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FIRM HETEROGENEITY, INTERNAL FINANCE, AND CREDIT RATIONING

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ABSTRACT

Assessing the extent to which agents or firms face capital-market imperfections and quantity restrictions on credit is crucial for measuring intertemporal tradeoffs in consumption or the cost of capital for investment. In contrast to standard price-clearing, "full-information" models of loan markets, in models of credit allocation where information is imperfect (which we describe as "information-intensive"), "the interest rate" need not reflect the shadow price of credit in financial intermediation. Credit rationing to some borrowers is likely.

In actual markets, many loan contracts are offered, both "full-information" and "information intensive." Our focus in this paper is on firm heterogeneity in credit markets; we analyze mechanisms by which credit markets sort borrowers in the presence of differing degrees of asymmetric information; we emphasize the potential for credit rationing in equilibrium and the response of credit allocation to borrower-specific shocks. Our approach suggests that external finance will be differentially available to entrepreneurs --holding constant their project opportunities -- according to their internal net worth position. That is, there is an important link for many firms between internal finance and investment spending.

We develop a simple general equilibrium model of credit allocation, in which different loan contracts are offered to different types of borrowers. The extent to which different borrowers can obtain credit depends on the distribution of internal finance, aggregate net worth levels, and whether projects are observable. While credit restrictions to some classes of borrowers are a feature of a multiple-contract equilibrium, the severity can vary substantially in response to financial disturbances. We consider shocks to borrowers' net worth. Credit restrictions may occur in response to a deterioration of net-worth positions. A "credit collapse," in which no loans are offered to certain types of borrowers is possible. Investment and financing decisions are not, in general independent. We discuss implications for tax policy and for public policy toward financial institutions.

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I. Introduction

Assessing the extent to which agents or firms face capital-market imperfections and quantity restrictions on credit is crucial for measuring intertemporal tradeoffs in consumption or the cost of capital for investment. The ability of individual firms to participate actively in capital markets is an important factor in models which use prices in centralized securities markets as measures of the marginal cost of capital.

In a standard Walrasian, "full-information" model of loan markets, factors determining asset supplies and demands fix interest rates, which then constitute the set of shadow prices for credit in various markets. In contrast to this price-clearing, full-information framework, models of loan markets where information is imperfect (which we describe here as "information-intensive" sectors) have emphasized that "the interest rate" need not reflect the shadow price of credit in financial intermediation and that credit rationing to some borrowers is likely (Jaffee and Russell, 1976; Stiglitz and Weiss, 1981; Bernanke, 1983; Blinder, 1987; Williamson, 1986, 1987). Friedman (1982) has noted a strong empirical link between credit availability and economic activity.[1]

In actual markets, many loan contracts are offered, both "full-information" and "information-intensive." Our focus in this paper is on firm heterogeneity in credit markets; we analyze mechanisms by which credit markets sort borrowers in the presence of differing degrees of asymmetric information across types of entrepreneur-borrowers.[2] We model the allocation of credit to heterogeneous entrepreneurs with different endowments of internal equity and project opportunities.

Our multiple-credit-markets approach suggests that external finance will be differentially available to entrepreneurs -- holding constant their project opportunities -- according to their internal net worth position. That is, there is an important link for many firms between internal finance and investment spending.[3] This result has implications for determinants of cross-sectional variation in investment behavior among firms of various sizes, from which single-credit market models of investment behavior necessarily abstract. Srini Vasan (1986, Chapter 3), using data on "small," "medium," and "large" U.S. manufacturing firms, demonstrates that such cross-sectional variation is empirically important -- both in terms of the basic determinants of investment and the cyclical sensitivity of investment.[4] Similar findings based on a panel of manufacturing firms are obtained by Fazzari, Hubbard, and Petersen (1987a), who distinguish between investment decisions of firms with low levels of internal equity relative to investment demand and firms for which cash flows exceed investment demand.

We develop a simple general equilibrium model of credit allocation, and analyze the operation of an economy-wide "mutual fund," which invests funds deposited by risk-neutral individuals in project loans. The extent to which different groups of borrowers can obtain credit depends on individual net worth positions, whether projects are observable, and on individual and aggregate net worth levels. Aggregate disturbances can have allocative effects on loan markets. While credit restrictions to some types of entrepreneurs are a feature of a multiple-contract equilbrium, the severity can vary substantially in response to financial disturbances. We consider shocks to borrowers' net worth. Credit restrictions may occur in response to

a deterioration of net-worth positions. Indeed, a "credit collapse," in which no loans are offered to certain types of borrowers, is possible (see also Mankiw, 1986).

