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What Banks Do and Markets Don't: Cross-subsidization

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What Broad Banks Do, and Markets Don't: Cross-subsidization

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Abstract

We show that interbank markets are a poor substitute for "broad" banks that operate across regions or sectors. In the presence of regional or sectoral asset and liquidity shocks, interbank markets can distribute liquidity efficiently, but fail to respond efficiently to asset shocks. Broad banks can condition on the joint distribution of both shocks and, hence, achieve an efficient internal allocation of capital. This allocation involves the cross-subsidization of loans across regions or sectors. Compared to regional banks that are linked through well-functioning interbank markets, broad banks lead to higher levels of aggregate investment, higher output, and less fluctuations within regions. However, broad banks generate endogenously aggregate uncertainty.

Keywords: Banking Restrictions; Interbank Markets; Universal Banking; Endogenous Uncertainty

JEL Classifications: G21; G28; D80; E44

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1 Introduction

Restrictions on the geographical and sectoral scope of U.S. banks' operations have been successively relaxed over the last two decades. In the wake of these changes, a number of banks have extended their operations across states either via mergers or by opening branches. Similarly, a reduction in Euro-area regulatory barriers has led to increased cross-national banking. However, while interbank markets in Europe have largely become integrated, substantial barriers to a fully integrated European banking sector remain (Trichet (2004)). As a result, European regulators today face a similar question to what American regulators faced twenty years ago: If interbank markets can be freely accessed by banks, are there gains from removing restrictions on the scope of banks? The answer to this question depends upon whether interbank markets can replicate internal capital allocations within banks that operate broadly across regions or sectors. In other words, are anonymous interbank markets where banks can borrow funds from other banks when faced with unexpected liquidity or asset shocks a substitute for "broad" intermediaries which operate across regions or sectors?

We argue that interbank markets are a poor substitute for broad banks in the presence of regional or sectoral asset *and* liquidity shocks. We adopt the standard view of banks as intermediaries that provide liquidity to depositors and make risky loans to entrepreneurs. To secure investment funds, entrepreneurs must pledge collateral whose value is risky, since they cannot commit to repay loans. Whenever the return on entrepreneurs' projects is not perfectly correlated with the value of collateral, the return on investment differs for depositors and entrepreneurs. In turn, regional shocks to collateral values and liquidity cause these differences in return (or wedges) to vary across regions. Regions with high liquidity needs and high collateral values have low wedges in return on investment, but require the withdrawal of funds to meet liquidity needs of lenders. Conversely, regions with low liquidity needs and low collateral values have large wedges in returns leading to the liquidation of investment projects and excess funds for investment in these regions. Interbank markets can distribute liquidity efficiently. This prevents the termination of projects due to liquidity needs in regions where the returns for depositors and entrepreneurs are similar. However, interbank markets fail to take into account the differential return on investment across regions. Broad banks that operate across regions can condition on the realized joint distribution of shocks to both satisfy the liquidity needs of lenders and efficiently allocate investment across regions. This internal allocation of capital involves the cross-subsidization of some projects ex-post that have high returns to entrepreneurs, but relatively low returns to depositors. As a result, broad banks lead to higher levels of aggregate investment and higher output than regional or sectoral banks with well-functioning interbank markets.

To formalize this argument we analyze an environment with multiple "regions" and region-specific liquidity and asset shocks. The basic environment has five key features. First, lenders face stochastic liquidity needs (modelled as preference shocks) which generates a deposit feature. Second, entrepreneurs have projects with returns exceeding the return on a storage technology. Third, lending contracts are subject to enforcement frictions. We assume that the repayment of debt contracts is enforced solely by the threat of seizing a collateral good. This leads to the financing of entrepreneurial projects via collateralized debt. The fourth feature is that the value of collateral is stochastic. As a result, low realizations of the collateral value induce depositors to reduce or stop lending, since they will be unable to collect on their loans. Finally, to capture the idea of "regions", we replicate our basic environment $N \geq 2$ times. Motivated by the observation that bank lending and deposit taking tends to be regionally or functionally specialized, we assume that depositors and entrepreneurs in each region are spatially separated from their counterparts in other regions.

We analyze two banking structures. In an *interbank market* arrangement, banks in each region are restricted to taking deposits and making loans to entrepreneurs in their region. There is a competitive interbank market where banks from different regions can borrow and lend taking the interbank interest rate as given. Interbank borrowing is fully backed by collateral as the rights to seize collateral are transferred between banks. The second structure formalizes *broad banks*. Banks are able to operate branches in every region that take deposits in a region and make loans to entrepreneurs in the same region. Hence, banking activity is still local. However, banks are now able to directly transfer resources across branches or regions. When making transfers, banks are constrained by the threat of potential competition from region-specific banks.[1] We model this threat as an outside option for lenders and entrepreneurs to form a region-specific coalition to finance projects locally.

In the interbank market setup, banks in regions with sufficiently bad asset shocks terminate all projects, as the amount that can recovered from entrepreneurs is less than the return on the storage technology. These banks are lending on the interbank market. Banks in regions with a high realization of the asset shock wish to borrow on the interbank market so as to avoid the liquidation of projects. The allocation of funds within a broad bank is more complicated as it depends upon the joint realization of the asset and liquidity shocks. As in the interbank market, broad banks transfer funds from regions with bad asset shocks to regions with good asset shocks and high liquidity needs. However, the broad bank is able to extract some of the surplus from entrepreneurs on islands receiving liquidity loans and use it to cross-subsidize projects in regions with bad asset shocks that would have been terminated with liquidity provision through interbank markets. Here it is the threat of exclusion from liquidity motivated loans that induces depositors and entrepreneurs in a region to stay with the broad bank despite their outside option and to agree with the transfers to cross-subsidize projects in other regions. Since the cost of exclusion depends upon the joint realization of the shocks, a negative correlation between liquidity and asset shocks lowers the outside option and leads to higher transfers, more cross-subsidization and higher aggregate investment.[2]

Our analysis generates a novel aspect for the relationship between aggregate uncertainty and banking restrictions. While broad banks reduce idiosyncratic regional risk, they also create endogenous aggregate uncertainty. The reason is that, with broad banks, the level of aggregate investment depends upon the extent of cross-subsidization which is a function of the realized joint distribution of asset and liquidity shocks. Purely idiosyncratic shocks across regions thus lead to *endogenous* aggregate fluctuations in the level of investment and output. With interbank markets and regional banks, investment depends solely upon regional asset shocks. Thus, idiosyncratic asset shocks lead to variations in the level of regional investment, but not aggregate investment.

