Conference on the Economics of Federal Credit Activity

Part II—Papers

Special Study

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CONGRESS OF THE UNITED STATES CONGRESSIONAL BUDGET OFFICE

CONFERENCE ON THE ECONOMICS OF FEDERAL CREDIT ACTIVITY

PART II - PAPERS

April 10-11, 1980

The Congress of the United States
Congressional Budget Office

PREFACE

At the request of the House Budget Committee's Task Force on the Budget Process and the House Banking Committee's Subcommittee on Economic Stabilization, the Congressional Budget Office (CBO) conducted a conference on the Economics of Federal Credit Activity on April 10-11, 1980, in Washington, D.C.

The proceedings of the conference have been published in two parts. Part I contained, for each of the topical sessions, the authors' summaries of their proposed papers, the formal comments offered by the discussants, and the discussion between the authors, discussants, and members of the audience. Part I was published in December 1980. This volume, Part II, contains the text of the prepared papers.

Patricia H. Johnston supervised the preparation of Part II for publication. Margalo Ashley-Bennett typed the volume for publication with assistance from Debra M. Blagburn and Nancy Brooks. Mary A. Anders proofread the many drafts. John D. Shillingburg was the conference coordinator.

Alice M. Rivlin
Director

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MACROECONOMIC CONSEQUENCES OF FEDERAL CREDIT ACTIVITY

by

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The Congress of the United States
Congressional Budget Office

PREFACE

The authors of this paper are Assistant Professors of Economics at the University of Wisconsin. Mary Kay Plantes' research was supported by funds granted to the Institute for Research on Poverty by the Department of Health, Education and Welfare pursuant to the provisions of the Economic Opportunity Act of 1964. The Congressional Budget Office provided research support to both authors. Frank de Leeuw and Donald Hester provided helpful comments. All errors are the responsibility of the authors.

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SECTION I. INTRODUCTION

Macroeconomic analyses typically focus on fiscal and monetary policy as the tools through which the economy may be controlled. An alternative policy, providing financial credit to select sectors of the economy, has traditionally received little attention. Nevertheless, federal credit programs have been a significant and growing part of federal economic policy. Recently, concern of the federal government's borrowing in private capital markets coupled with budgetary reforms have placed a spotlight on federal credit programs. The intent of this paper is to provide a framework for assessing the macroeconomic consequences of federal credit programs; specifically, effects of federal credit programs on output levels and composition and on prices are examined. In this paper we discuss the consequences of federal credit activity for the total amount of intermediary services provided in the economy, the reallocation of credit and real resources across different sectors of the economy, and for the standard monetary transmission process.

Many analyses of federal credit programs do not construct a general equilibrium macroeconomic framework. The consequences of such a myopic focus are serious if a program has macroeconomic impacts which influence the program's effectiveness. For example, Federal National Mortgage Association (FNMA) injection of funds into the mortgage market may not increase housing starts if the FNMA debt issues cause an increase in interest rates and an offsetting reduction in private loanable funds available to the housing market. By focusing on the macroeconomic impact of federal credit programs we hope to provide a more realistic picture of what outcomes policymakers can expect both immediately and in the future.

Our analysis focuses specifically on whether federal credit programs can reallocate resources from one sector of the economy to another. A detailed model of asset markets identifies a number of avenues through which private sector behavior in response to federal credit programs mitigates government attempts to redirect credit flows towards a specific type of lending. The above example argued that federal credit programs may reduce private sector loans to the targeted sector or class of borrowers. Also, households' equity holdings of the capital stocks which federal credit activity is attempting to increase may change. The change may result from private households using debt financing as a substitute for equity financing of capital purchases and, therefore, increasing other asset holdings in response to an increase in government loans. Alternatively, increases in government debt to finance the loan purchases may lead to some crowding out of household equity holdings of the targeted capital stock as well as other capital stocks.

Our detailed analysis examines the conditions under which the private sector responses to federal lending are sufficient to offset the intended purposes of the credit program.

Clearly, there are many other issues of interest. For examples: Does federal credit activity reallocate capital from less efficient to more efficient uses? Does federal credit activity increase the supply of savings? Does federal credit activity eliminate the adverse effects of regulations on financial institutions? We will not deal with these issues directly in our paper. The reader should note, however, that our analysis is a prerequisite for answering any of these questions. Whenever the private sector can reverse the intent of federal credit programs, these issues become inconsequential.

The paper is organized as follows. In Section I we discuss the general nature of federal credit programs and present some simplifying abstractions required to develop an analytic framework to assess the program's macroeconomic consequences. Specifically, we will draw an analogy between federal credit programs and the U.S. Treasury acting as a financial intermediary. In Section II, we outline the possible macroeconomic effect of federal intermediation services. Section III presents a detailed theoretical model for determining the effect of credit reallocation induced by federal credit programs. This section focuses specifically on whether the private sector's response to federal credit activity mitigates the intended effect of the program. Finally, Section IV contains a general discussion of federal credit activity's effect on the monetary mechanism.

SECTION II. AN OVERVIEW OF FEDERAL CREDIT PROGRAMS AND ANALYTIC SIMPLIFICATIONS

Federal credit activity takes three distinct forms: direct lending, guarantees of loans and other credit, and creation of secondary markets. Direct lending transfers funds from government to the private sector in exchange for a promise of future repayment. A federal loan guarantee provides that the government bear all default risks accompanying loans financed by private sector funds. Finally, secondary markets are created when a government-owned or -sponsored agency buys and sells loan assets, typically those guaranteed by the federal government. The magnitude of the purchase and sale activities determine the depth of the secondary market and, therefore, the liquidity of the loan asset.

A number of vehicles exist through which federal credit programs are administered: on-budget agencies, off-budget credit agencies, and federally sponsored credit agencies. Guarantees are supplied primarily by on-budget agencies; all three groups grant loans either directly or by purchasing federally guaranteed loans. All three also sell their loan assets and thus add depth to secondary markets.

Financing of federal credit transactions differs across the type of transaction engaged in. Not all forms of federal credit activity require direct expenditures. While direct lending requires an outlay of funds, guarantees require no expenditures, beyond administrative cost, until a default occurs. Secondary market operations do require a capital base although loan asset sales finance a large portion of repurchases.

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Financing of federal credit transactions also differs across the three types of agencies. On-budget agencies are allocated funds through the budgetary process. However, their gross lending is not subject to budgetary totals insofar as the agencies either receive repayments for previous loans (only net outlays appear in the budget) or if agencies sell loan assets.[1] Also, some on-budget entities are authorized to issue their own securities to the public, rather than rely on Treasury financing.

The spending of off-budget federally owned agencies is not included at present within the totals of the budgetary process. These agencies can borrow from the Treasury or the public; alternatively, they can raise funds via sales of loan assets and repayments.

Federally sponsored agencies were initiated with federal capital stock which has since been retired.[2] Currently, their activities are financed by borrowing funds from the public. In return for federal supervision, these agencies subject their securities to regulations applicable to a federally regulated institution, thereby lowering the rate of return required by investors to hold their securities.

Recently a new agency has entered the area of federal credit programs and altered traditional financing procedures. The Federal Financing Bank (FFB) was established in 1973 as a wholly owned, off-budget government corporation within the Treasury. It was created primarily to coordinate the borrowing activities of federally owned credit agencies that would otherwise independently enter securities markets. Coordination is accomplished by the FFB purchasing the agency's debt issues. The FFB also purchases loan assets held by federally owned agencies [3] and issues federally guaranteed loans to the private sector.

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[1] The loan asset may be sold by itself or pooled with other loan assets, in which case the pooled asset is referred to as a Certificate of Beneficial Ownership (CBO). In the latter case, ownership is not transferred; instead, the agency services the loan, passing interest and principle onto the CBO holders. CBOs often involves guaranteeing of loans or subsidization. These aspects of a CBO will be analyzed in the discussion of subsidy and guarantees.

[2] Congressional Budget Office, *Loan Guarantees: Current Concerns and Alternatives for Control* (January 1979), p. 30.

[3] The Student Loan Mortgage Association is the only federally sponsored agency eligible for FFB financing.

To finance its activities, the FFB must either borrow directly from the public or from the Treasury. One expensive venture into private capital markets resulted in FFB's Board of Directors requiring that FFB always turn to the Treasury for financing.[4]

The complexity of federal credit programs and their alternative sources of financing seriously interfere with attempts to develop an analytic framework for assessing the macroeconomic consequences of these programs. The simplest procedure is to treat all federal credit activities as analogous to the Treasury acting as a public financial intermediary.

The procedure is not only useful, but highly realistic. The realism stems from the realization that since the Treasury and FFB provide funds to agencies, lending by agencies with Treasury or FFB financing is not analytically different from lending by the Treasury or FFB. Also, the fact that FFB borrows from the Treasury at, essentially, the Treasury's borrowing cost results in the FFB not being analytically distinguishable from the Treasury.

The procedure is also realistic in describing the large number of federally sponsored lending institutions and some federally owned agencies which issue their own debt instruments and lend directly to the private sector. In effect, these agencies are doing exactly what is ascribed to the Treasury; their presence in federal credit transactions results in our viewing the Treasury as issuing multiple securities which are likely to be closely substitutable, owing to their federal backing and the presence of secondary markets. To simplify the analysis further, we can assume that both agency and Treasury securities are perfect substitutes.

The analogy is convenient because it allows us to overlook all of the within-government interactions and only address credit flows between the government and various sectors of the private economy. As a result of ignoring within-government credit transactions, our paper will not address the effect of federal credit programs on the Congressional budgetary process. Nor will our approach address whether federal credit programs are adequately measured in the budget.

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[4] See CBO, *Loan Guarantees*.

A second complexity of federal credit programs is the breadth of their targets, for example, farming, housing, and exports. Our theoretical analysis will abstract from how total credit activity is allocated across projects. Our model will include two sectors, one receiving and the other not receiving federal credit assistance.

A final complexity of federal credit programs is the number of ways in which they are financed. Including credit programs within the Treasury's domain greatly simplifies matters since the Treasury finances credit programs by money supply creation, taxes, and/or debt issuance. Throughout this paper we will treat all financing as debt financing. The assumption is innocuous since any other form of financing can be analyzed as debt financing combined with either an open market purchase (in the case of money supply financing) or retirement of debt through tax proceeds (in the case of tax financing).

SECTION III. THE RATIONALE FOR FEDERAL CREDIT PROGRAMS

Our analogy between federal credit programs and the Treasury acting as an intermediary leads us to ask why federal rather than private intermediation is used and whether federal intermediation displaces an equal amount of private intermediation. These questions are important because the more efficient the financial system is in intermediating between the ultimate lenders and borrowers, the more efficient will be society's allocation of real resources.

Federal credit programs are usually justified by the existence of imperfections in the private capital market. Incorrect perceptions of risk on the part of the private sector is one such imperfection. Veterans Administration mortgages and mortgage guarantees served to convince private financial intermediaries that the default risk on these mortgages was lower than the private sector initially expected.

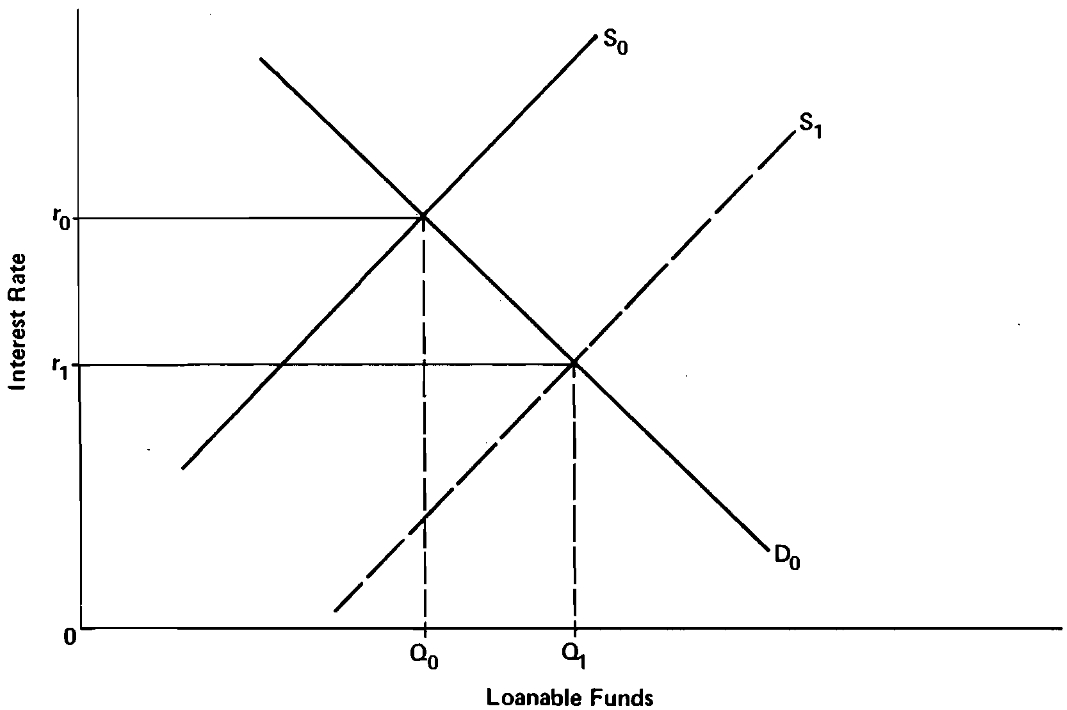
Federal credit programs are also advocated to reduce imperfections arising from monopolistic elements in the provision of intermediation services. For example, state chartering of savings and loan association banks historically prevented excess loanable funds in surplus regions of the nation from flowing to areas where an excess demand for mortgages existed. The Federal Home Loan Bank Board (FHLBB), a federally sponsored credit agency, was established in part to nationalize the market for mortgage funds. These are cases where federal credit activity may "crowd in" rather than "crowd out" private intermediary services. Another often cited imperfection is Regulation Q. Divergence between social and private costs is also cited as a justification for federal credit programs. Student loan programs, for example, exist to provide a socially desirable resource allocation.

The federal agencies may try to close the gap between social and private costs or overcome market imperfections through programs that consist of *at least one* and generally more than one of the following activities: substitution of the Treasury's credit worthiness for that of private borrowers, loan guarantees, subsidies, providing secondary market operations, and, finally, reallocating credit across sectors. All but the last of these characteristics are discussed in this section. Credit allocation is discussed in Section III.

Substitution of Government Credit Worthiness

Through direct lending, the Treasury sells federal government securities and uses the proceeds to accommodate targeted borrowers. From the perspective of the ultimate lender of funds, the credit worthiness of the Treasury has been substituted for that of private borrowers. Perceiving a decrease in risk, the lender's supply curve shifts right (see Figure 1). Initially the capital market has demand D_o and supply S_o. The equilibrium interest rate r_o and quantity of loanable funds Q_o clear the market. An increase in supply to S_1, as a result of perceived risk reduction on the part of lenders, lowers the market clearing interest rate to r_1 and the equilibrium quantity of funds supplied and demanded increases to Q_1.

Figure 1.



Loan Guarantees

Loan guarantees work much the same way by substituting the government's credit standing for that of the private sector. In doing so, the government is absorbing default risk. Graphically, government guarantees shift the supply curve to the right as in Figure 1. Note that loan guarantees require no initial Treasury expenditure beyond administrative costs.

Secondary Markets

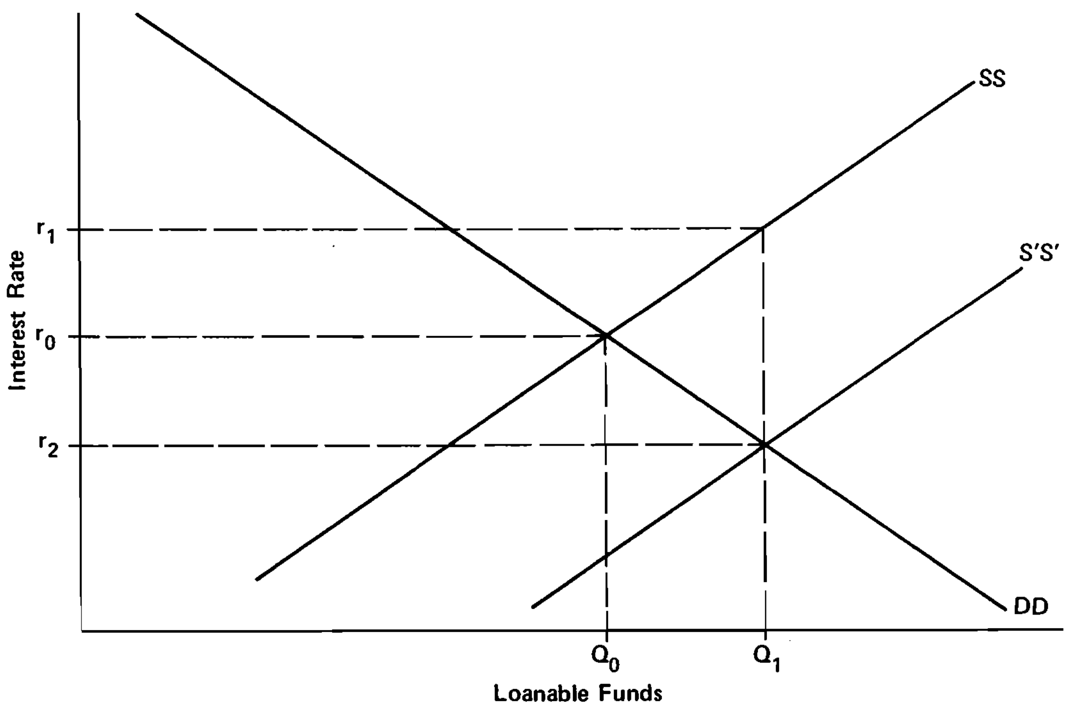
By providing a market in which lenders transform their loan assets into cash before the asset reaches maturity, loan assets are made more liquid by a secondary market.

This desirable transformation of asset characteristics reduces the interest rate charged by lenders, that is, as in Figure 1, the supply curve shifts right.

Subsidies

Another method for allocating capital is for the agency to pay a subsidy. Often the subsidy is indirect, as when the federal agencies do not pass on all administrative costs of issuing a loan guarantee. A direct subsidy arises when the government charges an interest rate on a loan below that which private intermediaries would charge, offers a loan guarantee that does not adequately cover default risk, or purchases (sells) assets at a premium (discount) on a secondary market. In Figure 2 we analyze the case of an explicit interest rate subsidy.

Figure 2.



Before the subsidy, the demand curve for funds is *DD* and the supply curve is *SS*. The equilibrium interest rate r_0 and quantity Q_0 clear the market. A subsidy of $r_1 - r_2$ shifts the supply curve vertically by this magnitude to S′S′.[5] In this new equilibrium r_1 is received by the suppliers of funds, r_2 paid by the demanders, $r_1 - r_2$ paid by the government and Q_1 is the equilibrium quantity of funds.[6] When a subsidy element is present, future expenditures are probable. For example, if the Treasury guarantees a loan and charges a premium for the guarantee which does not fully cover default risk, and if the borrower defaults, the Treasury will have to expend funds to the private sector to cover unpaid principle and interest. There are macroeconomic consequences of the subsidy-induced expenditure and a higher interest cost of the Treasury debt if the public views the government as "riskier" than it would be in the absence of subsidized federal credit programs.

Whether or not direct lending, loan guarantees, secondary market creation, or subsidies accomplish their objective depends crucially upon whether these activities succeed in increasing the flow of credit available to the sector or class of borrowers on which federal credit programs are targeted. The analysis presented above was a partial equilibrium analysis in that it did not address whether changes in other markets in response to the federal credit programs alter the direct effects described above of the federal credit program. We turn to this in Section IV.

SECTION IV. REALLOCATION OF CREDIT: GENERAL EQUILIBRIUM RESULTS

INTRODUCTION

This section presents a theoretical model for assessing the macroeconomic consequences of federal credit activity. As discussed in the previous section, one dimension

[5] Assumption in the figure is that subsidy is paid to lender.

[6] See R. G. Penner and W. L. Silber, "The Interaction Between Federal Credit Programs and the Allocation of Credit," *American Economic Review* (December 1973).

of this activity is the intermediary services provided by the federal agencies and whether these services result in a more efficient financial system. A more efficient financial system may increase the flow of savings if interest effects on savings decisions outweigh income effects on savings decisions. In this section we do not address these issues. Rather, through our model, we analyze the effectiveness of federal credit activity. Effectiveness is defined in terms of changing the capital stock in the sector of concern to the policymaker by reallocating credit flows to that sector.

To emphasize the need for a model of the type to be developed, consider the following simplistic analysis. A government loan of a given value results in real resources of equal value being allocated to that sector. If the funds from the loan are used to purchase capital, than the capital stock in that sector increases in real terms by the amount of the loan.

Our model will improve on this analysis on several levels. First, we distinguish between short-term and long-term adjustments: static and dynamic analyses, respectively. Secondly, within the static analysis, we model both a financial and a real sector. In the financial sector we impose balance sheet constraints on households, federal agencies, and financial institutions. The balance sheet constraint on federal agencies insures that the analysis of federal credit activity considers not only the use of the funds (the asset side of the balance sheet) but also the source of the funds (the liability side). The simplistic analysis presented above ignores both the effects of one sector's activity on other sectors and the effects of financing federal credit activity.

With a complete model of financial markets which contains balance sheet constraints, we turn to modeling of the real sector. This exercise allows us to make explicit the mechanism of transmission of federal credit activity from the asset markets to the real sector. Interactions between the asset markets and the real sector are captured in our static model. In this model, changes in the stocks of financial assets in the economy as a result of federal credit programs have an immediate effect on the array of rates of return and therefore on the flow variables of the real sector (for example, the investment rate).

Federal credit activity, by altering the rates of return on assets, changes the price signals received by the products of physical capital. These signals determine the rate of investment in the various sectors of the economy and the allocation of factors of production necessary to achieve the production of new capital goods. These changes are not incorporated in the static analysis, however, as we keep the stocks of physical capital constant under the assumption that the time period under study is too short for the flow supply of capital goods to affect the stock of capital goods. A dynamic analysis would relax this assumption and study both the steady-state to which the economy converges and how the steady-state is affected by federal credit activity.

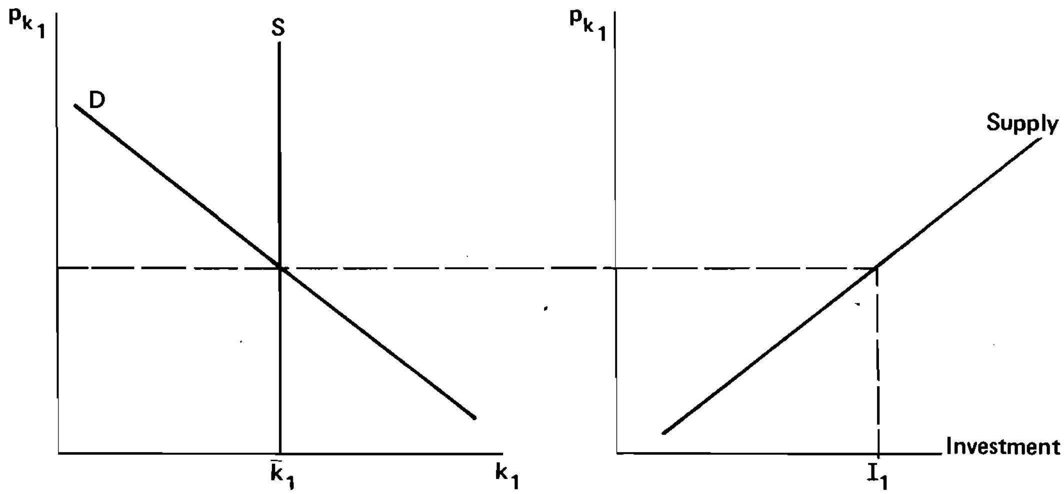
REAL SECTOR

In this section we give a brief overview of the real sector. There are three output supplying sectors which produce consumption goods, new capital of type one, and new capital of type two. The three factors of production (labor, capital of type one, which is the target of federal credit programs, and capital of type two) are perfectly mobile between sectors and sold on competitive markets. Competitive firms insure prices of the factors of production are equal in all sectors. There is full employment of all factors of production.

These assumptions as regards the labor market are quite standard. If labor supply and demand depend only on the real wage, they yield the standard classical labor market which is dichotomized from the rest of the model. The above treatment of the capital markets is not standard although it does follow in the tradition of Tobin, Foley and Sidrauski, and Henderson and Sargent.[7] As shown in these papers, if competitive firms can enter perfect markets for physical capital and if they face no adjustment costs, then the firm has a demand curve for physical capital, but does not have an investment demand function. There is no need for the firm to demand a finite investment flow if it can purchase existing physical assets on a perfect market.

[7] J. Tobin, "A Dynamic Aggretive Model," *Journal of Political Economy* (April 1955); D. Foley and M. Sidrauski, *Monetary and Fiscal Policy in a Growing Economy* (New York, 1971); and D. Henderson and T. Sargent, "Monetary and Fiscal Policy in a Two-Sector Aggregate Model," *American Economic Review* (June 1973).

In this model, the investment rate is supply determined. As shown below in the left-hand diagram, the supply of capital ($\bar{k}_1$) is given at a point in time. The firm's demand for capital established an equilibrium price for capital. In the right-hand diagram, the producers of new capital perceive this equilibrium price and produce new capital at the rate I_1.



The reason we choose this specification of the factor markets is threefold:

- The continuous equilibrium in these markets allows us to concentrate on the effect federal agency credit activity has on the price signals received by firms, for example, the conditions under which federal agency loans in the financial market for type one capital lead to a price signal that causes the producers of capital of type one to increase production, and the signals the producers of type two capital and of consumption goods receive.
- Many markets appear to fit our specification. For example, the housing market is one in which existing assets are sold on a competitive market. The bidding on this market establishes prices of housing and construction firms, seeing this price, produce new houses.

- The existence of a market for existing assets has important implications for the question of whether the private sector mitigate the federal agency credit activities. This will be discussed below.

