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RISK AND INTERMEDIATION IN A DUAL FINANCIAL MARKET MODEL

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Abstract

This paper investigates the relation between risk and the degree of financial intermediation in a model with moral hazard. Entrepreneurs can simultaneously get credit from two type of competing institutions: "financial intermediaries" and "local lenders". The former are competitive firms issuing deposits and having a comparative advantage in diversifying credit risks. The latter are individuals with a comparative advantage in credit arrangements with a "nearby" entrepreneur. Because of intermediation costs, local lenders are willing to diversify their portfolio by offering some direct lending to nearby entrepreneurs. We show that, in some cases, a fall in intermediation costs, by inducing local lenders to choose a safer portfolio, reduces entrepreneurs' effort and increases the probability of default. In these cases a taxation policy may be welfare-improving.

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1 Introduction

Premises. Financial market imperfections play a significant role in explaining capital accumulation and growth performance in developing countries. A number of empirical studies (*e.g.*, Levine (1997)) have shown that the development of formal financial market institutions (banks, financial intermediaries, stock markets) may be a key element in promoting economic growth. In particular, financial development reduces transaction costs that are responsible for excessive risk taking and it allows for better risk sharing and increasing liquidity so as to decrease the costs of raising funds and induce entrepreneurs to undertake more productive investments. These arguments justify the view that controlling international capital flows and taxing financial intermediaries is generally undesirable (McKinnon (1973)).

However, there is a large body of evidence showing that formal financial markets face serious informational problems and high default rates, especially in developing economies. These are typically characterized by an extensive resort to internal finance by entrepreneurs and a large informal sector for credit and risk sharing. Financial institutions face moral hazard problems and they are, to a large extent, unable to monitor firms' behavior. Hence, the question one may raise is whether informal market institutions may at least partially solve the incentive and informational problems that financial markets are unable to cope with.

The possibility that nonmarket financial institutions may have a positive role in developing economies has been extensively explored. In general, this possibility can be a consequence of assuming that some contractual arrangements cannot be legally enforced and informal markets for lending and insurance may have a comparative advantage in monitoring and enforcing contracts. This is, for instance, the assumption on which Stiglitz (1990) and Arnott and Stiglitz (1990) base their analysis of market and nonmarket insurance provision ("peer monitoring view").

In Arnott and Stiglitz (1990) there is a market for insurance with moral hazard where exclusive contracts are not enforceable. Moral hazard implies that the optimal incentive scheme is characterized by partial insurance. However, intermediaries operating in the formal market are unable to implement this contract since agents have the ability to seek additional unobservable insurance from some informal institutions. If these have no superior information, the resulting allocation may be inefficient. If (as assumed by Arnott and Stiglitz) informal institutions are unable to diversify risks as much as the formal institutions, non exclusive contracts have the additional effect of reducing the extent of risk sharing. However, if insurers operating in the nonmarket environment have more information and monitoring capabilities on the individuals' effort decisions, nonmarket insurance may be beneficial. Then, the interaction of market and nonmarket institutions have ambiguous effects on agents' welfare in the presence of incentive problems.

Overview. In this paper, we set up a model of a loan market with moral hazard where there are two types of financial institutions: formal intermediaries operating in a competitive environment (financial intermediaries) and informal lenders operating in a local, less competitive environment (local lenders). Our objective is to see how a small information advantage of the local lenders (*i.e.*, some intermediation costs faced by intermediaries) can be important to understand why financial development may sometimes fail to be beneficial for economic growth and default risks faced by entrepreneurs. As in Arnott and Stiglitz (1990), we have a model where borrowers can simultaneously obtain credit from competing institutions. However, we do not impose that agents' informal contractual arrangements are unobservable. In our model local, lenders have the option to impose exclusivity on their contracts. However, this option will not be exercised in equilibrium (and it is not desirable from a welfare point of view) since these competing institutions differ with respect to information, market power and attitude toward risk.

In our economy there is a continuum of identical risk neutral entrepreneurs operating investment projects with stochastic returns. Entrepreneurs have no initial endowment and they borrow from financial intermediaries and local lenders. Lending activity is subject to two types of market imperfections. First, there is a moral hazard problem, since entrepreneurs can affect the probability distribution of investment returns by making nonobservable effort decisions. Second, trading arrangements between lenders and borrowers are costly to establish outside some local environment. These costs (intermediation costs) may capture the costs of bookkeeping, enforcement, monitoring or transportation and they are assumed to be insignificant only when trading involves an entrepreneur and a local lender who lives where the entrepreneur's project takes place. One way to characterize our assumptions is to imagine that the economy is composed of a large number (a continuum) of small villages, each one populated by a local lender and an entrepreneur.

It is assumed that local lenders are risk averse individuals endowed with a fixed amount of loanable funds and that none of them is engaged in lending activity outside his own village (because of intermediation costs, he has no incentive to do so).

Financial intermediaries are a large set of competitive firms engaged in credit risk diversification. Since there is no aggregate uncertainty, they are able to offer their liabilities as a safe asset (deposits) to local lenders. However, the existence of intermediation costs implies that the rate of return on deposits is lower than the expected return on any given investment project and local lenders are willing to provide direct financing to entrepreneurs, *i.e.*, not all loanable funds are intermediated.

Both local lenders and intermediaries offer limited liability contracts to entrepreneurs. However, the nature of these contracts differ for a number of reasons. Intermediaries are assumed to be price taking and entrepreneurs can borrow as much as they want from them at the market rate. On the contrary, the contractual relation between a local lender and an entrepreneur is modeled as a principal agent relation where the local lender maximizes his own expected utility subject to the incentive compatibility constraint (arising from the nonobservability of effort) and a participation constraint (the entrepreneur may refuse the local lender's contract and get outside finance only). Local lenders are assumed to observe the entrepreneur's borrowing relations with outside parties. Hence, they can make their loan contract contingent on the entrepreneur's balance sheet position. A relevant feature of our model is that, despite this assumption, local lenders may find it in their own interest to allow entrepreneurs to borrow from multiple sources.

A competitive equilibrium in our economy is a set of contracts from local lenders, an interest rate on loans from intermediaries and an interest rate on deposits such that demand and supply of loanable funds are equalized. Nontrivial equilibria (*i.e.*, equilibria where local lenders and intermediaries are both active) are shown to exist, by an appropriate convexification over local lenders' optimal contracts. These equilibria are characterized by two relevant conditions. Namely, the marginal product of capital is equal to the rate on loans offered by intermediaries and this cannot be lower than the repayment *per* unit of loan to a local lender.

When the costs of intermediation are sufficiently high, the repayment rate to a local lender may be strictly lower than the marginal product of capital, *i.e.*, local lenders may be induced to offer credit at better conditions than intermediaries in order to increase the entrepreneur's effort (the probability of success of the project). It follows that entrepreneurs are rationed with respect to a loan offered by the local lender whereas they are not rationed with respect to a loan offered by intermediaries (whose repayment rate is equal to the marginal product of capital). This implies that entrepreneurs' effort is increasing in the share of total credit offered by local lenders.