Recent research has highlighted the development of financial intermediaries in equilibrium models of credit allocation (see for example Williamson, 1986). Our interest in this paper is not so much in "banks" as intermediaries (issuing demandable debt to depositors and making term loans), but in considering "sufficient statistics" for credit-market conditions in realistic markets, where both information-intensive and full-information loan contracts are signed. Our "sufficient statistics" consist of full-information loan rates and the quantity of credit made available in the information-intensive sector. These variables have figured prominently in empirical work (Bernanke, 1983; Calomiris and Hubbard, 1985; Calomiris, Hubbard, and Stock, 1986); we derive their role formally here.

The paper is organized as follows. Section II develops a model of equilibrium credit rationing, and examines the effects of internal finance on the availability of credit to information-intensive borrowers. We develop a two-period general equilbirium model of credit allocation, in which both information-intensive and perfect-information loan contracts are offered. Implications for public policy toward financial institutions and for the role of government finance are analyzed in section III; we review some empirical evidence there. Conclusions and extensions to dynamic models of debt maturity, net worth accumulation, and financial institutions are discussed in section IV.

II. Internal Finance, Credit Allocation, and Investment

Imperfect Information and Credit Allocation

In the simplest possible model, no information problems exist, and the competitive equilibrium in a Walrasian credit market involves clearing through "price." Firms borrow to finance projects as long as expected project returns exceed the cost of borrowed funds in the market. We will assume throughout this paper that borrowers must finance their investments internally or through debt (more on this later). The observation by Stiglitz and Weiss (1981) that when borrowers have private information about the riskiness of their project returns, lenders ("banks") cannot necessarily distinguish "good borrowers" from "bad borrowers" implies that adverse selection may render unprofitable a credit-market equilibrium in which loan contracts specify only price. That is, with a nonzero probability of default, banks consider the potential for loan repayment as well as the interest rate to be charged when assessing the profitability of a loan. Past some critical interest rate level, banks will be selected against by borrowers with a high probability of default; quantity rationing will be part of a competitive equilibrium in the information-intensive credit market.

The central contribution of Stiglitz and Weiss (1981) is that imperfect information can limit the number of loans a lender will make; that is, "credit rationing" occurs in the sense that within a class of observationally identical borrowers, not all receive loans. The basic original model is simple -- lenders can vary only the interest rate; different price-quantity combinations are ruled out. The profitability of loans to the lender does not increase uniformly with the interest rate. In particular, reductions in

borrower net worth can precipitate more severe credit rationing in information-intensive loan markets. Bester (1985) argues that if lenders are free to use different interest rates and collateral requirements across borrowers, no credit rationing occurs in equilibrium. It is important to note, however, that in Bester's model, investors have access to unlimited collateral -- that is, loans have only a liquidity function (see also Chan and Thakor, 1987 in this respect). In the multiple-contract model described below, we assume that an individual entrepreneur's available internal finance is given exogenously by his initial endowment and that project size is "large" relative to individuals' endowments. Under these conditions, the credit rationing observed in the Stiglitz-Weiss model will occur for some classes of borrowers in equilibrium.

Information and a General Equilibrium Model of Credit Allocation

In reality, many "markets" for credit exist side by side, differing in types of borrowers and the terms of loans. These markets effectively sort borrowers along dimensions of both "information intensity" and risk. Borrowers with significant financial resources and reputations (e.g., the federal government and large, publicly traded corporations) have access to "full-information" credit markets (such as those for commercial paper or long-term bonds), while imperfect information characterizes more accurately the loan market in other sectors.

Our conceptual experiment is to formalize a multiple-contract market-clearing process. Information-intensive and full-information contracts coexist. We develop a simple general equilibrium model of credit allocation.

Our focus is on the important role played by collateral in credit supply (i.e., borrower internal equity or net worth); we show that considering variations in internal equity not only enhances the potential for credit restrictions relative to standard full-information models, but also relative to the simple single-loan-contract models under imperfect information previously analyzed in the literature. Aggregate credit supply shocks have allocative effects in such a world, with quantity restrictions applied to borrowers participating in the information-intensive market, and price rationing of credit to higher-quality (less information-intensive) borrowers. If substitution in production across business activities is limited in the short run (i.e., if General Motors cannot immediately enter farming), credit restrictions to individuals will have real effects on investment (see for example Calomiris, Hubbard, and Stock, 1986).

We consider a stylized credit market with different borrowers indexed by (i) internal net worth, (ii) returns on project opportunities, and (iii) observability of projects by potential lenders. The model has two periods, during which investment and consumption are undertaken, respectively. In the first period, each of the countable infinity of agents is endowed with some amount of collateral and an "investment project." Consumption takes place during the second period. Individuals are assumed to be risk-neutral over consumption decisions. A key feature of the model is that investment projects are individual-specific, indivisible, and large relative to entrepreneurs' net worth.[5] Project technologies are either "observable" or "not observable."[6] Actual project returns are observable ex post.

