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Credit Rationing with Behavioral Foundations: Revisiting Stiglitz and Weiss

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Abstract: The seminal credit market model of Stiglitz and Weiss (1981) proposes that asymmetric information between borrowers and lenders creates a moral hazard in which borrowers to have an incentive to invest in risky projects, creating the basis for a rationing equilibrium in credit markets. Other recent behavioral work, argues that a different type of behavior is more central to credit market risk: the temptation for borrowers to use borrowed capital to meet short-term consumption needs rather than for productive investment (Banerjee and Mullainathan, 2010). In this note, we present a simple model that is able to explain credit rationing where present-bias, rather than an incentive to undertake risky projects, characterizes the root source of risk under asymmetric information in credit markets.

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1. INTRODUCTION

The credit rationing model of Stiglitz and Weiss (1981) is one of the most celebrated theoretical papers in all of economics, and has arguably shaped the views of economists about the nature of credit markets more than any other single piece of research.[1] Their model presents a type of moral hazard in which borrowers, due to a convex payoff function over returns, have an incentive to invest in risky projects over safer ones. This incentive is at odds with the interests of lenders, who, given their concave payoff function over borrower returns, would prefer borrowers to invest in safer projects to increase the probability of loan repayment. In their model, riskier borrowers are willing to pay higher interest rates because they realize high rates of return in the good states of nature, but are insulated from losses under joint liability in the bad state of nature. Credit rationing occurs because lenders have an incentive to keep interest rates at sub-market-clearing levels in order to bring safer projects back into the pool.

This "risky-versus-safe project" framework in the Stiglitz and Weiss model has served as an underpinning for a tremendous amount of work in development economics, such as Ray (1997), Bardhan and Udry (1999) and especially microfinance Stiglitz (1990), (Armendáriz and Morduch, 2005; 2010), Ghatak (1999, 2000), Ghatak and Guinnane (2001), Armendáriz de Aghion, and Gollier (2000), and empirical work such as Wenner (1995), Wydick (1999), and Giné et al. (2010).

Recent empirical work in behavioral economics, however, has argued that risk in credit markets does not originate in a borrower incentive to intentionally invest in risky projects, but in a set of behavioral issues related to self-control Work such as Ashraf et al. (2006), Bertrand et al. (2005), and Banerjee and Mullainathan (2010) points to the temptation to consume borrowed rather than invest borrowed capital as being primal to the risk that lenders face in credit markets. Indeed in a companion paper to this research, Zeballos et. al. (2012) find in a series of experiments with 200 Bolivian microfinance borrowers that real-world members of defaulting borrowing groups are significantly *less* likely to invest in risky projects than members of borrowing groups with excellent repayment records, and more likely to make "safe" experimental choices associated with consumption. Other non-experimental empirical work, such as McIntosh et al. (2011) finds that among a sample of microfinance borrowers who had taken loans officially for business investment, the likelihood that a household purchases a television set purchase rose by more than a third in the first year they took a microfinance loan.

[1] A search for the paper in Google Scholar shows Stiglitz and Weiss (1981) to have 9,192 citations by other papers and books. The paper has had a profound impact in the field of microfinance, where a similar search finds 1,070 papers treating the topic of microfinance citing the Stiglitz and Weiss paper.

2. A SIMPLE MODEL OF CREDIT CONSUMPTION AND CREDIT RATIONING

We present here a simple principal-agent model of credit rationing in which the focus of moral hazard endemic to credit markets lies not substantially in the temptation to undertake risky projects, but rather around issues surrounding the temptation to consume rather than invest, even when investment may yield a potentially high future return. Like a propensity for risk-taking, an individual borrower's degree of temptation to consume a loan rather than invest it productively is information that is asymmetric between borrowers and lenders. Our model is thus rooted in the behavioral framework of Laibson (1997), Ashraf, Karlan, and Yin (2004), and Banerjee and Mullainathan (2010). The core of the model manifests what this and other recent research has come to regard as a central issue between lenders and borrowers in developing country settings: the tension between the temptation for borrowers to use any available liquidity to meet (often dire) present consumption needs, and the substantial future returns that may be realized from productive investment in the informal enterprise (de Mel, McKensie and Woodruff, 2008).