Hence, in our model a higher amount of direct finance from a local lender may reduce the moral hazard problem. This result can be viewed as a version of a standard trade-off between the degrees of insurance and moral hazard. The more are local lenders insured against risk arising from direct investment, the less is the effort of the borrower in reducing risk implied by the contract.

From a general equilibrium perspective, the size of a local lender's direct loan to a nearby entrepreneur is a function of intermediation costs, since these costs are affecting the opportunity cost of direct lending ("risk premium"). It follows that a higher intermediation cost may increase the local lender's direct investment and raise the entrepreneur's effort to reduce the probability of default.

In other words, we have shown an instance in which a fall in intermediation costs, *i.e.*, an increase in financial development (a rising share of intermediated funds) may go along with an increase in the risk of default.

One may ask if our results are mainly a byproduct of intermediaries' price taking behavior. As an alternative specification, intermediaries could be assumed to pick the loan rate so as to maximize entrepreneurs' payoff for a given opportunity cost of lending (Bertrand competition in the market for loans and price taking behavior on the deposit side). One can argue that the competitive equilibria in this economy (when they exist) are competitive equilibria of the original economy. Hence, our results carry over to the case in which intermediaries have strategic behavior.

In the final section of the paper, we discuss the policy implications of the model and show that the presence of a tax rate on deposits may be beneficial when this implies a rise in the entrepreneurs' effort. The possibility of a rise in effort as a consequence of a tax on financial intermediation cannot be ruled out for the same reasons that explain the positive effect on effort of a rise in intermediation costs.

Motivation of the basic assumptions. We believe that our model has some resemblance with the reality of credit transactions in developing economies, where formal banking activity is competing with small and fragmented local financial markets and moneylenders. However, competition between different types of intermediaries is not restricted to developing economies. In highly industrialized economies, small banks, with close connections with local entrepreneurs, may coexist with other financial intermediaries, operating on a larger scale and having more loose and distant connections with their clients. In all these cases, it is reasonable to assume that small banks (or moneylenders) have a limited opportunity of diversifying their assets and face smaller transaction costs when relating with local borrowers. Also the assumption that moneylenders can impose exclusivity on contracts appears natural, though it plays no role in the simple framework we consider.

The existence of a transaction cost differential between financial intermediaries and local lenders is clearly the most critical and questionable assumption in our model. As we have already said at the beginning, transaction costs may arise from lack of information or from the physical costs of exchange (due to transportation and physical distance between borrowers and lenders).

A large literature on nonmarket institutions for credit and risk sharing in developing countries has documented and rationalized the idea that local financial markets and moneylenders have a comparative advantage in monitoring and enforcement capacity. For example, a simple way to rationalize these costs is to assume that entrepreneurs can hide the realizations of investment returns. With limited liability contracts, they may have an incentive to misreport these realizations unless the lender is monitoring. However, misreporting may be difficult, if not impossible, when the lender operates close by. This story can be considered as part of the "peer monitoring view" (see Besley (1995) for a survey), *i.e.*, the idea that risk sharing mechanisms or loan contracts may involve smaller agency costs when they involve geographically proximate individuals. Lower agency costs arise from the fact that, within local informal markets, the terms of contracts may be more sophisticated, social control may limit shirking behavior and punishment strategies may be more effective. Discussing the relative performance of credit transactions involving banks and moneylenders, Bell (1988, p. 787) argues that, whereas banks may enjoy a lower opportunity cost of lending,

> [...] they will not, however, possess the moneylender's inside knowl-

> edge of rural life and prospective clients, and they will be burdened with overheads and salary bill that looks profligate beside his. Except for borrowers seeking very large loans, therefore, it seems that the bank's administrative costs will far exceed those of the moneylender.

These considerations may give some support to the assumption that financial intermediaries face higher intermediation costs with respect to local lenders in a local environment despite their ability to diversify their assets.

The reality of credit transactions in developing countries may be used to support the other critical assumption of the model. Namely, that local lenders enjoy a monopoly power and financial intermediaries operate in a more competitive environment. In fact, most accounts of credit markets and interlinked transactions in rural India (*e.g.*, Basu (1984), Bhaduri (1977) and Rudra (1984)) view moneylenders as agents holding monopoly power in highly fragmented credit markets. Our assumption that financial intermediaries are perfectly competitive firms may be too extreme. However, we believe this to be a first approximation and a very stylized description of a real financial market in which moneylenders (or small local banks) have a local monopoly and formal intermediaries are operating in competitive, more open environments.

2 The Model

Agents and technologies. We consider a one-good overlapping generations economy populated by three types of agents: local lenders, entrepreneurs (also called borrowers) and financial intermediaries. Local lenders and entrepreneurs are two-period lived and they are a continuum uniformly distributed over the unit interval.

One way to interpret our model is to assume that there is a continuum of villages, with each village being populated by one entrepreneur and one local lender. Across villages, local lenders and entrepreneurs are identical.

Local lenders are endowed with an amount $w > 0$ of the consumption good in the first period of life, they only consume when old and they are risk averse. A local lender faces two investment opportunities: deposits $d \geq 0$, yielding a safe gross return $\rho \geq 0$, and a loan $(b, z) \geq 0$ to the entrepreneur operating in his own village.

Entrepreneurs are risk neutral, they have no physical endowment, but they are endowed with the ability to run a given investment project. A project activated by an entrepreneur is a technology transforming $k \geq 0$ units of the good in a given period into $\theta f(k) \geq 0$ units of the same good in the next period, where θ is a random variable. The technology is assumed to have the following properties.

Assumption 1 (Production) *$f : \mathbb{R}_+ \to \mathbb{R}_+$ is smooth, bounded, strictly increasing and strictly concave, with boundary conditions*

$$f(0) = 0 \text{ and } \lim_{k \to 0} f'(k) = \infty.$$

Assumption 2 (Risk) *The random variable θ is identically and independently distributed across entrepreneurs with support $\{0, 1\}$. The probability that $\theta = 1$ is denoted by p.*

We assume that the maximum loss that an entrepreneur can be forced to bear when he is unable to fulfill his contractual obligations cannot exceed the value of his assets. Since he has no assets when the project fails, all financial contracts are limited liability contracts such that the lender gets nothing when $\theta = 0$. In this case we say that the entrepreneur is bankrupt.

Intermediaries are a large, finite set. These are competitive firms collecting deposits from local lenders, on which a given gross rate of interest, $\rho \geq 0$, accrues, and offering nonrationed credit to entrepreneurs at a given gross rate of interest, $r > 0$. Each intermediary can be active in many villages, a (Borel-measurable, possibly empty) subset of all villages. Since we assume that borrowers are all equal and the realizations of θ are i.i.d. across borrowers, the law of large numbers implies that the effective revenue to an intermediary *per* unit of loan is deterministic.