We assume equal numbers of individuals with access to each of three project types -- 1, 2, and W. Project opportunities 1 and 2 are

indistinguishable to lenders, while project opportunity W is observable. Endowments of entrepreneurs with access to projects 1 and 2 is denoted by C_k, with an equal number of high (k=H) and low (k=L) endowment types within each information-intensive project classification. Full-information borrowers have identical endowments C_W. A fourth group of individuals are pure savers; that is, they have no project opportunity. They have identical net worth C_S. Thus entrepreneurs (those individuals with project opportunities) divide into five groups, which differ according to project opportunities and collateral endowments. There are, however, only three observable classes of borrowers: Walrasian (W); high-endowment, information-intensive (I^H); and low-endowment, information-intensive (I^L).

On the supply side of the credit market, individuals either invest their endowments directly in their own projects or turn their endowments over to a central mutual fund, which offers different contracts to different borrowers. Savers deposit their endowments in the mutual fund. The "mutual fund" is a convenient fiction for a large number of competing mutual funds. That is, rents from successful projects accrue to successful entrepreneurs, not to lenders. We employ the fiction of an economy-wide mutual fund rather than focus on developing various financial intermediaries endogenously because we are interested primarily in borrower heterogeneity, in particular credit allocation over different types of borrowers.[7] In the real world, of course, borrowers may be segmented in different loan markets and shocks which are specific to particular loan markets -- for example, a contraction of high-powered money -- will also have important effects on the allocation of investment funds (see Bernanke, 1983; and Calomiris, Hubbard, and Stock, 1986).

De Meza and Webb (1987) show that the adverse selection problem which gives rise to credit rationing in Stiglitz and Weiss (1981) can be eliminated through the use of equity finance in a model in which entrepreneurs share identical expected project returns. De Meza and Webb demonstrate, however, that when projects' expected returns differ, debt finance is optimal because it avoids the "lemons-market" disadvantages inherent in external equity finance (as, for example, in Myers and Majluf, 1984).[8] In order to abstract from equity finance we assume that both expected returns and variances differ across projects.[9] "Good" projects stochastically dominate "bad" projects. We consider only fixed-rate debt contracts between borrowers and lenders.[10]

The three projects are described as follows. The observable project (W) has a mean gross return $\bar{R}_W$ and a distribution of returns given by F (R). The two projects in the information-intensive (I) sector -- I_1 and I_2 -- have mean gross returns of $\bar{R}_1$ and $\bar{R}_2$, respectively, and distributions of returns, $F_1(R)$ and $F_2(R)$, respectively. Mean gross returns are such that $\bar{R}_1 > \bar{R}_W > R_2$ and $\bar{R}_W > \frac{1}{2}(\bar{R}_1 + \bar{R}_2)$. (Following the logic of de Meza and Webb (1987), one could assume that project I_1 earns R_1 with probability p_1 and zero otherwise, while project I_2 earns R_2 with probability p_2 and zero otherwise, where $p_1 > p_2$ and $R_1 > R_2$.)

When the project's gross return is less than the amount borrowed to finance investment, the individual loses his equity in the project. Because of this "limited liability" assumption, the lower bound on the gross return for an entrepreneur is zero. Bankruptcy occurs if

$$R < (1 + i) S,$$

where the lender receives R and where i is the interest rate charged and S is

the amount of the loan. S equals (X - C), where X is project size, and C is the level of internal net worth. Let $\bar{\rho}$ be the (endogenous) equilibrium expected return from a mutual fund share, so that $C_k(1 + \bar{\rho})$ is the opportunity cost of investing one's endowment, k = L,H,W,S. An individual of type (k,ℓ) will borrow to finance his project if his expected profit from so doing exceeds his opportunity cost, that is, if

$$(1) \quad \pi_{k,\ell} = \int_0^\infty \max[R - (1 + i_k) S_k; 0] dF_\ell(R) > C_k(1 + \bar{\rho}); \; k = H,L,W; \ell = 1,2,W.$$

F_ℓ is the distribution function of returns. For pure savers, the expected gross return from mutual fund investment in the first period is $C_k(1 + \bar{\rho})$.

The question arises of whether projects will be partially financed directly by investors' endowments, or financed fully by loans from the mutual fund in which all endowments are deposited (see also de Meza and Webb, 1987). Under the assumption of risk neutrality there will be no motive for diversification (which would make internal finance unattractive). Investors with project 1 opportunities will always prefer to invest in their own project rather than earn the average rate of return (marginal rate of interest on loans) from the mutual fund because all mean project returns are less than or equal to that of their own projects. Project 2 borrowers will imitate project 1 types in their credit market behavior -- otherwise they would reveal their identity. Thus all information-intensive borrowers who receive loans will use their endowments to fund a portion of their projects. Information-intensive borrowers who do not receive loans will deposit their endowments in the mutual fund. These conditions mean that in equilibrium all information-intensive borrowers who engage in projects will borrow only the amount needed to finance

the project over and above their initial endowments. Of course, W-type borrowers will also self-finance, so long as the equilibrium expected rate of return in the mutual fund is lower than or equal to the return on their projects. The decision to self-finance does not affect the equilibrium allocation of credit, since self-finance is contingent on receiving a loan. Only the distribution of profits, not the allocation of funds, is affected by self-financing.