The model has two interesting empirical implications. First, broad bank lending within a region should respond less to regional asset shocks than that of regional banks. Second, the removal of barriers to broad banks should lead to a reduction in idiosyncratic output and investment fluctuations across regions. These implications are in line with recent empirical findings on the relationship between restrictions on inter-state banking and real economic activity in the U.S. Morgan, Rime and Strahan (2004) find that increased interstate banking in the U.S. during the 1980s and early 1990s was accompanied by a reduction in the idiosyncratic variability of state output.[3] Demyanyk, Ostergaard and Sorensen (2004) also find a reduction in idiosyncratic income fluctuations across states in the U.S. following banking de-regulation. They argue that this insurance is provided largely through less fluctuations in bank loans to small business.[4]

Closest in spirit to our environment is recent work by Diamond and Rajan (2001) and Kashap, Rajan and Stein (2002) that addresses the question of what makes banks "special" compared to other types of types of financial intermediaries and markets. Kashap, Rajan and Stein (2002) argue that banks exist to economize on liquidity. They show that when both borrowers and lenders are subject to imperfectly correlated liquidity needs that a bank is able to reduce the amount of reserves needed to provide for sufficient liquidity. Diamond and Rajan (2001) examine an environment with liquidity and asset shocks. They argue that the financial fragility of banks (whereby banks borrow short and lend long) helps banks to commit not to hold-up depositors. Their work is complementary to ours. We addresses the question of restricting the scope of bank operations whereas these other papers provide a rational for the existence of banks. We also differ from these papers in the way we model asset shocks. Building upon Kocherlakota (2001), we assume that limited enforcement requires lending to be secured with a risky collateral good.

Also related to our work are Battacharya and Gale (1987), Chari (1989) and Battacharya and Fulghieri (1994). These papers find that interbank markets cannot provide liquidity efficiently and achieve an optimal diversification of liquidity risk when a bank's true liquidity needs or investment returns are private information. Apart from assuming full information, our work differs from these papers in two dimensions. First, we analyze a model where both stochastic liquidity needs and co-insurance against asset risk interact to shape interbank relationships. Second, we look at the question whether alternative arrangements such as broad banks could improve upon interbank markets.[5]

The remainder of the paper is organized as follows. The next section sets out the environment, concentrating on the contractual framework and the enforcement frictions. Section 3 analyzes the provision of liquidity via competitive markets, while Section 4 discusses the failure of the market solution in achieving efficiency and highlights the benefits of broad banks.

Section 5 discusses the implications of our model and outlines some empirical examples which match our results. All proofs are relegated to the appendix.

2 An Investment Problem with Default and Demand for Liquidity

There are three periods $t = 0, 1, 2$. The economy is composed of $N \geq 2$ locations or "islands". Each location is populated by a measure one of both entrepreneurs and investors.

Investors have a single unit of a consumption good and can access a storage technology with gross return of 1 at any time. With probability $\tilde{\theta}$ $(1-\tilde{\theta})$ lenders only value consumption at $t = 1$ $(t = 2)$, where $\tilde{\theta}$ is a random variable with support $\Theta \subset (0, 1)$. Formally, preferences of lenders at date $t = 1$ are defined by

$$u_L(c^1_{L,i}, c^2_{L,i}; \theta_i) = \begin{cases} c^1_{L,i} & \text{if type 1 and realization is } \theta_i \\ c^2_{L,i} & \text{if type 2 and realization is } \theta_i \end{cases},$$

where $c^t_{L,i}$ is the amount consumed by an investor at t on location i. Preferences at date 0 are given by expected utility $E[u_L(c^1_{L,i}, c^2_{L,i}; \theta_i)]$. The random variable $\tilde{\theta}_i$ represents a location-specific liquidity shock a la Diamond and Dybvig (1983). A realization θ_i is interpreted as the fraction of investors on island i that have a need for liquidity, since they only want to consume at $t = 1$.

Entrepreneurs are endowed with an investment project and an indivisible special good, called collateral. Their project must be initialized at $t = 0$ and be financed continuously through $t = 2$ to yield any return. An amount $x > 0$ of the consumption good invested in the project at $t = 0$ yields a return of $\min\{Rx, R\}$ units of the consumption good at $t = 2$. If funds are withdrawn from the project at $t = 1$, the project is terminated and yields no return at $t = 2$. New investments at $t = 1$ are not productive.

Collateral is special since only the individual entrepreneur derives utility from it. With probability $\tilde{\pi}$ $(1-\tilde{\pi})$ the collateral's value is V (0), where $\tilde{\pi}$ is a random variable with support

$\Pi \subset (0,1)$. We assume that entrepreneurs consume only at $t = 2$, and preferences at $t = 2$ depend on the realized value of collateral. Preferences can be represented by:

$$u_B(c_{B,i}^V, c_{B,i}^0; \pi_i) = \begin{cases} c_{B,i}^V + V & \text{if collateral has value and realization is } \pi_i \\ c_{B,i}^0 & \text{if collateral has no value and realization is } \pi_i \end{cases},$$

where $c_{B,i}$ denotes the entrepreneurs' consumption of the good. Preferences at $t = 0$ are represented by $E[u_B(c_{B,i}^V, c_{B,i}^0; \pi_i)]$.