Intermediation costs and loan contracts. Entrepreneurs can simultaneously contract with many intermediaries and local lenders. The reason why these two sources of credit may coexist depend on how intermediation costs affect the economy. We assume that trading arrangements in the market for loans are costly (because of lack of information[1] or physical costs of exchange) except for the relations involving the local lender and the entrepreneur living in the same village. Since local lenders are not engaged in lending activity outside their village, intermediation costs are only incurred by financial intermediaries.

If $a \geq 0$ is the amount of funds offered by intermediaries to entrepreneurs for production, each successful entrepreneur is obliged to repay ra to intermediaries. However, when intermediaries collect such repayments, a fraction of them is lost. We assume that this cost is proportional to the amount of collected resources and is captured by the parameter $1 > \gamma > 0$.

Assumption 3 (Transaction costs) *Intermediaries collect repayments from successful borrowers by paying $1 > \gamma > 0$ units of the unique final commodity for every unit of repayment.*

Local lenders never invest directly in a project activated by an entrepreneur living in a different village and, therefore, they are unable to diversify funds among projects unless they go through an intermediary, *i.e.*, unless they make a deposit (indirect investment). To fix the ideas, we imagine that a contract offered by an intermediary is part of market, or formal, finance and all contracts offered by local lenders is part of nonmarket, or informal, finance.

The reason why local lenders may be induced to offer direct finance to an entrepreneur is that, because of intermediation costs, the rate on deposits may

[1] One way to rationalize these costs is to assume that entrepreneurs can hide the realizations of investment returns. Since contracts imply limited liability, they may have an incentive to misreport these realizations unless the lender is monitoring.

be too low. In other words, even if intermediaries are making zero profit at equilibrium, the price of the insurance that they are offering to local lenders by issuing deposits is not a fair price and local lenders are induced to insure themselves incompletely against the risk of investment activity.

Moral hazard and incentive compatibility. Let $a \geq 0$ be the size of the loan that a borrower takes from intermediaries at the gross rate of interest $r > 0$. A loan from a local lender is a pair $(b, z) \geq 0$, where b is the size of the loan and z is the size of the repayment, *i.e.*, the amount that the local lender receives from the borrower in the next period if the project is successful. Given $c = (b, z, a)$ and r, the revenue of a successful borrower is $f(a+b) - ra - z$.

The relation between borrowers and lenders is affected by a moral hazard problem: the probability distribution of investment projects depends on a costly unobservable effort, $1 > e \geq 0$, provided by the entrepreneur.

Assumption 4 (Effort) *The probability p of a successful project equals the entrepreneur's effort, $1 > e \geq 0$, and this has a disutility measured by $v(e) = v(p)$. The disutility function $v : [0,1) \to \mathbb{R}$ is smooth, strictly increasing and strictly convex, with boundary conditions*

$$v(0) = 0, \ \lim_{e \to 0} v'(e) = 0 \text{ and } \lim_{e \to 1} v'(e) > M,$$

where $M = \sup_{k \geq 0} f(k)$.

The expected payoff of a borrower getting credit at conditions (c, r) is

$$p\left(f(a+b) - ra - z\right) - v(p).$$

The optimal effort (probability), p, is given by a continuous function of parameters and is fully characterized by the first-order condition

$$v'(p) \leq f(a+b) - ra - z,$$

with equality if $f(a+b) - ra - z > 0$. We use $\phi : \mathbb{R}_+ \to [0,1)$ to denote the inverse of v', so that, if $f(a+b) - ra - z \geq 0$, the optimal effort is chosen by entrepreneurs so as to satisfy the incentive compatibility constraint $p = \phi(f(a+b) - ra - z)$. It is clear that the borrower expected utility increases with the optimally chosen effort.

Local lenders' contracts. Local lenders act as principal with respect to borrowers and can enforce exclusive contracts. Their consumption across the two idiosyncratic states is denoted by $x = (x_g, x_b) \geq 0$. We assume that local lenders are risk-averse and their preferences are represented by a Bernoulli utility satisfying some standard hypotheses.

Assumption 5 (Local lenders' preferences) *The utility $u : \mathbb{R}_+ \to \mathbb{R}$ is smooth, strictly increasing and strictly concave, with boundary (Inada's) condition*

$$\lim_{x \to 0} u(x) = \infty.$$

A local lender is not competing with any other local lender when offering a loan to the entrepreneur in his village. He is assumed to choose this loan (b, z) so as to maximize his own expected utility for a given rate of interest $r > 0$ charged by intermediaries and a given safe rate on deposits $\rho \geq 0$. Since the local lender can observe the entrepreneur's balance sheet position, he can make loans contingent on the loan size a that the entrepreneur obtains from intermediaries. Then a local lender is effectively choosing the borrower's entire liability position and repayment (except for the market rate r). This choice is represented by the vector $c = (b, z, c)$ (henceforth called a "contract"), where a is an enforceable recommendation on the amount of funds obtained from intermediaries and (b, z) is the local lender's loan.

The local lender's problem reduces to

$$\max_c pu\left(\rho\left(w-b\right)+z\right)+\left(1-p\right)u\left(\rho\left(w-b\right)\right)$$

$$\text{subject to } p=\phi\left(f\left(a+b\right)-ra-z\right)\geq \max_{k\geq 0}\phi\left(f\left(k\right)-rk\right),$$

where the explicit (participation) constraint ensures that contract c is not refused by the entrepreneur, whereas incentive compatibility is embodied in the map ϕ.[2]

Since the local lenders' problem is nonconvex, optimal contracts need not form a convex set and the existence of an equilibrium in pure actions may fail. We, therefore, introduce probability measures on contracts provided by local lenders. These can be interpreted either as a random choice of each local lender or as the distribution of determinist choices across villages. Without loss of generality, we restrict ourself to finitely supported probability measures.

Equilibrium contracts. The intermediary's profit on a single project is

$$\left(\left(1-\gamma\right)pr-\rho\right)a.$$

Averaging across villages, intermediary's profit is

$$\sum_j\left(\left(1-\gamma\right)p_jr-\rho\right)a_j\pi_j,$$

where π represents the distribution of contracts across villages. Thus, intermediaries pool infinitely many risky projects and eliminate risk completely.

A *competitive equilibrium* consists of a safe rate of interest on deposits, $\bar{\rho} \geq 0$, a rate of interest on loans, $\bar{r} > 0$, and a (finitely supported) probability measure on local lenders' contracts, $\bar{\pi}$, such that the following three properties are satisfied:

- each local lenders' contract, $\bar{c}_j = \left(\bar{b}_j, \bar{z}_j, \bar{a}_j\right)$, having positive probability, $\bar{\pi}_j > 0$, is optimal given the rate of interest on deposits, $\bar{\rho} \geq 0$, and the rate of interest on loans, $\bar{r} > 0$;

[2] To simplify the presentation, here and in the following, we do not explicitly write all the nonnegativity constraints.