The expected profitability to the mutual fund of loans received by each (observable or unobservable) project class ℓ is given $\rho_{k,\ell}$, where

$$(2)\quad \rho_{k,\ell}S_{k,\ell} = \int_0^\infty \min\,[(1 + i_k)S_k,\ R]\ dF_\ell(R);\ k = H,L,W;\ \ell=1,2,W;$$

Where $S_{k,\ell} = X_\ell - C_k$. Because of the possibility of default, the profitability of the loan is dependent on the amount of the internal net worth of the borrower. Ex post non-pecuniary penalties are excluded by assumption.

Given existing information-intensive net worth levels (again denoted by H and L), the competitive mutual fund will order its opportunities so that for all borrowers who receive loans, the rate of profit to the mutual fund is equivalent; otherwise, competing mutual funds could bid away borrowers. Investors are interested in obtaining funds as long as their net profits from project investment are positive.

The asymmetry of information between borrowers and lenders leads to an adverse selection problem in the information-intensive market, as in Stiglitz and Weiss (1981). That is, in borrower categories within the information-intensive sector, there exists a maximum loan profit rate ρ^* for lenders, at which $\partial\rho/\partial i = 0$, given the internal net worth levels for information-intensive

borrowers. That is true because average profitability on loans in the information-intensive sector depends on the mix of applicants (between project 1 and project 2 borrowers). Over an initial range of i (for a given value of collateral), $\partial\rho/\partial i > 0$, because as interest rates increase the fund earns more interest, with no increase in the extent of adverse selection; at interest rates greater than $\bar{i}$, good borrowers drop out of the market.[11] Thus the maximum profit the fund could make would be achieved by setting $i = \bar{i}$ (for a given collateral value) and choosing borrowers from among its pool of applicants.

The fund's maximum profit rate on information-intensive projects in any observable collateral class C_k is thus a probability-weighted combination of the profit rates from loans on unobservable projects 1 and 2:

$$(3) \quad \rho^*(C_k, \bar{i}_k) = f(\rho_1(C_k, \bar{i}_k), \rho_2(C_k, \bar{i}_k)), \; C_k < \bar{C}(\bar{\rho}),$$

where the implied weights depend on the mix of applicants. It is because of this adverse selection problem that borrowers' equity in projects is important. We denote by $\bar{C}$ the level of collateral (net worth) at which information-intensive loan applicants will sort themselves according to true underlying project returns.[12] That is, $\bar{C}$ is the net worth level such that

$$\pi_1 = (1 + \bar{\rho})\bar{C}.$$

Hence $\bar{C}$ will depend on the expected mutual fund return $\bar{\rho}$. The higher is the opportunity cost of investing one's net worth in a project, the lower will be the critical net worth level $\bar{C}$. When internal net worth is less than $\bar{C}$, "good" (project 1) and "bad" (project 2) borrowers with low collateral will not be distinguishable. As net worth rises to $\bar{C}$, equation (1) implies that

borrowers with inferior projects will no longer have an incentive to compete for loans, leaving only good projects in that net worth class to seek loans, and thus eliminating problems associated with asymmetry of information.

If for some information-intensive borrowers ρ^* is greater than the expected return on the full-information project alternative ($\bar{R}_w$) -- that is, if $C_k > \bar{C}$ for some of these borrowers -- and if the projects are the ones receiving funds on the margin, then the equilibrium return on loans to the information-intensive borrowers, $1 + \rho$, is just equal to $\bar{R}_w$. If $\bar{R}_w$ exceeds $1 + \rho^*$ -- that is, if $C_k < \bar{C}$ -- for all information-intensive borrowers, then information-intensive borrowers will be the marginal borrowers, because the maximum return when borrowers pool, $\frac{1}{2}(\bar{R}_1 + \bar{R}_2)$, is less than $\bar{R}_w$. As total wealth to be allocated increases, marginal conditions in the loan market will change, as different borrowers are brought in on the margin. That is, changes in the aggregate level of net worth can have allocative effects. Marginal conditions (and the participation of particular classes of borrowers) depend as well on the allocation of wealth -- i.e., internal equity -- since changes in this allocation can affect the profitability of lending to information-intensive borrowers.

Proposition 1 makes precise (i) the role of internal equity in credit allocation when full-information and information-intensive credit markets coexist; and (ii) the extent to which "underinvestment" in particular sectors occurs.