In our environment, collateral plays an essential role due to an enforcement problem. Entrepreneurs cannot commit to payments to lenders at $t = 2$. They can, however, pledge collateral which investors can seize in the event of non-repayment of loaned funds. Even though lenders do not value collateral, it allows entrepreneurs to credibly commit to repay loans, since losing valuable collateral is costly. Making the value of the collateral stochastic for entrepreneurs creates a default problem where the random variable $\tilde{\pi}$ represents a location-specific collateral or asset shock. Assuming a law of large numbers, a realization π_i is the fraction of borrowers with valuable collateral on island i.

To summarize the timing, at $t = 0$ investors on island i invest x_i^0 on their island and store $1-x_i^0$. This initial investment can be seen as a loan commitment to entrepreneurs, made before information about the liquidity and asset shock is known. At $t = 1$, $\tilde{\pi}_i$ and $\tilde{\theta}_i$ are realized for each island. The investors' types and the fraction of entrepreneurs with valued collateral on each island are *publicly* known. However, at this point investors and entrepreneurs do not know which entrepreneurs will value collateral at $t = 2$. Hence, $\tilde{\pi}_i$ is a perfect signal about the overall default problem on island i. Based on this information, lenders decide on the new investment $x_i^1(s)$ and ask for withdrawals $x_i^0 - x_i^1(s) \geq 0$. This captures the reversibility of loan commitments once more information has become available. Entrepreneurs, however, have the option to refuse to honor the withdrawal requests. If investors can withdraw funds, they either consume or store them. At the beginning of $t = 2$ individual entrepreneurs learn whether they value collateral or not and project returns are realized. Entrepreneurs decide whether to repay lenders and consumption takes place.

To simplify the analysis, we assume that the random variables $\tilde{\theta}$ and $\tilde{\pi}$ can both take on only N different values. Furthermore, we assume that each value occurs exactly once. A state s of the economy is thus given by an assignment of the N values for each random variable to the N islands. In other words, a state is a joint distribution of the N values for both random variables across the N islands. There are $N!$ such assignments and we assume that they occur with equal probability. Hence, there is no aggregate uncertainty and islands face only idiosyncratic shocks.[6]

Next, we define some terminology. An *allocation* specifies (i) investment $\{x_i^0, x_i^1(s)\}_{i=1}^N$, (ii) non-negative consumption $\left\{c_{B,i}^V(s), c_{B,i}^0(s), c_{L,i}^1(s), c_{L,i}^2(s)\right\}_{i=1}^N$, and (iii) ownership of collateral $\left\{\delta_i^V(s), \delta_i^0(s)\right\}_{i=1}^N$, where $\delta_i(\cdot) \in \{0, 1\}$ for all states s. The functions $\delta_i(\cdot)$ specify whether the entrepreneurs lose ($\delta_i(\cdot) = 0$) or retain ($\delta_i(\cdot) = 1$) their collateral.

An allocation is *feasible* if (i) the investors' consumption in the first period is less than their withdrawals and (ii) total consumption in the second period is less than the return on investment and storage.

$$\theta_i c_{L,i}^1(s) \leq (1 - x_i^1(s)) \tag{1}$$

$$\left[\pi_i c_{B,i}^V(s) + (1 - \pi_i) c_{B,i}^0(s)\right] + (1 - \theta_i) c_{L,i}^2(s) \leq R x_i^1(s) + \left[(1 - x_i^1(s)) - \theta_i c_{L,i}^1(s)\right] \tag{2}$$

$$0 \leq x_i^1(s) \leq x_i^0. \tag{3}$$

Investors have the option of not investing and of withdrawing their funds at $t = 1$. Hence, for an allocation to be individually rational for lenders, it must satisfy

$$c_{L,i}^1(s) \geq 1 \tag{4}$$

$$c_{L,i}^2(s) \geq 1. \tag{5}$$

for all s. Upon receiving funds, entrepreneurs have the option of not repaying the initial investment. To borrow, they must pledge their collateral good, which they forfeit whenever they do not repay their funds. Hence, for an allocation to be individually rational for entrepreneurs, it has to satisfy

$$\pi_i[c_{B,i}^V(s) + \delta_i^V(s)V] + (1 - \pi_i) c_{B,i}^0(s) \geq R x_i^0 \tag{6}$$

$$c_{B,i}^V(s) + \delta_i^V(s)V \geq Rx_i^1(s) \tag{7}$$

$$c_{B,i}^0(s) \geq Rx_i^1(s). \tag{8}$$

The first constraint compares the expected value of honoring withdrawal requests at $t = 1$ with the value of continuing investment at the original level. At $t = 2$, entrepreneurs compare the value of not repaying and defaulting with the consumption when paying back the loan. If entrepreneurs have worthless collateral, they always default and consume the entire project return. We call an allocation *incentive feasible* if it is feasible and individually rational for investors and entrepreneurs.

Finally, we make two assumptions. The first implies that all withdrawal requests by lenders at $t = 1$ will be honored, since the expected cost of defaulting at $t = 1$ always exceeds the expected gain for an entrepreneur.

Assumption 2.1. $\min_{\pi_i \in \Pi} \pi_i V \geq R$.

The second assumption is on the size of liquidity needs relative to the aggregate size of the default problem. This assumption restricts our attention to the case where the demand for liquidity is not so high that it dwarves the overall default problem in the economy.[7]

Assumption 2.2. *Let* $\pi_1 < \cdots < \pi_N$ *and let* Γ *be the smallest integer such that* $\sum_{\{i|i>\Gamma\}}(\pi_i R - 1) \geq 0$. *We assume that* $\Gamma \geq \sum_{i=1}^{N} \theta_i$.

3 Liquidity Provision through Competitive Markets

We first look at optimal incentive feasible allocations for a single region that cannot trade funds with other regions. To characterize these allocations we solve an optimal contract (or planning problem) between depositors and entrepreneurs. As the solution to this problem exhibits both demandable debt (deposits) and collateralized loans, we interpret it as a banking arrangement or bank that is associated with each location.

We then look at a competitive market for borrowing and lending funds across locations or, equivalently, banks. Depositors fund only local projects, but face random liquidity needs.