The linkage between the real and financial sectors is provided by relationships between the price of types one and two capital (p_{k_1} and p_{k_2}) and the rental rates, or rates of return, for types one and two capital, r_{k_1} and r_{k_2} respectively. We postulate the following relations: [8]

$$r_{k1}=\frac{R^1\ (p_{k1},\ p_{k2})}{p_{k1}},\ R_1{}^1<0,\ R_2{}^1>0$$

$$r_{k2}=\frac{R^2\ (p_{k1},\ p_{k2})}{p_{k1}},\ R_1{}^2>0,\ R_2{}^2<0.$$

An explanation of the power of the above assumptions is in order. Assume there is an exogenous change in the preferences of portfolio holders: they desire to hold more type one capital. One channel of transmission of this preference change is as follows: since the stock of type one capital is fixed in the short-run, the return on this capital must fall in order to dampen demand for it. Our above assumption postulates that this fall in the return of type one capital reduces the rental rate on capital and increases the price of capital. The increased price stimulates production of this type of capital. In short, an increased demand for type one capital stimulates production of this capital. Such a response seems necessary for dynamic stability of the system.

ASSET MARKET

The asset market is described by the portfolio decisions of both the households and the financial intermediaries. Household decisions are summarized in a set of asset demand equations which describe how individuals allocate a given stock of wealth across alternative assets. The asset and debt holdings of the household sector consist

[8] Technically, it is not justifiable simply to assume the signs of the above derivatives. Rather, the relationships should be derived from our model. Such a derivation will depend on the relative capital intensities of the three sectors. In this version of our paper, instead of postulating the capital intensities that are necessary for the above signs, we posit the signs directly.

of outside money, government bonds, deposits at a financial intermediary, two types of real capital, and two types of loans. The private financial sector's decisions center on allocating its stock of deposit and other liabilities across alternative assets. In our model, the private financial sector consists of only one intermediary whose source of funds is its deposits and whose use of funds includes government security holdings, money, and two types of loans. This particular simplifying assumption presumes that all intermediaries are identical. We also assume this intermediary has no net worth.

HOUSEHOLD ASSET DEMANDS

The households' asset demand equations are derived from a utility maximizing framework where asset holdings are subject to a wealth constraint. Wealthholders demand for assets are represented by:

H Wealth owners' demand for government bonds

J_1 Wealth owners' demand for type one capital

J_2 Wealth owners' demand for type two capital

DD Wealth owners' demand for the deposits of the financial intermediaries

O Wealth owners' demand for outside money

Households may borrow from the bank for the purposes of holding real capital. These loan demands are represented by:

L_1 Wealth owners' demand for loans to finance type one capital purchases

L_2 Wealth owners' demand for loans to finance type two capital purchases

The presence of debt financed equity holdings results in J_1 and J_2 including both equity and debt financed capital demands.

The structure of the asset demand functions parallels that of Tobin and Brainard.[9] Asset demands are affected by the assets own return and the return on substitutes for the asset. Income and wealth also affect asset demands. Since households may borrow from the bank for the purposes of holding real capital, capital demands will be

[9] J. Tobin, "A General Equilibrium Approach to Monitary Theory," in J. Tobin, ed., *Macroeconomics* (Holland, 1971); and J. Tobin and W. Brainard, "Pitfalls in Financial Model Building," *American Economic Review* (March 1968).

affected by the interest cost of loans. Loan demands will depend upon the loan rate and the return on the capital purchased by the loan, as well as on income and wealth.

Asset demand equations, then, are summarized by:

$$H = H[r, y, W]$$
$$J_1 = J_1[r, R_1, y, W]$$
$$J_2 = J_2[r, R_2, y, W]$$
$$DD = DD[r, y, W]$$
$$O = O[r, y, W]$$
$$L_1 = L_1[r_{k_1}, R_1, y, W]$$
$$L_2 = L_2[r_{k2}, R_2, y, W]$$

where r is a vector of asset returns

$$r = \{r_{k1}, r_{k2}, r_B, r_D, r_m\}$$

with

r_{k1} The real return on type one capital

r_{k2} The real return on type two capital

r_B The real return on government bonds

r_D The real return on deposits held at the financial intermediary

r_m The real return on outside money.

and R_1 and R_2 are loan rates on type one and type two loans, respectively, y is the real income and W is real wealth. The household budget constraint is that the sum of asset demands equal private sector wealth or that

$$W = J_1 + J_2 + H + DD + O - L_1 - L_2$$

Note again that $(J_1 - L_1)$ and $(J_2 - L_2)$ are equity holdings of types one and two capital. The wealth constraint imposes the restriction that

$$J_{1W} + J_{2W} + H_W + DD_W + O_W - L_{1W} - L_{2W} = 1$$

and that

$$J_{1r_i}+J_{2r_i}+H_{r_i}+DD_{r_i}+O_{r_i}-L_{1r_i}-L_{2r_i}=0,\ i=B,\ M,\ K_1,\ K_2.$$

$$J_{1R_1}-L_{1R_1}=0$$

$$J_{2R_2}-L_{2R_2}=0$$

where A_W is the partial derivative of asset demand 'A' with respect to real wealth and A_{r_i} is the partial derivative of asset demand 'A' with respect to return i. The adding up constraints imply that only six of the seven demand equations are independent.

We will assume that all assets are gross substitutes, that is, that an increase in one asset's rate of return will raise the demand for that asset and reduce or leave unchanged the demand for all other assets, ceteris paribus.[10] In order to keep our results tractable, we will hold wealth fixed, an assumption which does not alter the conclusions of our asset market analysis in any significant way.[11] In order to close the model, we will hold income constant throughout our analysis of the asset market. Future research will close the model by adding real sector adjustments.

The arguments of the asset demand equations implicitly assume that credit is not fungible, that is, that the availability of type one and type two loans only affect the demand for type one capital and type two capital, respectively, An alternative hypothesis is that credit is fungible, that is, that a loan issued to finance (say) one type of capital holdings may be indirectly used to finance holdings of another type of capital. Thus, if mortgages are plentiful, an advocate of the fungibility hypothesis would argue that homeowners will increase their mortgage-equity ratios and use the resultant available funds to purchase other assets. As a result, loan rates will affect all asset

[10] Blanchard and Plantes identify the restrictions imposed on the covariance matrix of asset returns for assets to be gross substitutes. O. Blanchard and M. K. Plantes, "A Note on Gross Substitutability of Financial Assets," *Econometrica* (April 1977).

[11] Specifically, H, DD, and M, will be less sensitive to r_{k1} and r_{k2} as a result of keeping wealth fixed, but will still be reduced by increases in r_{k1} and r_{k2}. J_1 and LL_1 will be less sensitive to r_{k2} and more sensitive to r_{k1}. J_2 and LL_2 will be less sensitive to r_{k1} and more sensitive to r_{k2}.

demands and conversely loan demands will be influenced by all asset returns for which substitution is profitable. Thus, the fungibility hypothesis argues that the total credit availability and not its composition determines macroeconomic outcomes. The implications of the fungibility assumption will be discussed below.

FINANCIAL INTERMEDIARIES

As mentioned above, the model consists of one intermediary whose liabilities consist solely of deposits and whose assets consist of outside money, government bonds, and loans. We define the intermediary's demand functions as:

DD^f intermediary's demand for deposits

eDD^f intermediary's demand for outside money

bDD^f intermediary's demand for government bonds

l_1DD^f intermediary's demand for type one loans

l_2DD^f intermediary's demand for type two loans

Since the intermediary's asset holdings are constrained by its deposit liabilities,

$$e+b+l_1+l_2=1$$

We assume that the intermediary is a profit maximizer with constraints imposed by government reserve requirements and liquidity considerations. Thus returns on assets held by the intermediary will influence asset holdings. Again, we assume gross substitutability on the part of the intermediary, that is, that an increase in one asset's return will increase the share of deposit liabilities allocated to that asset and reduce or leave unchanged the share going to other assets. Increases in the deposit rate and decreases in asset returns will decrease the bank's demand for deposit liabilities, ceteris paribus. Thus:

$$DD^f=DD^f[r_D, r^f]$$

$$e=e(r_f, Z)$$

$$b=b(r_f, Z)$$

$$l_1=l_1(r_f, Z)$$

$$l_2=l_2(r_f, Z)$$

where r_f is a vector of asset returns relevant to the intermediary's behavior

$$r_f = \{r_m, r_B, R_1, R_2\}$$

and Z is the required reserve ratio. Since the intermediary can hold excess reserves, $e > Z$. The assets equal liabilities constraint of the intermediary implies that

$$e_{r_i} + b_{r_i} + l_{1r_i} + l_{2r_i} = 0$$

where d_{r_i} is the partial derivative of share 'd' with respect to asset return i.

EQUILIBRIUM IN THE ASSET MARKET

The equilibrium condition in the asset market is that asset demands equal asset supplies. Real private sector wealth is comprised of the following asset supplies:

$$\frac{B}{P} = \text{supply of government bonds}$$

$$P_1k_1 - L_1 = \text{equity in type one capital}$$

$$P_2k_2 - L_2 = \text{equity in type two capital}$$

$$\frac{M}{P} = \text{supply of outside money}$$

where P_1 and P_2 are the price of types one and two capital, respectively, divided by the price of consumption goods, P. Note that all asset supplies are denominated in terms of the price of consumption goods and that deposits are excluded from the definition of real wealth because they are both an asset and liability of the private sector. Note, finally, that the implicit assumption that the debt of the government, $(M+B)/P$, is viewed as net worth of the private sector.

The equilibrium conditions, along with the previously discussed constraints imposed by the household wealth constraint, the balance sheet constraint of the intermediary, and the assumption of gross substitutability are summarized in Table 1.

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TABLE I. ASSET DEMAND, EQUAL ASSET SUPPLY CONDITIONS

$$\frac{B}{P}=H(r,\ y,\ W)+b(r_f)DD(r,\ y,\ W)$$

$$P_1k_1=J_1(r,\ R_1,\ y,\ W)$$

$$P_2k_2=J_2(r,\ R_2,\ y,\ W)$$

$$DD(r_f,\ r_D)=DD(r,\ y,\ W)$$

$$\frac{M}{P}=O(r,\ y,\ W)+e(r_f)DD(r,\ y,\ W)$$

$$l_1(r_f)DD(r,\ y,\ W)=L_1(r_{k1},\ R_1,\ y,\ W)$$

$$l_2(r_f)DD(r,\ y,\ W)=L_2(r_{k2},\ R_2,\ y,\ W)$$

where

$$r=\{r_{k_1},\ r_{k_2},\ r_B,\ r_D,\ r_m\}$$

$$r_f=\{r_B,\ r_m,\ R_1,\ R_2\}$$

Wealth Constraint of Household

$$W=H+J_1+J_2+DD+O-L_1-L_2$$

which implies

$$H_w+J_{1w}+J_{2w}+DD_w+O_w-L_{1w}-L_{2w}=1$$

$$H_{r_i}+J_{1r_i}+J_{2r_i}+DD_{r_i}+O_{r_i}-L_{1r_i}-L_{2r_i}=0$$

Balance Sheet Constraint of Intermediary

$$e+b+l_1+l_2=1$$

which implies

$$e_{r_i}+b_{r_i}+l_{1r_i}+l_{2r_i}=0$$

Private Sector Wealth Definition

$$W=(p_1k_1-L_1)+(p_2k_2-L_2)+\frac{(M+B)}{p}$$

(Continued)

TABLE I. (Continued)

Gross Substitutability Assumption

Household:

$$J_{1r_{k1}}>0 \; J_{2r_{k2}}>0 \; H_{r_B}>0 \; DD_{r_D}>0 \; O_{r_m}>0$$

$$L_{1r_{k1}}>0 \; L_{2r_{k2}}>0$$

All other partial derivatives with respect to asset returns are less than or equal to zero.

Intermediary:

$$DD^{f}_{r_B}>0 \; DD^{f}_{r_m}>0 \; DD^{r}_{k_1}>0 \; DD^{r}_{k_2}>0$$

$$b_{r_B}>0 \; e_{r_m}>0 \; l_{1R_1}>0 \; l_{2R_2}>0$$

All other partial derivates with respect to asset returns are less than or equal to zero.

A few specific comments are in order about the structure of the model presented in Table 1.

Gross Substitutability of the Aggregate Portfolio. While assets are gross substitutes for households and also for the financial intermediary, there is no guarantee that assets will be gross substitutes in the aggregate portfolio of the private sector. This is most clear in the case of the money equilibrium equation. For the households, an increase in the return on deposits will decrease the households' demand for money, ceteris paribus. However, it will also increase its demand for deposits, *DD*, and thus the intermediary's demand for money, $e \cdot DD$. Which effect dominates is unclear, especially if the share of deposits placed in reserves is high. For our analysis, we will assume that assets are gross substitutes in the aggregate portfolio.

Money Supply Effects. Some of our assumptions in modelling the asset market are not innocuous, but are required to keep our results tractable. For example, excluding deposits from the definition of the money supply precludes credit activity influencing the money supply. The hypothesis that federal credit activity influences the money stock is not implausible. It has been argued that the stock of "money" that matters for the determination of aggregate output and the price level is really an "effective money," that is, a combination of money plus outstanding interest-bearing government debt.[12] If this view is correct, then federal credit activity, by increasing government interest-bearing debts, affects macroeconomic variables even if there is no increase in intermediation services or a reallocation of resources.

Second, even if it is only money that matters for macroeconomic analyses and not, in addition, all government interest-bearing debt, there is the possibility that federal credit activity affects the aggregate stock of money. For example, federal agency securities are eligible to be used for repurchase agreements by banks. Such agreements effectively allow banks to use reserves to make loans and reduce reserve levels. As a result, the effective money stock increases. Thus, if banks desire to engage in more repurchase agreements but are constrained by the volume of eligible collateral, an increase in government agency debt can increase the volume of repurchase agreeements and thus the money supply.

Finally, changes in asset returns in response to federal credit activity may result in changes in deposit holdings and, therefore, a more realistically defined money stock.

One Intermediary. By subsuming all private intermediaries into one intermediary, we are not able to examine how competition among private intermediaries is affected by federal credit programs. While our model does address federal credit activity crowding out of "the" private intermediary's services, the reader should note that the type of crowding out we are examining is quite simplistic. We hope in later research to key in more directly on competition between federal and private intermediation.

[12] See The Radcliff Commission, *Report of the Committee on the Working of the Monetary System* (London: Her Majesty's Stationery Office, 1959).

Financial Institution Regulations. As discussed in Section II, regulations on financial institutions may be one reason why federal credit programs exist. Furthermore, they may be one reason why credit programs succeed in reallocating credit flows. The asset market as presented includes no regulation in the case where $Z=0$. Regulation can be introduced however in any or some combination of the following:

(A) $Z \neq 0$

(B) r_D fixed or has a ceiling

(C) R_1 and/or R_2 fixed or has a ceiling.

Fixing the deposit rate causes banks' demand for deposits and the households' supply of deposits to diverge; deposits levels are determined by households in this case. When R_1 (or R_2) is fixed, loan demand and supply are no longer equal. In this case the banks' supply of loans combined with government lending, where appropriate, determine the amount of lending. With flexible loan and deposit rates, competition among intermediaries will result in a predetermined relationship between the return on the intermediaries' use of funds and the deposit rate.

Changes in the Asset Market Structure in Response to Federal Credit Activity. We chose a model with two types of loans and capital to highlight the reallocation effects of federal credit programs; in our comparative state exercises, federal credit activity will be focused on only one of the two sectors. The different forms of federal credit activity can each be represented in the accounting framework and asset demand equations presented here. Direct lending by the Treasury for sector type one borrowing is included in the asset market by replacing the equilibrium condition for type one loans with

$$l_1 DD + \frac{GL}{P} = L_1[r_{k1}, R_1, y, W]$$

and the wealth equation of Table 1 with

$$W = \left(P_1 k_1 - L_1 - \frac{GL}{P}\right) + (P_2 k_2 - L_2) + \frac{M+B}{P}$$

where GL is the nominal amount of direct government lending. A loan guarantee is represented in the asset market by a shift term in the asset demand specifications. As discussed above, guarantees reduce the default risk to the lender, thereby leading to a reduction in the interest rate required to make funds available. Secondary market operations are represented in the asset markets in a way that parallels direct lending since a secondary market maker purchase of a loan asset is essentially a direct loan. To the extent that initial lenders value the extra liquidity of an asset which has a secondary market, a shift parameter is required in the asset demand specification. The federal direct loans and secondary market activities are subject to the requirement that

$$\frac{dB}{p}=\frac{dGL}{p}.$$

Thus government loans will cancel with changes in the stock of bonds in the above definition of wealth. As mentioned above, loan guarantees require no initial financing.

We can do comparative static exercises using the asset market equilibrium conditions only. To do this we must hold income, y, and the price of consumption goods constant.[13] To make our results tractable, we will impose the following restrictions on the asset model presented above:

(A) No asset portfolio adjustment on the part of banks, that is, e, b, l_1 and l_2 are constant.

(B) Only type one capital holdings can be financed by debt holdings, that is, $l_2=0$ and $L_2=0$.

DIRECT GOVERNMENT LENDING FOR TYPE ONE CAPITAL

To start, we assume that the deposit rate is fixed. Under this and our previous assumptions, we evaluate changes in debt-financed government loans for type one

[13] This is equivalent in an IS–LM framework to examining the vertical shift of the asset market equilibrium curve in interest rate-income space in response to exogenous shocks in the asset markets.

capital purchases using the following set of equations:

$$p_1k_1=J_1(\underset{+}{r_{k_1}}, \underset{-}{r_{k_2}}, \underset{-}{r_B}, \bar{r}_D, \bar{r}_M, \underset{-}{R_1}, \bar{y}, \bar{w})$$

$$p_2k_2=J_2(\underset{-}{r_{k_1}}, \underset{+}{r_{k2}}, \underset{-}{r_B}, \bar{r}_D, \bar{r}_M, \bar{y}, \bar{w})$$

$$\frac{B}{p}=H(\underset{-}{r_{k_1}}, \underset{-}{r_{k_2}}, \underset{+}{r_B}, \bar{r}_D, \bar{r}_M, \bar{y}, \bar{w})+\bar{b}\cdot DD(\underset{-}{r_{k_1}}, \underset{-}{r_{k_2}}, \underset{-}{r_B}, \bar{r}_D, \bar{r}_M, \bar{y}, \bar{w})$$

$$l_1\cdot DD(\underset{-}{r_{k_1}}, \underset{-}{r_{k_2}}, \underset{-}{r_B}, \bar{r}_D, \bar{r}_M, \bar{y}, \overline{W})+\frac{GL}{p}=L_1(\underset{+}{r_{k_1}}, \underset{-}{R_1}, \bar{y}, \overline{W})$$

Signs below asset returns indicate the sign of the partial derivative. The money equation is dropped because the wealth constraint makes any one asset demand equation redundant. A fixed deposit rate precludes deposit equilibrium; rather, deposits will be determined by households' demand for deposit holdings at the fixed deposit rate. The return on money is fixed as a result of our holding the price of consumption goods fixed and outside money having no associated nominal rate of return.

The government direct loan is represented by $dGL=dB$.

For the asset market to stay in equilibrium then, the following conditions must hold:

$$\begin{aligned} EDk_1&=0\\ EDk_2&=0\\ EDB&=0\\ ESL_1&=0 \end{aligned}$$

where EDk_1, EDk_2 and EDB are excess demands for k_1, k_2 and bonds, respectively. ESL_1 is the excess supply of loans. Changes in government loans, GL, and government bonds, B, generate excess supplies in the loan market and bond market. Asset returns adjust to eliminate these excess demands and supplies. The adjustments, however, must also insure that the capital markets stay in equilibrium. The necessary adjustment is summarized by:

$$\text{(I)} \qquad \begin{bmatrix} a_{1r_{k_1}} & a_{1r_{k_2}} & a_{1r_B} & a_{1R_1} \\ a_{2r_{k_1}} & a_{2r_{k_2}} & a_{2r_B} & 0 \\ a_{Br_{k_1}} & a_{Br_{k_2}} & a_{Br_B} & 0 \\ a_{L_1r_{k_1}} & a_{L_1r_{k_2}} & a_{L_1r_B} & a_{L_1R_1} \end{bmatrix} \begin{bmatrix} dr_{k_1} \\ dr_{k_2} \\ dr_B \\ dR_1 \end{bmatrix} = \frac{1}{P} \cdot \begin{bmatrix} 0 \\ 0 \\ dB \\ -dGL \end{bmatrix}$$

or

$$\underset{(4\times4)}{\{a_{ij}\}} \; \underset{(4\times1)}{\{dr\}} = \frac{1}{p} \underset{(4\times1)}{X}$$

where

a_{1r} is the change in the excess demand for type one capital in response to a change in asset return r;

a_{2r} is the change in the excess demand for type two capital in response to a change in asset return r;

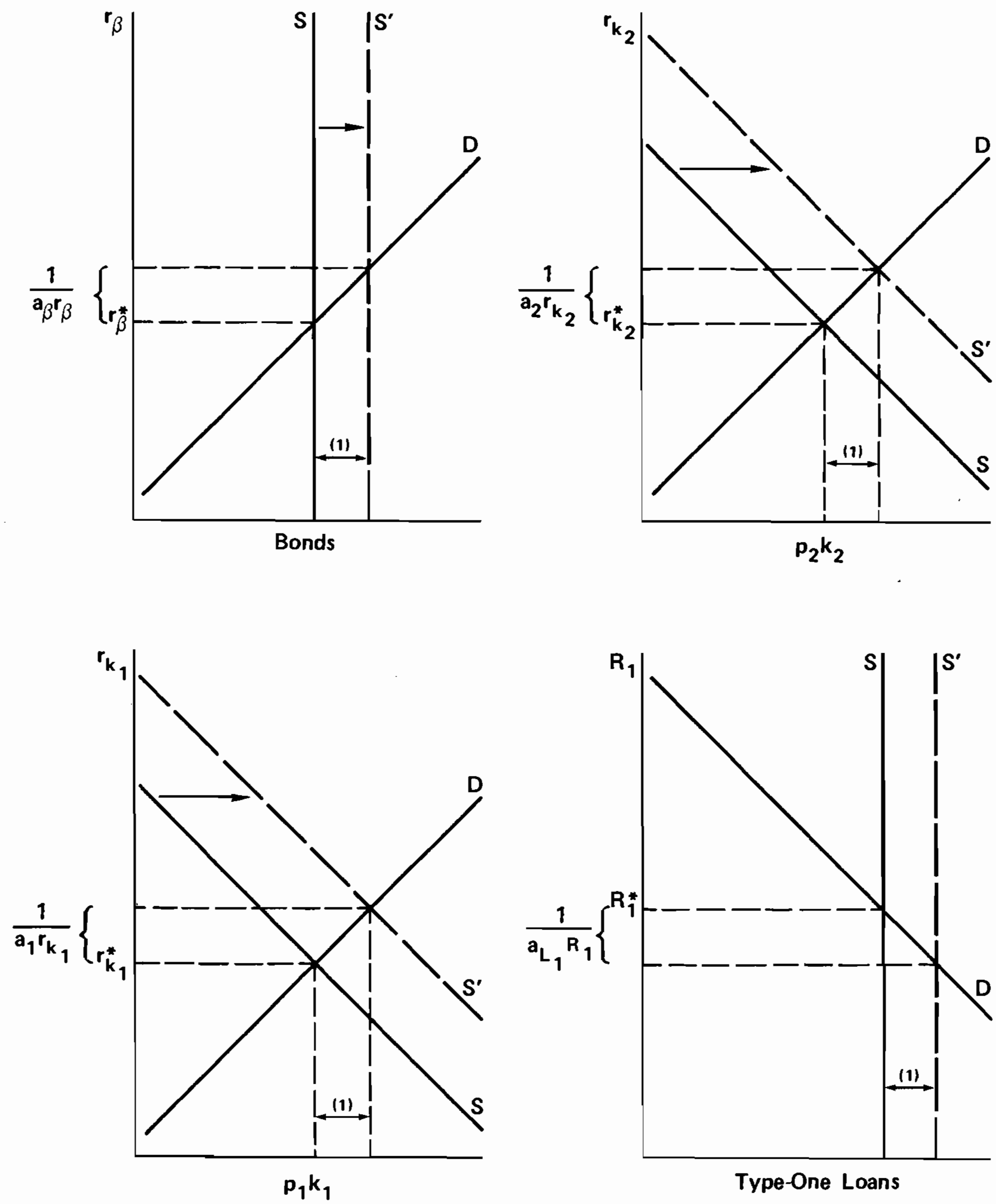
a_{B_r} is the change in the excess demand for bonds in response to a change in asset return r; and

a_{L_1r} is the change in the excess supply of type one loans in response to a change in asset return r.

Figure 3 presents demand and supply curves for the four asset markets described in Figure 1. In the bond market diagram, for example, the demand for bonds is seen as an increasing function of the return on bonds, while the supply is fixed. In a partial equilibrium (that is, bond market only) analysis, a one unit increase in the supply of bonds would require a rise in r_B of $1/a_{Br_B}$, where $1/a_{Br_B}$ is the slope of the bond demand curve and a_{Br_B} measures the responsiveness of a change in the excess demand for bonds to a unit change in r_B, holding all else constant. Demand and supply curves for other assets are presented in Figure 1 also.