Proposition 1: Depending on per capita levels of internal net worth, the allocation of funds to classes of borrowers alternatively will follow the full-information credit allocation or ration funds

away from information-intensive borrowers who would receive credit in the absence of asymmetric information. A "financial collapse" may occur, in which some or all classes of information-intensive borrowers are denied any access to credit.

Proof:

Within the framework described above, borrowers may be ordered in terms of desirability depending on their project opportunities and net worth C_k. Three possible orderings exist:

(i) $\bar{R}_W - 1 > \rho^*(C_H, \bar{i}_H) > \rho^*(C_L, \bar{i}_L)$, when $H,L < \bar{C}(\bar{\rho})$,

(ii) $\rho^*(C_H, \bar{i}_H) > \bar{R}_W - 1 > \rho^*(C_L, \bar{i}_L)$, when $L < \bar{C}(\bar{\rho}) < H$, and

(iii) $\rho^*(C_H, \bar{i}_H) > \rho^*(C_L, \bar{i}_L) > \bar{R}_W - 1$, when $H,L > \bar{C}(\bar{\rho})$.

In other words, the maximum possible gross rate of return from contracts offered to information-intensive borrowers exceeds $\bar{R}_W$ only when borrowers with the same (high) net worth level and different production opportunities do not pool. This occurs only when internal net worth exceeds the critical level $\bar{C}(\bar{\rho})$. The level of aggregate net worth determines, for any of the three orderings, which borrowers class received funds on the margin. The profit rate from marginal loans sets the profit rate for inframarginal loans as well; marginal and average profit rates ($\bar{\rho}$) are equal.

Under ordering (i), increasing aggregate net worth causes $\bar{\rho}$ to fall from $\bar{R}_W - 1$ to $\rho^*(C_H, \bar{i}_H)$, and then to $\rho^*(C_L, \bar{i}_L)$. Under (ii), $\bar{\rho}$ follows the path: $\bar{R}_1 - 1$, $\bar{R}_W - 1$, $\rho^*(C_L, \bar{i}_L)$, $\bar{R}_2 - 1$. For ordering (iii), $\bar{\rho}$ falls from $\bar{R}_1 - 1$ to $\bar{R}_W - 1$ to $\bar{R}_2 - 1$. Thus, depending on the aggregate level and distribution of net worth, some classes of borrowers may be rationed (i.e., receive a loan opportunity only through a lottery with a certain probability)

or excluded entirely from the credit market.

We stress two corollaries of Proposition 1 addressing the importance of internal equity for investment.

Corollary 1: The distribution of investment across borrower types depends on the distribution of endowments among borrowers and savers.

Discussion:

Changes in net worth that precipitate a change in funding ordering, but hold constant the aggregate endowment level, are borne by the marginal borrower class. That is, some groups of borrowers may be denied credit. These borrowers must be information-intensive. Hence, the share of information-intensive investment in total investment can never increase when the aggregate net worth of potential borrowers (non-S-type individuals) is reduced, and will in general decrease. A fortiori, changes in H or L relative to $\bar{C}(\bar{\rho})$ will have allocative effects.

Corollary 2: Any redistribution of funds from entrepreneurs to savers that change H or L relative to $\bar{C}(\bar{\rho})$ will reduce the share of investment undertaken by information-intensive borrowers.

Discussion:

This corollary follows immediately from Proposition 1 and Corollary 1. Consider a redistribution of internal finance ΔC from potential entrepreneurs to be given to savers -- changing $(H,L,\bar{C}(\bar{\rho}))$ to $(H-\Delta C,L-\Delta C,\bar{C}(\bar{\rho}))$. If the new internal net worth positions are such that funding ordering (iii) prevails, the redistribution is only a transfer. If funding ordering (ii) obtains, then

I^L borrowers may not be granted loans; under funding ordering (i), the information-intensive sector as a whole may experience financial collapse, with most or all of mutual fund deposits invested in full-information projects. The return on the mutual fund deposits is lower going from (iii) to (ii) to (i). Taken together, corollaries 1 and 2 imply that financing and investment decisions are not independent.

III. Public Policy: Some Remarks

Internal Finance and Public Finance

The simple setup of the model in section III permits some observations about the effects of tax policy on credit allocation. We consider the government sector as having commitments for a stream of public projects. The government's revenue requirements depend on its endowment relative to the cost of the exogenously specified projects. If required public spending exceeds the endowment of the government, taxes will be levied. If the public endowment exceeds the cost of public projects, the government becomes a net contributor of funds to the economy-wide mutual fund.