- intermediaries make zero profits, *i.e.*,

$$\sum_j ((1-\gamma)\,\bar{p}_j \bar{r} - \bar{\rho})\,\bar{a}_j \bar{\pi}_j = 0,$$

  where $\bar{p}_j = \phi\left(f\left(\bar{a}_j + \bar{b}_j\right) - \bar{r}\bar{a}_j - \bar{z}_j\right)$;

- markets clear, *i.e.*,

$$\sum_j \left(\bar{a}_j + \bar{b}_j\right)\bar{\pi}_j - w = 0.$$

Intermediaries can be regarded as short-term firms endowed with a constant return-to-scale technology which transforms deposits $d \geq 0$ in a given period into $(1-\gamma)\,prd$ units of commodity in the following period. The 'technological' parameter p, however, embodies the external effect of local lenders and borrowers and is endogenously determined.

Comments on the notion of equilibrium. Our notion of equilibrium requires that, given the contractual arrangements prevailing between local lenders and borrowers, intermediaries provide all contracts that involve nonnegative profit at the equilibrium rates on deposits and loans, which motivates our formulation of the participation constraint. The additional no-profit condition can be regarded as responding to a free-entry principle: if intermediaries made positive profit, competition would induce a decline in the rate of interest on loans and/or an increase in the rate of interest on deposits.

One may argue that, in our description of the economy, any comparative statics result could be an artifact of the price-taking assumption, *i.e.*, the hypothesis that intermediaries are unable to set the rate on loans strategically. We argue, however, that, if we assumed that intermediaries were Bertrand competitors in the market for loans and price-takers with respect to the rate on deposits, this would add only additional restrictions on a competitive equilibrium. Nevertheless, proving the existence of an equilibrium in the alternative setting could be problematic. This justifies a price-taking formulation as a first-approach to the problem.

Suppose that, holding expectations on the local lenders' contract, intermediaries set the loan rate so as to maximize their profit given the rate on deposits and subject to incentive compatibility and participation constraints. Under Bertrand competition, a competitive equilibrium would also be an equilibrium of the modified economy provided that lowering the rate on loans does not allow any intermediary to make positive profit and borrowers to reach a higher expected utility, possibly admitting a readjustment of local lenders' contacts. Strategic intermediaries then impose some additional constraints on equilibrium: basically, a set of conditions preventing them to have profitable deviations. *Vice versa*, an equilibrium with strategic intermediaries is also a competitive equilibrium insofar as intermediaries make no profit, which is not, in general, guaranteed, because of multiple optimal choices by local lenders, when one allows for a reaction of local lenders to the rate of loans chosen by an intermediary. As far as comparative statics analysis is concerned, therefore, the two models would lead to analogous conclusions, at least locally around robust equilibria.

3 Optimal Contracts

Characterization. Given $r > 0$ and $\rho \geq 0$, optimal local lenders' contracts exist. However, since moral hazard induces a nonlinear dependence of local lenders' expected utility on probability, we cannot exclude multiple optimal choices.

Proposition 1 (Optimal contracts) *For every $r > 0$ and $\rho \geq 0$, optimal contracts exist. Moreover, (a) two distinct optimal contracts involve distinct supplies of effort and, so, associated probabilities; (b) if a contract is optimal, then $rb \geq z$ and*

$$p = f(a + b) - ra - z = \max_{k \geq 0} f(k + b) - rk - z;$$

(c) if a contract is optimal and $pr > \rho$, then $w > b > 0$. Finally, the optimal contracts correspondence is upper hemicontinuous with compact values.

Proof. Since production is bounded and $r > 0$, we can truncate the space of choices for a local lender without affecting the optimality of his choice. Namely, let

$$T = \{(b, z, a) \geq 0 : w \geq b \geq 0, M \geq z \geq 0\},$$

where $M = \sup_{k \geq 0} f(k)$. The participation constraint defines a continuous correspondence $g : \mathbb{R}_{++} \times \mathbb{R}_{+} \mapsto T$ with nonempty, compact and convex values. Berge's Maximum Theorem then implies nonemptiness and upper hemicontinuity of optimal choices jointly in (r, ρ).

(a) If two distinct solutions are optimal given $r > 0$ and $\rho \geq 0$ and involve the same probability, then its proper convex combination satisfies the participation constraint and makes the local lender strictly better off since the probability does not decrease.

(b) If $z > 0$ and

$$f(a + b) - ra - z < \max_{k \geq 0} f(k + b) - rk - z$$

then the local lender would be able to increase the probability without altering his consumption across the two idiosyncratic states, which makes him strictly better off. If $z = 0$, it is clear that $b = 0$ and the result follows by the participation constraint.

(c) If not, then $(b, z) = 0$ and a is uniquely determined by the condition $f'(a) - r = 0$. Then the alternative contract $(\lambda, r\lambda, a - \lambda)$ makes the local lender better off for some small, positive λ. **Q.E.D.**

Local lenders' optimal contracts are of two types, which we define as binding and nonbinding, according to whether, respectively, the participation constraint is satisfied with equality or strict inequality (or, which is equivalent, $rb = z$ or $rb > z$).

Exclusive vs. nonexclusive contracts. Suppose that we remove the assumption that the local lender is able to make his loans contingent on a, because the borrower's balance sheet position is not entirely observable (nonexclusive contracts). In this case, the local lenders' problem is

$$\max_{(b,z)} pu\left(\rho\left(w-b\right)+z\right)+\left(1-p\right)u\left(\rho\left(w-b\right)\right)$$

$$\text{subject to } p=\max_{a\geq 0}\phi\left(f\left(a+b\right)-ra-z\right)\geq \max_{a\geq 0}\phi\left(f\left(a\right)-ra\right),$$

This amounts to letting a borrower negotiate the loan with an intermediary and with a local lender independently. It is, however, clear that this modification of the problem would not alter our analysis in any meaningful way.

First-order conditions. Optimal contracts can be characterized using first-order conditions. It is clear that a is optimal only if

$$f'\left(a+b\right)-r\leq 0, \tag{1}$$

with the equality if $a>0$. Thus, borrowers are never rationed by intermediaries. When $pr>\rho>0$, the contract $c=(b,z,a)$ is designed by a local lender so as to satisfy two purposes, the optimal allocation of wealth between a risky and a safe activity and the creation of the incentive to the borrower.

Wealth is allocated according to

$$pu_g'\left(r-\rho\right)=\left(1-p\right)u_b'\rho, \tag{2}$$

where marginal utilities are evaluated at the good state, $x_g=\rho\left(w-b\right)+z$, and the bad state, $x_b=\rho\left(w-b\right)$, consumptions. Such a condition states that the marginal rate of substitution between bad and good state consumption equals the "fair" price of insurance, $\left(1-p\right)/p$, plus a measure of the spread between the marginal product of capital and the deposit rate, a risk premium. The local lender chooses a risky portfolio as long as the risk premium is positive (that is, $pr>\rho$).

A second first-order condition is

$$u_g-u_b\leq pu_g'v'', \tag{3}$$

where equality holds if the contract is nonbinding. If the participation constraint is strict at an optimal contract, condition (3) states that the marginal benefit to the lender of an increase in the cost of borrowing, z, cannot fall short of its marginal cost, *i.e.*, the drop in the lender's expected utility due to a fall in the probability, p. This is called the "pecuniary externality" in the literature on moral hazard and it shows a possible trade-off between the degree of insurance and the extent of moral hazard in the lender's choice problem (more insurance implies a smaller gap between x_g and x_b and a smaller value of p by equation (3)).