Being able to trade liquidity across locations improves welfare since there is no diversification of investment at $t = 0$. Loans on the interbank market are secured by transfering collateral rights across locations or banks. This allows funds to be transfered across location, ruling out a default problem by banks and enabling an efficient distribution of liquidity.

3.1 Regional Banks

Suppose that goods cannot flow between islands at $t = 1$. This captures the absence of markets for liquidity or direct exchange of funds at $t = 1$ after the local liquidity needs and the collateral shock are known. To find an optimal incentive feasible allocation for each location, due to linearity of the utility functions, we can simply maximize total surplus at $t = 0$ and assume that all surplus accrues to borrowers

$$E\left[\sum_{i=1}^{N} \pi_i \left[c_{B,i}^V(s) + \delta_i^V(s)V\right] + (1-\pi_i)c_{B,i}^0(s)\right]. \tag{9}$$

Assumption 2.1 guarantees that investors decide to advance all their funds initially ($x_i^0 = 1$). Withdrawals at $t = 1$ depend on how large liquidity needs are and on how severe the default problem is. Since there are no markets for liquidity, each location has to withdraw a fraction θ_i of investment to satisfy liquidity demands. Whether the remaining funds stay invested depends on the *average* returns on loans on the island. Investors can receive a return only from entrepreneurs with valuable collateral.

If the collateral shock π_i is greater or equal than $1/R$, investors can receive a return greater or equal than 1 at $t = 1$. Hence, they will keep the remaining funds $(1 - \theta_i)$ invested. Otherwise, the effective return on investment is less than one, since too many entrepreneurs default at $t = 2$. In this case, all funds are withdrawn at $t = 1$. This is summarized in the following proposition.

Proposition 3.1. *On islands with average returns from loans greater than* 1*, an optimal allocation finances as many projects as possible after providing investors with liquidity. On* *all other locations no projects are financed at $t = 1$. Investment levels are given by*

$$x_i^1(s) = \begin{cases} 1 - \theta_i & \text{if } \pi_i R \geq 1 \\ 0 & \text{otherwise.} \end{cases}$$

The optimal incentive feasible exhibits both a demandable debt (deposits) and a debt contract feature. These are the two features that define a bank. The deposit contract feature arises from the fact that depositors can withdraw funds upon demand either to meet personal liquidity needs or to liquidate investment on the island in response to information about negative asset shocks.[8] Project finance resembles collateralized debt as loans are explicitly backed by borrowers collateral. Whenever an incentive feasible allocation exhibits these features, we interpret it as a banking arrangement or bank.

3.2 Interbank Markets

Regional banks can now trade funds at $t = 1$ on a competitive market to meet liquidity needs. The initial investments x_i^0 continue to be island specific. When solving for the equilibrium outcome, it is useful to look at a local planner designing an optimal allocation for a region at $t = 0$ taking as given a competitive interbank market at $t = 1$. At this stage, the local planner for each island or location (i) takes the interest rate as given and (ii) demands or supplies funds on a decentralized market after both shocks have been realized and are publicly known.

The optimal state-contingent allocation continues to resemble a regional banking arrangement. To ensure that loans between locations are honored we allow for the transfer of title to collateral across islands. Transfers of funds across islands thus correspond naturally to collateralized interbank lending.

The local planner decides simultaneously whether to borrow or lend on the market at the gross interest rate R_{IB} and whether to continue funding projects of entrepreneurs on her island. When making this decision, he still has to take into account the default problem of individual entrepreneurs and the liquidity demands of investors on her island.

Let z_i denote the funds supplied on the market by the planner for island i where $z_i \geq 0$ ($z_i \leq 0$) denotes lending (borrowing). Taking into account withdrawals by early investors, total resources at $t = 2$ available for consumption at i are:

$$Rx_i^1 + R_{IB}z_i + [(1 - \theta_i) - z_i - x_i^1] \tag{10}$$

where the first term describes the gross return from continuing projects in a location, while the second term refers to the proceeds from supplying loans on the market. The last term describes the funds not used for investment and hence stored. Thus we require that

$$x_i^1 \leq (1 - \theta_i) - z_i. \tag{11}$$

Each planner faces a borrowing constraint on the market. Specifically, the planner can borrow only up to an amount where the value of the assets at $t = 2$ *after paying lenders* in her own location is greater than the costs of repaying the loan. This ensures that her loan from the market can be collateralized. The borrowing constraint is given by

$$-z_i R_{IB} \leq \pi_i R x_i^1 + [(1 - \theta_i) - z_i - x_i^1] - (1 - \theta_i). \tag{12}$$

The planner's net assets are the returns on performing loans and the amount of idle funds less the pay-outs to lenders. The total costs of fulfilling the obligation from borrowing is given by the principal plus interest. Note that this constraint is endogenous in the sense that it depends on the interest rate R_{IB}.

3.3 Equilibrium

The planner at each location takes the interest rate R_{IB} as given and chooses an incentive feasible allocation for his location that maximizes the entrepreneurs utilities. Since $x_i^0 = 1$ is still optimal and the same participation constraints bind as in the optimal allocation on the location with autarky, the planner solves

$$\max_{(x_i^1, z_i)} \pi_i V + (R - 1)x_i^1 + (R_{IB} - 1)z_i \tag{13}$$

subject to

$$(11) \text{ and } (12)$$

$$x_i^1 \in [0, 1]$$

at $t = 1$ once the state s is known. An *interbank market equilibrium* at $t = 1$ is an interest rate $\hat{R}_{IB}$ and investment levels $\{\hat{x}_i^1, \hat{z}_i\}_{i=1}^N$ such that given (i) $\hat{R}_{IB}$, the planner for every location i chooses $(\hat{x}_i^1, \hat{z}_i)$ optimally and (ii) the market for borrowing and lending clears ($\sum_{i=1}^N \hat{z}_i = 0$).