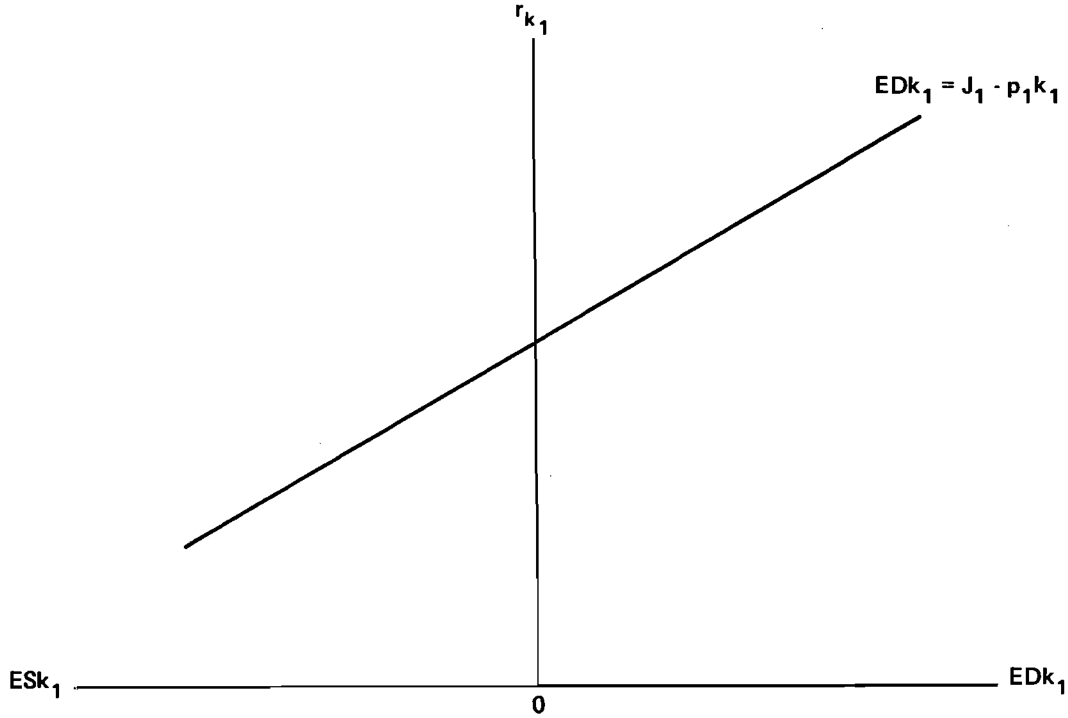
A general equilibrium analysis does not keep all else constant. In Figure 4, we plot the general equilibrium excess demand function for the type one capital market.

Figure 3.
Partial Equilibrium Demand and Supply Curves



In the general equilibrium framework, the $1/a_{ii}$ change in asset return i in response to a one unit excess supply of the asset is no longer sufficient for attaining asset market equilibrium. Rather, the asset return must change in a way that incorporates all linkages existing among markets. The slope of the general equilibrium excess demand function incorporates these linkages.

Figure 4.



The important points to note about the general equilibrium excess demand function (for capital of type one for example) is that the rise in r_{k_1} in response to a one unit increase of asset supply is greater than that indicated in the partial equilibrium analysis of Figure 3; when the capital one market has excess supply and r_{k_1} increases, the spillover effects onto other markets and the resulting feedback effects to the market for capital of type one all tend to reinforce the upward pressure on r_{k_1}. Consider two of these feedback effects:

- An increase in r_{k_1} decreases demand for capital of type two which causes r_{k_2} to rise. This feeds back into the capital-one market, decreasing demand and further increasing r_{k_1}.
- The increase in r_{k_2} also decreases the demand for bonds which causes r_B to rise. This rise in r_B in turn decreases demand for capital of type one which causes r_{k_1} to rise even more.

Thus all asset returns are changing along a general equilibrium excess demand function. (See Appendix B for a mathematical derivation of the slope of the excess demand function.)

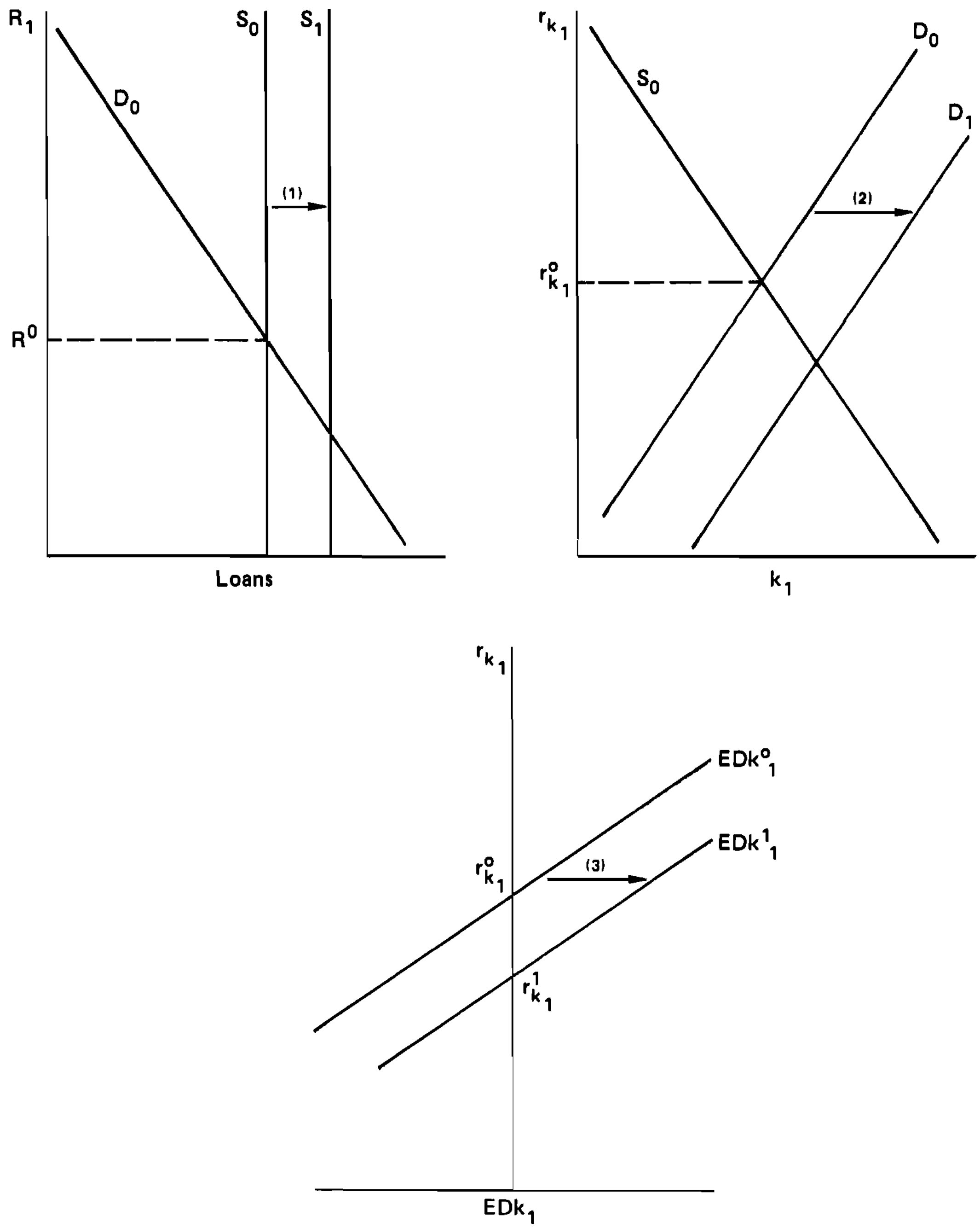
INCREASE IN GOVERNMENT LENDING

An increase in government lending produces, at initial asset returns, an excess supply of type one loans. This is represented in Figure 5 by a horizontal shift of the loan supply curve of $1/p\ dGL$. The asset market adjustment to the increase in loans are labelled numerically in Figure 5 to accompany the following discussion.

(1) At the initial loan rate R_1^0 an excess supply of loans exists leading to a reduction in R_1.

(2) However, declines in the loan rate create an excess demand for capital one. Thus, as a result of the increase in GL, we have an excess demand for capital at the initial value of r_{k_1}.

Figure 5.
Increase in Government Loans



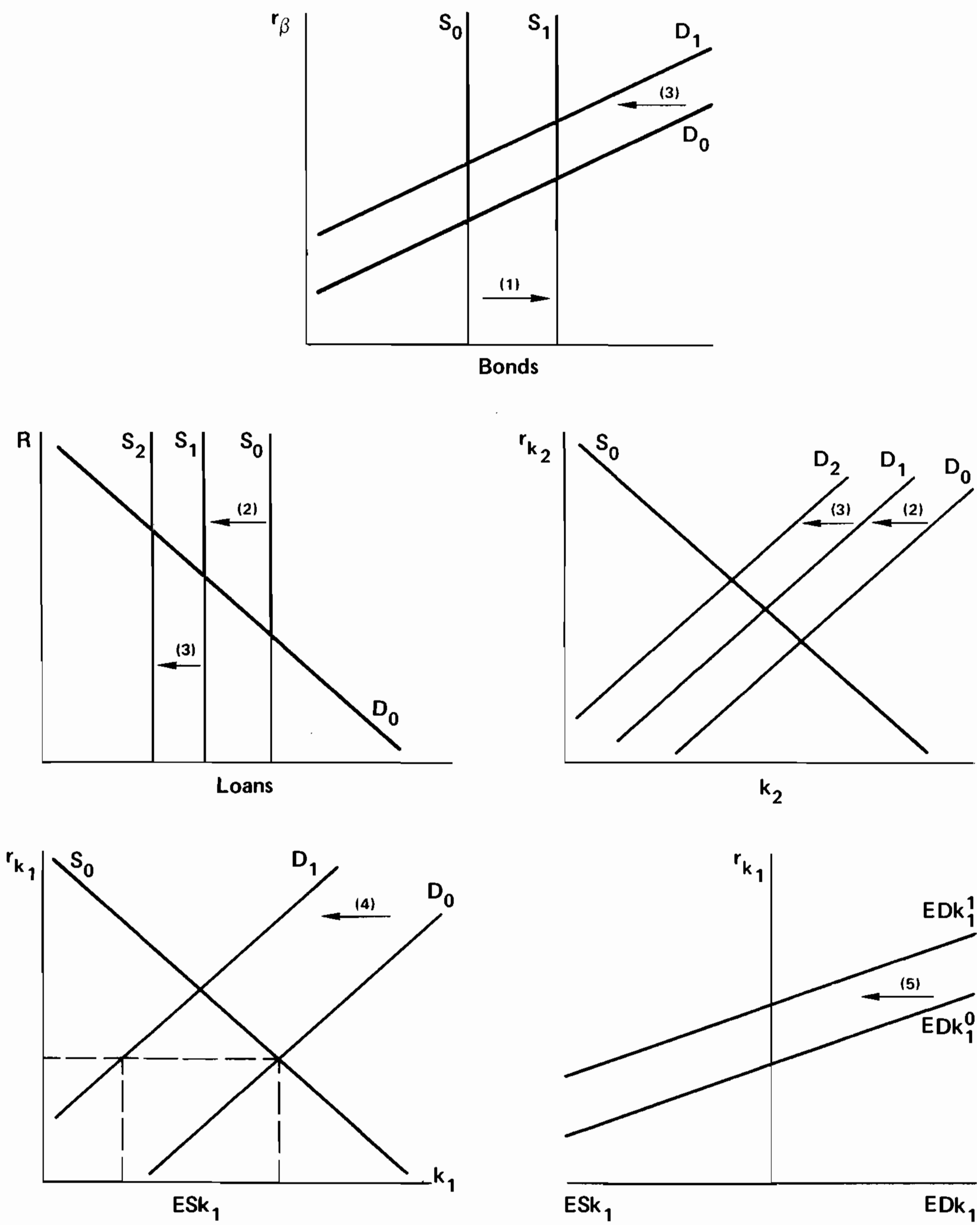
(3) To find the new equilibrium value of r_{k1} we shift the general equilibrium curve to the right by the amount of excess demand generated in step (2) at the initial value of r_{k_1}. Thus r_{k_1} will decline in the general equilibrium analysis to $r_{k_1}^1$. In general, the horizontal shift of the general equilibrium excess demand curve for capital one would include effects such as: a change in the loan rate affecting excess demand for capital two, and the resulting change in r_{k_2} also shifting the excess demand curve for capital one. However, under the present specification of the model, these effects are absent. These effects will be discussed in this paper when we address the issue of fungibility.

As in the partial equilibrium analysis, an increase in government loans leads to a reduction in R_1. The reduction in R_1 is greater in a general equilibrium analysis, however, since changes in asset returns in other markets enhance the excess supply of loans at the initial loan rate. The decline in the return on type one capital is thus greater.

INCREASE IN GOVERNMENT DEBT

The asset market adjustments to an increase in government debt are presented in Figure 6. Shifts are labeled in these diagrams to correspond to the numbering scheme below. In stages (1) through (4) below, we increase the supply of bonds, hold r_{k_1} constant, and analyze the total excess demand created in the market for capital of type one. Then, letting r_{k_1} change, we use the previously derived general equilibrium excess demand curve to analyze the new equilibrium level of r_{k_1}.

Figure 6.
Increase in Government Bonds



(1) An increase in bonds increases rB by

$$\frac{1}{a_{Br_B}}\frac{1}{p}\Delta B$$

(2) The increase in r_B creates an excess demand for loans and an excess supply of type two capital at the initial values of R_1 and r_{k_2}. To clear these markets both the loan rate and type two capital return rise.

(3) Changes in r_{k_2} enhance the disequilibrium in bonds, loans, and type two capital markets as indicated in Figure 6. The three shifts summarize all of the repercussion effects on these markets.

(4) The increases in r_B, R_1 and r_{k_2} create an excess supply of type one capital. Increases in r_B create an excess supply of capital of $a_{1r_B}\Delta r_B$ where a_{1r_B} measures the sensitivity of the excess demand for type one capital to r_B. Increases in R_1 and r_{k_2} increase the excess supply of type one capital by $a_{1R_1}\Delta R_1$ and $a_{1r_{k_2}}\Delta r_{k_2}$, and cause r_{k_1} to rise.

FEDERAL CREDIT ACTIVITY

The analysis presented above argued that increases in government loans reduce r_{k_1} while increases in government debt required to finance the loan operations increase r_{k_1}. Which affect dominates depends upon whether the excess supply of type one capital arising from debt finance exceeds the excess demand of type one capital arising from government lending at the initial r_{k_1} level, that is, whether the ED_{k_1} function of Figure 4 shifts right or left. A net leftward shift insures a reduction of r_{k_1} and an increase in p_1, changes which signal producers to increase the flow supply of new type one capital.

We gain some insights into the general equilibrium effect of bond financed federal lending by decomposing the effects into the creation of excess demand in the market for type one capital (the horizontal shift of the excess demand curve in Figure 4) and the response of r_{k_1} to this excess demand (the movement along the new general equilibrium excess demand curve).

The necessary condition for a decrease in r_{k_1} is:

$$(1) \qquad a_{1R_1}\Delta R_1^* + a_{1r_B}\Delta r_B^* + a_{1r_{k_2}}\Delta r_{k2}^* > 0$$

where a_{1R}, $a_{1r_B}^*$ and $a_{1r_{k2}}$ are all less than zero. The above condition implies a rightward shift of the Figure 4 excess demand curve which would lower r_{k_1}. The variables ΔR_1^* Δr_B^* and Δr_{k2}^*. are the changes in R_1, r_B, and r_{k_2} following a federal credit transaction, holding r_{k_1} fixed at its initial level. Thus they are partial equilibrium changes. Clearly the general equilibrium changes in these returns will differ since changes in r_{k_1} affect the loan, bond, and type two capital market; the general equilibrium changes will be of the same sign, however. The values of ΔR_1^*, Δr_B^* and $\Delta r_{k_2}^*$ are

$$(2) \qquad \Delta R_1^* = \frac{1}{A}[a_{2r_B}a_{Lr_{k_2}} + a_{2r_B}a_{Br_{k_2}} - a_{2r_{k_2}}a_{L_1r_B} - a_{B2 \cdot k_2}a_{r_B}] \gtrless 0$$

$$\Delta r_B^* = \frac{1}{A}{}_{2k}a_{r_2}a_{L1K1} > 0$$

$$\Delta r_{k2}^* = -\frac{1}{A}a_{2r_B}a_{L_1R_1} > 0$$

where A is a positive constant equal to the cofactor of a_{11} in $\{a_{ij}\}$.

The increase in both r_B and r_{k_2} is unambiguous. From inequality one we see these increases tend to diminish (if not reverse) the rightward shift of the excess demand curve for capital one. Higher bond and type two capital returns discourage type one capital holdings leading to an excess supply of type one capital and pressures for r_{k_1} to rise. This is part of the crowding out accompanying federal credit programs' attempts to lower the return on the targeted capital.

The sign of the other determinant of the shift in the excess demand curve, ΔR_1^*, is ambiguous. The increased supply of government loans creates an excess supply of loans. However, increases in r_B and r_{k_2} lead to a reduced supply of private loans to finance type one capital purchases. Which effect dominates determines the sign of ΔR_1^*. If ΔR_1^* is positive, then an even greater excess supply of type one capital arises, leading to an unambiguously positive increase in r_{k_1}. In the event that ΔR_1^* is negative, the implications for the type one capital market are unclear. A negative ΔR_1^* will increase type one capital demand while positive Δr_B^* and $\Delta r_{k_2}^*$ will decrease type one capital demand. The more substitutable are bonds and type one capital or type one and type two capital and the less sensitive is capital demand to the loan rate, the greater is the crowding out of federal loans to finance type one capital purchases.

GENERAL EQUILIBRIUM MODEL VERSUS "STRAW MAN" MODEL

The results above argue strongly that there is no guarantee that federal lending to the private sector will provide an equivalent increase in the production of new capital. Increases in the return on bonds and the return on other capital accompanying the increased supply of government bonds result in:

- Less private intermediation in the targeted loan market, and
- Less equity demand for the targeted capital.

Both contribute to smaller reductions in r_{k_1} and may even result in no decline in p_1.

A third source of crowding out may arise from credit being fungible, that is, loans for type one capital being used to finance purchases of other assets. Meltzer, for example, argues that a government-induced increase in the supply of mortage loans merely leads private households to substitute debt for equity in the financing of housing.[14]

The extent of credit fungibility depends on the structure of the capital goods markets. If there is no market for existing capital, then new government loans which are tied to the purchase of type one capital must lead to the purchase of new capital of an equivalent nominal value. For example, government loans to finance synthetic fuel projects will lead to new fuel plants since the borrowers must purchase fuel plants and the market for existing plants is thin.

If there is a market for existing capital, however, the agency loans may be used to purchase existing capital. Presumably the purchase of existing capital bids up its price

[14] A. H. Meltzer, "Credit Availability and Economic Decisions: Some Evidence from the Mortgage and Housing Markets," *Journal of Finance* (June 1974).

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and thus the seller of capital may not reinvest his funds in the type of capital he just sold. The funds may be used to purchase bonds, for example. Thus the effect on the stock of type one capital will depend on (1) the feedback effect on the type one capital market from adjustments in the bond market, for example, and (2) the response of the producers of type one capital to the increased price. To the extent that this occurs, credit will appear fungible in the aggregate, although it may not be for the individual household. As mentioned above in the description of the real sector of the model, we assume there exist perfect markets for capital, an assumption quite realistic for the housing and other markets.

We can examine the implications of fungibility for the effectiveness of federal credit activity by respecifying the asset market behavioral equations to include the loan rate. We have:

$$J_1 = E_1 + L_1$$

where J_1 is total demand for type one capital, E_1 is equity holdings of capital, and L_1 is, as before, debt financed holdings of capital. In the nonfungible case, the loan rate only affects borrowing and, thus,

$$J_{1R_1} = L_{1R_1}.$$

In this case equity holdings are independent of the loan rate.

In the case where credit is fungible, lower borrowing rates may induce households to substitute debt finance for equity finance of type one capital holdings and use the freed equity to purchase other assets. In this case

$$E_{1R_1} > 0 \text{ and } |J_{1R_1}| < |L_{1R_1}|$$

where E_{1R_1} is the sensitivity of equity holdings to the loan rate.

In addition, we need to respecify loan demand to depend on any asset return whose value exceeds the borrowing rate (say r_B and r_{k2})

$$L_1 = L_1(r_{k1}, R_1, r_{k2}, r_B, \bar{r}_M, \bar{r}_D, \bar{y}, \bar{W})$$

with $L_{1r_{k_2}}>0$ and $L_{1r_B}>0$. For example, if r_{k2} increases and credit is fungible, the demand for type one capital loans may increase; substitution of debt for type one equity provides funds to purchase type two capital. We also need to include the lending rate in any asset demand function whose own return exceeds the borrowing rate.

$$H=H(r_{k1}, r_{k2}, r_B, r_M, r_D, R_1)$$

$$J_2=J_2(r_{k1}, r_{k2}, r_B, r_M, r_D, R_1)$$

with $H_{R_1}<0$ and $J_{2R_1}<0$.

As before the horizontal shift of the general equilibrium excess demand function for type one capital is

$$EDk_1=a_{1R}\Delta R^*+a_{1r_B}\Delta r_B+a_{1r_{k_1}}\Delta r^*_{k_1},$$

and the change in r_{k_1} depends upon the size and sign of EDk_1 and the slope of the general equilibrium excess demand function for type one capital. Credit fungibility affects both of these determinants.

Fungibility may affect the size and sign of EDk_1 at the initial level of r_{k1}; interestingly, the change is not entirely in the direction argued by Meltzer and others. With fungible credit we redefine ΔR^*_1, Δr^*_B and $\Delta r^*_{k_2}$ as

$$\Delta R^*_k=\frac{1}{A}[a_{2r_B}a_{L_1r_{k_2}}+a_{2r_B}a_{Br_{k_2}}-a_{2r_{k_2}}a_{L_1r}-a_{2rB_{k_2}}a_{Br_B}]\gtrless 0$$

$$\Delta r^*_B=\frac{1}{A}[a_{2r_{k_2}}a_{L_1R_1}+a_{2r_{k_2}}a_{BR_1}-a_{L_1r_{k_2}}a_{2R_1}-a_{Br_{k_2}}a_{2R_1}]\gtrless 0$$

$$\Delta r^*_{k_1}=\frac{1}{A}-[a_{2r_B}a_{L_1R_1}+a_{2r_B}a_{BR_1}-a_{2R_1}a_{L_1R}\mathrm{F}-a_{Br_B}a_{2R_1}]\gtrless 0$$

If we assume that the a_{ij}, $j=r_{k1}, r_{k2}, r_B$ are not changed by the introduction of fungibility and that the change in $a_{L_1R_1}$ is small, the EDk_2 is affected by fungibility in the following ways:

- Whereas r_B and r_{k_2} unambiguously rise in the no fungibility case, fungibility generates some excess demand pressures in the bond and type two capital market to offset the excess supply pressures resulting from bond financing. Reductions in the loan rate following increased government lending now increase the demand for bonds and for type two capital and reduce the increase in r_B and r_{k_1} required to equilibrate these markets. In essence fungibility *reduces crowding out* of type one capital holdings that generally accompanies bond financing.

- Fungibility has an effect on ΔR_1^* also. A smaller excess supply (and hence decline in R_1^*) may arise because increases in r_B and r_{k_2} to clear the bond and type two capital markets will increase the demand for loans. The stronger is the sensitivity of loan demand to r_B and r_{k_2}, the greater is this effect.
- In the event of a net excess supply of loans and reduction of R_1, the decline in R_1 has less of an effect on the excess demand for type one capital and the resultant decline in r_{k_1}. This is because fungible credit provides for households substituting debt financing for equity financing, thus reducing the size of a_{1R}.

The change in r_{k_1} for a unit increase in the excess supply of type one capital is

$$\frac{A}{\det\{a_{ij}\}}$$

and

$$\Delta r_{k_1} = [EDk_1] \cdot \frac{A}{\det\{a_{ij}\}}.$$

The bigger is the determinant of $\{a_{ij}\}$, (that is, the flatter is the excess demand for type one capital in Figure 4) the smaller is the change in r_{k_1} accompanying the excess demand or supply of type one capital at the initial level of r_{k_1}. Appendix C shows that credit fungibility, as defined here, leads to smaller changes in r_{k_1} in response to excess demands or supplies of type one capital.

In conclusion, credit fungibility reduces the excess demand for type one capital accompanying direct government lending and reduces the reduction in r_{k_1} required to equilibrate asset markets. However, it also reduces the excess supply of type one capital accompanying the financing of government lending and reduces the increase in r_{k_1} required to equilibrate the asset markets. Credit fungibility, in and of itself, is not sufficient for preventing a reallocation of credit flows as a result of federal credit programs.

We have not completed our analysis of federal lending under alternative scenarios about financial regulation. Moving from a fixed deposit rate to a variable deposit rate has an ambiguous effect on the excess demand for type one capital. On the lending side, the variable rate leads to a smaller ΔR_1^*, as reductions in R_1 induce reductions in r_D and hence disintermediation. However, a larger shift in the excess demand function for any given ΔR_1^* occurs because the accompanying decline in r_D increases equity demand. On the financing side, less disintermediation and therefore a smaller excess supply of type one capital accompanies the increase in government bonds and R_1, but the higher deposit rates contribute directly to the excess supply of capital by reducing type one equity demand. The analysis of fixed loans rates is complicated by whether quantity of credit influences asset demands in the fungible credit case.

SUBSIDIES, GUARANTEES, AND SECONDARY MARKET OPERATIONS

Section II of the paper argued that government subsidies, guarantees, and creation of secondary market operations, to the extent that they reduce interest rates charged by lenders, shift the supply curve of type one capital loans rightwards. In our model, this occurs only when loans are substitutable with other assets in the portfolio of financial intermediaries. Substitution occurs when the intermediary's share of deposits allocated to different assets (b, e, l_1 and l_2) varies with changes in bond and loan returns, as described in Table 1.

