may in fact be multiple equilibria. The results discussed here apply to any valid equilibrium.

effect (since in this case lenders are indifferent to the probability of default):

$$\frac{dR^*}{dc_{|c=(1+\omega)L}} = 1 - \frac{1}{p(e^*)} \tag{C.8}$$

In the far more common case where loans are less than fully secured, there is an important feedback effect whereby the positive effort response is magnified by the negative interest rate response, which is itself magnified by the effort response. The interest rate responds to non-appropriable sanctions in much the same way, except that there is no direct effect since sanctions do not improve lenders' recovery on default:

$$\frac{dR^*}{ds} = \frac{de^*}{ds}\left[\frac{p'(e^*)[c-(1+\omega)L]}{p(e^*)^2}\right] \tag{C.9}$$

Since the interest rate declines here purely in response to the increase in effort, $\frac{dR^*}{ds} > \frac{dR^*}{dc}$ and so the negative effect is smaller in magnitude. It follows that $\frac{de^*}{ds} < \frac{de^*}{dc}$, meaning that changes in sanction move the equilibrium effort level and interest rate strictly less than equivalent changes in collateral.

The intuition behind this dynamic is as follows. When the borrower defaults on project failure, increased punishment of default makes failure strictly less attractive. This induces an increase in effort since effort reduces the probability of failure. In turn, the reduced probability of failure reduces the interest rate, making success strictly more attractive – inducing a further increase in effort. All incentives are mutually reinforcing, pushing toward a positive effort response and a negative interest rate response. Collateral, because it directly provides additional downward pressure on the interest rate, further magnifies both the effort and interest rate responses.

Turning then to the welfare implications, borrower returns – the maximand in Equation (C.1) above – are representative of overall welfare whenever borrowers are presumed to be homogeneous. This is because all surplus accrues to borrowers when profits are competitively driven to zero. Thus, equilibrium welfare W^* is simply:

$$W^* = p(e^*)\cdot(Q-R^*) + (1-p(e^*))\cdot(-c-s) - e^* \tag{C.10}$$

When collateral is used to induce first-best effort, the level of collateral is, in fact, at the welfare-maximizing social optimum. This can be seen by considering the following F.O.C.:

$$\frac{dW^*}{dc} = \frac{de^*}{dc}p'(e^*)(Q-R^*+c+s) - \frac{dR^*}{dc}p(e^*) - (1-p(e^*)) - \frac{de^*}{dc} \tag{C.11}$$

Following Equation (C.2) and presuming that $s = 0$, first-best effort implies $c = R^*$ and $p'(e^*) = \frac{1}{Q}$.

Substituting into the above:

$$\frac{dW^*}{dc} = \frac{de^*}{dc} - \frac{dR^*}{dc}p(e^*) - (1 - p(e^*)) - \frac{de^*}{dc} \tag{C.12}$$

The two $\frac{de^*}{dc}$ terms cancel because, at the first-best level of effort, the direct returns to effort exactly balance the cost of that effort (a condition that essentially defines first-best to begin with; see Section 2.1). The two remaining terms cancel as well, because Equation (C.4) implies that $c = (1 + \omega)L$ when $c = R^*$, and so $\frac{dR^*}{dc}$ is the simpler version in Equation (C.8). Once everything cancels, $\frac{dW^*}{dc} = 0$.

This optimality of first-best effort can help to justify attempts to facilitate the greater use of collateral by low-income borrowers. In this case, pushing toward first-best also pushes toward the social optimum.

The same is not generally true when using non-appropriable default sanctions rather than collateral. Consider the effect of such sanctions on equilibrium welfare:

$$\frac{dW^*}{ds} = \frac{de^*}{ds}p'(e^*)(Q - R^* + c + s) - \frac{dR^*}{ds}p(e^*) - (1 - p(e^*)) - \frac{de^*}{ds} \tag{C.13}$$

This looks much the same as Equation (C.12) above, but the lesser effect of sanctions on effort level and interest rate changes the location of the second-best social optimum (i.e., the level of sanction – and consequent effort – that actually maximizes welfare). When sanctions are used to induce first-best effort, $c = 0$, $s = R^*$, and $\frac{dW^*}{ds}$ reduces only so far as:

$$\frac{dW^*}{ds} = -\frac{dR^*}{ds}p(e^*) - (1 - p(e^*)) \tag{C.14}$$

This is not, in general, equal to zero and thus is not the welfare-maximizing level of sanction. For non-pathological parameter choices, it is in fact negative because the welfare-maximizing level of sanction is strictly lower than the level that induces first-best effort. Note, for example, the fact that welfare is maximized at the bottom of the deadweight loss curve in Figure 1. By the point of first-best effort, deadweight loss is increasing in sanctions.

To see why this must be the case, consider the benefits and costs of punishment from the perspective of borrowers (to whom welfare gains and losses accrue). There are two benefits, both of which follow from the fact that punishment induces greater effort and therefore a higher probability of project success: (1) the higher probability of success is itself a benefit, and (2) the equilibrium interest rate falls, increasing the borrower's return on success. There are also two costs: (1) there is the cost of the additional effort, and (2) on default, punishment is more harsh. At the first-best effort level, benefit #1 and cost #1 are the same whether the effort was induced using collateral or sanction. Because the interest rate responds less to sanction than collateral, however, benefit #2 is strictly less under sanctions than it is under collateral. And because effort also responds less to sanction than to collateral, cost #2 is strictly greater. Thus, the benefits of first-best effort are strictly less under sanctions, and the costs are strictly greater. Since the costs and benefits just perfectly balance in the collateral case, they tip unequivocally toward costs in the sanction case. Thus, $\frac{dW^*}{ds} < 0$ at the first-best level of effort, indicating that the welfare-maximizing level of sanction is strictly lower.

Note, however, that this entire discussion considers only *ex ante* incentives; it relies on the presumption that borrowers always repay on success and default on failure. As Figure 1 illustrates, the second-best sanction level actually provides insufficient incentive for repayment *ex post*. Thus, if project outcomes cannot be contracted upon and repayment must be incentive-compatible, then sanctions will need to be set high enough to prevent *ex post* moral hazard. In such settings, the third-best social optimum will entail potentially significant losses from *ex ante* moral hindrance.