Consider first the case in which the public sector requires additional funds and uniform lump-sum taxes on endowments are imposed prior to credit allocation. The effects of taxation on the allocation of funds for investment depends both on the aggregate level of collateral and its distribution, as would be expected from the allocations discussed before. That is, all other things equal, reductions in the total amount of private funds should lead to an increase in the share of investment undertaken by full-information borrowers. Moreover, uniform (lump-sum) taxation of net worth prior to investment

reduces collateral of I^L borrowers proportionately more than that of I^H borrowers, making more likely the possibility of the complete closure of the loan market to I^L borrowers.

Policy-induced redistributions of money from the "corporate sector" (individuals with project endowments) to the household sector (individuals including those who are "savers") will in all likelihood reduce investment profitability as it reduces the share of investment done by information-intensive entrepreneurs. One such redistribution was accomplished in the Undistributed Profits Tax of 1936-1937, in which a progressive surcharge was placed on retained earnings to encourage payout. Dividend payments relative to earnings increased substantially during the two years for which the surtax was in effect (Poterba, 1987). Available evidence on behavioral responses is sketchy, with the consensus being that large companies issued (primarily debt) securities to raise funds externally for investment. Small and medium-sized companies in growing industries were paying out little, and suffered a loss in internal finance as a result of the surcharge. Surveys cited by a contemporary chronicler suggest a decline in investment in those groups (see the discussion in Lent, 1948). The Tax Reform Act of 1986 raises substantially the average tax rate on corporate earnings; an analysis of its likely effects on corporate saving is given by Poterba (1987). The Act redistributes funds from the corporate sector to the household sector, where average tax rates are lowered. Our model would predict that investment decisions of information-intensive firms are affected by this redistribution.

The importance of internal finance -- particularly for information-intensive borrowers -- suggests the possibility that the impact of tax policy

on investment may be channeled as much through its effects on net cash flow (as an addition to internal equity) as through its effects on the "cost of capital". That is, depending on levels of internal equity, information-intensive borrowers may face binding internal-finance contraints, with a very high shadow price of debt-finance. For such borrowers, the effects of tax policy on investment would come through impacts on internal equity and cash flow and not just through changes in the full-information cost of capital in centralized securities markets. That is, average tax rates matter as well as marginal tax rates.[13]

Public Policy and Financial Institutions

The multiple-credit-markets approach outlined here sheds new light on public policies toward financial institutions. Actual loan markets are not a replication of an identical mutual fund. Real-world markets are characterized not only by a multiplicity of potential contracts (differing in price or quantity terms) at the national level, but by regional and institutional differences as well, because of, inter alia, restrictions on the types of securities in which certain institutions may invest and on intrastate and interstate branch banking. The resulting diminished ability to spread risks leaves lenders more vulnerable to deflationary shocks. For such institutions, adverse shocks to borrowers' net worth are likely to have still more negative effects on the availability of credit to information-intensive borrowers, since other borrowers will have access to less localized, full-information credit markets.

Empirical evidence from historical experience illustrates the sensitivity of credit allocation to the responses of financial institutions to periodic

episodes of deflation. That deflationary shocks can disrupt credit markets has been suggested by Fisher (1933) and Minsky (1977). In our model, large reductions in borrower net worth are associated with the first two funding orderings described in the proof of proposition 1, where full-information interest rates are high, and credit in information-intensive sectors will be scarce, though loan rates may not rise. Support for these responses to aggregate deflationary shocks to net worth is provided for the pre-Federal-Reserve period in Calomiris and Hubbard (1985) and for the period of the Great Depression of the 1930s in Bernanke (1983).

A contemporary example of multiple market clearing in response to deflationary shocks and reductions in internal equity is reflected in the recent troubles of the federal Farm Credit System (FCS). Agricultural borrowers from "banks" in the FCS are required to hold stock in the bank from which the loan was obtained. In periods of deflation in farm prices (and land values), default rates can be expected rise, inflicting capital losses on all remaining borrowers. Of course, some borrowers could liquidate their loans and refinance them in full-information credit markets. As strong (high net worth) borrowers leave the FCS to obtain funds in full-information markets, the cost of credit to weaker borrowers rises, worsening the adverse selection problem and increasing the likelihood of a credit collapse (see the discussion in Calomiris, Hubbard, and Stock, 1986).

IV. Conclusion and Extensions

The principal findings of the paper were stated in the introduction. We consider differences in equilibrium credit availability to various types of borrowers and projects and responses to disturbances. This merger of

full-information and information-intensive credit markets is an important step toward an examination of why different forms of financial institutions and loan contracts emerge, and what public policies toward credit markets should be.

Two theoretical extensions of this paper seem particularly promising -- (i) modeling further the dynamic accumulation of net worth, and (ii) motivating the existence of particular information-intensive intermediaries. With respect to the former, it is important to consider saving toward the threshold level of internal finance required to gain access to particular loan markets in a stochastic cyclical context.[14] An additional element of precautionary response might be the agglomeration of internal equity through mergers.