4 Existence

A simple consequence of our definition of an equilibrium is that the rate on loans, $r > 0$, charged by intermediaries coincides with the marginal product of the aggregate investment, $w > 0$, in the risky project, unless intermediaries remain inactive.[3]

Proposition 2 (Characterization) *Let (r, ρ, π) be a competitive equilibrium. Then $r \geq f'(w)$, with equality if $\rho > 0$.*

Proof. If $\rho > 0$, all optimal contracts imply $w - b > 0$. Optimality requires condition (1) with equality, which can be consistent with market clearing only if $r = f'(w)$. If $\rho = 0$, it follows $w - b = 0$ at all optimal contracts, which satisfy market clearing only if $a = 0$. Therefore, $r \geq f'(b) = f'(w)$. **Q.E.D.**

Competitive equilibria trivially exist when $\rho = 0$, since we allow for inactive intermediaries. However, since random choices and the continuum of local lenders restore convexity, competitive equilibria exist even with intermediation ($\rho > 0$).

Proposition 3 (Existence) *A competitive equilibrium exists. Moreover, there is a competitive equilibrium with intermediation (that is, with $\rho > 0$).*

Proof. The first statement is straightforward. Set $\rho = 0$. Suppose that there are no intermediaries and local lenders are the only source of credit for borrowers. Take any optimal contract (b, z) for local lenders in this modified problem and choose r high enough so as to make nonprofitable for borrowers to demand loans at the rate r when (b, z) is available (this amounts to choose r so as to satisfy $r \geq f'(w)$ and $rb \geq z$).

Concerning the second statement, set $r = f'(w)$, which ensures market clearing, and consider the correspondence

$$\Lambda(\rho) = \{(1 - \gamma)\,\phi\,(f(w) - ra - z)\,r - \rho : (b, z, a) \text{ is optimal at } (r, \rho)\},$$

which is well defined on $S = \mathbb{R}_+$. This is an upper hemicontinuous correspondence with nonempty, compact values. In addition, $\min \Lambda(0) > 0$ and $\min \Lambda(\rho) < 0$ for some large enough $\rho > 0$. Let

$$\begin{aligned} S_+ &= \{\rho \in S : \max \Lambda(\rho) \geq 0\}, \\ S_- &= \{\rho \in S : \min \Lambda(\rho) \leq 0\}. \end{aligned}$$

If $S_+ \cap S_- = \emptyset$, then we have a nontrivial partition of S into two nonempty, closed sets (these sets are closed by the upper hemicontinuity of Λ), which is a contradiction since S is connected. It is then easy to show that profits can be made zero in correspondence of any $\rho \in S_+ \cap S_-$ by choosing a probability

[3] As a consequence, to simplify the equilibrium analysis, we omit r from notation whenever it is possible.

measure π over two optimal contracts, one implying nonnegative profit and the other nonpositive profit for intermediaries. **Q.E.D.**

Notice that a competitive equilibrium with intermediation may well involve only binding contracts for local lenders. In such a case, indeed, credit from local lenders and intermediaries are prefect substitute for a borrower. The interesting case is, however, that of a competitive equilibrium in which local lenders provide funds to borrowers which, though rationed in size, bear a more favorable implicit rate of interest, that is, local lenders' equilibrium contracts are nonbinding.

5 Comparative Statics

We now explore the effect of a varying value of the intermediation cost on the equilibrium probability of a successful investment project. In particular, we aim at pointing out that an increase in transaction costs may raise the average probability of successful projects.

We carry out a competitive statics exercise around a competitive equilibrium with a *unique nonbinding* contract for local lenders such that local lenders' optimal contracts can be (locally) expressed as a smooth function of all parameters. Equilibria of this sort are referred to as *smooth equilibria.*

Locally, around a smooth equilibrium, the equilibrium effect of a change in transaction costs can be examined in the (p, ρ)-plane studying the intersection of the zero-profit condition,

$$(1-\gamma)\,pr-\rho=0,$$

and the function $p = p(\rho)$ which locally gives the optimal probability chosen by local lenders as the rate on interest on deposits, ρ, varies. Comparative statics then reduces to the following observation.[4]

Proposition 4 (Comparative statics) *If, at a smooth equilibrium, the success probability associated with optimal contracts is locally decreasing in ρ (that is, $\partial p/\partial\rho < 0$), then the equilibrium probability is locally increasing in transaction costs (that is, $\partial p/\partial\gamma > 0$).*

Proof. Indeed, the zero-profit condition implies

$$\frac{\partial\rho}{\partial\gamma}=(1-\gamma)\,r\frac{\partial p}{\partial\gamma}-pr.$$

Therefore, since $\partial p/\partial\gamma = \partial p/\partial\rho\cdot\partial\rho/\partial\gamma$,

$$\frac{\partial p}{\partial\gamma}=-pr\left(1-(1-\gamma)\,r\frac{\partial p}{\partial\rho}\right)^{-1}\frac{\partial p}{\partial\rho},$$

[4] Here and in the following, the derivatives with respect to endogenous parameters (such as the rate of interest on deposits and, later, the subsidy) capture the (parametric) optimal behavior of local lenders, whereas the derivatives with respect to exogenous parameters (such as transaction costs and, later, the tax rate) represent equilibrium adjustments.

which is positive if $\partial p/\partial\rho < 0$. **Q.E.D.**

The result is a consequence of the trade-off faced by local lenders between insurance and incentive to borrowers. If local lenders reduce the incentive to borrowers when facing higher returns on the safe asset, then higher transaction costs require a lower rate of interest on deposits in order to restore equilibrium. This comparative statics result is exemplified in Figure 1, where the equilibrium values of p and ρ are derived from the intersections of two curves, the zero profit line, $p = \rho/(1-\gamma)\, r$, and the curve $p(\rho)$ defining the optimal success probability that a local lender is implementing as ρ varies around the smooth equilibrium value.

To more specific about the circumstances in which a rise in transaction costs may imply a rise in the equilibrium success probability, we decompose local lenders' optimization problem into two parts (details are in Appendix A). First, locally, we force the local lender to sustain a given probability when the rate on deposits slightly varies, which amounts to optimally choose the investment in the risky project, $b = \psi(\rho, p)$, under incentive compatibility and participation constraints, given the probability. Second, we let local lenders adjust the probability, which delivers the optimal solution of the original problem. Letting $M_j = -u_j''/u'_j$ be the Arrow-Pratt degree of risk aversion at j-state consumption, in Appendix A, we show that the condition stated in Proposition 4 can be written as

$$a\left(-\frac{\gamma}{(1-p)(1-\gamma)} + v'' p M_g\right) + (1-(1-\gamma)\,p)\, r\left(\frac{1}{1-p} + v'' p M_g\right)\frac{\partial\psi}{\partial\rho} < 0,$$

with all variables evaluated at the equilibrium values. If intermediation costs are high enough and the absolute risk-aversion is, say, bounded, the first term in the left-hand side of the above inequality is negative. Therefore, a sufficient condition for the equilibrium success probability to be locally increasing in intermediation costs is that the local lender's risky investment for given probability p, $\psi(\rho, p)$, is locally decreasing in the safe return ρ. Notice that

$$\frac{\partial\psi}{\partial\rho} = \frac{a\,(M_b - M_a) - ((1-\gamma)\,p\,(r-(1-\gamma)\,pr))^{-1}}{(r-(1-\gamma)\,pr)\, M_g + \rho M_b}.$$

An instance in which the condition is satisfied is when the absolute degree of risk aversion is constant and γ is relatively high.