When making his investment decision at $t = 1$, the planner compares the rate of return of investing in projects at her own location with the return on interbank loans. Her choice is restricted both by the total funds available for investment and the borrowing constraint. It is clear that any interbank rate above R or below 1 cannot be an equilibrium as the market would not clear. Hence, $R_{IB} \in [1, R]$. For any interest rate $1 \leq R_{IB} \leq R$, the planner would like to borrow so much as to satisfy all liquidity needs, i.e. $-z_i = \theta_i$. This would allow him to set investment to $x_i^1 = 1$ and finance all projects at $t = 1$. His obligation is the loan plus interest ($\theta_i R_{IB}$) and the investments by the island's investors $(1 - \theta_i)$. Running every project in his location at $t = 1$, his assets at $t = 2$ are $\pi_i R$.

Comparing assets and debt, whether the planner is constrained depends on the *average return on loans* in his location. First, if $\pi_i R \geq R_{IB} \geq 1$ he is unconstrained and will borrow up to $-z_i = \theta_i$. The fraction of performing loans in the location is so high, that the planner can fully secure borrowing. Otherwise, he is borrowing constrained whenever her liquidity needs are too high or, equivalently, when he would like to borrow more than he could repay with the returns on investment. In this case, the planner is constrained if $\theta_i \geq \frac{\pi_i R - 1}{R_{IB} - 1}$ and, if $\pi_i R > 1$, the amount is given by

$$z_i = \frac{1 - \pi_i R}{R_{IB} - 1} x_i^1 > -\theta_i. \tag{14}$$

Finally, if $1 > \pi_i R$, the planner is borrowing constrained regardless of her liquidity needs. He can never promise to pay all the loan back, since the planner's return on loans to local entrepreneurs is less than 1. Hence, he supplies a positive amount of funds ($z_i \geq 0$) to the interbank market. Equation (12) is then a solvency constraint for each location. A local planner that lends funds would like to use the returns from interbank lending to compensate for losses on some of the location's projects which all have a social return of $R > R_{IB}$. Hence, investment on every island is positive at $t = 1$ whenever $R_{IB} > 1$. Furthermore, total investment is given by $x_i^1 + z_i = 1 - \theta_i$ for every island, since the storage technology is strictly dominated. This effect is driving the next result which is formally proven in the appendix.

Proposition 3.2. *The unique equilibrium is given by the interest rate* $R_{IB}^* = 1$ *and all projects on locations with average returns from loans of at least* 1 *get financed. Investment levels at* $t = 1$ *are equal to*

$$x_i^1(s) = \begin{cases} 1 & \text{if } \pi_i R \geq 1 \\ 0 & \text{otherwise.} \end{cases}$$

When $R_{IB} = 1$ locations with a low average return on loans are indifferent between supplying funds on the market. By Assumption 2.2, there are enough funds for satisfying the demand for liquidity. For higher interest rates there is *always* excess liquidity in the market for $R_{IB} > 1$.[9] Markets work well for providing liquidity where it is needed despite the default problem. All locations which are solvent ($\pi_i R \geq 1$) obtain enough loans through the market to satisfy their liquidity needs. In fact, none of the borrowing constraints (12) bind in equilibrium.

4 A Market Failure: Lack of Cross-subsidization

4.1 Broad Banks and Cross-subsidization

We now compare the market equilibrium with broad banks. Banks are broad if they operate across locations. This is equivalent to looking at a *global* planning problem. A central planner decides on the allocation of funds across locations and does not rely upon a decentralized market with a price mechanism.

The optimal allocation for the central planner still exhibits the crucial features of a bank. In effect, the planner runs an internal market for investment funds, where each region has a bank branch or subsidiary that intermediates local lending to entrepreneurs. Branches must offer terms to local depositors and entrepreneurs that are at least as good as what a regional bank could offer. This is formalized as an outside option for regions that restricts the allocations a central planner can choose and is formalized as a participation constraint for each entire island.

The central planner can now move goods directly across locations at $t = 1$ and $t = 2$. Resources are then only constrained across locations, but not for individual locations or, equivalently

$$\sum_{i=1}^{N} \theta_i c^1_{L,i}(s) \leq \sum_{i=1}^{N} (1 - x^1_i(s)) \tag{15}$$

$$\sum_{i=1}^{N} \left[\pi_i c^V_{B,i}(s) + (1 - \pi_i) c^0_{B,i}(s) + (1 - \theta_i) c^2_{L,i}(s)\right] \leq \sum_{i=1}^{N} \left[R x^1_i(s) + (1 - x^1_i(s)) - \theta_i c^1_{L,i}(s)\right]. \tag{16}$$

This implies that the central planner - after using funds from locations with low returns for providing overall liquidity - would distribute goods at $t = 1$ across locations to finance as many projects as possible. This involves the cross-subsidization from locations with high returns from loans ($\pi_i R > 1$) to other locations in order to induce investors there not to withdraw their funds at $t = 1$. Investors on these locations receive then a transfer that guarantees a return of at least 1. Ex-ante welfare increases, since the objective of the central planner is strictly increasing in the number of projects financed across locations.

Even within a broad bank, there should be limitations on cross-subsidization. Cross-subsidizing projects means that ex-post some regions make transfers to others. There is then an incentive for investors and entrepreneurs in these regions to contract with an alternative intermediary that only operates regionally. We formally model this as an outside option, which we interpret as the possibility of intermediating investment through a regional bank at $t = 1$. This bank matches the deposits of patient investors with the claims on projects of entrepreneurs. It captures the potential of a regional bank to offer local entrepreneurs better borrowing conditions than a broad bank which uses funds from lending in that region to cross-subsidize projects in other regions.[10]

The incentives of regions as a whole to participate in cross-subsidization at $t = 1$ after information on returns and liquidity needs is available, is given by a local planning problem at $t = 1$. Let W^A_i be the value of the alternative allocation that a local planner for island i would choose at $t = 1$ and denote the value of the allocation the central planner chooses for location i by W^C_i. The participation constraint for regions at $t = 1$ given liquidity and asset shocks is

$$W_i^C(s) \geq W_i^A(s), \tag{17}$$

where $W_i^C(s) \equiv \theta_i c^1_{L,i}(s) + (1-\theta_i)c^2_{L,i}(s) + \pi_i \left[c^V_{B,i}(s) + \delta_i^V(s)V\right] + (1-\pi_i)c^0_{B,i}(s)$.