Consider a market of lenders who lend one unit of capital to risk-neutral borrowers. The cost of capital to lenders plus the one unit of principal is equal to c. The one unit of principal plus borrower interest is due in the future period and is equal to r. Borrowers face two decisions which correspond to participation and incentive constraints in the standard principal-agent framework: First agents must decide whether or not to borrow one unit of capital. If they abstain from borrowing, agents receive a reservation payoff equal to zero in the present and v in the future period. But if agents opt to borrow, borrowers must then choose between consuming the unit of capital in order to receive a payoff equal to 1 today, and investing the unit of capital, which will yield a net utility of $R-r$ in the future period. The parameter $\theta_i = 1 + \delta_i$, where $\delta_i > 0$ reflects a borrower's present bias, which favors present-day consumption of borrowed capital over investment of that capital in favor of future return. (Note that because our model only consists of two periods, θ_i is also consistent with the standard neo-classical discounting framework, in which δ_i may be interpreted as an individual discount rate.) Multiplying each of the three terms by θ_i yields borrower *i*'s utility function:

$$U_i = max\,\{v,\ \theta_i,\ R-r\} \qquad (1)$$

In this model we abstract from ex-post issues of moral hazard; if investment occurs, a project is always successful, yields the gross return *R*, and the lender is repaid. If utilities are equal between decisions, assume an agent will first borrow and invest (satisfy both participation and incentive constraints), second borrow and consume (satisfy participation, but not the incentive constraint), and last abstain from borrowing (fail to satisfy the participation constraint).

Equation (1) implies that the *participation* constraint will be satisfied (an agent will accept a loan) if

$$R - r \geq v \tag{2}$$

$$\text{or} \quad \theta \geq v \tag{3}$$

The *incentive* constraint will be satisfied (a borrower will invest borrowed capital) if

$$R - r \geq \theta. \tag{4}$$

Let $\theta_i \in (1, R]$, and the distribution of θ_i be continuous and uniform across the set of potential borrowers. Furthermore, let the function $f(r)$ be the fraction of the set of borrowers who satisfy the incentive constraint in (4) given that they satisfy the participation constraint in (2) and (3), noting that $f'(r) < 0$. Thus $f(r)$ becomes the repayment rate, which is declining in r, since as the lender's interest rate increases, it draws more borrowers into the pool that satisfy the participation constraint in (2) (for whom $\theta \geq v$), but , violating who violate the incentive constraint in (4), (*i.e.* for whom $\theta > R - r$). We assume lenders maximize the profit function,

$$\pi = (r - c)f(r) - c\big(1 - f(r)\big) \tag{5}$$

where differentiating (5) with respect to the interest rate yields

$$\frac{d\pi}{dr} = f(r) + rf'(r). \tag{6}$$

Notice that when the interest rate is low, (6) is positive, but at higher interest rates (6) becomes negative as $f(r)$ goes to zero. The incentive constraint given in (4) and uniform distribution of θ_i implies that $f(r) = \frac{R-r}{R}$, so that lender profits in (5) are maximized at $\hat{r} = \frac{1}{2}R$.

FIGURE 1 provides a mapping of the satisfaction of participation and incentive constraints in (r, θ_i) space. As shown in FIGURE 1, as the interest rate increases, the dotted line showing the fraction of borrowers repaying their loans, $f(r)$ decreases as the participation constraint continues to be satisfied, but higher interest rates induce more borrowers to divert loans into present consumption from investment that would yield returns in the future.

The most problematic borrowers, from a lender's perspective, are located in the "Nevada-shaped" area that lies in the northeastern section of the map where present bias is high. In this case the participation constraint is satisfied (so that borrowers take loans at any interest rate), but they consume capital instead of investing it, not allowing them to generate the future liquidity needed to repay loans. To the northwest of this lies a triangular area in which θ_i is lower such that neither participation nor incentive constraints are satisfied as the payoff to these borrowers from consuming loans is lower. Below this area in the west part of the map is the complementary triangular area in which θ_i is lower, and the incentive constraint becomes satisfied, but high r makes it such that the participation constraint remains unsatisfied—borrowers favor their reservation payoff v over the future benefits of borrowing and investing. The southwest area of the map contains the area in which both the participation constraint and incentive constrains are satisfied; r is low enough to induce these agents into borrowing, and θ_i is low enough that as borrowers they invest the borrowed capital rather than consume it.