In Figure 2, we present a simulation where a rise of γ has a negative effect on the local lender's expected utility and a positive effect on the success probability p. Restrictions on fundamentals are

$$u(x) = 2\sqrt{x},\ f(w) = 8.5,\ f'(w) = 1.5 \text{ and } w = 5.$$

We plot local lenders' indirect expected utility function, $\mathcal{W}(\rho, p)$, for the first part of the decomposed optimization problem, so that, for a given value of ρ, the maximum of $\mathcal{W}(\rho, \cdot)$ gives the probability optimally chosen by local lenders.

The Figure shows that $\mathcal{W}(\cdot, p)$ shifts downward and to the right when ρ goes from 0.4 to 0.6, which proves that this economy satisfies the condition stated in Proposition 4. Indeed, by computation, one can show that there is a smooth equilibrium with $p = 0.7$, $\gamma = 0.42$, and to $p = 0.72$, when $\gamma = 0.63$.

6 Efficiency

Constrained efficiency. Call $(z, m) \geq 0$ an allocation if it satisfies $f(w) - m - z \geq 0$. An allocation $(\bar{z}, \bar{m})$ is constrained Pareto efficient if it solves

$$\max_{(z,m)} pu\left((1-\gamma)\, pm + z\right) + (1-p)\, u\left((1-\gamma)\, pm\right)$$

subject to

$$p = \phi\left(f(w) - m - z\right) \geq \bar{p} = \phi\left(f(w) - \bar{m} - \bar{z}\right).$$

A constrained efficient allocation can be obtained by a planner who makes transfers, subject to transaction costs, and does not control for contractual arrangements. Set $\bar{h} = (1-\gamma)\, \bar{p}\bar{m}$ and $\bar{s}$ so as to satisfy $f(w) - f(\bar{s}) = \bar{z}$. The planner transfers $\bar{s}$ from local lenders to entrepreneurs before production takes place. After production, she collects $\bar{m}$ from successful entrepreneurs and redistributes $\bar{h}$ to local lenders, which is physically feasible, given intermediation costs, at the expected effort. Taking transfers as given, local lenders and entrepreneurs write a contract prescribing a repayment z from successful entrepreneurs in exchange for the additional funds $w - \bar{s}$ used in production. Since entrepreneurs can refuse contracts involving an expected utility lower than what transfers can guarantee, the individually rationality constraint requires

$$\bar{z} = f(w) - f(\bar{s}) \geq z.$$

It follows that z is chosen so as to maximize local lenders' expected utility, $p\left(u\left(z + \bar{h}\right)\right) + (1-p)\, u\left(\bar{h}\right)$, subject to entrepreneurs' participation constraint,

$$p = \phi\left(f(w) - \bar{m} - z\right) \geq \bar{p} = \phi\left(f(w) - \bar{m} - \bar{z}\right),$$

which exactly delivers the solution to our original maximization problem.

Proposition 5 (Market inefficiency) *Smooth equilibria are not constrained efficient.*

To verify this, consider the first-order conditions for the planner's problem. Such conditions are

$$\left(pu'_g + (1-p)\, u'_b\right)(1-\gamma) - u'_g \quad = \quad 0. \tag{4}$$

$$u_g - u_b - u'_g\left(pv'' - m\right) \quad \leq \quad 0, \tag{5}$$

Condition (4) is equivalent to the optimal portfolio choice of a competitive equilibrium (equation (2)), whereas the inequality (5) includes an externality which is neglected by competitive individuals (compare with condition (3) when it holds with equality).

Welfare and taxation. Since the equilibrium success probability is increasing in the entrepreneurs' expected payoff (expected profit minus disutility of effort), a rise in intermediation costs is always beneficial for entrepreneurs' welfare whenever this cost has a positive effect on p. This may not be a Pareto improvement, since a rise in γ may produce a fall in the equilibrium deposit rate ρ and this fall always has a negative effect on local lenders' expected utility.[5]

In order to have a Pareto improvement from a rise in γ, it is sufficient to show examples in which p is increasing and ρ is non decreasing in γ at equilibrium. In general, we cannot rule out this possibility, since a rise in γ has two opposite effect on ρ, a direct and an indirect effect. The direct effect of a rise of γ on ρ is negative and measured by pr (the effect for given equilibrium probability), the indirect effect is positive and measured by $(1-\gamma)\, r \cdot \partial p / \partial \gamma$. Hence, a Pareto improving rise of γ can only arise if the effect of γ on p is strong enough, *i.e.*, $(1-\gamma)\, r \cdot \partial p / \partial \gamma > pr$.

A potential role for taxation emerges when there are transaction costs, since the competitive equilibrium allocation is not constrained efficient when the equilibrium contract is nonbinding. Let $1 > \tau \geq 0$ be a proportional tax on the real rate on deposits earned by the local lenders and $m \geq 0$ a lump-sum subsidy. Denoting ρ the net rate of interest on deposits, the local lender's problem becomes

$$\max_c pu\left(\rho\left(w-b\right)+z+m\right)+\left(1-p\right)u\left(\rho\left(w-b\right)+m\right)$$

$$\text{subject to } p=\phi\left(f\left(a+b\right)-ra-z\right)\geq \max_{k\geq 0}\phi\left(f\left(k\right)-rk\right).$$

A competitive smooth equilibrium requires the additional restriction of a balanced tax policy, that is,

$$m-\left(\frac{\tau}{1-\tau}\right)\rho a=0.$$

We carry out a comparative statics exercise moving from a smooth equilibrium without taxation.

Observe that the equilibrium effect of an increase in the tax rate τ on local lenders' expected utility at $\tau = 0$ can be written as

$$\left(pu_g'+\left(1-p\right)u_b'\right)\left(\rho a+\left(1-\gamma\right)ra\frac{\partial p}{\partial \tau}\right),$$

where all variables are evaluated at equilibrium values. Hence, the imposition of a small tax rate on the safe rate of return along with a balanced budget transfer to local lenders implies a Pareto improvement whenever this implies a rise in the equilibrium probability of success.

Proposition 6 (Welfare-improving policy) *If, at a smooth equilibrium with $\tau = 0$, the success probability associated with optimal contracts is locally decreasing in ρ (that is, $\partial p / \partial \rho < 0$), then the equilibrium probability is locally increasing in the policy parameter τ (that is, $\partial p / \partial \tau > 0$).*

[5] This is obvious since a lower ρ reduces local lenders' expected utility, while it does not modify the set of contracts satisfying the participation constraint.