Locations with a low average return on loans ($\pi_i R < 1$) would receive a positive transfer with cross-subsidization. Hence, their participation constraint will never bind. For all other locations transfers will be negative and the constraint could be binding. Using Proposition 3.1, the value of an optimal incentive feasible allocation for a single island is given by

$$W_i^A(s) = R(1-\theta_i) + \theta_i + V\pi_i, \tag{18}$$

since the local planner has to stop a fraction θ_i of projects to satisfy their liquidity needs. Denoting $T_i(\cdot)$ as the total transfer for island i, the value of an allocation offered by the central planner W_i^C is

$$W_i^C(s) = 1 + (\pi_i R - 1)x_i^1(s) + T_i(s) + \pi_i V + R(1-\pi_i)x_i^1(s). \tag{19}$$

Transfers are also limited by the fact that enforcement of loans with *each* entrepreneur on an island is limited. Given investment at $t = 1$, at most $x_i^1(s)(\pi_i R - 1)/\pi_i$ can be extracted from any entrepreneur that does not default. The next lemma summarizes this discussion and characterizes the participation constraint (17) in terms of feasible transfers $T_i(\cdot)$ between locations.

Lemma 4.1. *A transfer is feasible if and only if*

$$-T_i(s) \leq \min\{\theta_i(R-1) + (x_i^1(s)-1)(R-1), (\pi_i R - 1)x_i^1(s)\} \tag{20}$$

for any i s.th. $\pi_i > \bar{\pi}$ and $T_i(s) \geq 0$ otherwise.

Since overall welfare is strictly increasing in the number of projects run across islands at $t = 1$, the social planner will make the maximum feasible transfer of funds between islands. The maximum amount that can be taken from islands with $\pi_i R > 1$ is given by $\bar{T}_i(s) = (-1)\min\{\theta_i(R-1), (\pi_i R - 1)\}$. These transfers go to the islands with the highest returns on loans with average return on loans less than 1 (i.e., the highest π_i's such that $\pi_i R < 1$).

Liquidity needs are financed by terminating all projects on locations with the lowest rate of return on loans. This maximizes the number of projects running at $t = 1$ while guaranteeing investors a return of at least 1 on all islands.

Proposition 4.2. *The optimal allocation with broad banks finances as many projects as possible on locations with an average rate of return on loans less than* 1*. Investment at* $t = 1$ *is uniquely characterized by*

$$x_i^1(s) = \begin{cases} 1 & \text{if } \pi_i > \tilde{\pi} \\ \tilde{x} & \text{if } \pi_i = \tilde{\pi} \\ 0 & \text{if } \pi_i < \tilde{\pi} \end{cases},$$

where $\bar{\pi} \geq \tilde{\pi}$ *and* $\tilde{x} \in [0, 1]$ *satisfies* $\sum_{\{i|\pi_i R<1\}} [(\pi_i R - 1)x_i^1(s)] = \sum_{\{i|\pi_i R \geq 1\}} \bar{T}_i(s)$*. Furthermore, the optimal allocation depends on the joint distribution of shocks* s*, rather than only the realization of the asset shocks.*

Unlike in the market equilibrium, the *constrained* efficient allocation described in the Proposition depends on the specific realization of the joint distribution s. Whereas asset shocks still determine which islands keep their funds invested, the amount of transfers depends on the size of the liquidity shock for locations with a high average return on loans. Liquidity shocks serve as a “threat point” to prevent islands from deviating from the allocation proposed by the social planner. In the absence of liquidity shocks ($\theta_i = 0$ for all i), the local planner for any island would never have an incentive to accept a negative transfer at $t = 2$.

Strictly positive liquidity needs, however, give value to participating in an allocation with negative transfers. The maximum transfer a local planner accepts depends on the relative size of the two shocks, π_i and θ_i, for each location. This determines the value for the island of staying with the optimal allocation once the shocks are known. Hence, this value depends on the joint distribution of shocks across islands. The optimal allocation depends then on the realized joint distribution and, hence, involves endogenous aggregate uncertainty, even though the economy as a whole is exposed solely to idiosyncratic shocks.

4.2 Inefficiency of Market Equilibrium

The market equilibrium is not constrained efficient. Both constrained efficient allocations and equilibrium allocations separate the mechanisms for liquidity provision from the financing of projects. Locations with a sufficiently high rate of return on their loans receive sufficient liquidity from other islands to keep all projects alive.

While markets can efficiently allocate liquidity across islands, they are unable to cross-subsidize between islands which is preferred ex-ante since it enables the economy to keep more projects running at $t = 1$. To the contrary, for any state at $t = 1$ the social planner can exploit the liquidity needs of locations and transfer resources across locations in order to compensate investors for losses on non-performing loans. In fact, the optimal allocation can be seen as a peculiar way of conditioning on the joint distribution of shocks, thereby effectively charging differential interest rates for obtaining liquidity that are always strictly greater than 1. This is impossible in equilibrium, since liquid funds are always in excess supply.

Corollary 4.3. *The optimal allocation strictly dominates the equilibrium allocation in welfare and has strictly higher investment at $t = 1$ independent of the realized joint distribution of shocks s.*

Finally, the first-best allocation in this economy would feature even more investment and no aggregate uncertainty, since transfers are not restricted to satisfy the participation constraint (17) and are restricted only by the excess return on performing loans, i.e., $T_i(s) \leq (\pi_i R - 1)x_i^1(s)$. For the constrained efficient allocation, a negative correlation between both shocks helps to increase investment at $t = 1$ relative to the first-best. This is due to the fact that the higher the liquidity needs on islands with good collateral shocks, the more transfers are feasible. Provided liquidity needs are high enough on all islands with $\pi_i R \geq 1$ - more specifically, $\theta_i \geq \frac{\pi_i R - 1}{R-1}$ - the participation constraint is not binding for any location and the allocation corresponds to the first-best.