With respect to the second extension, given the demonstrated importance of internal finance for the sorting of borrowers and the costs of adverse shocks to net worth in terms of reduced credit availability, both borrowers and lenders may choose to undertake costly investments in "information" -- "reputations" for borrowers and the development of specialized intermediaries by lenders. For example, intermediaries could differ in the costs of gathering information about prospective borrowers. "Banks" may be the lenders most efficient in monitoring information-intensive loans, so that banks failures could have real effects by destroying information capital and raising monitoring costs in the aggregate. Alternatively, borrowers may decide to invest in costly signals and audits in order to gain admittance to centralized, full-information financial markets which supply funds relatively elastically. Evidence from the mid-1930s indicates that this was one run

response to the high number of bank failures of the early 1930s (see Butters and Lintner, 1945). Incorporating these dynamic considerations (as for example in the banking model of Bernanke and Gertler, 1985) would add significantly to the richness of the approach presented here.

Both of these extensions suggest the importance of research on links between credit-market structure and the persistence of aggregate income fluctuations. The model developed here provide a good basis for such dynamic analysis because of its potential to describe the availability of various types of loan contracts in response to aggregate disturbances and their impact on the persistence of those disturbances. The accumulation of internal finance by borrowers is important, and cyclical fluctuations in the quantity of funds available for internal finance will accentuate economy-wide fluctuations in income (see also the discussion in Bernanke and Gertler, 1987; and Greenwald and Stiglitz, 1986). During a boom -- when collateral levels are high -- more socially productive investments can be undertaken in information-intensive sectors of the economy. These considerations may also be significant for the evaluation of federal credit-market interventions or of certain fiscal policies.

Finally, on an empirical level, our approach provides theoretical motivation for the inclusion of particular indicators of credit scarcity in econometric work. The model yields testable hypotheses about the impact of shocks to internal finance on loans to information-intensive borrowers (both absolutely and relative to full-information borrowers). In particular, the emphasis on fluctuations in the value of internal net worth suggests useful applications to studies of business investment and to financial crises. Such

empirical tests are important as evidence of the quantitative significance of credit rationing and as guidelines for public policy.

Footnotes

1. King (1986) is unable to isolate the effects of innovations in banks loans from the effects of innovations in banks deposits, and argues, therefore, that there is little empirical basis for distinguishing between the liquidity-preference transmission mechanism and the loan-supply transmission mechanism of monetary policy. Bernanke (1986) argues that non-recursive ("structural") orthgonalizations of VAR models lend more support to the credit-supply approach than the simple recursive method.

2. Bernanke and Gertler (1985) have addressed some of these issues in their consideration of bank intermediation in a general equilibrium framework. Boyd and Prescott (1986) also demonstrate that financial-intermediary coalitions are part of an efficient arrangement in the sense that they are needed to support the participants' private-information core allocations.

3. An emphasis on internal finance in the investment decision is not new. Butters and Lintner (1945) analyzed the importance of internal finance for the development of growing enterprises. Arguments linking cash flow and investment are articulated in Meyer and Kuh (1957). See also Eisner (1978).

4. Srini Vasan designates small, medium-sized, and large corporations to be, respectively, firms with assets below $10 million, firms with assets between $10 and $100 million, and those with assets over $100 million. He finds that external equity finance (new share issues) is rare in general, and is virtually nonexistent outside large firms. Smaller firms rely mainly on bank loans and other short-term debt for external finance. Dividend payout ratios increase significantly with firm size (see also the analysis in McDonald and

Soderstrom, 1986; and Fazzari, Hubbard, and Petersen, 1987a). Moreover, the volatility of dividends and earnings are higher for small firms and their investments and sales are more procyclical than those of larger firms indicating a greater reliance on internal finance and the potential importance of cash flow per se. Thus, although small firms account for a small percentage of average investment and sales, they account for a much larger percentage of cyclical variability in these variables. In part, this also reflects the reliance of small firms on bank debt for external finance, since bank loan supply is sensitive to aggregate credit cycles (see Eckstein and Sinai, 1986).

5. Modeling specifically the allocation of capital to projects with at least some degree of individual specificity is crucial to understanding potential real effects of shocks to borrowers' collateral. If borrowers and lenders were identical in their access to projects, unanticipated deflation would be, for example, merely a redistribution of wealth.

6. It is important to consider both perfect-information and information-intensive loan markets to motivate examination of real-world institutions. For example, Bernanke and Gertler (1987) employ a model of costly state verification to motivate links between the level of collateral and the availability of credit. In actual credit markets, some borrowers (our information-intensive firms) are doubtless subject to insider (equity) and outsider (debt) distinctions, while others (full-information firms) offer the same information to holders of both debt and equity claims (e.g., large, publicly traded corporations).