We present three examples of credit rationing equilibria under different formulations of the model that we believe are relevant to credit markets in developing countries. The present-bias based model generates similar credit rationing phenomena to the Stiglitz and Weiss model, but with stronger behavioral foundations. We also believe the model is more applicable to important issues in credit markets in developing countries and serves as a stronger theoretical framework for thinking about important issues in microfinance.

EXAMPLE 1: CREDIT MARKET RATIONING UNDER FULLY ASYMMETRIC INFORMATION.

The demand and supply curves for credit in FIGURE 2 are derived from (1) through (6) and can be related to FIGURE 1. The demand curve consists of two vertical segments. At high interest rates, where $r > R - v$, the participation constraint is satisfied only for agents who would borrow to consume. As the interest rate decreases to $r \leq R - v$, agents with less present bias are drawn into the borrowing pool, those who would choose to invest borrowed capital.

The supply curve reflects the first-order condition in (6). It is positively sloped at low r, but then at $\hat{r}$ takes a negative slope at the interest rate at which lender profits reach a maximum. Parallel to Stiglitz and Weiss, we assume that if the supply of funds is commensurate with the return earned by lenders on loans, then the supply curve (as seen in FIGURE 2) will be upward sloping as long as lender profits increase with higher interest rates (equation (6) > 0), but turn downward-sloping when higher interest rates create a lower return on loans (equation (6) < 0). The interest rate at which the supply curve bends backward is at $\hat{r}$, the first-order condition implied when (6) is set equal to zero.

This creates the possibility of an interior optimum interest rate for lenders under which credit rationing occurs at the interest rate $\hat{r}$. Notice that this credit rationing interest rate is lower than the Walrasian market clearing interest rate at r^* in FIGURE 2. As in the Stiglitz and Weiss risky-projects model, an interior interest rate optimum for lenders does not guarantee credit rationing, but is sufficient for credit rationing if the interior solution is less than the market clearing level of interest, as in FIGURE 2. This credit rationing equilibrium mirrors the credit rationing equilibrium in Stiglitz and Weiss' THEOREM 5. As shown in FIGURE 2, a fraction ϕ among a group of observationally indistinguishable individuals receive a loan, while some fraction $1 - \phi$ do not.

EXAMPLE 2: CREDIT MARKET RATIONING OVER OBSERVATIONALLY DISTINGUISHABLE BORROWERS.

The model is easily extended to reflect a more common situation of partial informational asymmetry, whereby a lender can identify sub-populations of agents who present a greater credit risk than others. In this example, suppose some fraction γ of potential borrowers are *blue* and that 1 - γ are *red*, a trait observable to lenders. To simplify, let v equal zero, and suppose θ_i is restricted to only two values where $\theta_i \in \{1, \theta_H\}$ and $\theta_H > R$. A fraction d_R of reds are characterized by $\theta_i = \theta_H$ and the remaining fraction $(1 - d_R)$ have $\theta_i = 0$. Blues are observed by lenders to be better investors on average, where a fraction $d_B < d_R$ have $\theta_i = \theta_H$, and $(1 - d_B) > (1 - d_R)$ have $\theta_i = 1$. Thus (4) never holds for a total fraction equal to $d_B\gamma + d_R(1-\gamma)$ of borrowers (red and blue) for any $r > 0$, so that the participation constraint is always satisfied and the incentive constraint is never satisfied. These borrowers always demand loans at any interest rate, consume their unit of capital and default on their loan. The complementary fraction of agents $\gamma(1-d_B)+(1-\gamma)(1-d_R)$ will always invest if they borrow, but they will only obtain loans when the payoff to borrowing and investing is positive, *i.e.* if the interest rate falls to at least $R - v$.