Proof. Locally, equilibria are a smooth function of the policy parameter τ which satisfies the following system of equations

$$\begin{aligned}(1-\gamma)\, pr - \left(\frac{1}{1-\tau}\right)\rho &= 0,\\ m - \left(\frac{\tau}{1-\tau}\right)\rho a &= 0,\end{aligned}$$

where p and a are optimally chosen by local lenders given relevant parameters. Differentiating, we obtain

$$\frac{\partial \rho}{\partial \tau} = (1-\gamma)\, r \frac{\partial p}{\partial \tau} - \rho.$$

Since $\partial p/\partial \tau = \partial p/\partial \rho \cdot \partial \rho/\partial \tau + \partial p/\partial m \cdot \partial m/\partial \tau$ and $\partial m/\partial \tau = \rho a$,

$$\frac{\partial p}{\partial \tau} = \rho \left(1 - (1-\gamma)\, r \frac{\partial p}{\partial \rho}\right)^{-1} \left(a \frac{\partial p}{\partial m} - \frac{\partial p}{\partial \rho}\right),$$

where all the derivatives are evaluated at the smooth equilibrium without taxation. In appendix B, we show that the last term above is always positive. It then follows that $\partial p/\partial \rho < 0$ suffices to have $\partial p/\partial \tau > 0$. **Q.E.D.**

We remark that a negatively sloped probability in the rate of interest on deposits is not a necessary condition in order to obtain a welfare improvement through taxation.

7 Conclusion

We have considered an economy where entrepreneurs can simultaneously get loan contracts from two types of lenders, financial intermediaries and local lenders. The former have a comparative advantage in the diversification of risks and the latter have a comparative advantage in saving costs related with lending activity within a local environment. This allows local lenders to act as monopolists with respect to the local entrepreneur. However, local lenders' inability to diversify, make them exposed to excessive risk taking. Within this environment we have shown that an increase in the costs of intermediation may induce entrepreneurs to choose safer projects, through a moral hazard mechanism in the relation between borrowers and lenders. This effect comes about because a higher cost of intermediation implies a fall of intermediaries' finance and an increase in the amount of direct lending from local lenders who are able to offer credit at cheaper conditions.

A remarkable feature of the model is that our result holds despite the fact that intermediaries are choosing contracts so as to maximize entrepreneurs' profits, *i.e.*, so as to maximize the probability of success of investment projects (the increasing relation between this probability and the entrepreneurs' profits is a consequence of moral hazard), whereas local lenders are choosing contracts so as to maximize their own expected utility. In addition, our result is of a general equilibrium type and any increase in the costs of intermediation translates into a fall in the rate of return on the safe asset of local lenders' portfolio, *i.e.*, a rise in the spread between risky and safe asset returns. In fact, one could interpret our result as a consequence of a standard trade-off between moral hazard and insurance.

Our assumptions about the characteristics of local lenders and intermediaries try to mimic the basic features of an economy where financial market imperfections and an imperfect legal system allow for the coexistence of market and nonmarket finance. The former is represented by a set of competitive intermediaries engaged in risk diversification and operating economy-wide. The latter is represented by a very large set of local moneylenders. An immediate prediction of our model is that there may be specific environments where taxing the rates of return offered in the market by intermediaries may be beneficial.

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A Appendix

For analytical tractability, locally, around a smooth equilibrium, we find it useful to decompose local lenders' problem into two parts. Suppose that local lenders are forced to choose a contract which sustains a *given* probability, p, consistent with incentive compatibility and participation constraints. This amounts to consider the modified problem

$$\max_b pu\left(\rho\left(w-b\right)+rb-s\left(r,p\right)\right)+\left(1-p\right)u\left(\rho\left(w-b\right)\right),$$

where $0\leq s\left(p\right)\leq rw$ is such that $p=\phi\left(f\left(w\right)-rw+s\left(p\right)\right)$. (Remember that, at a smooth equilibrium, $r=f'\left(w\right)$.) This problem admits a unique solution, $\psi\left(\rho,p\right)$, that is continuous in all parameters. Local lenders then choose the probability, p, so as to maximize the 'indirect' utility function,

$$pu\left(\rho\left(w-\psi\left(\rho,p\right)\right)+r\psi\left(\rho,p\right)-s\left(p\right)\right)+\left(1-p\right)u\left(\rho\left(w-\psi\left(\rho,p\right)\right)\right),$$

subject to the implicit participation constraint given by $0\leq s\left(p\right)\leq rw$. This approach gives solutions that are equivalent to those of the original problem. In terms of first-order conditions, the first step requires equation (2) for a given probability, whereas the second step can be studied using condition (3).

Locally, around a smooth equilibrium, we have that $b=\psi\left(p,\rho\right)$ is the unique solution to

$$\Psi\left(b,\rho\right)=\left(r-\rho\right)pu'\left(\rho\left(w-b\right)+rb-s\left(p\right)\right)-\rho\left(1-p\right)u'\left(\rho\left(w-b\right)\right)=0,$$

where $s\left(p\right)=v'\left(p\right)-f\left(w\right)+f'\left(w\right)w$. A choice of $p=p\left(\rho\right)$ by local lenders is optimal if it satisfies the remaining first-order condition (3) with equality, that is,

$$\Phi(p,\rho)=u\left(x_g\left(p,\rho\right)\right)-u\left(x_b\left(p,\rho\right)\right)-v''\left(p\right)pu'\left(x_g\left(p,\rho\right)\right)=0,$$

where

$$\begin{aligned} x_g\left(p,\rho\right) &= \rho\left(w-\psi\left(p,\rho\right)\right)+r\psi\left(p,\rho\right)-s\left(p\right), \\ x_b\left(p,\rho\right) &= \rho\left(w-\psi\left(p,\rho\right)\right). \end{aligned}$$

By the implicit function theorem, the marginal effect on the probability chosen by local lenders induced by a marginal variation of the rate of interest on deposits can be written as $\partial p/\partial\rho=-\left(\partial\Phi/\partial p\right)^{-1}\cdot\partial\Phi/\partial\rho$ and, by the second-order conditions for optimality, we can verify that $\partial\Phi/\partial p<0$. By computation,

$$\frac{\partial\Phi}{\partial\rho}=A+B\frac{\partial\psi}{\partial\rho},$$

where

$$\begin{aligned} A &= u_g'a\left(-\frac{pr-\rho}{\left(1-p\right)\rho}+v''pM_g\right), \\ B &= u_g'\left(r-\rho\right)\left(\frac{1}{1-p}+v''pM_g\right). \end{aligned}$$

Here $M_j = -u_j''/u_j'$ is the absolute risk-aversion measure at state j consumption. Using $\partial\psi/\partial\rho = -(\partial\Psi/\partial b)^{-1} \cdot \partial\Psi/\partial\rho$, we obtain

$$\frac{\partial\psi}{\partial\rho} = \left(\frac{1}{r-\rho}\right) \frac{a(r-\rho)(M_b - M_g) - \rho^{-1}r}{(r-\rho)M_g + \rho M_b}.$$

B Appendix

We expand our analysis in Appendix A in order to take into account the effect of the subsidy on local lenders' optimal choices.