5 Conclusions

Restrictions on the scope of banking matter even in the presence of well-functioning interbank markets. This is somewhat surprising, as one might think that interbank markets could allow regional banks to circumvent restrictions on the geographical or sectoral operation of banks. We show, however, that broad banks can achieve higher level of investments than regional banks that are linked through an interbank market. Their advantage stems from the internal allocation of capital that leads to cross-subsidizing investment projects across regions.[11] As a result, idiosyncratic fluctuations in regional output are decreasing with the extent of cross-regional banking in our model.

This prediction appears to be consistent with recent U.S. experience. Morgan, Rime and Strahan (2004) document that barriers on inter-state banking in the U.S. began to be relaxed in the early 1980's. This process culminated with the passage of the Reigle-Neals act in 1994, which effectively removed most of the remaining barriers. They find that the reduction in these barriers was accompanied by an increase in the extent of interstate banking as well as a reduction in idiosyncratic state output fluctuations. Demyanyk, Ostergaard and Sorensen (2004) draw similar conclusion for an increase in income smoothing across states following U.S. banking de-regulation. They link this phenomenon to the role of banks in financing small businesses. In our model, this channel drives the result that broad banks lead to better inter-regional risk sharing among bank-financed entrepreneurs than regional banks with interbank markets.

Furthermore, our analysis implies that broad banks which allocate capital internally can endogenously generate aggregate uncertainty across regions.In an optimal allocation of capital, the level of transfers between branches – and hence the level of investment – depends upon the realized joint distribution of asset and liquidity shocks. It is exactly this feature which generates endogenous aggregate uncertainty leading to higher aggregate output and more volatility with broad banks than with regional banks and interbank markets.

All these findings indicate that regional banks with well-functioning interbank markets are not a satisfactory alternative to broad banks. This also suggests that there may be significant gains from reducing barriers to cross-national banking. Currently, financial market regulators in Europe are grappling with the question of how to structure cross-national financial markets and institutions to deepen financial integration after the introduction of the Euro. Our findings suggest that establishing pan-European interbank markets might not be enough. The optimal policy may entail a significant reduction in barriers to the cross-border operation of intermediaries rather than simply the creation of a freely functioning cross-country interbank market.

Last, our results may also shed some light on examples of regionally operating banks entering into informal (and sometimes formal) arrangements to provide mutual insurance against shocks affecting their assets and liabilities. These interbank relationships typically feature some form of limited enforcement as banks are free to exit. For example, the arrangements between cooperative banks in Germany appear to match the story of the model. Independent, regionally operating cooperative banks and savings banks in Germany are arranged in groups centered around a head organization.[12] This organization coordinates liquidity provision among the smaller individual banks. In addition, these clubs explicitly agree to provide insurance against asset shocks in financial crises to one another. Another historical example is provided by Gorton (1985), who documents that during periods of high liquidity needs, American clearinghouses in the National Banking era would provide guarantees of members assets.[13] In both examples, there is active liquidity provision between banks and "insurance" against asset shocks. We conclude that the commitment to provide insurance is credible in these example, since leaving the arrangement could considerably aggravate access to liquidity.

Finally, we make some short remarks about the robustness of our results. A key assumption is that the return on projects is independent of the value of collateral. This assumption is reasonable for many projects where entrepreneurs post assets (i.e. personal homes) as collateral for projects which do not directly use the collateral. In such a world, shocks to the value of collateral lead to a reduction in loans by local banks but do not directly affect the return on the projects. Our results are robust to relaxing this assumption by allowing for stochastic project returns. What is essential for our results, however, is that fluctuations in project returns are not perfectly positively correlated with the value of collateral. For such cases, fluctuations in the value of collateral will lead to ex-post variations in the wedges on investment returns for depositors and entrepreneurs across regions.

A second key assumption is that all the surplus from financing projects goes to entrepreneurs. Our results, however, survive as long as entrepreneurs receive some surplus from investment.[14] Clearly, at $t = 1$, depositors would prefer that negative net present value projects (from the perspective of the bank) are not funded, if this translated into higher payouts to them. In contrast, entrepreneurs prefer to commit ex-ante to loan contracts that incorporate the cross-subsidization of projects. What is key for our results is thus that banks can commit not to recall loans to identifiable loss making projects (entrepreneurs) as long as their solvency is maintained.

We also want to stress that the result on endogenous aggregate uncertainty generalizes to any setting with multi-dimensional risk sharing. This result arises as long as there are two or more distinct sources of uncertainty where the threat of exclusion from trades that mitigate one source of risks can be used as "leverage" to induce or increase risk sharing along the second dimension.

6 Appendix

Proof of Proposition 3.1

Proof. It is optimal to set $\delta_i^V(s) = 1$, since collateral is only valued by entrepreneurs. By Assumption 2.1, this implies that the entrepreneur's individual rationality constraints (6) and (7) do not bind for any investment x_i^0 and $x_i^1(s)$. Also, investors are able to withdraw their funds at stage $t = 1$ after they observe the realization of $\tilde{\pi}_i$ and $\tilde{\theta}_i$. Then $x_i^0 = 1$ initiates the maximum number of projects and is, thus, optimal.

Since all other individual rationality constraints are binding, liquidity needs at $t = 1$ imply that $x_i^1(s) \leq 1 - \theta_i$. The feasibility constraint (2) can be rewritten as

$$\pi_i c_{B,i}^V(s) \leq (\pi_i R - 1) x_i^1(s).$$

Suppose that $\pi_i R < 1$. Any strictly positive $x_i^1(s) \in (0, 1 - \theta_i]$ violates the non-negativity of $c_{B,i}^V(s)$. Hence, only $x_i^1(s) = 0$ is feasible.