In FIGURE 3 we show a credit rationing equilibrium with observationally different groups of borrowers that has the following characteristics: Assuming that the blue borrowers are profitable, or $\pi_B = (r - c)[1 - (d_B)] - cd_B \geq 0$, then blue borrowers will be offered credit at a competitive (zero-profit, but not market clearing) interest rate equal to $\hat{r}_B = \frac{c}{1-d_B}$. A fraction d_B of blues will default. If d_R is sufficiently high, then $\pi_R = (r - c)[1 - (d_R)] - cd_R < 0$ for all $r < R - v$ and reds will be denied credit. In this outcome we have credit rationing based on observable characteristics, which in the real world may affect groups that might be perceived as having a high present bias, such as members of poor households in developing countries. Interest rates are kept low enough to draw in the low-θ blue agents, who will invest loans productively, but all red agents (even those who would like to borrow at the prevailing "market" rate and would invest capital productively) are denied credit at any interest rate.

EXAMPLE 3: RATIONING WITH MULTIPLE CREDIT MARKETS INCLUDING MICROFINANCE.

Consider the previous set-up in EXAMPLE 2, but where new lending technology makes it possible to offer profitable contracts to *red* borrowers. Some of the now well-known technologies such as the skilled use of group lending and credit officer incentive contracts, dynamic incentives, and microfinance credit reporting systems can reduce default rates and allow for more cost-efficient lending to the poor. Group training sessions with borrowers before lending and the *esprit de corps* of credit groups may shift preferences away from satisfying short-term needs and toward investment. Some combination of these innovations may facilitate an equilibrium in which red borrowers get credit, albeit at a higher interest rate than blue borrowers.

In this example we have credit rationing at $\hat{r}_B = \frac{c}{1-d_B}$, where both red and blue borrowers would like to borrow at the blue interest-rate. Red borrowers are offered loans only at the higher interest rate, $\hat{r}_R = \frac{c}{1-d_R}$, as in FIGURE 4. This kind of market segmentation is common in developing countries, where wealthy borrowers and those with sufficient collateral to cover large loans are able to borrow at lower formal-sector rates. The poor and informal sector entrepreneurs are traditionally given credit from traditional money lenders at much higher rates. Yet even with the current innovations in microfinance, these borrowers pay microloan interest rates that are often two to three times those offered by the formal financial sector.

7. CONCLUSION

Why propose an alternative model of credit rationing if a new model built around present bias and the temptations of consumption yields similar results, *i.e.* credit rationing equilibria similar to the ones in the "risky-project-based" moral hazard? That the risky-project-based framework has enhanced our understanding of credit market failure does not necessarily render it a suitable framework for building applied models of credit markets and designing appropriate policies for microfinance.

Much of the more recent literature investigating credit market issues in developing countries and microfinance has argued that self-control issues, nudges, and reference points lie at the heart of savings and borrowing behavior (Bertrand et al., 2005; Ashraf et al., 2006; Gugerty, 2007). We have constructed a model that generates credit rationing on the stronger behavioral foundations of this new literature rather than on assumptions about credit market behavior that appear to be unsupported by recent empirical work. Further work that incorporates behavioral economics into its research methodology will lead to the development of more robust models that not only allow us to understand the operations of markets, but can be used to guide important policy questions faced by development practitioners.