7. Indeed, Williamson (1986) emphasizes the importance of developing financial intermediation from first principles. While loans from intermediaries are important to some (information-intensive) borrowers, they are not uniformly important to all borrowers. Srini Vasan's "small," "medium-sized," and "large" firms (see the description in footnote 4) relied on bank loans for 79 percent, 64 percent, and 17 percent of their external finance, respectively.

8. De Meza and Webb (1987) obtain an overinvestment result within a framework similar to ours, but different in four important respects, in that they rely on: (i) identical distributions of project returns across entrepreneurs (entrepreneurs differ only in their probabilities of success), (ii) identical net worth across entrepreneurs, (iii) the existence of a continuum of individual types (rather than some number of discretely different types), and (iv) an exogenously determined marginal expected return to lenders. By relaxing (i), we can obtain the sort of credit rationing suggested by Stiglitz and Weiss (1981) when collateral levels are sufficiently low. Our multiple-markets approach relaxes (ii)-(iv) to examine the effects of collateral changes on the allocation of credit across different types of borrowers.

9. In the U.S. manufacturing sector, new share issues as a source of external finance are significant only for the very largest firms (Srini Vasan, 1986). Important recent papers by Myers and Majluf (1984) and Greenwald, Stiglitz, and Weiss (1984) explain why asymmetric information either eliminates effectively any reliance on external equity finance in the market or causes suppliers of new equity to demand a large premium. See also the

review of arguments in Greenwald and Stiglitz (1986). Myers and Majluf consider a situation in which managers (or current owners) are better informed about the true value of both the firm's investment opportunities and the existing assets in place. Managers are assumed to act in the interest of existing shareholders, and potential new investors are aware of this. Given this set of assumptions, firms may be forced completely out of markets for external equity finance. See also the analysis in Fazzari, Hubbard, and Petersen (1987a).

10. That is, we exclude interest rates that vary with a firm's performance. There are enforcement issues raised by such contractual contingencies in debt instruments: First, ex post third-party verification must be straightforward ("id certum est quod certum reddi potest" -- that is certain which can be made certain). Second, if the borrower can exercise influence over the outcome, this unequal power might raise questions as to whether the contract is negotiated "in good faith" and whether the "mutuality" test of compensation is satisfied. Contracting contingent on a price index does not raise these issues, while contracting on firm performance does (for definitions of terms, see Dawson, Harvey, and Henderson, 1982, pp. 228-38; and Kimbrough, 1974, pp. 68-70). These enforcement considerations suggest that attempts to mimic aspects of an equity position in a limited form with interest rate contingencies might be an unenforceable compromise between ownership, on the one hand, and a fixed promise, on the other hand. It is likely that, were such contingent contracting feasible, it would occur as a means of charging different loan fees to borrowers with different unobservable project opportunities. The adverse-selection problem in our model will not be

eliminated by this complication, as long as firms' realizations are less than fully revealing of their underlying project opportunities.

11. The adverse selection result obtains because of the different distributions of project returns for entrepreneurs of types 1 and 2. For interest rates greater than $\bar{i}$, project 1 borrowers drop out, and project 2 borrowers remain.

12. The importance of collateral as borrower net worth in a project has been emphasized by Leland and Pyle (1977) and Bernanke and Gertler (1987).

13. This emphasis on the difference between the shadow cost of internal and external finance parallels closely the examination of "liquidity-constrained" consumers in Hubbard and Judd (1986, 1987), where the effects of average, not marginal, tax rates dominate as long as the constraint binds. Fazzari, Hubbard, and Petersen (1987b) and Greenwald and Stiglitz (1987) discuss conditions under which average tax rates are relevant for the investment decision.

14. That is, are there circumstances under which borrowers with access to credit would turn down projects with positive net present value in order to be able to borrow in future periods? More broadly, can fluctuations in borrower net worth generate persistent effects on investment ("accelerator effects")?

Consider an extra period in the model, and assume that individual-specific project opportunities are randomly distributed in each period, so that it is not possible for lenders to learn usefully about the characteristics and types of borrowers. In the first period, an individual borrower is either granted a loan or not. If credit is made available in period 1, the borrower must decide whether or not to invest. Given the

significance of entrepreneurs' net worth in the credit allocation process, there is an important interdependence between investment decisions in the two periods. If there were an adverse realization of project returns in the first period, net worth positions for some borrowers may be eroded sufficiently to preclude obtaining a loan in the second period. As long as borrowers are optimizing over both periods, depending on expectations about the relative expected profitability of investments made in the two periods, some borrowers may turn down investment opportunities with positive net expected returns in the first period in order to be more sure of obtaining a loan in the second period. Under a full-information credit allocation with risk-neutral borrowers, such a result would never obtain; borrowers would undertake investment in the first period whenever the expected net present value is positive.

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