Given endogenous bank behavior, we can analyze the effect of a subsidy guarantee or secondary market operation which shifts the supply curve of loanable funds downwards by an amount S as shown in Figure 2. In the case of endogenous bank behavior, the loan supply curve becomes and its slope becomes

$$GL+l_1(r_B, R_1, Z)DD(\ \ )$$

$$\frac{1}{l_{1R_1}} \cdot DD(\ \ )$$

A subsidy changes the loan rate received by the intermediary from R_1 to

$$R_{1f}=R_1+S$$

While a guarantee or the creation of a secondary market for a loan asset maintains the equality between the loan rate paid by the borrower and received by the intermediary, it alters the share of deposits banks allocate to loans and bond holdings at existing returns on these assets. This change can be represented by a shift term, γ, in the intermediary's asset demands

$$\begin{array}{ll} l_1(R_1, r_B, Z, \gamma) & l_4>0 \\ b(R_1, r_B, Z, \gamma) & b_4 \gtrless 0 \\ e(R_1, r_B, Z, \gamma) & e_4 \gtrless 0 \\ & l_4+b_4+e_4=0 \end{array}$$

We can analyze the general equilibrium response to a loan subsidy paid to an intermediary by:

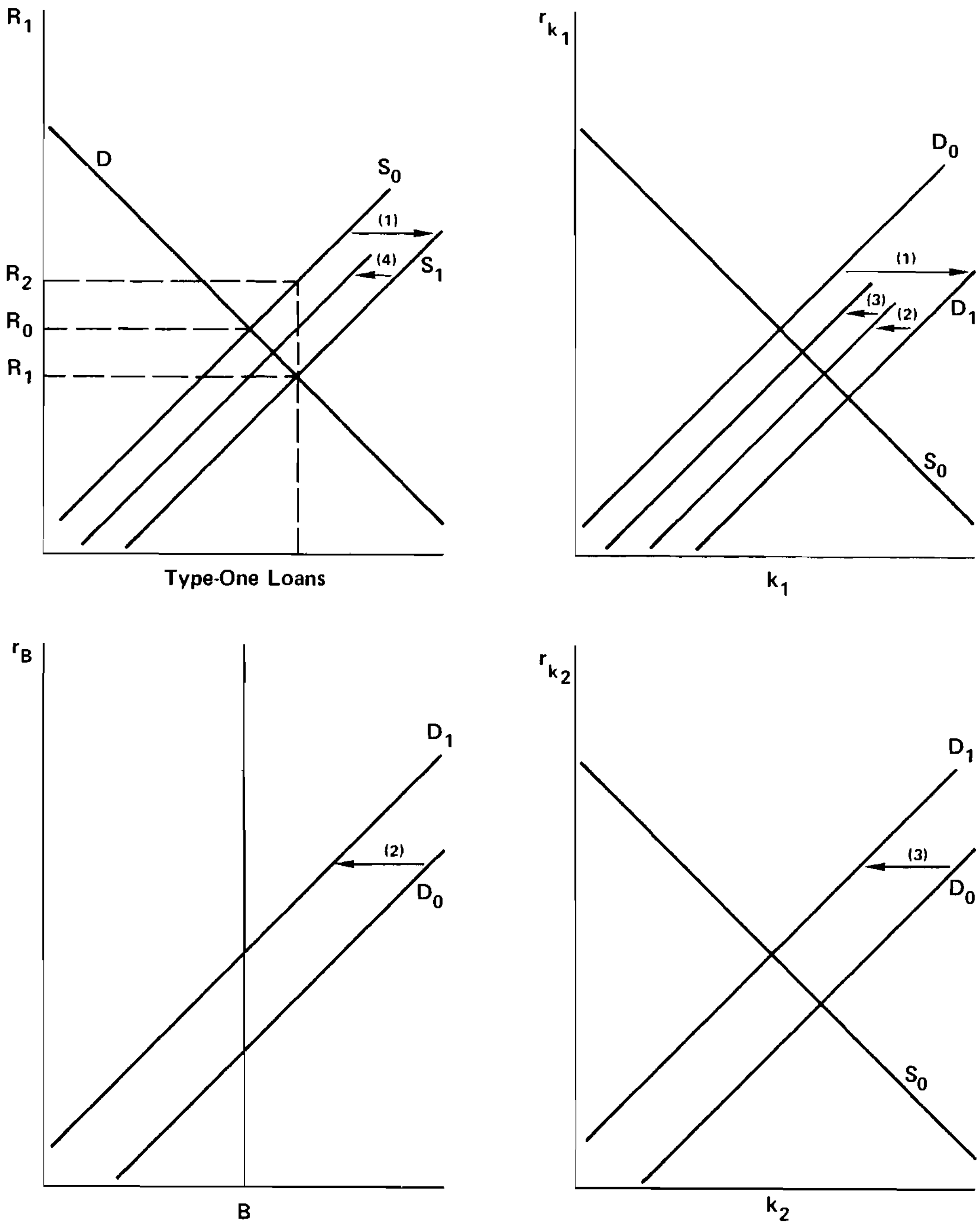
$$\text{(I1)} \qquad \begin{bmatrix} a_{1r_{k_1}} & a_{1r_{k_2}} & a_{1r_B} & a_{1R_1} \\ a_{2r_{k_2}} & a_{2r_{k_2}} & a_{2r_B} & 0 \\ a_{Br_{k_1}} & a_{Br_{k_2}} & a_{\beta r_B}+b_{r_B} \cdot DD & b_{r_{1f}} \cdot DD \\ a_{L_1r_{k_1}} & a_{L_1r_{k_2}} & a_{L_1r_B}+l_{1r_B} \cdot DD & a_{L_1R_1}+l_{1r_{1f}} \cdot DD \end{bmatrix} \begin{bmatrix} dr_{k_1} \\ dr_{k_2} \\ dr_B \\ dR_1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ -b_{R_{1f}} \cdot DD \\ -l_{1R_{1f}} \cdot DD \end{bmatrix} dS$$

$$\underset{(4\times 4)}{\{a'_{ij}\}} \quad \underset{(4\times 1)}{\{dr\}} = \underset{(4\times 1)}{X\ dS}$$

where $|b_{R_{1f}}DD|dS$ is the excess supply of bonds and $|l_{1R_{1f}}DD|dS$ is the excess supply of loans accompanying a government interest subsidy of dS.

Figure 7 examines the markets' responses to the shift in the loan supply curve. The asset market adjustments are labelled to coincide with the following discussion:

Figure 7.
Interest Rate Subsidy



(1) The subsidy creates an excess supply of loans leading to a fall in the interest rate paid by borrowers (R_1). Since, in this case, we are assuming no fungibility, there is no feedback on the borrower's demand for type two capital or bonds. The financial intermediary is now receiving R_2. The difference between R_2 and R_1 is the amount of the interest rate subsidy. The increase in the amount of loans increases the demand for type one capital.

(2) However, where do the funds for the new loans come from? The financial intermediary, seeing its returns on loans increase to R_2, decreases its demand for bonds. This increases r_B which decreases the demand for k_1.

(3) The increase in r_B also decreases the demand for capital of type two, and increases its rate of return which decreases the demand for capital of type one.

(4) Higher r_B and r_{k_2} reduce deposit demand, leading to a reduction in the supply of type one loans. Whether the size of this shift exceeds the initial shift will be discussed below.

The excess demand for type one capital at the initial r_{k_1} is

$$a_{1r_{k_2}}\Delta r^*_{k_2}+a_{1r_B}\Delta r^*_B+a_{1R_1}\Delta R^*_1$$

where $\Delta r^*_{k_2}$, Δr^*_B and ΔR^*_1 are the changes in r_{k_2}, r_B, and R_1 following the subsidy guarantee, or secondary market creation, holding r_{k_1} fixed

$$\Delta r^*_{k2}=\frac{1}{A}[a_{2r_B}b_{R_{1f}}\cdot DDa_{L1R1}]>0$$

$$\Delta r^*_B=\frac{-1}{A}[a_{2r_{k2}}b_{R_{1f}}\cdot DDa_{L1R1}]>0$$

$$\Delta R^*_1=\frac{1}{A}[l_{1R}\cdot DD[a_{2r_B}a_{Br_{k_2}}-a_{2r_{k_2}}(a_{Br_B}+b_{r_B}\cdot DD)]+b_{R_1}DD[a_{2r_{k_2}}(a_{L1r_B}+l_{1r_B}\cdot DD)-a_{2r_B}a_{L1r_{k_2}}]]\gtrless 0$$

where A is the cofactor of a_{11} in $\{a_{ij}\}$ and $A>0$.

The sign of ΔR^*_1 is ambiguous as the subsidy increases loan supply, driving down R_1 (that is, the $l_{1R_{1f}}\cdot DD[\quad]$ term in ΔR^*_1) but the increase in r_B and r_{k_1} cause disintermediation and upward pressure on R_1 (that is, the $b_{R_{1f}}\cdot DD[\quad]$ term in ΔR^*_1).

ΔR_1^* will be negative if

$$l_{1R_{1f}}[a_{2r_{k_2}}(a_{Br_B}+b_{r_B}\cdot DD)]>b_{R_{1f}}[a_{2r_{k_2}}(a_{L1r_B}+l_{1r_B}\cdot DD)]+a_{2r_B}[-b_{R_{1f}}a_{L1r_{k_2}}+l_{1R_{1f}}a_{Br_{k_2}}]$$

Under the assumption of gross substitutability of assets for both households and the intermediary

$$l_{1R_{1f}}\geq b_{R_{1f}}$$

$$a_{Br_B}+b_{r_B}\cdot DD\geq a_{L_1r_B}+l_{1r_B}\cdot DD$$

These conditions cannot guarantee a fall in R_1^* however and, therefore, an excess demand for type one capital at the initial r_{k_1} arising from R_1 changes. If the intermediary significantly adjusts its bond demand rather than its reserve demand following the subsidy ($b_{R_{1f}}$ large), if the sensitivity of household's bond and deposit demand to r_{k_2} ($a_{Br_{k_2}}$ and $a_{L_1r_{k_2}}$ respectively) is large, and/or if the response of type two capital demand to r_B changes is large (a_{2r_B}), R_1 will fall by much less and may in fact rise. Such a rise, combined with the increase in r_{k_2} and r_B, would lead to an excess supply of type one capital, a reduction in the supply price of type one capital, and a reduction over time in the production of type one capital.

The analysis of a loan guarantee or the creation of a secondary market would parallel the above discussion. The right hand vector in (II) would be replaced by

$$\begin{bmatrix} 0 \\ 0 \\ -b_\gamma DD \\ -l_\gamma DD \end{bmatrix} d_\gamma$$

If $b_\gamma<0$, that is, if a loan guarantee leads to a decline in the share of deposits banks allocate to bonds, the effect on r_{k_1} would, again, be ambiguous. If $b_\gamma>0$, that is, if guarantees and creation of a secondary market cause intermediaries to increase its loan and bond share (and reduces its cash share), r_{k_1} would unambiguously decline.

The analysis presented here demonstrates that power of general equilibrium framework for evaluating the effects of federal credit activity. Whereas the partial equilibrium analysis indicates that guarantees, subsidies, and the creation of a secondary market for an existing loan asset will allocate credit in a desirable fashion, the general equilibrium analysis identifies offsetting changes in other markets and a resultant disintermediation in the market of interest to policymakers. Note that this section did not address financing of subsidies; financing may be contemporaneous or occur at a later date. In either case, debt financing is accompanied by crowding out of type one capital holdings and private sector disintermediation.

SECTION V. THE MONETARY MECHANISM AND CONCLUSION

Federal credit activity may affect the transmission mechanism for monetary policy. Traditionally, housing starts are sensitive to monetary policy and changes in housing starts lead the business cycle. To the extent that credit availability affects housing starts,[15] federal credit activity aimed at maintaining the supply of mortgage funds available to housing will mitigate monetary policy's effect on housing starts. In future research, we hope to address this issue as well as the effects of federal credit activity on the money supply as discussed in Section III.

This paper attempted to develop an analytic framework for assessing the macroeconomic consequences of federal credit activity. We started by imposing a set of assumptions that allowed us to view all federal credit programs as analagous to the Treasury acting as a financial intermediary. We then argued that all credit programs are characterized by at least one of the following:

- Substitution of private sector credit worthiness for government,
- Credit worthiness,
- Loan guarantees,
- Secondary market creation and operations, or
- Subsidies.

[15] See Meltzer, "Credit Availability and Credit Decisions."

These activities will achieve their objective only if they succeed in reallocating credit flows to the sector on which federal credit programs are targeted.

In this paper we analyzed the conditions under which federal credit programs can reallocate credit. This analysis demanded a general equilibrium framework, that is, one incorporating the response of all asset and goods markets to federal credit programs. In this paper we analyzed only the asset market response to bond-financed federal credit programs. The asset market analysis indicated that three aspects of the private sector response to federal credit programs may, in fact, reverse the desired effect of direct lending programs:

- Disintermediation in private sector financial institutions which reduces the supply of private sector loans to the targeted sector;
- Crowding out of equity financed holdings of the targeted capital;
- Substitution of debt financed for equity financed holding of the targeted capital in the event that credit is fungible in the households' portfolio.

We also examined the general equilibrium effects of a subsidy, or other nonloan activities, which initially increase the supply of loans to the targeted sector. Here we also found that disintermediation and crowding out are important ingredients for evaluating the effects of federal credit programs, *even when* budget financing is not required to implement the program.

Clearly, much work remains. In the asset market we need to evaluate the contribution of regulations (for example, Regulation Q) on the asset market outcomes. Given asset market adjustments, we will then evaluate the effects of these adjustments on the real sector. Specifically, we will look at how changes in asset returns affect the allocation of capital and labor to the producing sectors and how stocks of capital change over time. This dynamic analysis will open up numerous avenues for evaluating federal credit activity's macroeconomic consequences, such as inflation, capital stock changes, and potential output changes.

APPENDIXES

APPENDIX A

The matrix of concern is found by totally differentiating the asset market equilibrium conditions with respect to r_{k_1}, r_{k_2}, r_B, R_1, B and the representative element a_{ij} is the partial derivative of the i'th equilibrium condition with respect to the j'th rate of return. By our assumption of gross substitutability on the aggregate portfolio, the following proposition borrowed from Brainard applies.

Proposition 1: Let A be an $n \times n$ indecomposable matrix with $a_{ii} > 0$; $a_{ij} \leq 0$, $i \neq j$; $\Sigma_i a_{ij} \geq 0$ for all j and with strict inequality for at least one j. Then:

(i) $|A| > 0$

(ii) $A^{-1} > 0$; cofactor $a_{ij} > 0$; $i,j = 1, \ldots, n$.

APPENDIX B

To solve for the slope of the excess demand function for capital of type one we use Cramer's rule to solve for dr_{k_1}/d_{k_1}.

Totally differentiating the system of asset market equilibrium conditions yields:

$$\begin{bmatrix} \\ a_{ij} \\ \\ \end{bmatrix} \begin{bmatrix} dr_{k_1} \\ dr_{k_2} \\ dr_B \\ dR_1 \end{bmatrix} = \begin{bmatrix} p_1 dk_1 \\ p_2 dk_2 \\ dB/p \\ -dGL/p \end{bmatrix}$$

where the matrix $[a_{ij}]$ is the same as the matrix on page 49.

From Appendix A we know the determinant of $[a_{ij}]$ is positive. Using Cramer's rule, and setting $dk_1 = dB = dGL = 0$, we substitute the righthand vector into the first column of $[a_{ij}]$. Proposition 1 of Appendix A shows that the determinant of this matrix is positive. Thus dr_{k_1}/dk_1 is positive and this is the slope of the general equilibrium excess demand function for the market for capital of type one.

Two important results for our study are the signs of dr_{k_1}/dGL and dr_{k_1}/dB. Using Cramer's rule to solve for dr_{k_1}/dGL, we set $dk_1 = dk_2 = dB = 0$ and substitute the right-hand vector of exogenous changes into the first column of the above matrix. Proposition 1 indicates that the sign of the determinant of the new matrix is positive. Thus, knowing the sign of the original matrix, we know $dr_{k_1}/-dGL > 0$ or $dr_{k_1}/dGL < 0$. To solve for dr_{k_1}/dB we set $dk_1 = dk_2 = dGL = 0$. Perhaps the simplest way to sign this derivative is to multiply each element of both vectors appearing in the above equations by -1. The matrix $[a_{ij}]$ is unchanged and thus its determinant it still positive. Substituting the right-hand vector into the first column of $[a_{ij}]$ yields a matrix to which Proposition 1 applies. Thus $-dr_{k_1}/-dB > 0$ or $dr_{k_1}/dB > 0$.

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Similar exercises for the other markets derive the slopes of the general equilibrium excess demand functions in Figure 4.

To sign other relationships in our model, the following proposition, borrowed from Brainard, is often useful in conjunction with Proposition 1.

Proposition 2: Let J be a matrix formed by replacing the first column of A above with a vector of non-positive elements $[y_i]$ with at least one $y_i < 0$.

Then:

(i) $|J| < 0$.

(ii) The elements in the first row of J^{-1} are strictly negative.

APPENDIX C

This appendix discusses the change in the determinant of a_{ij} when credit fungibility is introduced into the asset sector. Since the determinant of $\{a_{ij}\}$ can be evaluated by expansion along the fourth column of $\{a_{ij}\}$ we find that

$$\Delta\det\{a_{ij}\} = \Delta a_{LR} \cdot \mathrm{cof}(a_{LR}) + \Delta a_{BR} \cdot \mathrm{cof}(a_{BR}) + \Delta a_{2R} \cdot \mathrm{cof}(a_{2R}) + \Delta a_{1R} \cdot \mathrm{cof}(a_{1R}).$$

Since all cofactors are positive (Proposition 2 of Appendix B), there are offsetting factors in comparing the determinant of $\{a_{ij}\}$ in the fungible and nonfungible cases. Increases in a_{LR} and reductions in a_{1R} cause the determinant to be largeı; that is, cause a smaller change in r_{k_1} to clear any disequilibrium in the type one capital market. On the other hand, sensitivity of bonds and type two capital to the loan rate reduces the size of the determinant since they enhance any existing excess demand or supply in the type two capital maıket. Any excess demand in type one capital and reduction in r_{k_1} leads to an excess supply of loans and, therefore, a reduction in R_1. If bond demand is sensitive to the loan rate, an excess demand for bonds arises. The reduction in r_β required to clear the bond market aggravates the initial excess demand for type one capital and requires a larger decline in r_{k_1}.

Which effect dominates can be determined by evaluating the household wealth constraints. Specifically, since

$$J_{1R_1} + J_{2R_1} + H_{R_1} + DD_{R_1} + O_{R_1} - L_{1R_1} = 0$$

then, if

$$DD_{R_1} = O_{R_1} = 0,$$

$$\Delta J_{1R_1} + \Delta J_{2R_1} + \Delta H_{R_1} - \Delta L_{1R_1} = 0$$

or

$$\Delta a_{1R_1} + \Delta a_{2R_1} + \Delta a_{BR_1} - \Delta a_{LR_1} = 0$$

$$\Delta a_{1R_1} + \Delta a_{2R_1} + \Delta a_{BR_1} = \Delta a_{LR_1}.$$

Since $\mathrm{cof}(a_{LR})$ exceeds all other cofactors under the assumption of gross substitutability, the net change in the determinant of $\{a_{ij}\}$ following the introduction of fungibility is positive. For a given excess demand (supply) of type one capital, a smaller change in r_{k_1} is required to equilibrate the market.

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LOAN GUARANTEES AND CROWDING OUT

by

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PREFACE

The author of this paper is Professor of Economics, Arizona State University. William Boyes, John Kent Hill, Raymond Lombra, John McDowell, and Don Schlagenhauf provided helpful comments.

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SECTION I. INTRODUCTION

This paper is concerned with providing a framework for analyzing the provision of federal credit through loan and securities guarantees and the impact that guaranteed borrowing has on the financial markets and the allocation of credit in the economy. Government guarantees of credit have grown tremendously, some would say alarmingly, in recent years. The provision of guaranteed credit has a history dating back to the Great Depression and the establishment of agencies such as the Federal Housing Administration (FHA). However, the guarantee process has taken on new dimensions over the last decade with programs that are effectively subsidy programs. Further, in the last few years guarantees have been provided for the financing of large ventures. The Lockheed, New York City, and Chrysler cases are particular examples of the latter. 1/

Federal credit provided through guarantees has particular appeal in the political process. Guarantees are regarded by many as virtually "costless" since subsidy and large venture guarantees essentially show up in the federal budget only if the guarantee is exercised, that is, the borrower defaults. For actuarially sound programs, for example, FHA insurance, default risk is covered by insurance premiums, so it is anticipated that defaults would never be reflected in the budget. 2/ Thus, Congress can provide benefits to constituent groups without the appearance

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1/ The terminology of this paper follows that of the Congressional Research Service which distinguishes between three classes of guarantee programs: (1) actuarially sound programs; (2) programs requiring subsidies; (3) financing of large ventures. Congressional Research Service, Federal Loan Guarantees and Their Use as a Mechanism to Correct Market Imperfections, Assist Marginal Borrowers, and Finance Discrete Ventures (April 27, 1977); and Senate Budget Committee, Federal Energy Financing (August 30, 1976).

2/ There are administrative costs associated with all programs, however, and these are sometimes substantial. Administrative (Continued)

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of any cost to the government. However, the costlessness of the guarantee programs may be an illusion, at least from the perspective of the economy. 3/ The guarantee of private borrowing distorts the market decision on credit allocation. Guaranteed borrowers, in the absence of guarantees, would at least have to pay a higher cost for funds or would not be able to borrow at all. Thus, the pecking order in the market is altered in favor of guaranteed lending and away from nonguaranteed lending. Further, the additional demand for funds by those guaranteed borrowers, who in the absence of guarantees would not have otherwise been able to obtain credit at all, puts upward pressure on interest rates, implying that at a minimum, nonguaranteed borrowers are in some sense paying for the guarantees through higher interest rates on their borrowing. 4/ In addition, some nonguaranteed borrowers may not be able to obtain credit at all, either because they are unwilling to pay the now higher rates or because during periods of stringency credit is simply not available. The productive activity of these borrowers is thus lost to the economy, although the market may have decided in the absence of guarantees that these excluded borrowers would have received credit in preference to the now guaranteed borrowers. This implies a market decision that the now excluded borrowers would have used the credit more efficiently. Thus, the credit allocation process is perverted.

2/ (Continued) costs are reflected in the budget but these costs will be ignored in the analysis. Further losses above receipts for the subsidy programs are usually met by direct appropriations.

3/ In disucssing government-mandated portfolio restrictions such as Regulation Q, Penner and Silber state, "Because portfolio restrictions can initially be implemented without cost to the government's budget, they have provided the illusion of being costless to society." Rudolph G. Penner and William L. Silber, "The Interaction Between Federal Credit Programs and the Impact on the Allocation of Credit," American Economic Review (December 1973), pp. 843. The same may be said for guarantees.

4/ In fact, to the extent that interest rates rise because of these credit demands, the Treasury itself is paying more for its borrowings--a direct budget cost.

The damage done is compounded by the fact that no assessment is made of the quality of the borrowing done under guarantees. Guarantees raise the stature of the guaranteed borrowing to such an extent that many lenders regard the guaranteed borrowing as equivalent to government borrowing. Thus, like government borrowing, there is no question of an issue being taken up nor is there an assessment made of the economic feasibility of the project being funded. This result follows logically since information is costly to obtain and, if the project should fail, the borrowing is guaranteed.

The traditional notion of crowding out has been applied to government issued securities crowding out private borrowing through availability, interest, and wealth effects. Implicitly assumed in this literature has been the preeminent role of government debt in the financial markets. This debt is regarded as the least risky and most liquid of any debt coming to market. Thus, it receives preference in the market, especially since government is not in any way constrained in what it can pay and will always pay whatever is necessary to clear the market. While government guaranteed debt differs in some ways from government issued debt, nevertheless much of the analysis of crowding out may usefully be extended and modified to investigate the impact of guarantees on the financial markets and the allocation of credit in the economy. Such an investigation is the purpose of this paper.

The paper is organized as follows. Section II presents an introduction and overview of federal guarantee programs and attempts to place these in the context of traditional public finance actions of the government. Section III provides a brief review of the crowding-out literature and emphasizes the relevant aspects of the literature for this study. In Section IV, a model is developed that identifies the critical factors that influence the extent of crowding out that results from guaranteed financing in the absence of money supply changes. Section V analyzes the strategy of monetary policy and how this modifies the conclusions drawn from the model. Section VI conducts some simulation experiments based on the model. Section VII discusses the implications for the allocation of resources, economic growth, and inflation that arise from the preceding analysis. Finally, Section VIII presents the conclusions of the study.

SECTION II. THE GUARANTEE PROGRAMS

The growth of guarantee programs has been rapid in the last few years. Originally designed to aid home buyers and placed on an actuarially sound basis, in the 1960s these guarantees were extended through subsidies to marginal borrowers like students and lower-income families. While the actuarially sound and subsidy programs have continued to grow, guarantees have also been directed at relatively large projects like Lockheed, New York City, and Chrysler. 5/

It is not, however, until one examines the listing of guarantee programs and the associated numbers that the extent of the guarantees are realized. The federal budget lists 31 programs and, after adjustment to avoid double counting (for example, GNMA guarantees of FHA-VA pools), total guarantees are estimated to be $239.4 billion as of fiscal year 1980. 6/

In a major contribution to the theory of public finance made many years ago, Richard Musgrave distinguished between the various functions to be provided by the federal budget. 7/ While guarantees, unless there are defaults, essentially do not impact on the budget, it is nonetheless instructive to use the Musgrave framework to put guarantees into context. Musgrave distinguished between the allocation, distribution, and stabilization functions of government. The stabilization function relates to fiscal policy, and clearly guarantees are not designed with fiscal policy in

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5/ For an introduction to the loan guarantee programs, see Congressional Budget Office (CBO), Loan Guarantees: Current Concerns and Alternatives for Control," Background Paper (August 1978); and for a more detailed discussion, see CBO, a companion paper of the same title, A Compilation of Staff Working Papers (January 1979).

6/ Budget of the United States Government for Fiscal Year 1980, Special Analysis F, p. 163.

7/ Richard Musgrave, The Theory of Public Finance (McGraw-Hill Book Co., 1959).

mind unless the very broadest latitude is given to defining fiscal policy. 8/ Thus, reference must be made to the allocation and distribution functions to find a rationale for guarantees.

The distribution function relates to redistribution of income. Clearly in some ways guarantees, like mortgage guarantees for low-income individuals, have some distributional element to them. However, many guarantee programs, especially those that have grown so rapidly in recent years, fall outside the range of the distribution function. Thus, we are left with the allocation function.

There are two types of "wants" that Musgrave indicates are appropriately satisfied through the allocation function, "social wants" and "merit wants."

> Social wants are those wants satisfied by services that must be consumed in equal amounts by all. People who do not pay for the services cannot be excluded from the benefits; they will not engage in voluntary payments. Hence the market cannot satisfy such wants. 9/

Merit wants on the other hand are:

> . . . wants that could be serviced through the market but are not, since consumers choose to spend their money on other things. The reason for budgetary action in this case is not to be found in the technical difficulties that arise because certain services are consumed in equal amounts by all. The reason, then, for budgetary action is to correct individual choice. (Emphasis added.) 10/

8/ This may be an overstatement in that a number of guarantee programs clearly had countercyclical effects when proposed and initially implemented, for example, FHA insurance. However, the secular growth in guarantees has for the most part removed the stabilization rationale. In fact, it might be argued that this secular growth has prevented aggregate policy from fully working and has lengthened policy lags.