Locally, around a smooth equilibrium, let $b = \psi(p, \rho, m)$ be the unique solution to

$$\begin{aligned} \Psi(b, \rho, m) &= \\ (r-\rho)pu'(\rho(w-b) + rb - s(p) + m) - \rho(1-p)u'(\rho(w-b) + m) &= 0, \end{aligned}$$

where $s(p) = v'(p) - f(w) + f'(w)w$. A choice of $p = p(\rho)$ by local lenders is optimal if it satisfies the remaining first order condition (3) with equality, that is,

$$\Phi(p, \rho, m) = u(x_g(p, \rho, m)) - u(x_b(p, \rho, m)) - v''(p)pu'(x_g(p, \rho, m)) = 0,$$

where

$$\begin{aligned} x_g(p, \rho, m) &= \rho(w - \psi(p, \rho, m)) + r\psi(p, \rho) - s(p) + m, \\ x_b(p, \rho, m) &= \rho(w - \psi(p, \rho, m) + m). \end{aligned}$$

Applying the implicit function theorem, the marginal effect on the probability chosen by local lender induced by a marginal variation of the subsidy can be written as $\partial p/\partial m = -(\partial\Phi/\partial p)^{-1} \cdot \partial\Phi/\partial m$ and, by the second-order conditions, we can show that $\partial\Phi/\partial p < 0$. By computation,

$$\frac{\partial\Phi}{\partial m} = a^{-1}A + B\frac{\partial\psi}{\partial m},$$

where the terms A and B are defined in Appendix A. Moreover, using $\partial\psi/\partial m = -(\partial\Psi/\partial b)^{-1} \cdot \partial\Psi/\partial m$, we obtain

$$\frac{\partial\psi}{\partial m} = \frac{M_b - M_g}{(r-\rho)M_g + \rho M_b}.$$

Therefore, using the results in Appendix A which are not altered by the introduction of a subsidy, we have the equivalence

$$a\frac{\partial p}{\partial m} - \frac{\partial p}{\partial\rho} > 0 \text{ if and only if } a\frac{\partial\psi}{\partial m} - \frac{\partial\psi}{\partial\rho} > 0,$$

which, identifying terms, amounts to satisfy $((r-\rho)\rho)^{-1}r > 0$.

The effect of an increase in intermediation costs
on equilibrium values of ρ and p.

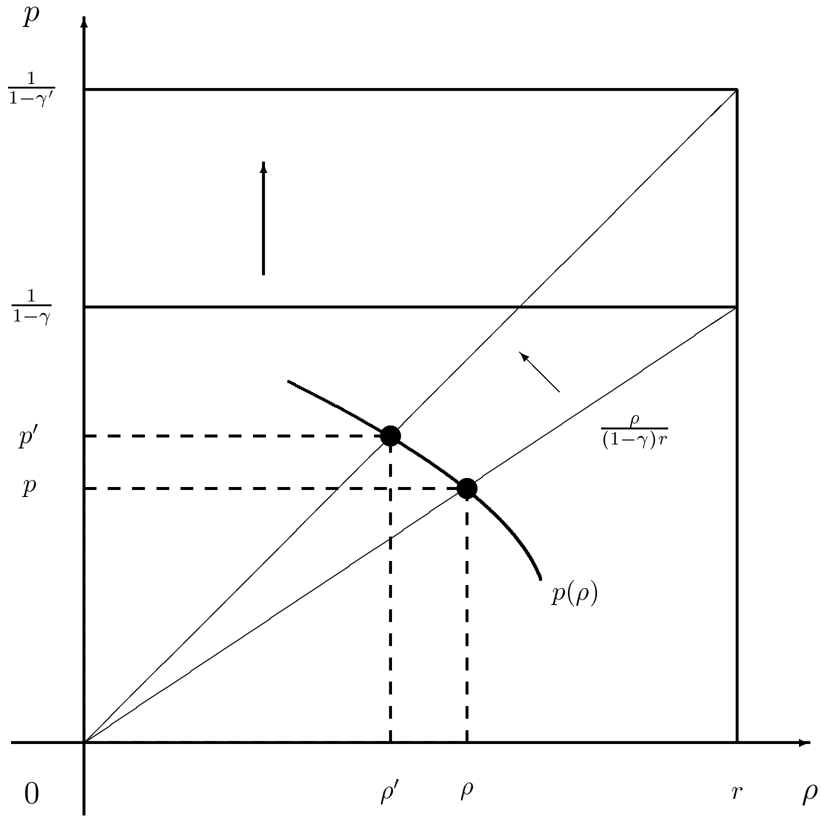

Figure 1

Indirect expected utility $\mathcal{W}(\rho, p)$.
Curve above: $\rho = .6$, $\gamma = .42$. Curve below: $\rho = .4$, $\gamma = .63$.

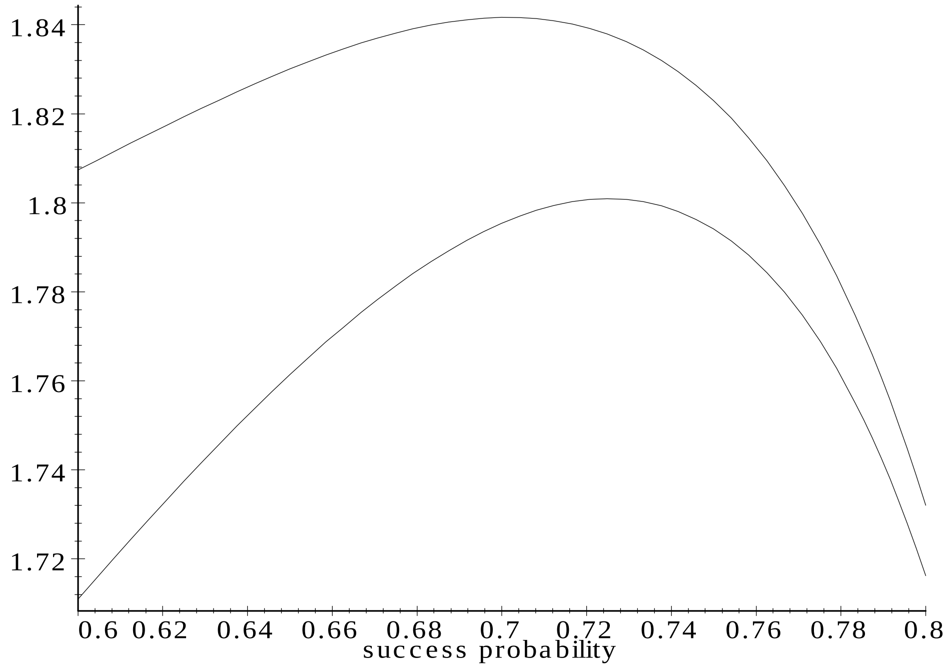

Figure 2