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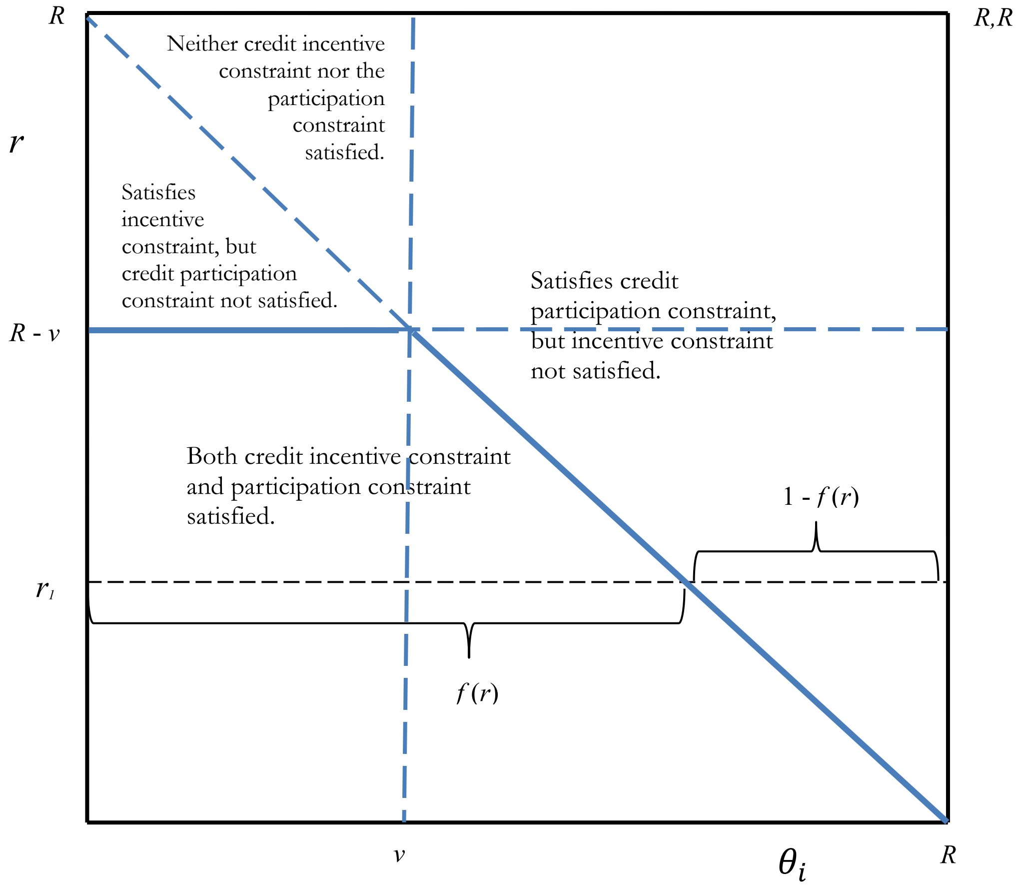