9/ Musgrave, The Theory of Public Finance, p. 8.

10/ Ibid., p. 9.

Clearly the satisfaction of social wants is irrelevant as an explanation of government guarantees and only in merit wants can the justification be found, in the context of the Musgrave framework, for guarantees, especially those that do not have distributional element such as the Chrysler guarantees.

However, the Musgrave framework points up an essential element of the current analysis. The satisfaction of merit wants is by definition an alteration of market preferences. By guaranteeing loans and securities issues, the government does automatically alter market decisions, that is, the decision not to grant credit or to grant credit at much higher prices in the absence of guarantees. Guarantees may even crowd out completely other projects that the market would agree to finance in the absence of guaranteed issues taking precedence.

SECTION III. A REVIEW OF THE CROWDING-OUT LITERATURE

Before moving on to discuss the crowding-out literature, it seems useful to define the term crowding out as it will be used in this study. Crowding out conventionally means the replacement either wholly or in part of private debt issuance by government debt issuance so that the projects crowded out are either unfundable due to availability or only fundable at a level of interest rates that is considered too high for the prospective borrower to go ahead with the project. 11/ However, we may further broaden this view of crowding out. To the extent that guarantees put a net additional demand on the financial markets and institutions for credit, in the absence of offsetting additions to the supply of loanable funds through either additional money creation or

11/ This is the effect usually associated with deficit spending having deleterious consequences for private investment. As Friedman points out, this can occur even if the economy is at less than full employment. However, Friedman goes on to analyze this issue in detail, discussing situations where he argues "crowding in" can take place. Benjamin M. Friedman, "Crowding Out or Crowding In? Economic Consequences of Financing Government Deficits," Brookings Papers on Economic Activity, No. 3 (1978), pp. 593-654.

saving behavior on the part of the public, the interest rate must rise. Thus, the cost of private projects, even those that are still executed, is raised. Further, the entire structure of market rates is altered as is the resulting allocation of credit in the economy with implications over time for economic growth. 12/ All these elements are part of our consideration of crowding out by government guarantees and will be considered in due course in the paper.

Blinder and Solow succinctly summarize the notion of crowding out commonly employed:

> . . . crowding out is an integral part of the Keynesian tradition and is, in fact, disputed by almost no one. This is the notion that deficit spending not accompanied by new issues of money carries with it the need for the government to float debt issues which compete with private debt instruments in financial markets. The resulting upward pressure on interest rates will reduce any private expenditures which are interest-elastic--which may include some spending by state and local governments as well as private spending on consumer durables, business fixed investment, and residential construction. 13/

They analyze crowding out and conclude that it turns out in a "properly" specified model under what they regard as plausible conditions that not only does bond-financed government spending

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12/ Silber and Penner and Silber discuss, in the context of the mortgage market, the importance of changing the risk characteristics of securities. Among other things, they point out that these securities may become considerably more appealing to asset holders and increasingly substitutable for other securities in holder portfolios even if risk perception is reduced only by small amounts. William L. Silber, "Selective Credit Policies: A Survey," in Ira Kaminow and James M. O'Brien, eds., Studies in Selective Credit Policies (Federal Reserve Bank, Philadelphia, October 1975), pp. 95-120; and Penner and Silber, "The Interaction Between Federal Credit Programs."

13/ Alan S. Blinder and Robert M. Solow, "Does Fiscal Policy Matter?" Journal of Public Economics (November 1973), p. 320.

fail to crowd out equivalent levels of private spending but it is more expansionary in the long run than deficits financed by money creation due to the necessity of debt service. 14/ Tobin and Buiter in a slightly modified version of the Blinder-Solow model come to similar conclusions. 15/

In another paper, Tobin argues that crowding out can only take place if the public's demand for wealth is a positive function of the interest rate and part of the newly accumulated wealth is held in additional money balances. 16/ These specifications are needed for Tobin does not dispute the notion that the increased supply of bonds raises the interest rate. 17/ William Silber, in a very important paper, has argued that the existence of positive wealth effects on the demand for money have been overlooked in the analysis of crowding out and, when this is recognized, increases in the demand for money may counteract the positive impact of wealth effects on spending. 18/

Following Silber's original insight, Meyer 19/ considered the government budget constraint first put forward by Christ 20/ and the fact that the private balance sheet must balance, originally

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14/ Ibid., p. 327.

15/ James Tobin and Willem Buiter, "Long-Run Effects of Fiscal and Monetary Policy on Aggregate Demand," Cowles Foundation Discussion Paper No. 384 (December 1974).

16/ James Tobin, "Deficit Spending and Crowding Out in Shorter and Longer Runs" (Mimeographed, no date), pp. 1-2.

17/ Ibid., p. 9.

18/ William L. Silber, "Fiscal Policy in IS-LM Analysis: A Correction," Journal of Money, Credit and Banking (November 1970), pp. 461-72.

19/ Lawrence H. Meyer, "The Balance Sheet Identity, the Government Financing Constraint, and the Crowding-Out Effect," Journal of Monetary Economics (January 1975), pp. 65-78.

20/ Carl Christ, "A Simple Macroeconomic Model With a Government Budget Constraint," Journal of Political Economy (January 1968), pp. 53-67.

emphasized by Brainard and Tobin. 21/ He demonstrates that, as long as these constraints are recognized, the restrictive assumptions of the monetarist crowding-out literature are not necessary for crowding out to take place. In a model constructed that incorporates the budget constraint and the adding up conditions, he shows the direct effects on portfolios can lead to crowding out even if the other requirements are not met. Both Silber and Meyer have shown that one cannot ignore the financial markets and portfolio decisions in analyzing crowding out and attention to these is central to this paper.

The issues that have been analyzed by the crowding-out literature examined here have most to do with complete crowding out. Partial crowding out has not been questioned. Even in the Blinder-Solow quotation at the beginning of this section it was recognized that interest rates would rise and they argue:

> This financial side-effect (the rise in interest rates) will partially offset the expansionary effect of the original increase in public spending." (Emphasis added.) 22/

However, as pointed out above, they go on to develop a theoretical model that results in debt financed increases in public spending having an even more expansionary effect than money financed increases over time. In putting forward this conclusion, however, they fail to analyze fully the financial market impacts.

The analysis that follows in this paper makes some use of the crowding-out literature. The importance of additional credit demands in raising interest rates (financial market effects) and portfolio decisions are crucial in the analysis. An important distinction should, however, be drawn at the outset. In the crowding-out literature, wealth effects enter the argument: whether they exist and what effect they have on spending and portfolio decisions. In the case of guaranteed borrowing, however, wealth effects are irrelevant unless the guarantee comes into effect.

21/ William Brainard and James Tobin, "Pitfalls in Financial Model Building," American Economic Review (May 1968), pp. 97-122.

22/ Blinder and Solow, "Does Fiscal Policy Matter?", p. 320.

Wealth effects in the crowding-out literature stem from the notion that taxpayers do not discount the future tax obligation associated with additional government bond financing. Although this proposition is disputed by some, 23/ it is nevertheless irrelevant to guaranteed debt which is private. Clearly, unless the guarantees are actuated, the obligation is a private obligation which offsets the increase in assets of the holders of the obligations. This distinction should be kept in mind as the analysis is developed in this paper. 24/

There is another element that should be noted: the strategy of monetary policy in determining whether crowding out actually takes place. While additional saving takes time to accumulate in response to interest rate increases, additional money supply creation occurs rapidly if the Fed follows an interest rate target. Although the purist would say that, if increased money supply is automatically forthcoming, this means that the deficit is money financed and hence the case of crowding out doesn't exist; yet for the pragmatic orientation of this study, these distinctions are important as will be seen below.

SECTION IV. A MODEL

The first task of this paper is to develop a model that will yield insights into what guarantees do in the financial markets. Particularly, in order to have a mechanism to evaluate what guarantees mean in the crowding-out context, the variables and parameters that are important to consider must be identified. To

23/ Robert J. Barro, "Are Government Bonds Net Wealth," Journal of Political Economy (November/December 1974), p. 1095-1117; and Milton Friedman, "Comments on the Critics," Journal of Political Economy (September/October 1972), pp. 906-50.

24/ However, it should be noted that, to the extent guaranteed loans are financed through the Federal Financing Bank and in turn the FFB borrows from the Treasury, the increase in Treasury securities to finance its loans to the FFB may mean an increase in net wealth indirectly caused by guarantees under the assumption that government debt is net wealth. This situation, however, is not considered in the analysis.

construct a tractable model, however, requires a number of simplifying assumptions. Perhaps the most significant of these is to assume that guarantees are issued exclusively on bonds and that all financing of guaranteed securities, government securities, and private nonguaranteed securities takes place in the bond market. 25/ That is, no allowance is made for disparate financing sources. Other assumptions will be made clear as the analysis progresses.

The crowding-out literature, as previously noted, examines issues of interest rate effects, credit availability effects, and wealth effects to assess crowding out in the context of bond-financed government spending. While the latter is irrelevant to the guarantee programs (in the absence of default), the former are both important.

Figure 1 presents a model of the demand and supply of bonds (or conversely the demand for funds and the supply of funds). This model is very useful for isolating the key elements of interest in the study of crowding out and guaranteed securities. Constructing the schedules as functions of the inverse of the interest rate (that is, functions of price) and assuming all securities are perpetuities make it easier to demonstrate the factors on which an evaluation of crowding out turns. The schedule B_{pg} is the supply of guaranteed securities. B_{pg} is assumed completely unaffected by the interest rate and determined by administrative and Congressional action.

(1) $B_{pg} = \bar{g}$

Interest rate considerations are irrelevant to the decision to guarantee, and all securities guaranteed are going to be financed. At any point in time, the amount of these securities is fixed.

The schedule B_g represents government financing. Government financing is independent of the interest rate (in the period of analysis at least) and determined by the government budget

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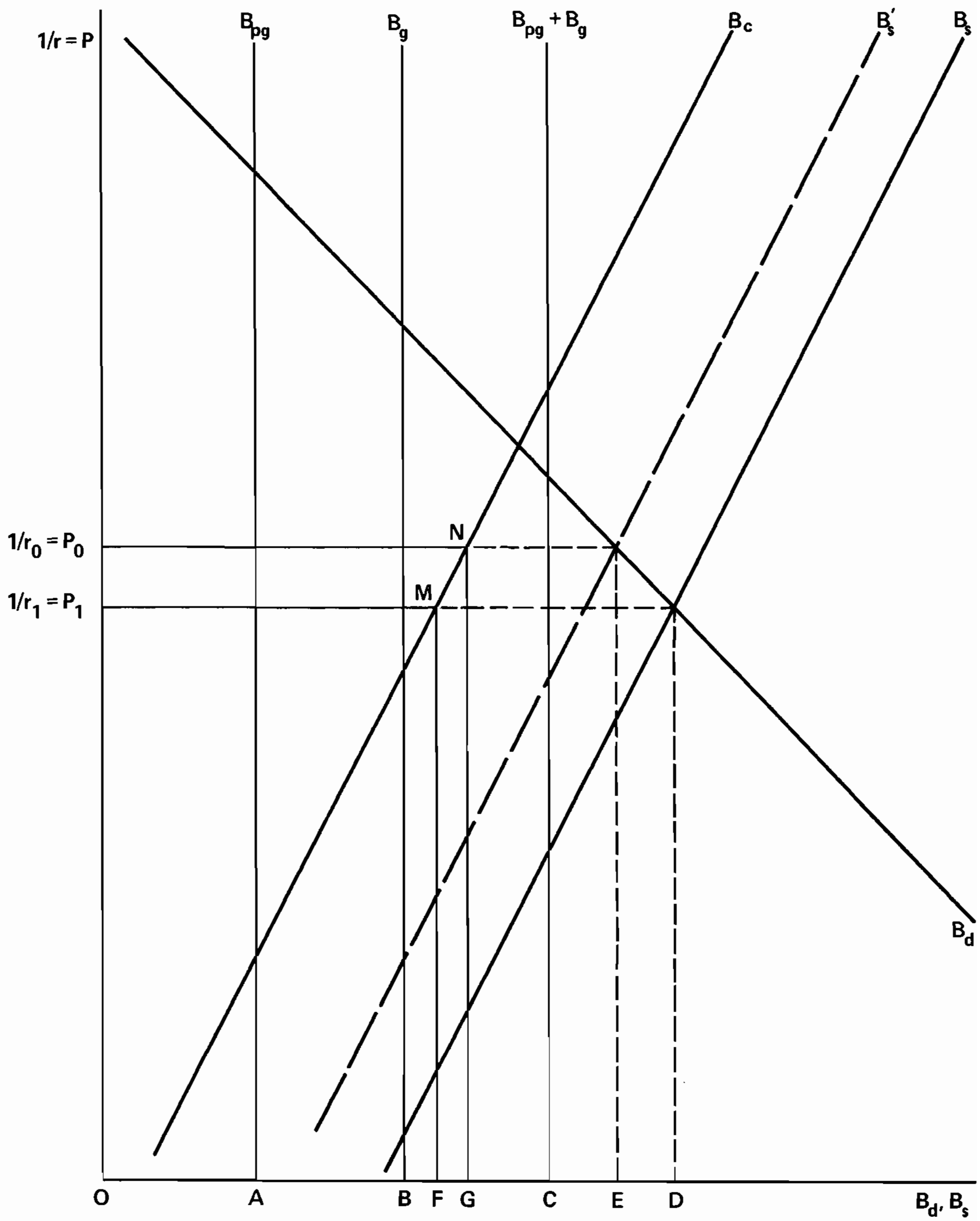
25/ While this assumption is very simplistic, nevertheless it serves to identify in a qualitative way what the impact of guarantees depend upon. More problematical is the interpretation of the simulations using the model below.

Figure 1.



constraint. 26/ Meyer points out that although the constraint is in flows, if changes in stocks in the model are computed over the same period as the flows take place, the model will be uniformly dimensioned. 27/ The government budget constraint is

$$(2) \qquad G + T = t + \Delta m + \Delta B_g$$

where

G = government spending

T = transfers

t = tax revenue

Δm = change in the money supply

ΔB_g = bonds issued to finance government spending

By assuming $T = t$, since taxes and transfers are not important in the analysis, and Δm zero, then

$$(2a) \qquad G = \Delta B_g$$

that is, all expenditures are bond financed.

Schedule B_c is the supply of corporate, that is, private, nonguaranteed, bonds and is a positive function of the price of securities (a negative function of the interest rate) and of the financing needs of the corporation for investment,

$$(3) \quad B_c = f\ (1/r, D); \ \frac{\partial B_c}{\partial (1/r)} > 0; \ \frac{\partial B_c}{\partial D} > 0$$

where D = external financing deficit, that is, the amount by which financing needs exceed internal funds. 28/

26/ Christ, "A Simple Macroeconomic Model with a Government Budget Restraint."

27/ Meyer, "The Balance Sheet Identity," p. 68.

28/ See Barry Bosworth, "Patterns of Corporate External Financing," Brookings Papers on Economic Activity, No. 2 (1971), (Continued)

Since B_{pg} and B_g are fixed, and both types of securities have preference in the market so that those supplies of securities will always be taken up, the two schedules can be summed to yield $B_{pg} + B_g$. Further $B_{pg} + B_g$ plus the supply of nonguaranteed corporate bonds (B_c) can be summed to yield B_s. The demand for bonds (the supply of loanable funds) is a positive function of the interest rate and thus a negative function of price.

$$(5) \quad Bd = f\ (1/r); \ \frac{\partial Bd}{\partial (1/r)} < 0$$

It is further assumed that the private balance sheet constraint 29/ is met so that

$$(4) \quad a = m + B$$

where

m = money held in portfolios

B = bonds held in portfolios

a = total assets

and therefore any increase in bond acquisition must be offset by a reduction in asset money demand, assuming the money supply unchanged. Assuming the commodity market is in equilibrium, using Walras' Law, the money market can be dropped from consideration and the bond market focused upon exclusively.

The market clearing interest rate is r_1 where $B_s = B_d$ and total financing is OD. Private financing is equal to OF. Suppose,

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28/ (Continued) pp. 253-79; and Herbert M. Kaufman, "Business Reliance on External Sources of Finance and the New Corporate Bond Market," Journal of Economics and Business (Winter 1976), pp. 146-50.

29/ Brainard and Tobin, "Pitfalls in Financial Model Building;" and Meyer, "The Balance Sheet Identity."

however, that there was no guarantee program. Then the bond supply curve would be B_s'. B_s' can be thought of as strictly eliminating from the supply side of the market all securities that would be guaranteed. Simply no present issuers of guaranteed securities would come to market in the absence of guarantees. (Alternatively and more realistically, some securities would still come to market resulting in a rightward shift in B_c in the absence of guarantees and perhaps a rotation at the bottom since in the absence of guarantees these securities would be concentrated at the high end of the interest rate spectrum. If this occurs, then B_s would not shift back as much. However, for simplicity, the assumption is made that no guaranteed securities would come to market in the absence of guarantees. However, qualitative results are not altered if the alternative assumption is utilized.) 30/ Thus, if guarantees are eliminated, total financing is OE, composed of government financing OB and private financing OG. The interest rate falls to r_0 and it is clear that OG is greater than OF. The amount of additional private financing that takes place in the absence of guarantees (or conversely the reduction in private financing with guarantees) depends on the difference in area between OP_1MF and OP_0NG. This difference in area in turn depends on the elasticities of the supply and demand for bonds. Thus, to measure the difference in area, the amount crowded out by guarantees, these elasticities would have to be known. First, to show the critical nature of the elasticities, consider the following analysis where the effect of a change in guarantees is evaluated.

Elasticity Treatment 31/

The impact of guaranteed financing on nonguaranteed private financing, as suggested above, is dependent on the supply and demand elasticities in the bond market. For analytical convenience in the analysis that follows, government bond supply and government guaranteed bonds are aggregated since they are both assumed interest inelastic. 32/

30/ There is little question, however, that in a complete quantitative analysis, the extent to which the guarantee process adds to the net demand for funds would need detailed attention.

31/ This section owes much to discussions with John Kent Hill.

32/ Thus the analysis is equally valid for a change in government bond financing, excluding wealth effects.

The interest elasticity of the demand for bonds is:

$$(1)\quad \eta_d \equiv \frac{dB_d}{dr}\frac{r}{Bd} = \frac{\hat{Bd}}{\hat{r}}$$

where

$Bd(r)$ = demand for bonds, $B_d' > 0$

r = interest rate

and the " ^ " (hat) denotes percentage changes in the variables of interest, i.e., $\hat{r} = \frac{dr}{r}$.

The bond supply elasticity is

$$(2)\quad \eta_s = -\frac{dB_s}{dr}\frac{r}{B_s} = -\frac{\hat{B}_s}{\hat{r}}$$

where $B_s(r)$ = supply of bonds by the private sector $B_s' < 0$.

Also let

B = exogenous (interest inelastic) component of aggregate bond supply (government securities plus government guaranteed securities)

Θ_B = (initial) fraction of total bond supply accounted for by B

$\Theta_s = (1-\Theta_B)$ = (initial) fraction of total bond supply accounted for by B_s

The percentage change in the interest rate, r, resulting from a change in B can be determined. In equilibrium:

$$(3)\quad B_d(r) = B_s(r) + B$$

Totally differentiating (3) and solving yields

$$(4)\quad \frac{dr}{dB} = \frac{1}{B_d' - B_s'}$$

and converting to percentage changes and expressing in terms of elasticities and proportions:

$$(5)\quad \frac{\hat{r}}{\hat{B}} = \frac{\Theta_B}{\eta_d + \eta_s \theta_s}$$

To determine the percentage change in the value of private financing that results in a percentage change in B

$$(6)\quad \hat{PF} = -\hat{r} + \hat{B}_s = -\hat{r}\,(1+\eta_s) \text{ 33/}$$

where PF = change in private financing.

Substituting from (5)

$$(7)\quad \hat{PF} = -\left\{\frac{(1+\eta_s)\Theta_B}{\eta_d+\eta_s\theta_s}\right\}\frac{\Delta B}{B}$$

The dollar change in the value of private financing for a dollar change in guaranteed financing is

$$(8)\quad PF = -\left\{\frac{(1+\eta_s)\Theta_s}{\eta_d+\eta_s\theta_s}\right\}\left(\frac{1}{r}\right)\Delta B$$

Thus the change in private financing is dependent on the supply and demand elasticities as well as the fraction of bond financing originally accounted for by private financing.

The impact of the parameters $(\eta_d, \eta_s, \theta_s)$ in determining the amount of private financing crowded out with an increase in guaranteed securities can be seen.

(1) The more (less) elastic is the demand for bonds, the smaller (larger) the reduction in private financing. A small change in the interest rate is sufficient to induce absorption of the additional bonds into asset holder portfolios.

33/ $\hat{PF} = \widehat{\left(\frac{1}{r} B_s(r)\right)}$ evaluated at r.

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(2) The impact of the supply elasticity depends upon the relative sizes of η_d and Θ_s. The reduction in private financing will be directly related (inversely related) to η_s as

$$\eta_d \lesseqgtr \theta_s$$

Inelastic private sector bond supply would moderate the reduction in new issues for a given change in r. But inelastic supply would also result in a more pronounced fall in bond prices. The more elastic is bond demand, the smaller the fall in bond prices and hence the weaker the effect of price in (8).

(3) The higher (lower) the fraction of total bond supply accounted for by the private sector (Θ_s) the greater (smaller) the decline in private sector financing caused by a given exogenous increase in supply.

The elasticity relationships developed will be utilized later in the study to perform simulation experiments to evaluate the impact on private financing of increases in guaranteed securities. At this point, suffice it to say that it has been shown how bond supply and demand elasticities determine the impact of guaranteed securities on private financing.

Credit Availability and Crowding Out

A simple modification of Figure 1 can be used to demonstrate the situation where price may not be the only factor driving some private financing out when guarantees exist. Consider a situation where the amount of loanable funds become fixed at some level--that is, there is simply no additional credit forthcoming no matter what the interest rate. 34/ Assume that the demand for bonds

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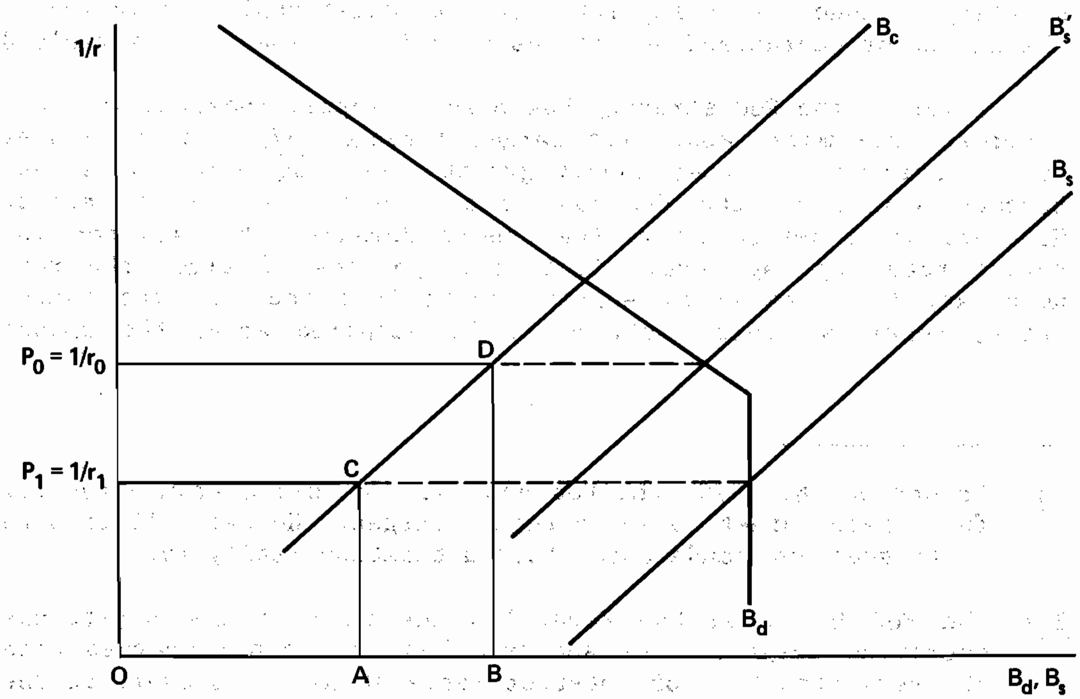
34/ This is not a farfetched assumption in the short run. With money supply fixed, the only other additional source of funds comes from the transfer from money holding to bond holding and from additional saving at the higher rate of interest. The latter takes time to accumulate (Meyer, "The Balance Sheet Identity") and the former is constrained by the need for transactions balances. Put differently, the demand for money as a portfolio asset reaches zero at some rate.

therefore looks like the curve in Figure 2. (The B_{pg} and B_g are omitted from the diagram for ease of presentation. However, recall that $B_s = B_{pg} + B_g + B_c$ and $B_s' = B_g + B_c$). The way the diagram is drawn the B_s curve which contains the guaranteed securities now intersects the B_d curve in the inelastic portion of the curve. Thus, as can be seen, the amount available for private financing is less than in the previous case--that is, the rectangle P_1OAC is even smaller than P_1OFM in Figure 1 for a given amount of guaranteed securities. Not surprisingly, if availability is also a constraint, even more private financing is crowded out. The amount of the difference between the two rectangles in Figure 2 now depends on the supply elasticity since the elasticity of demand is zero. 35/ The more inelastic is the bond supply curve, the more private financing is crowded out for a given increase in guaranteed

Figure 2.



35/ Solving (8) for the case of $\eta_D = 0$ yields: $PF = -\frac{1}{\eta_s}(\frac{1}{r})\Delta B$

securities. How much is crowded out depends on where B_d turns perfectly inelastic and whether B_s intersects the B_d curve in the inelastic portion. Clearly if B_s does not intersect the B_d in the inelastic portion, availability is not a constraint and this case is the same as the situation depicted in Figure 1.