If $\pi_i R \geq 1$, $c^V_{B,i}(s) \geq 0$. Since the objective function is strictly increasing in $c^V_{B,i}(s)$ and $c^0_{B,i}(s)$, which are increasing in $x^1_i(s)$, it is optimal to set $x^1_i(s) = 1 - \theta_i$. $\square$

Proof of Proposition 3.2:

Proof. Let $R_{IB} = 1$. The only feasible choice for every island with $\pi_i R < 1$ is $x^1_i = 0$. The island is then indifferent between any level of $z_i(s)$ and $x^1_i(s) = 1$ and $z_i(s) = -\theta_i$ for any island with $\pi_i R \geq 1$ maximizes the planner's objective function. The maximum total supply of funds is given by

$$\sum_{\{i|\pi_i R<1\}} (1-\theta_i) > \Gamma - \sum_{\{i|\pi_i R<1\}} \theta_i.$$

For market clearing it is sufficient that $\Gamma - \sum_{\{i|\pi_i R<1\}} \theta_i \geq \sum_{\{i|\pi_i R\geq 1\}} \theta_i$ which is ensured by Assumption 2.1. Hence, $R_{IB} = 1$ is an equilibrium.

Next, we show uniqueness. Let $R_{IB} \in (1, R]$ and suppose there exists an equilibrium. In equilibirum the return on investment of funds is then strictly greater than the storage technology. Hence, taking the interest rate R_{IB} as given the planner chooses $x^1_i(s) + z_i(s) = (1 - \theta_i)$ for all i. By market clearing, we have

$$\sum_{i=1}^{N} x^1_i = \sum_{i=1}^{N} x^1_i(s) + \sum_{i=1}^{N} z_i(s) = \sum_{i=1}^{N} (x^1_i(s) + z_i(s)) = N - \sum_{i=1}^{N} \theta_i.$$

Hence, all funds are invested after liquidity needs have been satisfied. However, only at most $\sum_{i=1}^N x^1_i(s) = N - \Gamma < N - \sum_{i=1}^N \theta_i$ projects can be financed to satisfy a return of 1 for the $N - \sum_{i=1}^N \theta_i$ remaining investors at $t = 2$. Hence, $\sum_{i=1}^N z_i(s) > 0$, a contradiction.

$\square$

Proof of Proposition 4.1

Proof. The objective function (9) is strictly increasing in the number of projects financed, $\sum_{i=1}^{N} x_i^1(s)$. Suppose transfers from islands with $\pi_i R\ geq 1$ are given by $\bar{T}_i(s)$ and set transfers for all other islands equal to $\pi_i R - 1$ in a descending order starting from the largest π_i such that $\pi_i < 1/R$ until overall net transfers are zero. Set investment levels as given in the Proposition. Such an allocation and transfers are clearly feasible, since Assumption 2.2 implies that islands receiving transfers and providing liquidity at $t = 1$ are distinct. The rate of return for investors net of investment for investors is then just given by 0.

To prove that this allocation and transfers are optimal, note that any lower amount of transfers reduces $\sum_{i=1}^{N} x_i^1(s)$ and, hence, cannot be optimal. Let $\epsilon > 0$ and consider the following, feasible reallocation of investment

$$\hat{x}_i^1(s) = \begin{cases} 1 - \epsilon & \text{for some n s.th. } \pi_n \geq \tilde{\pi} \\ \epsilon & \text{for some m s.th. } \pi_m < \tilde{\pi} \\ x_i^1(s) & \text{otherwise.} \end{cases}$$

This leads to a rate of return net of investment for investors across all islands at $t = 1$ equal to

$$(1 - \epsilon)(\pi_n R - 1) + \epsilon(\pi_m R - 1) + \sum_{i, i \neq n,m}^{N} x_i^1(s)(\pi_i R - 1) < 0.$$

Therefore, to satisfy the individual rationality constraints (5) investment has to be reduced further for some island i with $1/R > \pi_i > \pi_\Gamma$. This reduces overall investment and, hence, cannot be optimal. $\square$

Notes

[1]One interpretation is that banking is a "contestable" market in the sense that new regional banks can freely enter the market place and offer contracts to local entrepreneurs and depositors.

[2]It is worth emphasizing that the relative inefficiency of interbank markets is not due to limited diversification, but limitations on cross-subsidizing regional investment.

[3]Jayaratne and Strahan (1996) and Clarke (2004) argue that the removal of interstate banking restrictions was also accompanied by an increase in the growth rate of output in the respective states.

[4]Several other papers have argued that there is evidence supporting the important role of internal capital markets for lending policies of regional bank branches (see for example Houston, James and Marcus (1997) and Houston and James (1996).

[5]Allen and Gale (1997, 2000) also argue that banks (or financial intermediaries) can improve upon market outcomes, but through a different channel. By accumulating reserves as a buffer against aggregate (generational) shocks, intermediaries are able to better smooth intertemporal consumption.

[6]For the formal construction of the probability space see Koeppl and MacGee (2001).

[7]For a complete characterization of the case when liquidity needs are high, see Koeppl and MacGee (2001).

[8]Calomiris and Kahn (1991) argue that demandable debt is the crucial feature characterizing banks. They also provide evidence that elements such as suspension schemes were only used by banking systems and not by individual banks.

[9]When the interest rate increases, the supply of funds *falls*. Planners that supply funds obtain more funds to subsidize the locations projects. In other words, an increase in R_{IB} relaxes the solvency constraint (12) for such planners and reduces the supply of funds. The supply of funds, however, always decreases less than the demand when interest rates rise.

[10]If the central planner could simply impose participation on the regions, it is immediate that he could do at least as well as the interbank market. However, in an interbank market equilibrium, local planners voluntarily choose to participate in inter-regional trade. Our argument for the superiority of broad banks *does not* rely upon a central planner that can force regions into participating in trade across regions.

[11]One caveat is that we abstract from informational and managerial frictions that figure prominently in the literature associated with internal capital markets in firms and conglomerates (see for example Stein (1997) and Maksimovic and Phillips (2002)).

[12]See Ehrmann, Gambacorta, Martinez-Pages, Sevestre and Worms (2001) for an exposition on this feature of the German banking sector.

[13]See also Williamson (1989) for a historical comparison of Canadian and U.S. banking arrangements.

[14]In other words, what is required is that lenders do not receive all of the surplus from lending.

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