Figure 1: Credit Rationing Model: Possible Borrower Outcomes in (θ_i, r) space

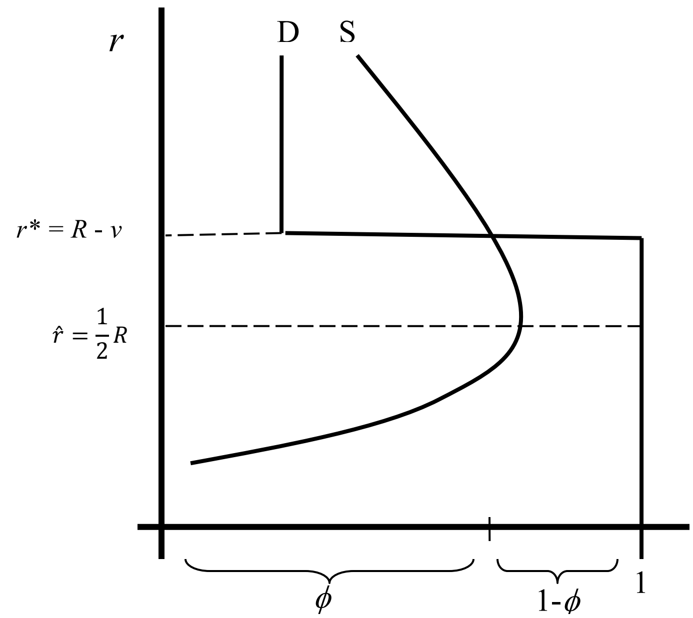

Figure 2: Credit Rationing Equilibrium

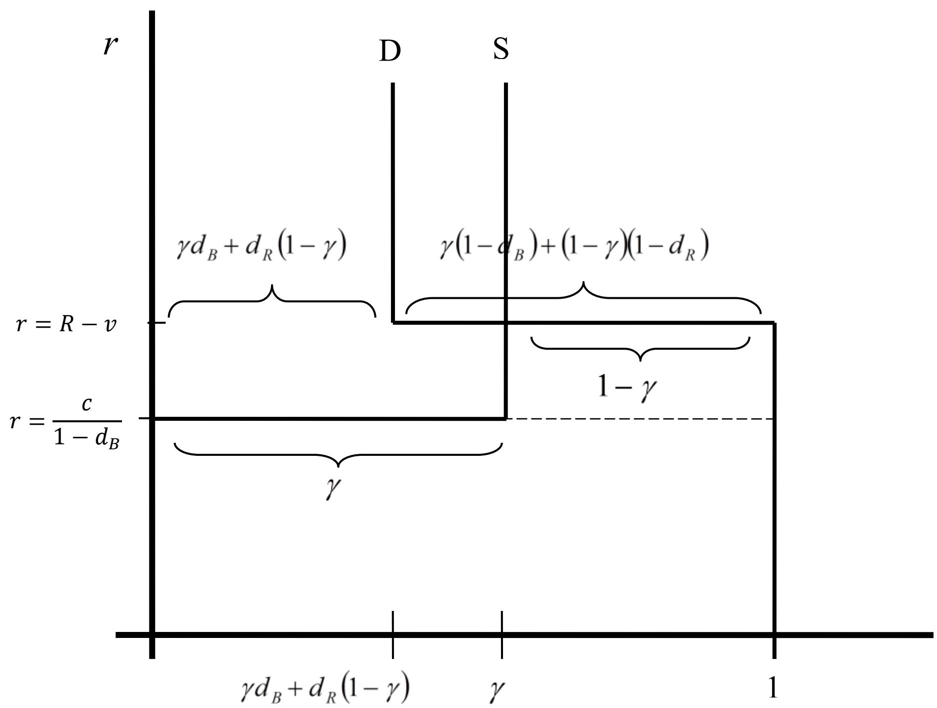

Figure 3: Credit Rationing with Observational Differences

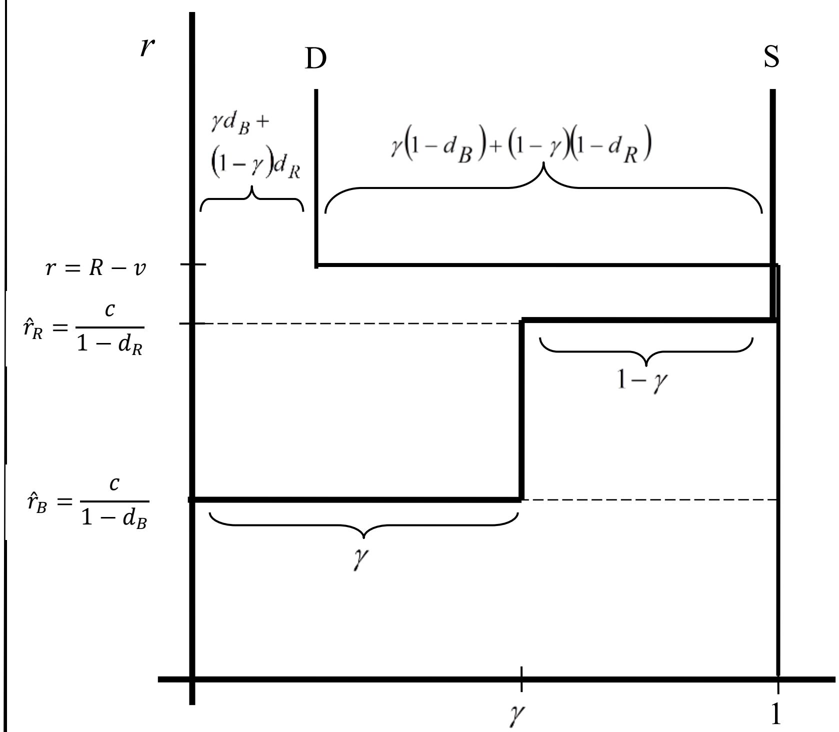

Figure 4: Rationing with Two Identifiable Markets