SECTION V. THE STRATEGY OF MONETARY POLICY AND CROWDING OUT

Until now the analysis has assumed a fixed money supply. However, this is an unrealistic assumption even in the short run, particularly in light of the strategy of monetary policy pursued in the 1970s which has given heavy weight in the short run to moderating movements in the interest rate. 36/ By taking the strategy of monetary policy into account, additional information on the impact of guaranteed securities on private financing is yielded.

Briefly, the Fed strategy has been to supply reserves when the interest rate moves above its targeted range. 37/ In the longer run as evidence of money supply growth exceeding long-run targets becomes available, the Fed may raise the interest rate target. However, in a period of rising credit demands, the targeted interest rate may lag, over significant periods of time, the rate necessary to bring money supply growth into the targeted range. Hence, reserves could continue to be supplied above the amount

36/ On October 6, 1979, the Fed announced a switch from a federal funds rate target to an aggregate target. However, it remains to be seen how fundamental this alteration really is.

37/ The Fed has used the Federal funds rate as its day-to-day operating target. The analysis has not been concerned with the term structure of interest rates at all. However, to the extent that the interest rates do move together, the following analysis is still indicative of the impact of the monetary strategy.

necessary to achieve monetary growth rates believed desirable by the Fed. 38/

The traditional crowding-out literature is concerned with the impact of government bond financing on private spending in the absence of money creation. In fact, monetarists would argue that if money creation occurs (the debt is monetarized), then monetary rather than fiscal policy is taking place. However, in the analysis we are not dealing with government debt issued for fiscal policy purposes or any other reasons but rather with the effect of guaranteed debt on the financial markets. Thus, to make a realistic assessment of what impact guaranteed debt has on private financing and the allocation of resources in the economy, we must take monetary policy into account. 39/

Returning to the issue being explored in this paper, the analysis thus far indicates that the increase in guaranteed debt puts upward pressure on the interest rate. Suppose this increase is sufficient to move the interest rate outside the Fed's targeted range. This would mean an increase in reserves and the money supply, especially in the short run before any adjustments could be made in the targeted rate. 40/ Thus the money supply would expand. Since only money and bonds are held as assets in private portfolios under the assumptions that have been made, some of the increase in the money supply would serve to increase the demand for bonds. This would be in addition to the direct increase in bond demand from Fed open market operations. This causes a rightward shift in the demand curve and the full impact depends on the Fed reaction function and the money multiplier. If the Fed is assumed to supply sufficient reserves to alleviate any upward pressure on

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38/ In fact, the lag involved could be argued to have motivated the "change" in policy on October 6, 1979.

39/ This is not to suggest that money creation is not analyzed in the crowding-out literature. Blinder and Solow make the comparison between money creation and bond financing an essential element of their analysis. Blinder and Solow, "Does Fiscal Policy Matter?"

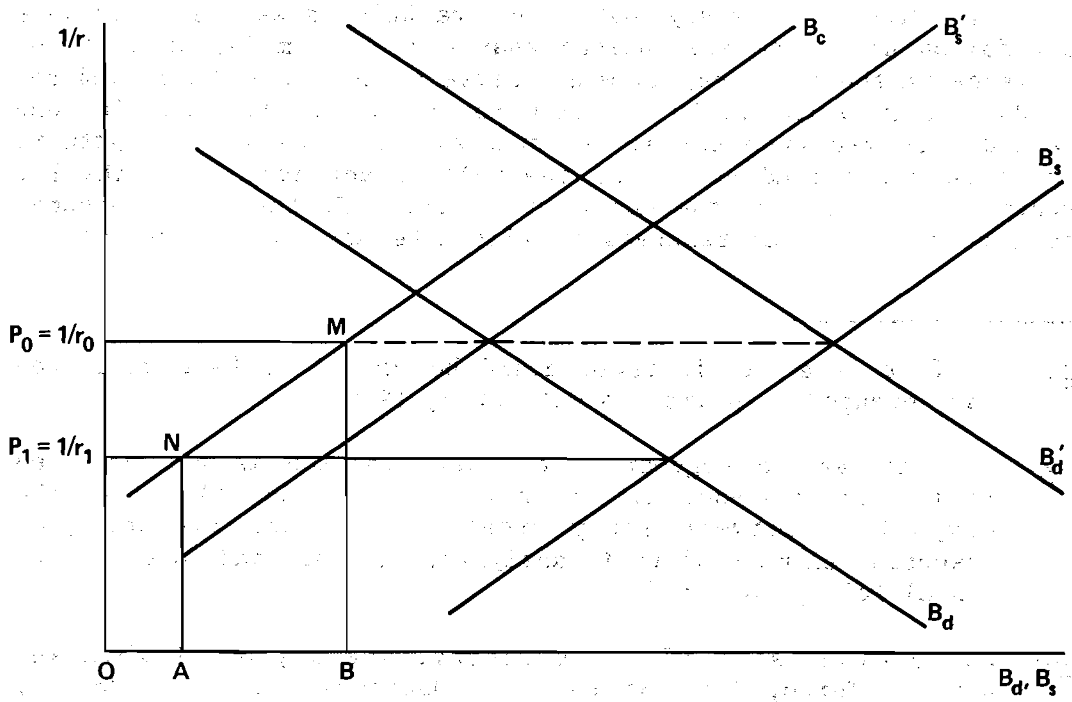
40/ For a discussion of Fed strategy, see Raymond Lombra and Raymond Torto, "The Strategy of Monetary Policy," Monthly Review, Federal Reserve Bank of Richmond (September/October 1975), pp. 3-14.

the interest rate (and this would depend on the width of their interest rate band), then no crowding out would take place. However, this has inflationary implications that will be discussed in Section VII.

Figure 3 shows the situation graphically. (Once again the B_{pg} and B_g curves are omitted for simplicity.) Figure 3 depicts the situation (which need not obtain) where the increased demand for bonds is accommodated due to the expansion of the money supply. Private financing remains unchanged in this case.

If the Fed hadn't reacted to the rise in rates caused by the introduction of the guaranteed securities, the situation would be the same for a given change in guaranteed financing as depicted in Figure 1--that is, private financing would have been the rectangle OP_1NA instead of OP_0MB. Had the Fed been following a reserve aggregate strategy such a situation as depicted in Figure 3 would not have occurred since there is nothing inherent in the guarantees themselves to affect the level of reserves or the money supply.

Figure 3.



SECTION VI. EVALUATING THE EXTENT OF CROWDING OUT

The expression for the reduction of private nonguaranteed financing when an increase in guaranteed securities occurs (equation 8) can be utilized to perform simulation experiments. Before proceeding, however, it is important to reiterate the limitations of the analysis so that the simulation results are only taken as suggestive of the approach, not exact measurements. Particularly recall that the model was developed by assuming all financing took place in the bond market and that bonds were homogeneous except for the higher standing in the market accorded government and guaranteed securities so that any new issue was certain to be taken up. No allowance was made for the different ways (short-term, long-term, commercial banks, etc.) in which guaranteed borrowing takes place in reality. The manner of financing is extremely important as it affects the term structure of interest rates and interest rate differentials within maturity classes which in turn has additional implications for financial flows in the economy and asset holder preference. While these issues are ignored here, the various financing modes must be addressed in fully developed empirical work designed to measure accurately the extent of crowding out. 41/ It is also assumed that no reaction by the Fed to changes that take place in the interest rate as a result of

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41/ The development of a model incorporating alternative financing channels and of empirical work designed with reference to these is the subject of future work planned by the author. In addition, focusing on different channels of financing leads to consideration of asset substitutability in holder portfolios. This question is inextricably tied to the notion of financing modes and will also be addressed in future work. (See, for example, Penner and Silber, "The Interaction Between Federal Credit Programs"; D.C. Rao and Ira Kaminow, "Selective Credit Controls and the Real Investment Mix: A General Equilibrium Approach," in Ira Kaminow and James M. O'Brien, eds., Studies in Selective Credit Policies (Federal Reserve Bank of Philadelphia, October 1975), pp. 173-95; and James Tobin, "An Essay on Principles of Debt Management," Fiscal and Debt (continued) changes in guaranteed financing is forthcoming. Later the Fed reaction will be considered to more closely approximate reality. These limitations should be kept in mind in interpreting the results of the simulation experiments.

As of December 31, 1979, Salomon Brothers 42/ estimates that there was about $4 trillion in total debt outstanding. This includes short-term as well as long-term debt but excludes trade credit. This figure is used in the denominator of the expression Θ_s (the ratio of private securities to total securities) 43/ in equation (8) which is reproduced below. The numerator of Θ_s is

$$(8) \qquad PF = \frac{(1+\eta_s)\theta_s}{\eta_d+\eta_s\theta_s} \frac{1}{r}\Delta B$$

$4 trillion less the debt of the federal government, state, and local governments, 44/ federal agencies, and guaranteed debt.

41/ (continued) Management Policies, Commission on Money and Credit (Englewood Cliffs: Prentice-Hall, 1963), pp. 143-218. Further, the simulations reported are not time dimensioned. Timing effects of certain government programs can be important as Swan has argued in another context. Craig Swan, "The Impact on Residential Construction of Federal Home Loan Bank Board Policy," Journal of Monetary Economics, Supplemental Vol. 4 (1976), pp. 205-29.

42/ All financial data other than guarantees were drawn from the tables in Salomon Brothers, 1980 Prospects for Financial Markets (November 1979), pp. 19-37. The data on guarantees were from Budget of the U.S. Government for Fiscal Year 1980, Special Analysis F.

43/ An alternative would only have to utilize long-term debt, since the model was developed for the bond market. However, we believed it more useful and realistic to include all debt.

44/ Some state and local debt is clearly interest elastic so assuming all state and local debt interest inelastic is only an approximation.

Thus, the numerator of Θ_s is approximately \$2.25 trillion and Θ_s is .56. This proportion will be used throughout the simulations. Since .56 is clearly a gross estimate and since Θ_s is a critical parameter in the simulations that follow, the results should also be treated with some caution for this reason as well as for those given above.

Equation (8) is evaluated for various estimates of the supply and demand elasticities. It is assumed throughout that these elasticities are less than 1 to accord with intuition and a whole array of interest elasticities previously estimated in financial markets. All cases assume an increase of \$1 billion in guaranteed securities. Table 1 summarizes the results.

Case 1 is a situation where the demand elasticity is relatively high and the supply elasticity low. In this situation an increase in guaranteed securities of \$1 billion results in a reduction of \$736 million in private nonguaranteed financing ceteris paribus. That is, less than complete crowding out takes place. With the relatively elastic demand the price fall (the interest rate increase) is moderated.

TABLE 1. SIMULATION RESULTS FOR A \$1 BILLION INCREASE IN GUARANTEED SECURITIES

Case	η_s	η_d	Θ_s	Δ Private Financing (in billions of dollars)
1	.2	.8	.56	-0.736
2	.2	.3	.56	-1.630
3	.9	.8	.56	-0.816
4	.9	.3	.56	-1.320

Case 2 presents a situation where both supply and demand elasticities are low. In this case crowding out is more than complete because the price drop is substantial.

Case 3 shows a situation where both supply and demand are relatively elastic. In this case again as in Case 1, crowding out is not complete. The elasticity of supply however leads to a larger reduction in private financing than in Case 1.

Case 4 presents a situation where supply is relatively elastic and demand inelastic. The inelasticity of demand leads to more than complete crowding out but the price change is moderated somewhat by the elasticity of supply compared to Case 2. 45/

Thus in the absence of accommodating monetary policy, crowding out is substantial in all cases under our assumptions. In the cases of very inelastic demand, overcrowding out results. It is, however, unrealistic to assume that given the strategy of monetary policy in the post-World War II period discussed above that the implied increases in interest rates, especially in the overcrowding out situations, would be allowed by the Fed, at least in the short run. Rather the upward pressure on interest rates would be resisted by the Fed through reserve supplying operations and the crowding out would not take place to the extent indicated or not at all. However, Fed accommodative behavior in this situation has obviously serious inflationary implications as will be discussed in the next section. If the Fed ever follows a true reserve aggregate strategy, this situation would not obtain and crowding out can be serious in fact as well as in theory.

45/ At first glance the overcrowding out indicated in Cases 2 and 4 may appear surprising. However, when it is realized that no monetary reaction to the large interest rate changes implied by those cases due to the inelasticity of demand is allowed nor is any change in saving behavior permitted, that is, the result is _ceteris paribus_, the result is understandable. The large change in price that results due to the inelasticity of demand, even in the case where the supply response moderates that change, is sufficient when multiplied by the change in the volume of securities to yield overcrowding out _ceteris paribus_. Meyer points out in the case of debt financed changes in government expenditures when the financial market effects are considered: "Complete and _more than complete_ crowding out can occur without any parameters taking on extreme values." (Emphasis added.) Meyer, "The Balance Sheet Identity," p. 74.

Besides the strategy of monetary policy, another factor which will increase the amount of loanable funds is an increase in the saving rate. However, it would take time for meaningful changes in the amount of saving to occur and for the funds to accumulate. Therefore, overlooking this factor seems realistic. 46/

The amount of crowding out indicated in the preceding analysis in the absence of monetary changes is compelling even when viewed as very gross estimates. These results have implications for the economy because of the impact on resource allocation over time that must be addressed. This view of guarantees as costless is found to be true only in a budgetary sense. 47/ Further, with a Fed interest rate strategy offsetting crowding out, inflationary effects are also apparent. These macroeconomic impacts are considered in the next section.

SECTION VII. THE ALLOCATION OF RESOURCES: MACROECONOMIC IMPACTS

To the extent that crowding out takes place as a result of guaranteed financing, this has negative implications for the future growth and productivity of the economy. If crowding out does not take place because of accommodative monetary policy, this has implications for the future course of inflation which in turn also has implications for the future growth of the economy.

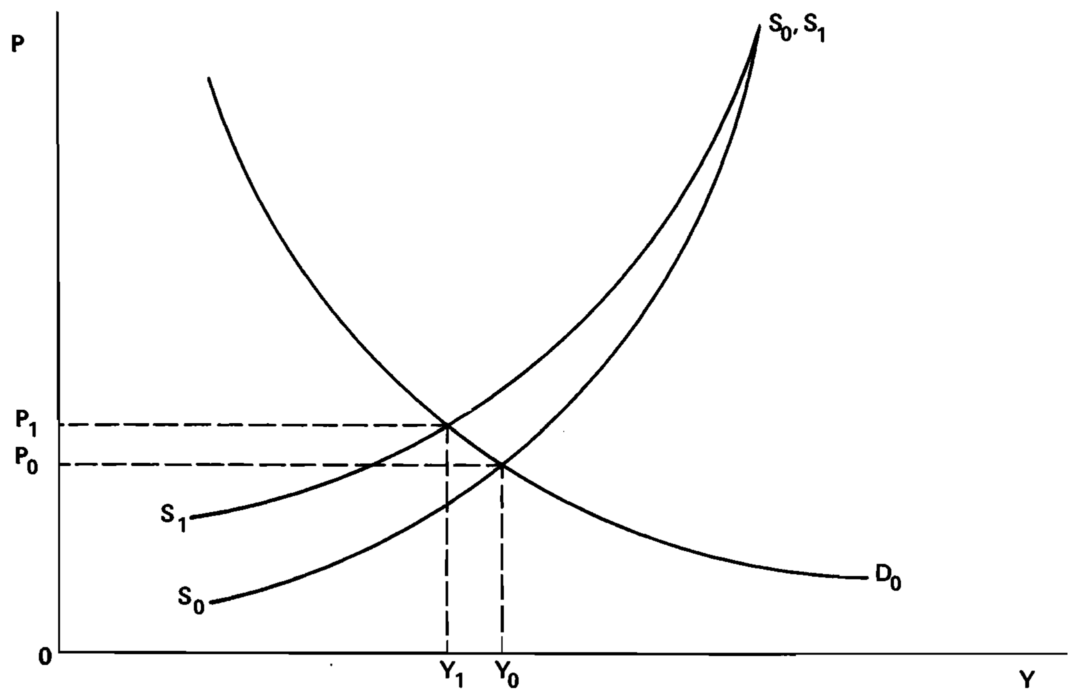
The various paths that the economy can take as a result of an increase in the amount of guaranteed financing can be briefly sketched using aggregate demand-aggregate supply analysis. Figure 4 initially presents the situation prior to any increase in

46/ For an analysis of the effect of rate of return on saving behavior, see Michael J. Boskin, "Taxation, Saving, and the Rate of Interest," Journal of Political Economy (April 1978, Part 2), pp. S3-S27.

47/ Even here, however, as pointed out above, to the extent increased amounts of guaranteed securities coming to market put upward pressure on interest rates, there is a true budgetary cost of increased guaranteed financing for the rate at which the government itself can borrow is increased.

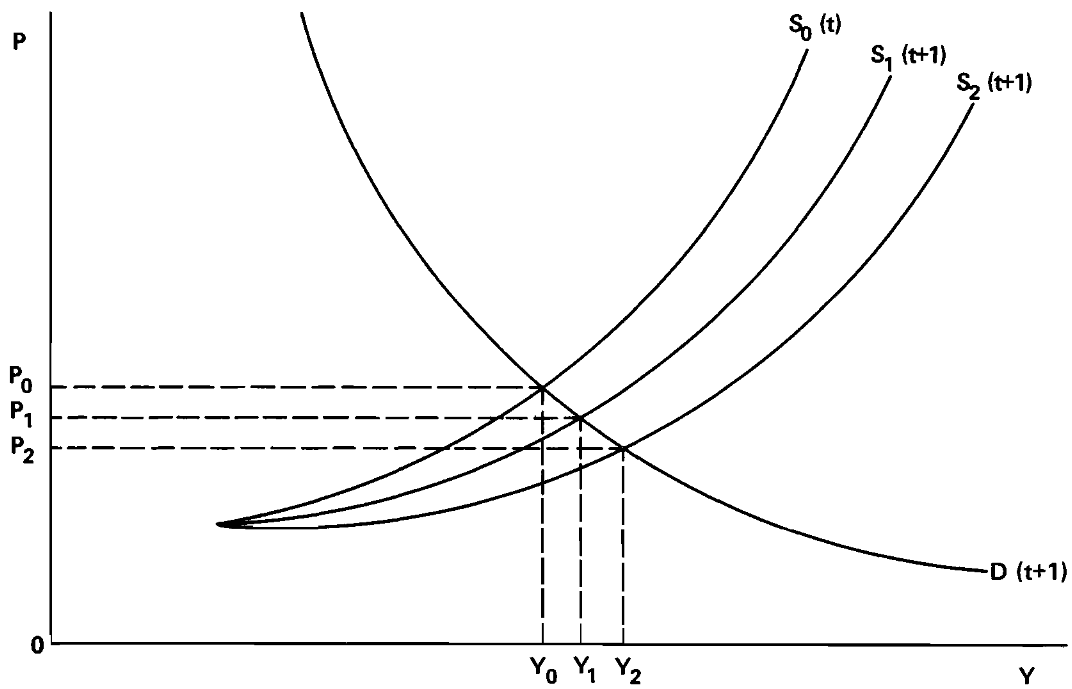
guaranteed financing (the schedule subscripted 0). Output is at Y_0 and the price level at P_0. Now let an increase in guaranteed financing occur that crowds out an equivalent amount of private financing. Under the assumption that the financing that now takes place under guarantees would not have occurred at all in their absence either because the financing would not have been available or because cost would have been too high, the aggregate demand curve would be unchanged. However, the aggregate supply curve would shift upward reflecting a rise in the cost of production as the guaranteed financing flows to firms that are less efficient in their operations. (This is implicit in the need for guarantees.) This is reflected in the fall in output to Y_1 and a rise in the price level to P_1. Thus the existence of guarantees adds to inflationary pressure (assuming this is not a once and for all change in guarantees which would imply a one time change in the price level) and a reduction in the productivity and output of the economy.

Figure 4.



However, the more interesting question is what happens through time as the resource base grows. Increases in guarantees over time, if complete crowding out occurs, implies that less efficient elements are receiving financing in preference to more efficient elements. Thus, this implies that the increases in production over time would be less with guarantee than otherwise. Figure 5 illustrates the case for the movement of the aggregate supply curve through time with and without guarantees. $S_0(t)$ is the original aggregate supply curve at time t. $S_1(t+1)$ is the aggregate supply curve that obtains at time t + 1 where 1 may refer to a long period of time measured in years. $S_2(t + 1)$ is the aggregate supply curve that would have obtained if the private financing crowded out by the guaranteed financing would have instead taken place. If D(t+1) is the relevant aggregate demand curve at time

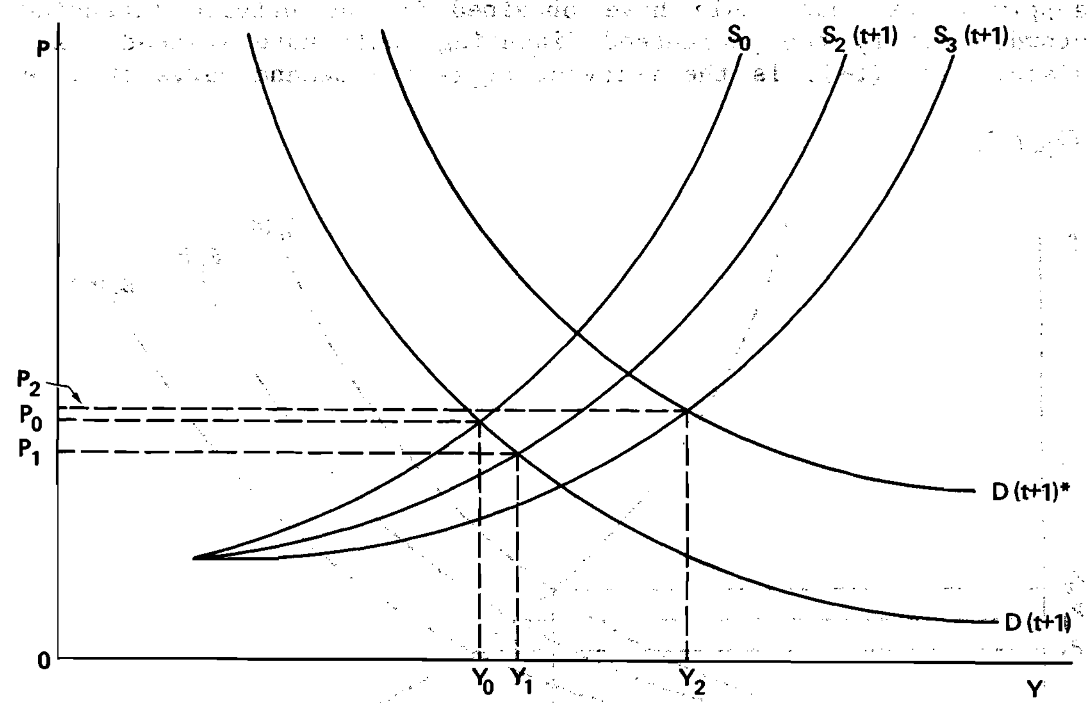
Figure 5.



t+1, then clearly the price level is higher and output lower than it would have been. 48/

If crowding out is not complete (cases 1 and 3 above), the results would be less dramatic but would still show similar effects unless crowding out were zero. Suppose, however, that there is not crowding out because the Fed accommodates any increase in credit demands through increases in the money supply. Figure 6 shows this situation.

Figure 6.



48/ This assumes that the same aggregate demand curve is applicable in either case. This is a simplifying assumption. Depending on assumptions, it is possible that this curve would be different in each case. Assuming it is the same should not alter the qualitative results.

$S_3(t+1)$ shows the position of the aggregate supply curve where guaranteed financing is added to private financing because the Fed accommodates this financing. However, the aggregate demand curve shifts to $D(t+1)^*$ with the increased money supply provided by the Fed and while output expands to Y_2 the price level is higher than it would have been without guarantees (P_2 exceeds P_1). Thus the Fed action results in an acceleration in inflation. In fact, where P_2 is depends on how close we are to full employment, the slope of the aggregate supply curve, and the shift in the demand curve. Further, not analyzed but also a likely result would be an upward shift in the aggregate supply curve as the additional demand for factors of production inherent in the accommodative behavior of the Fed raised the entire cost structure of the economy. Thus even more inflationary pressure than indicated in Figure 6 is likely and less output increase (perhaps even a fall) than shown.

These scenarios need to be analyzed formally and integrated with the preceding model. However, it is sufficient to suggest that a policy of guarantees is not costless to society either in lost potential output or inflationary pressure or both.

SECTION VIII. IMPLICATIONS AND FUTURE WORK

Guarantee programs have proved to be very popular with the Congress and successive administrations because their budgetary impacts are relatively small (though significant) in the absence of default. The direct costs of these programs consist of the administrative costs associated with most programs 49/ and the subsidy cost of some programs. Further, it was pointed out above that, to the extent guaranteed financing puts upward pressure on interest rates, there are additional government debt servicing

49/ We have said little about these costs but they are not trivial. For example, the actuarially sound guarantee programs such as FHA insurance have huge and costly bureaucracies associated with them.

costs. These latter costs are typically not considered. However, the real cost of guarantees is the cost to society through crowding out. These costs measured in terms of lost actual and potential output and inflation can be substantial if crowding out is significant, as the paper suggests may be the case. If increased credit demands associated with guarantees are accommodated by monetary policy on the other hand, this has inflationary implications. 50/ Guarantee programs must be evaluated with respect to these economic costs if appropriate judgments as to their efficacy are to be made.

This paper has provided a framework for analysis of the financial and economic impacts of loan guarantees. Critical parameters necessary for evaluating the extent of crowding out that results from guarantees have been identified as some rough estimates of the extent of crowding out under various assumptions of parameter values have been made. The analytical framework developed can be expanded substantially, however, to include important elements that were necessarily abstracted from in this paper, such as the various financing channels open to guaranteed borrowers and the degree of asset substitutabilty in asset holder portfolios. Further, empirical work should be directed at estimating the expanded model in order to obtain detailed estimates of crowding out caused by guaranteed financing. The author hopes to pursue such work in the future.

50/ And through the Fisher effect, interest rates would be expected to reflect increased inflationary expectations over time.

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SUBSIDIES IN GOVERNMENT CREDIT PROGRAMS: GENERAL THEORY WITH ILLUSTRATION FROM THE MORTGAGE MARKET

by

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The Congress of the United States
Congressional Budget Office

PREFACE

The authors of this paper, William L. Silber and Deborah G. Black, are Professor of Economics and Finance and Ph.D. student, respectively, Graduate School of Business Administration, New York University. This paper was prepared under the sponsorship of the Congressional Budget Office. Additional resources were provided by HUD grant #H2978RG. Helpful comments were received from Rudolph G. Penner and Lawrence J. White.

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FIGURES

SUMMARY

This paper presents a framework for evaluating the costs and benefits of federal credit programs. On the benefits side, the analysis focuses on the determinants of credit program effectiveness in implementing the goals established by the enabling legislation. It shows that the effects of most programs are uncertain because the underlying parameters needed for their evaluation are generally unknown. On the cost side of the analysis, the paper indicates that most credit programs contain implicit rather than explicit government subsidies. This complicates considerably the cost/benefit calculation because the magnitude of the implicit subsidy is difficult to isolate. An example of the taxonomy, as well as the advantages and disadvantages of specific programs, is illustrated with current federal housing and mortgage credit programs.

SECTION I. INTRODUCTION

The theory of shifting and incidence of taxation has been extremely useful in furthering our understanding of federal credit programs. Shoup and Jasinowski extended the tax literature to subsidies in general, 1/ while Rao and Kaminow 2/ and Penner and Silber 3/ analyzed the implicit subsidies attached to various types of credit programs. The impacts on interest rates, credit allocation, and real resources have been the focal points of the analysis.

While the tax/subsidy framework has been a significant step forward in evaluating credit programs, there are dimensions to the current structure of federal credit programs, especially in the mortgage/housing area, that would benefit from a more detailed analytical structure. This paper develops the work of Penner and Silber 3/ to provide a richer and more precise categorization of credit program effectiveness. Examples from the vast array of housing-related programs illustrate the taxonomy.

Section II presents the standard price-quantity effects of subsidies and then summarizes the applications of federal credit programs. The most important distinguishing characteristic of alternative credit programs turns out to be whether they are levied on a per unit basis or are imposed as a "lump-sum" program. The categories will be labelled per unit subsidies and quantity-oriented subsidies. Section III examines the impacts of credit programs that apply to subsectors of a particular market. While these subsector programs sometimes can be analyzed within the

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1/ Carl S. Shoup and Jerry Jasinowski, The Economics of Federal Subsidy Programs: A Staff Study, Joint Economic Committee (1972).

2/ D.C. Rao and Ira Kaminow, "Selective Credit Controls and the Real Investment Mix: A General Equilibrium Approach," Journal of Finance, Vol. XXVIII, No. 5 (December 1973), pp. 1103-1118.

3/ Rudolph G. Penner and William L. Silber, "The Interaction Between Federal Credit Programs and the Impact on the Allocation of Credit," American Economic Review, Vol. LXIII, No. 5 (December 1973), pp. 838-852.

general framework of Section II, this is not always the case. Section IV provides a number of illustrations from credit programs in the mortgage/housing area and Section V concludes with a menu for empirical research.

SECTION II. THE EFFECTIVENESS OF FEDERAL CREDIT PROGRAMS

Following Shoup and Jasinowski, 4/ we distinguish three aspects of the subsidy component of federal credit programs: (1) legislative intent, (2) initial impact, and (3) incidence. These three dimensions are best illustrated by example. The legislator's intent might be to provide a subsidy to borrowers, either to increase resources into a particular activity (for example, housing) or to redistribute income to a particular borrower class. The initial impact is then set by law, such as a cash payment to borrowers when credit is extended or a reduction in interest payments to borrowers over the life of the loan. The final impact of the subsidy, its incidence, might be substantially different from the initial impact. An increase in competitively determined interest rates can effectively transfer the subsidy from borrowers to lenders, with or without any net increase in credit.

It is important to distinguish incidence in the financial sector from real-sector incidence. A reduction in interest cost to a specific category of borrowers and/or an increase in credit extended, such as for mortgages, may or may not have an effect on a specific type of real activity, such as housing. As Rao and Kaminow emphasize, only if there is specialization in the use of credit, so that mortgage funds, for example, are used to finance housing only (primarily), will there be a necessary connection between financial-sector incidence and real-sector incidence. 5/ To the extent, for example, that lower interest rates on borrowed funds merely raises loan-to-value ratios, there will be little impact on real activity. While there is likely to be some connection between specific financial effects and particular categories of real-sector activity, there is no doubt that slippage exists.

4/ Shoup and Jasinowski, The Economics of Federal Subsidy Programs, Chapter IV.

5/ Rao and Kaminow, "Selective Credit Controls."

In our discussion below, we will concentrate on the impacts of credit programs on interest rates and credit outstanding. While there is a presumption that real-sector activity will increase if interest rates fall and/or more credit is extended, our discussion will not focus on the conditions providing such results.

As mentioned above, there are two types of legislative intent for credit programs: (1) the reallocation of credit and resources towards a particular activity; (2) the redistribution of income towards particular borrower classes in the form of lower interest payments on certain types of loans. Rao-Kaminow and Penner-Silber focused on question (1). In our disucssion below, we also analyze the factors influencing the effectiveness of credit programs in redistributing income among borrower classes. Note that this dimension to a credit program's impact certainly need not have any effect on real-sector resource reallocation. In fact, total credit extended in a particular category, for example, mortgages, can remain unchanged (with no aggregate effect), but the composition of borrowers can be altered in line with the credit program's intent.

GENERAL SUBSIDY RESULTS

One overall principle that follows directly from the tax literature is that the incidence (final impact) of a subsidy is not altered by changing the (initial) impact of the subsidy. Giving the subsidy to borrowers or lenders does not change the incidence. Only the elasticities of market supply and demand curves determine who ultimately benefits from the subsidy. These principles are sufficiently important to warrant a somewhat detailed exposition. As it turns out, slight changes in some of the assumptions discussed below can cause substantial alterations in the results.

In the discussions that follow, we use the interest rate as a proxy for all of the terms of credit. While there are other dimensions to credit terms, such as downpayment requirements or collateral, we assume these are fixed, and capture all adjustments in these nonprice terms in the interest rate. In Figures 1 and 2, which illustrate the basic results of shifting and incidence, the interest rate on the vertical axis is the market rate on a loan category that is the legislator's intended target. The horizontal axis measures dollars loaned/borrowed. Thus, the supply schedule slopes upward, implying an increase in lending as rates increase and the demand curve slopes downward, reflecting a decrease in borrowing as interest rates rise.

Figure 1.

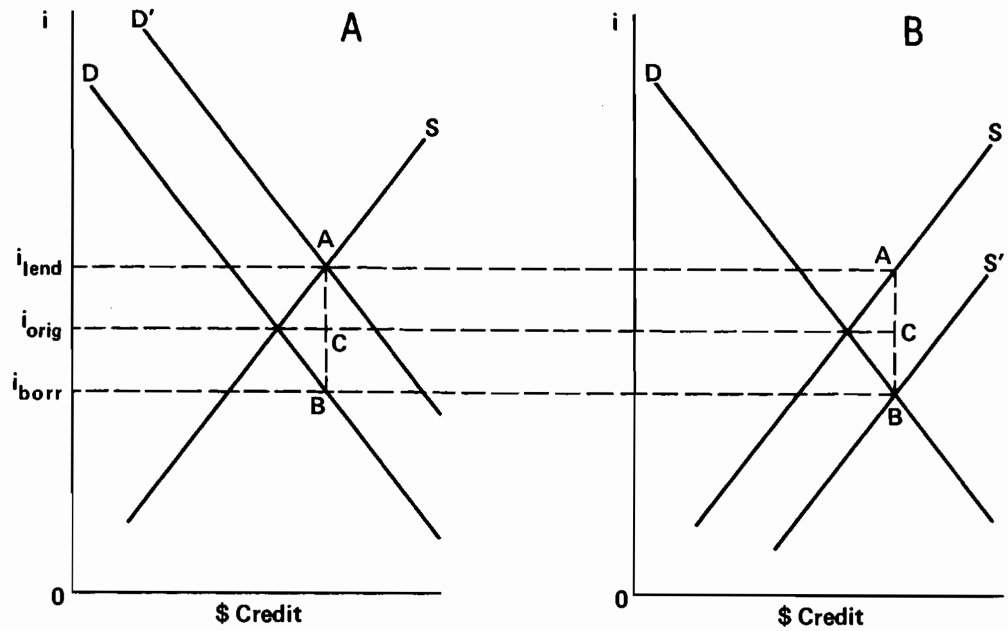
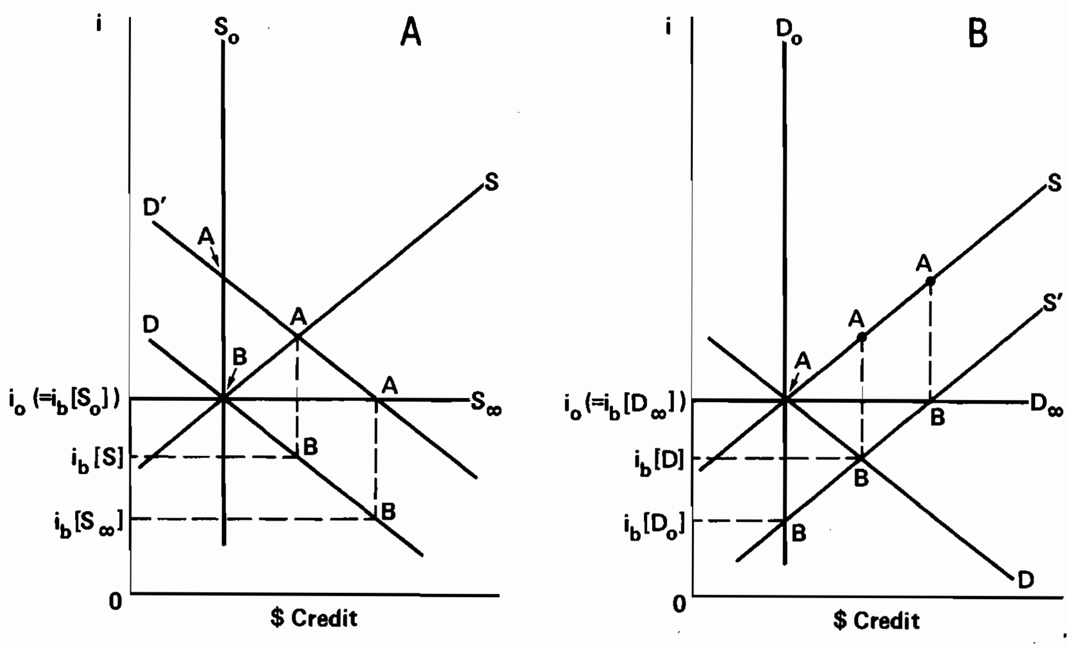


Figure 2.



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The simplest type of credit subsidy program is a cash grant per dollar borrowed, best represented by a reduction in the interest cost on a loan. This type of subsidy is analogous to a sales or excise tax, which is levied as a rate per quantity of a particular item. Penner and Silber refer to such subsidies as "wedge-type" programs because they intend to impose a wedge between the interest rate paid by the borrower and the yield received by the lender. 6/ It is more important to recognize that since these subsidies are granted per unit borrowed, they can be represented by vertical shifts in either supply or demand schedules.

Figure 1 shows the impact of an interest rate subsidy in the amount of AB. Figure 1-A illustrates the case in which the subsidy is offered to borrowers; Figure 1-B illustrates the case of a subsidy to lenders. We start out in each figure with D and S intersecting at i_{orig}. The subsidy AB offered to borrowers in Figure 1-A produces a vertical upward shift in D to D', reflecting the fact that borrowers will borrow the same amount if market interest rates were higher by AB. Similarly, in Figure 1-B, the supply curve shifts down vertically by the amount AB, reflecting the fact that lenders will lend the same amount if market rates fall by AB. The result of the subsidy in both cases is to raise the rate earned by lenders to i_{lend} and to lower the rate charged to borrowers to i_{borr}, with the subsidy AB interposing a wedge between the two.

The subsidy is shared by both borrowers and lenders even though the initial impact is either solely on borrowers (Figure 1-A) or solely on lenders (Figure 1-B). The incidence of the subsidy differs from the initial impact because the equilibrium rate of interest changes as a result of market pressures. In Figure 1-A borrowers bid up the rate offered lenders from i_{orig} to i_{lend} by the amount AC. In Figure 1-B lenders bid down the rate charged to borrowers by amount BC. If conventional market quotations on interest rates consistently report as the "market rate of interest" either the rate charged to borrowers or the rate earned by lenders, the two subsidies will, in fact, report identical movements in market interest rates.

But the direction of movement in either the lender rate or the borrower rate does not provide a complete picture of the incidence of the subsidy. If AB (the subsidy) is known precisely, then

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6/ Penner and Silber, "The Interaction Between Federal Credit Programs."

observing a particular "market" rate permits an unambiguous conclusion regarding movements in both borrower and lender rates. When the subsidy is unknown (as in many credit programs with implicit subsidies, such as government-sponsored secondary market operations), the rate movement recorded in the market does not provide a complete description of the incidence of the subsidy. Borrower rates may fall without any increase in lender rates or lender rates may rise without any decrease in borrower rates. The results depend upon the slopes of the supply and demand schedules (which are usually unknown parameters).

Figures 2-A and 2-B show that the shifting of the subsidy between borrowers and lenders is a function of elasticities of supply and demand. Figure 2-A shows that the greater the elasticity of supply (the flatter is S) the greater is the reduction in the borrower's rate of interest. If there is zero elasticity of supply (S_0), lenders capture all of the subsidy, while if there is infinite supply elasticity (S_∞), borrowers capture all of the subsidy. Figure 2-B shows that the greater the elasticity of demand (the flatter is D) the smaller is the reduction in the borrower's rate of interest. If demand is infinitely elastic (D_∞), lenders capture all of the subsidy, while if demand is completely inelastic (D_0), borrowers capture all of the subsidy.

These results for subsidies conform with the principles of shifting and incidence of taxation. The side of the market with the least elasticity captures most of the subsidy, just as it would bear most of the tax.

If instead of focusing on the subsidy per unit borrowed we look at the quantity of credit granted, a somewhat different result emerges. In particular, while the infinitely elastic demand curve and completely inelastic supply curve both produce the same incidence in terms of price effects, that is, no reduction in borrower interest rates, the effects on quantity of credit are very different: with S_0 there is no increased credit outstanding, while with D_∞ credit outstanding increases by the maximum amount, given the size of the subsidy (AB). Thus, if the legislative intent is to reduce borrower costs (an income distribution objective), then both S_0 and D_∞ thwart the objective; but if the legislative intent is to expand credit (with the quantity of credit presumably related to real resource use), then S_0 thwarts the objective but D promotes it. This asymmetry will recur in a slightly different form in our discussion below regarding subsector subsidies.

CREDIT PROGRAM EFFECTIVENESS

Penner and Silber focus their analysis on the relationship between the elasticity of supply and the efficacy of federal credit program subsidies. 7/ If securities are very close substitutes in lender portfolios, then the supply function will be quite elastic. Wedge subsidies will then be very effective in reducing borrower interest cost and in raising the volume of credit outstanding. In fact, Figure 2-A with the supply curve S illustrates the extreme case. The reasoning is straightforward: the subsidy offered on a particular category of security (whether initially given to borrowers or lenders) elicits an increase in supply of funds that restrains the rise in interest rates received by lenders. This permits the subsidy to drive down the rate charged to borrowers, as the quantity of lending expands.

This relationship between elasticity of supply and wedge programs is contrasted with a category of programs that Penner-Silber identify as portfolio-restriction type policies. In this case, the effectiveness of the credit program in reducing borrower interest rates is lower with a highly elastic supply schedule, precisely the reverse of the wedge-type programs just discussed (and inconsistent with the shifting and incidence of taxation).

The explanation of why portfolio-restriction policies cause a smaller reduction in borrower interest rates when the supply schedule is more elastic is best illustrated by example. Portfolio restrictions cause some group of institutions, such as savings and loan associations, to increase a particular category of lending, such as mortgages. This exogenous increase in supply of funds due to the portfolio restriction will cause a large reduction in borrower interest rates only if unrestricted lenders view mortgages as poor substitutes for other securities. If all securities were good substitutes, then the increased supply of mortgage funds due to the portfolio restriction would be offset by a decreased supply by other sectors--leading to little net increase in mortgage funds and little reduction in rates charged to borrowers.

The essence of this relationship rests with the initial impact of the credit program. The subsidy element comes from a shift in the supply schedule, as in Figure 1-B. But, unlike the wedge program, it is not illustrated by a vertical displacement of the function, since it is not levied on a per unit basis. Rather, the portfolio regulation policy causes a horizontal shift in the supply

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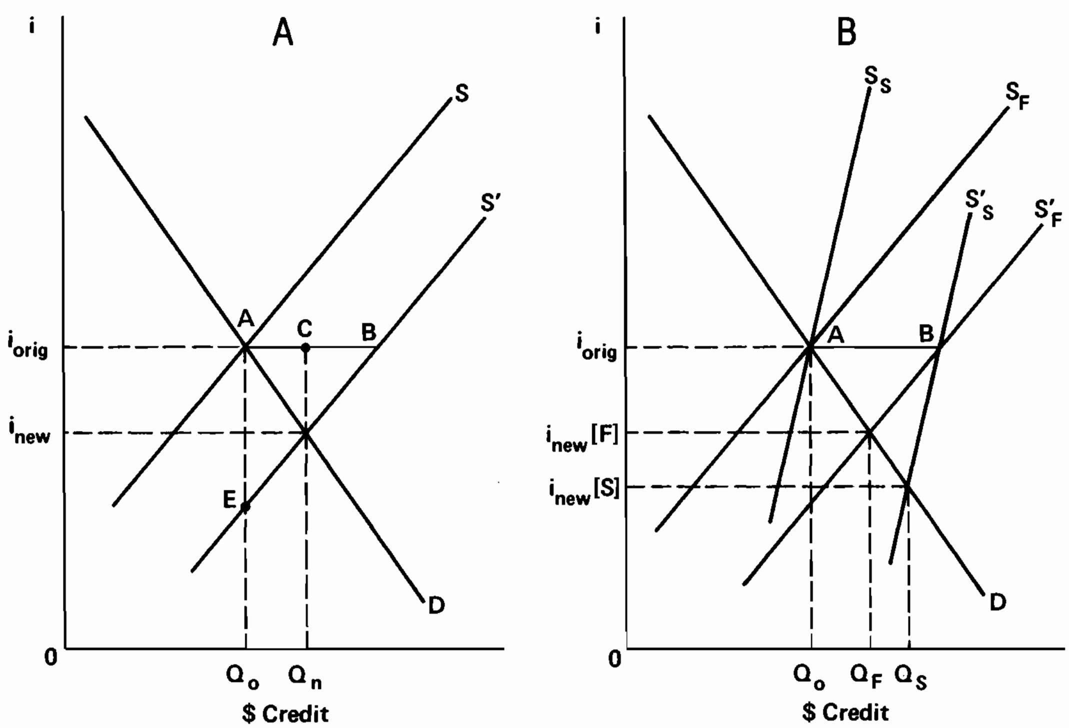
7/ Ibid.

of funds schedule. Figure 3-A shows a rightward shift in the supply curve S to S'. The magnitude of the horizontal shift, AB, measures the initial increased volume of lending forced by the regulation on (say) savings and loan associations or produced by direct government or agency lending. The increased initial lending drives down the interest rate, causing other lenders to withdraw funds (as a function of the elasticity of the supply schedule). The net increase in funds supplied (AC) is less than the initial impact, and the drop in the interest rate from i_{orig} to i_{new} is less than what it would have been without the offsetting private sector behavior.

Figure 3-B illustrates the general principle that the flatter the supply schedule, the less effective are such programs in driving down the interest rate and expanding the supply of funds. In the extreme case, if the supply schedule were infinitely elastic, there would be no rightward shift in aggregate supply due to the credit program. Increased lending by restricted sectors is offset by reduced lending from unrestricted sectors. No decline in borrower interest rates occurs.

The original Penner-Silber treatment of portfolio-restriction policies focused on the fact that such programs usually apply to a subsector of the market and that, unlike explicit interest rate

Figure 3.



subsidies, they do not intend to drive a wedge between borrower and lender rates. It turns out, however, that the fundamental unifying principle, in terms of the determinants of policy effectivenes, rests with the fact that the initial impact is not imposed on a per unit basis, but rather is quantity oriented. Any policy which shifts the supply curve horizontally, that is, causes initial quantity supplied to increase, will be more effective the less is the elasticity of supply.

This analysis may appear trivial in retrospect, but it generalizes the original Penner-Silber categorization. Moreover, it emphasizes that the wedge concept and the subsector characteristic are not crucial in determining the relationship between credit program effectiveness and the elasticity of the supply schedule.

UNCERTAINTIES AND CREDIT PROGRAM EFFECTIVENESS

It is interesting to note that the magnitude of the subsidy is not specified explicitly in the case of quantity-oriented credit programs. Only the volume of initial lending—either because of a portfolio restriction or because of direct lending by a government agency--is prescribed. Thus, the program's effectiveness is properly measured in terms of the net increase in lending and an associated reduction in the interest rate (with some unknown positive impact on resource use).

There is an equivalent per unit subsidy that would achieve the same incidence as the quantity-oriented program. The vertical line segment AE in Figure 3-A measures the per unit subsidy that would reduce borrower rates and increase quantity of credit outstanding in the same magnitudes as the portfolio restriction AB. In more general terms, it is always possible to specify equivalent per unit and quantity subsidies. In a world of certainty, Weitzman showed that price-setting and quantity-setting planning policies are equivalent. 8/ That is true in our case of credit subsidies as well. The price versus quantity decision and the per unit versus quantity programs become substantive issues only in a world of uncertainty. In our case, uncertainty over the slope of the supply curve creates uncertainty over the incidence of particular per unit versus quantity-oriented subsidies. Thus, it was important to show the relationship between alternative subsidy specifications

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8/ Martin L. Weitzman, "Prices vs. Quantities," Review of Economic Studies (1974), pp. 477-491.

(per unit versus quantity) and program incidence. As we have seen, the elasticity of the supply schedule affects the incidence of per unit and quantity subsidies in opposite directions.

The quantity-oriented credit program has been described as an exogenous rightward shift in the supply schedule (in the amount AB in Figure 3-A). An exogenous shift can be accomplished by legislative fiat. Such a program would create long-run offsetting private sector behavior unless accompanied by a lump-sum subsidy to the restricted sector. Such lump-sum subsidies are not usually made explicitly; rather they take the form of implicit subsidies. For example, to compensate S&Ls for portfolio restrictions, there is access to cheaper funds through advances from the Federal Home Loan Bank Board and restrained competition through differential rate ceilings under Regulation Q. But such subsidies are distinctly not levied on a per unit basis. They are equivalent to lump-sum subsidies.

This discussion exposes a likely characteristic of quantity or lump-sum credit programs: they frequently do not specify an explicit subsidy component. In fact, the subsidy is usually an uncertain magnitude. While the initial impact is set in terms of quantity of credit extended, this is not a measure of the subsidy. It is important to derive an estimate of such implicit subsidies.

SECURITY CHARACTERISTIC PROGRAMS: A CAREFUL INTERPRETATION

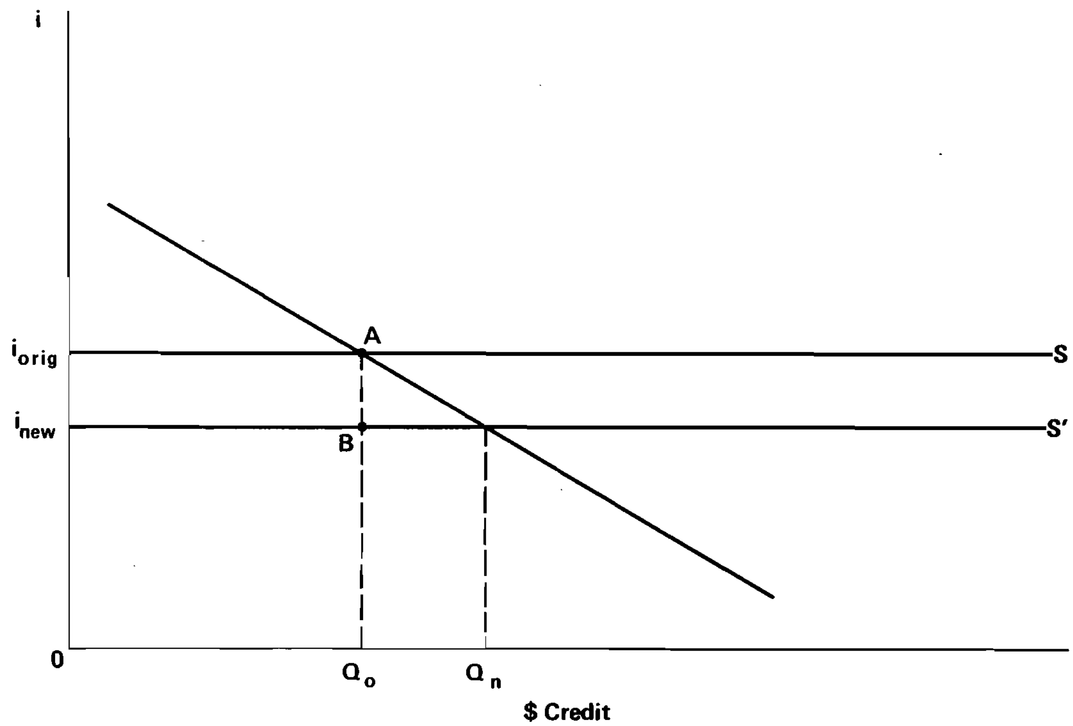
An apparently ambiguous case appears in what Penner-Silber refer to as federal credit programs aimed at "altering security characteristics." These are best illustrated by insurance and secondary market operations. An important point raised by Penner-Silber is that these credit programs affect the elasticity of the supply curve because they change (increase) the degree of substitution among securities. But this is not our concern in this paper. Rather, we must specify the way in which such programs shift the supply curve.

How such programs shift the supply curve is especially important in extreme cases. A horizontal supply curve (infinite substitutability among securities) implies that a quantity or lump-sum subsidy is completely ineffective because it does not affect aggregate behavior. This is illustrated by the impossibility of shifting a horizontal curve to the right. A per unit subsidy, on the other hand, will shift down even a horizontal supply schedule.

This perspective, in fact, provides the answer: security characteristic programs lower the interest rate that is necessary to elicit any particular supply of funds. They are analogous to explicit interest rate subsidies because they appear to suppliers of funds as per unit subsidies.

Thus, when a security becomes more liquid because of a government-operated secondary market (such as through the GNMA pass-through program), even a horizontal supply curve shifts downward. This means that borrower rates will be reduced by such programs even when the supply curve is infinitely elastic. This case is illustrated in Figure 4, with the supply curves shifting down to

Figure 4.



S' by the amount of the implicit subsidy AB. 9/ The rate charged to borrowers falls from i_{orig} to i_{new} and the quantity of credit expands from OQ_o to OQ_n. In fact, since the subsidy is levied on a per unit basis, Figures 2-A and 2-B summarize the determinants of policy effectiveness for these security characteristic programs as well as for the wedge programs they were originally intended for.

What confuses matters somewhat is that many security characteristic programs have associated quantity measurements, such as the volume of secondary market operations or the volume of securities subject to federal insurance. Moreover, like portfolio restrictions (which are quantity-oriented), they usually do not specify an explicit per unit subsidy. Nevertheless, they shift the supply curve vertically because the subsidy is enjoyed only on a per unit basis. There is, of course, the issue of identifying the uncertain per unit subsidy flowing from a particular security characteristic program. But that is a separate empirical issue.

SECTION III. SUBSECTOR CREDIT PROGRAMS

Most federal credit programs do not apply to all borrowers or lenders in a particular market. In the housing area, the tax deductibility of mortgage interest payments (without the imputation of income from home ownership) is the closest to such a policy. Broad-based secondary-market operations are also market-wide programs. But usual program specifications dictate that some class of borrowers--for example, those with low incomes, veterans, students--receive a particular subsidy. Similarly, supply side credit policies also usually apply to subsectors of the market. The effectiveness of such per unit subsector subsidies in expanding total credit can be analyzed with Figures 1 through 3 presented above. Total demand is the horizontal summation of subsector

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9/ It should be emphasized that the supply curve can shift vertically even without any implicit government subsidy. For example, the homogenization of the mortgage instrument produced by the GNMA pass-through program increases mortgage liquidity even without a subsidy. Thus, the size of the vertical shift in the supply curve caused by some credit programs can exceed the implicit subsidy.

demands. Total supply is derived in the same way. Any shift in a subsector demand or supply function because of a credit program subsidy provides a similar shift in the total market supply or demand schedule.

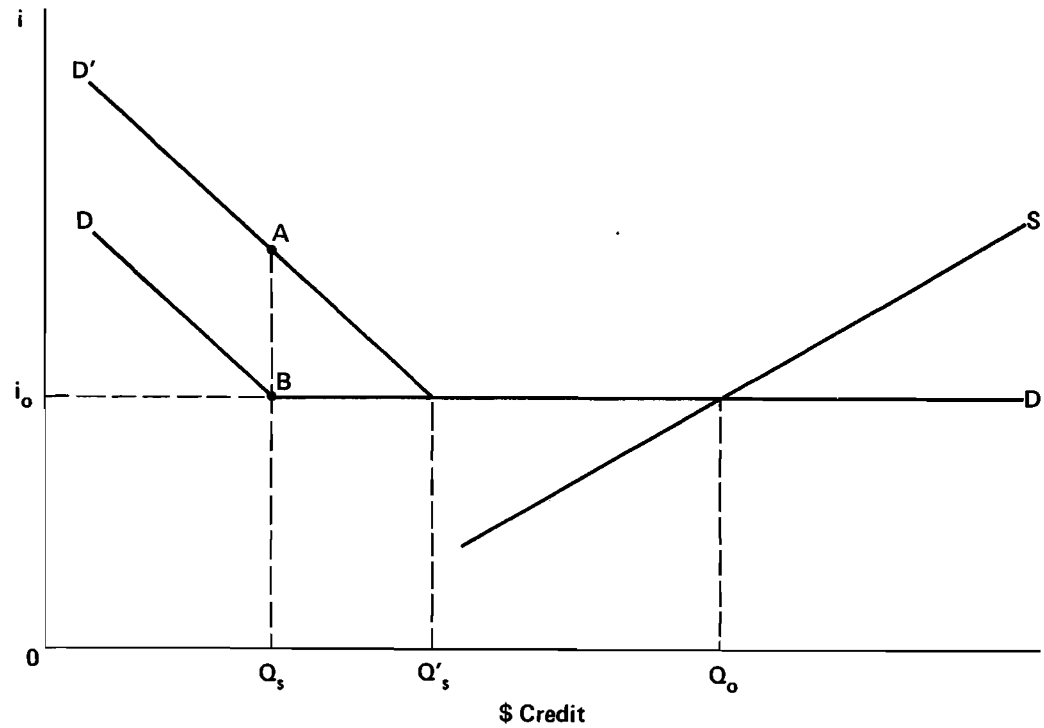
The legislative intent of subsector subsidies is sometimes to promote total credit and general output goals (such as the 10-year housing goals set forth in the 1968 Housing Act). But the more frequent objective is to redistribute income towards specific groups in the form of lower interest cost attached to specific (virtuous) expenditures. The circumstances under which the incidence of a subsector credit program conforms with such legislative intent have not received much analysis. The elasticity conditions which are crucial to our earlier analysis are important, but in a somewhat different way. To illustrate the key points, we isolate the circumstances under which a per unit wedge-type subsidy has the maximum effect on the cost of funds to the intended subsector. In other words, we would like to find the circumstances which minimize the shifting of the subsidy away from its legislative intent.

Since subsector subsidies shift the aggregate schedules in the same way as market-wide subsidies, Figure 1 can be used to show that providing a subsidy AB to a subsector, succeeds in driving down the cost to those selected borrowers by some fraction, CB. As with market-wide subsidies, the problem is that the rate earned by lenders rises by AC, and the intended subsector loses part of the subsidy due to rising market rates of interest. Note, however, that in this case, a higher cost of funds, equal to AC, is imposed on unsubsidized borrowers. Figure 2-A shows that if the supply curve is horizontal, there is no increase in the market rate of interest. The sector that received the subsidy AB benefits in the entire amount. Moreover, in this case, there is no cost to the unsubsidized sector since the market rate of interest remains at i_o.

SUBSECTORS WITH DIFFERENT ELASTICITIES

Since we are dealing with subsector subsidies, it is reasonable to examine circumstances in which elasticities differ between the subsidized and unsubsidized sectors. Consider the case where the demand curve is infinitely elastic for the unsubsidized sector, but negatively sloped for the subsector intended to receive the subsidy. Figure 5 illustrates the circumstances. The real world

Figure 5.

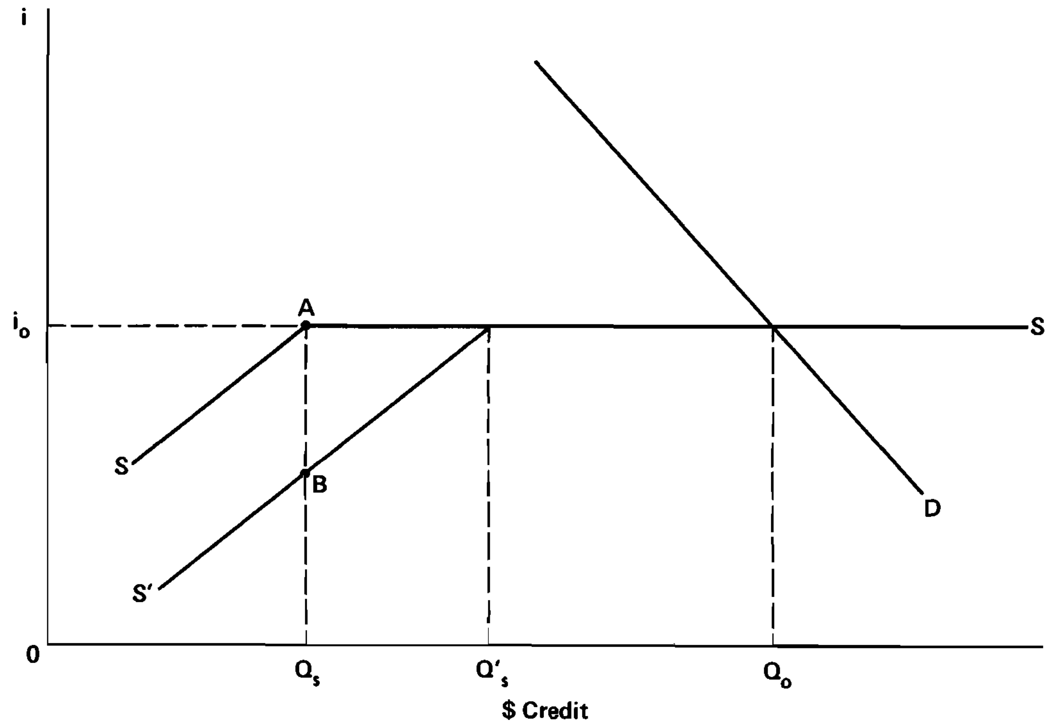


counterpart is one of two cases: (1) the unsubsidized borrowers have access to securities which are perfect substitutes (in financing a real expenditure) for the security in question, while subsidized borrowers do not have such alternatives; (2) the unsubsidized borrowers are easily dissuaded from the particular real expenditure financed by the security.

As can be seen in Figure 5, there is no change in the overall interest rate charged to unsubsidized borrowers and earned by lenders. It remains at i_o. Total credit outstanding also remains unchanged at $0Q_o$. The wedge subsidy does not intercede in overall market equilibrium. But it precisely accomplishes its objective of reducing borrowing costs to the subsidized subsector--net cost to subsidized borrowers declines by AB. Moreover, credit is diverted in the amount $Q_s' - Q_s$ toward subsidized borrowers and away from unsubsidized borrowers. Thus, an interest rate subsidy offered to a subsector of borrowers, when other borrowers have infinitely elastic demand curves, is most efficient in achieving its goal. In a sense, it has a zero excess burden--no other market prices are influenced as a consequence of the subsidy. The redistribution of income in the form of lower borrowing costs in a particular market is accomplished without distortions.

There is a symmetrical case with subsidies to a subsector of the supply side, when unsubsidized suppliers view securities as perfect substitutes for each other. Figure 6 illustrates the outcome: market interest rates remain at i_o; total supply of credit is fixed at OQ_o; the subsidy AB remains with subsidized suppliers only; funds loaned by the subsidized sector expands from OQ_s to OQ_s, with unsubsidized lending contracting to Q_s Q_o. Once again, the credit program is efficient if the objective was to

Figure 6.



subsidize a particular class of lenders without influencing market equilibrium. While this is usually not the case, there are circumstances in which an income transfer (rescue) might be the objective, without requiring immediate resource reallocation effects.

A major difference between these subsector credit program subsidies and the previous market-wide subsidies concerns the importance of the side on which the credit program is placed. When the unsubsidized subsector is characterized by perfect security substitutability, it is no longer a matter of indifference whether lenders or borrowers initially receive the subsidy. The subsidy stops with whoever receives it. There is no shifting. This is in marked contrast with the infinitely elastic supply and demand schedules of Figures 2-A and 2-B. Figure 2-A shows that an infinitely elastic supply curve implies borrowers receive all of the benefits in the form of reduction in yield, while Figure 2-B shows that an infinitely elastic demand curve leaves lenders with all of the benefits in the form of an increase in yield. These results do not follow when the subsidy is imposed on a subsector, under conditions of infinitely elastic market curves. The symmetry we observe for tax/subsidy programs regarding the irrelevance of the initial impact of the subsidy does not hold in such cases.

Another important characteristic of subsector programs under conditions of infinitely elastic market supply or demand curves is that per unit subsidies behave just like quantity-oriented subsidies. It makes no difference whether the non-horizontal sections of supply or demand in Figures 5 and 6 shift vertically or horizontally. The results are the same: the infinitely elastic sector prevents any potential offsetting effects induced by changes in market-wide yields.

LIMITED CREDIT PROGRAMS

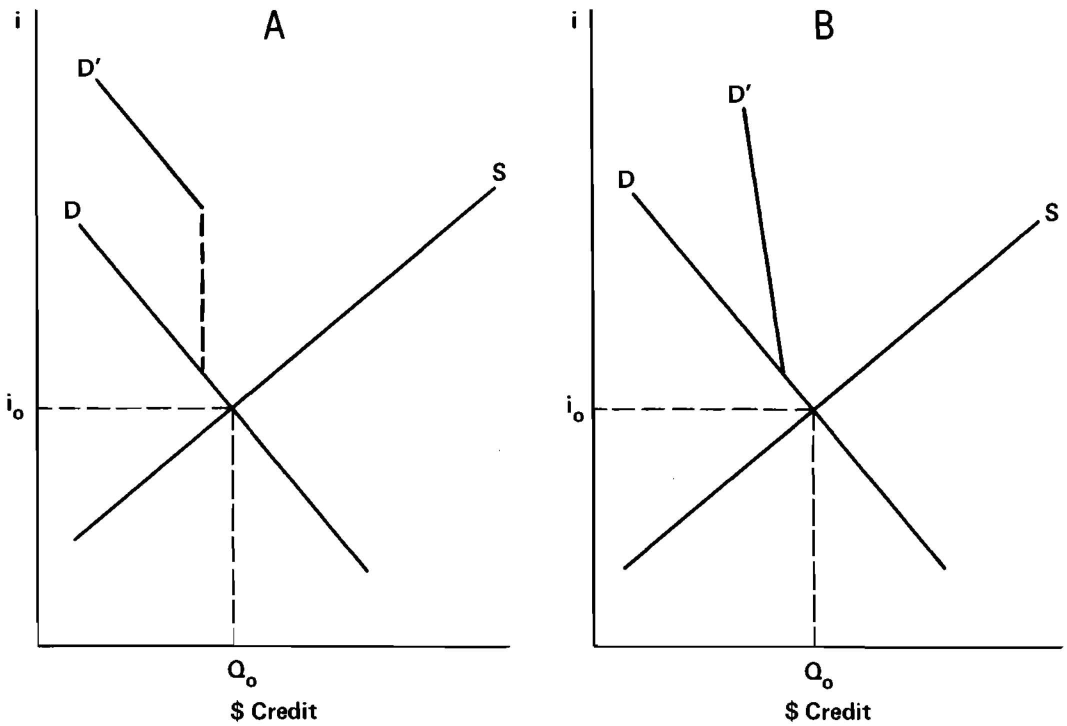
The credit programs analyzed thus far have assumed that the subsidy program is not limited by budget considerations. This was obvious for market-wide subsidies in which the demand curve (or supply curve) shifted vertically or horizontally throughout its length by a fixed amount. Thus, the per unit subsidy was offered to all who demanded it. In the case of quantity-oriented programs, the lump-sum subsidy is similarly available to all those complying with restrictions. Even the subsector programs were implicitly imposed without budget limit. Once the subsector is specified, for example, a particular income category, there is a parallel shift in the entire demand curve for that subsector. Thus, the market-wide and subsector programs were basically the same, except where the elasticities of supply or demand in the unsubsidized sector differed from the subsidized sector.

When budget appropriations limit the total magnitude of the subsidy, the simple horizontal or vertical displacement of the curves no longer represents the program's initial impact. Even programs that are normally available to all (market-wide) become subsector programs. More importantly, the nature of the horizontal or vertical shift varies with the formula for determining how the benefits are distributed (the initial impact of the program in our earlier terminology).

An agnostic assumption is that the subsidy is distributed randomly across the entire length of the demand curve. 10/ While that is an unrestrictive assumption, it is more interesting to cite a special case of subsidy distribution. Assume the subsidy is offered on a first come, first served basis. This offer can be limited to a subsector (such as those with incomes below some arbitrary level) or it can be made available to all. But we assume that budget limitations prevent the subsidy from reaching all those who want it. If the intramarginal borrowers are at the head of the queue, then the demand curve shifts as in Figures 7-A or 7-B. The parallel shift in 7-A represents a fixed per unit subsidy until the total appropriation is exhausted, while the tapered shift in 7-B represents a diminishing per unit subsidy until the total appropriation is exhausted. The important implication of either shift is that neither the market interest rate nor the overall quantity of credit are affected by the credit program. Such an outcome indicates that the program did not succeed in resource reallocation but it may have accomplished (in part) its income redistribution objectives.

10/ George M. von Furstenberg, "Distribution Effects of GNMA Home Mortgage Purchases and Commitments under the Tandem Plan," Journal of Money and Credit, Vol. 8 (August 1976), pp. 373, 389.

Figure 7.



SECTION IV. EMPIRICAL APPLICATIONS

The previous three sections developed a framework for analyzing federal credit programs. A number of characteristics were identified that influence how the ultimate benefits of a program are distributed, thereby extending the work of Penner-Silber. Other program characteristics inadvertantly confuse the cost-benefit calculations necessary to evaluate program effectiveness. Table 1 summarizes some of the issues that were discussed. We will comment selectively on the entries after describing the overall structure.

The programs listed as items 1 through 7 include the major categories of credit programs in the mortgage/housing area (Appendix A provides a brief description of program content). In fact, the list almost repeats the items described in Penner-Silber, with

TABLE 1.

Program	CHARACTERISTICS I Subsidy is per unit or quantity	II Objective is: (a) Resource reallocation (b) Income redistribution (borrowers) (c) Income redistribution (lenders)	III Potential confusion in I because quantity appears in program specification: yes or no	IV Subsidy is implicit or explicit
(1) Section 8	Per unit	(b)	No	Explicit
(2) Sections 235 and 236	Per unit	(b)	No	Explicit
(3) Tax Incentives	Per unit	(a)	No	Implicit
(4) Tandem				
(a) Subsidized	Per unit	(b) and (a)	Yes	Explicit
(b) Unsubsidized	Per unit	(a)	Yes	Explicit
(5) FHA Insurance	Per unit	(a)	Yes	Implicit
(6) Secondary Market				
(a) FNMA(MBB)	Per unit	(a)	Yes	Implicit
(b) GNMA and FHLMC (Pass-through)	Per unit	(a)	Yes	Implicit
(7) Portfolio Restriction				
(a) S&L Assets	Quantity	(a)	n.a.	Implicit
(b) Regulation Q differential	Quantity	(c)	n.a.	Implicit
(c) FHLB Lending	Quantity	(c)	n.a.	Implicit

(Continued)

TABLE 1. (Continued)

Program	CHARACTERISTICS V: Subsidy is market-wide or subsector	VI: Appropriation limits force rationing of the subsidy: yes or no	VII: An effect on market interest rates is likely: yes, no, or uncertain. If no because: (a) Appropriation limit (b) Subsector subsidy; and nonsubsidized sector is very elastic
(1) Section 8	Subsector	Yes	No, because (a) and maybe (b)
(2) Sections 235 and 236	Subsector	Yes	No, because (a) and maybe (b)
(3) Tax Incentives	Market-wide	No	Yes
(4) Tandem			
(a) Subsidized	Subsector	Yes	No, because (b) and (a)
(b) Unsubsidized	Market-wide	Yes	No, because (a)
(5) FHA Insurance	Subsector	No	Uncertain
(6) Secondary Market			
(a) FNMA(MBB)	Subsector	Yes, but self-imposed	Uncertain
(b) GNMA and FHLMC (Pass-through)	Market-wide	No	Yes
(7) Portfolio Restriction			
(a) S&L Assets	Subsector	No	No, in long run because (b)
(b) Regulation Q differential	Subsector	No	No, in long run because (b)
(c) FHLB Lending	Subsector	No	No, in long run because (b)

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the exception of the Section 8 program. Items 1 through 5 were called wedge-type programs in Penner-Silber, items 6 were labelled mortgage-characteristic programs, and items 7 were portfolio-restriction policies. As column I in the table shows, entries 1-6 belong to the per unit subsidy class while items 7 are in the quantity-oriented subsidy group, with the associated implications for policy effectiveness.

PROGRAM CHARACTERISTICS

Column II lists the policy objective of the program--either resource reallocation or income redistribution. There can obviously be disagreements over program aims, especially in the cyclical environment of housing finance. Thus, while line 4(a) cites the tandem subsidized program as having an income redistribution objective, since there is certainly an element of program timing to help avoid short-run decreases in housing activity, we also list resource reallocation as a goal. Other joint entries might be proposed in column II.

Note that the last two lines in column II list income redistribution on the lender side as the objective of the Regulation Q interest rate differential and Federal Home Loan Bank System lending to S&Ls. These were labelled "cost shifting" measures by Penner-Silber, which they are. In our current framework they fall into the income redistribution objective towards lenders, just as Sections 8 and 235 are income redistribution policies on the borrower side. A recently proposed Senate amendment to compensate S&Ls and savings banks for capital losses on their mortgage portfolio would come under the same classification.

Column III addresses a common confusion in per unit subsidies, namely, that some programs frequently have associated quantity specifications. Thus, for all of the per unit subsidies we simply answer whether the quantity dimension to the program could lead to confusion over whether the subsidy is per unit or quantity oriented (we enter n.a., not applicable, for the quantity subsidies). Obviously, the confusion disappears once the nature of the credit program is carefully analyzed. Thus, all of the answers in column III could be "no." Actually, column III is meant to alert us to the potential for improperly specifying the nature of the subsidy (a problem which recurs in the outline for empirical research in Section V).

A further cause for concern is whether the credit subsidy is implicit or explicit, as described in column IV. This creates measurement problems even at the impact level of the program (and certainly at the incidence level). As can be seen, only Sections 8, 235, and the tandem programs can be considered explicit credit subsidies. Estimates of the implicit subsidies must accompany the other programs.

One could argue that tax incentives are explicit rather than implicit subsidies since it is only a matter of specifying the marginal tax rate in order to derive the true subsidy. This is very much more explicit than extracting the implicit subsidy in items 6 or 7, in which secondary market contributions and preferential competitive treatment of financial institutions must be given a subsidy value. Tax incentives are also more explicit than the FHA insurance program since for the latter we must value the backup borrowing authority at the Treasury (available to meet defaults over and above paid-in FHA insurance premiums). Nevertheless, tax incentives are much less explicit than Sections 8 and 235 or even the tandems, since all the latter clearly identify the per unit dollar component of the program subsidy. Thus we have labelled tax incentives as implicit subsidies.

PROBABILITY OF INTEREST RATE EFFECTS

Columns V through VII are closely intertwined. The issue that is raised in column VII--whether there is an impact on market interest rates of the credit program--is, as we have seen, at the heart of cost-benefit analysis of credit programs. We have shown in our theoretical sections that sometimes--especially for income redistribution programs--the optimal condition is no final impact on market interest rates. But whatever the particular circumstance, the likelihood of an impact on market interest rates is determined, in part, by the program characteristics listed in columns V and VI. Column V indicates whether the credit program's initial impact is market-wide or is imposed on a subsector. Column VI records whether there are appropriation limits that necessitate nonprice rationing of the program's initial impact. Each of these requires some discussion.

The entries in column V indicate that most credit programs are of the subsector variety. The only market-wide programs are tax incentives in line 3, unsubsidized tandem in 4b, and the secondary market effects of GNMA and Federal Home Loan Mortgage Corporation pass-through securities in line 6b. The argument for market-wide initial impacts of tandem and secondary market pass-throughs stems from the fact that these credit programs apply to both the insured (FHA/VA) and conventional sectors (FHLMC creates participation certificates in conventionals).

It could be argued that tax incentives are really a subsector program because only individuals above a particular income level can benefit. This is certainly the case, except that some benefit accrues even to the lowest income groups. 11/ Considering the magnitude of the tax benefits and the fact that almost all potential homebuyers receive some benefit leads us to categorize the program as market-wide.

Column VI records a related component of the initial impact of credit programs: whether budget limitations prevent unlimited access to program benefits. As we described above, this, in effect, reduces a market-wide subsidy to a subsector program, with some form of nonprice queuing determining the distribution of benefits. It is not surprising to see in column VI that all of the credit programs with explicit subsidies (see column IV) have appropriation limits. Thus lines 1, 2, 4a, and 4b have "yes" entries in column VI. Of the remaining credit programs with implicit subsidies, only FNMA secondary mortgage operations have a limit on program size. All of the others are "demand determined," that is, anyone can draw on program operations at the specified price structure (for example, one-half percent premium for FHA insurance; 50 basis point differential for a GNMA wrapper on FHA mortgages).

The limitation set by FNMA on its secondary market operations is determined by FNMA's policies regarding its risk/profit trade-off in issuing mortgage-backed bonds to finance its mortgage purchases. From this perspective, it is possible to argue that Federal Home Loan Bank lending to S&Ls in line 7c is also limited by nonprice rationing. Thus, it can be argued that FHLB lending is not purely demand determined. We have retained a "no" entry in line 7c because there is evidence suggesting that savings and loan

11/ Congressional Budget Office, Federal Housing Policy: Current Programs and Recurring Issues, Background Paper (June 1978), Table 14.

demand for FHLB advances is the dominating factor in determining program activity. 12/

Column VII uses the entries in columns V and VI to evaluate the likelihood of market interest rate effects stemming from the particular program's activity. We assume that the credit programs shift the underlying supply and demand curves as described in Section II above. Even then, only those programs that are both market-wide in column V and budget unlimited in column VI are likely to have an interest rate effect. Thus, only tax incentives in line 3 and GNMA/FHLMC pass-throughs in line 6b have "yes" entries in column VII. The remaining subsector and/or budget limited programs will have interest rate effects under the conditions described in Section III above. For subsector programs, an infinitely elastic unsubsidized sector eliminates the interest rate impact. For programs with budget limitations, the propensity for intramarginal borrowers to appropriate the subsidy eliminates the market interest rate effect.

We have entered anticipated effects in column VII based on casual impressions regarding real world behavioral relationships. Thus, for example, lines 7a, 7b, and 7c record answers of "no" because in the long run there is probably an infinite elasticity of supply in the unsubsidized sector of the mortgage market. Thus, according to Figure 6, there would be no impact on market rates of subsidies to a subsector of the supply side of the market. Similarly, lines 1, 2, 4a, and 4b are not likely to have interest rate effects because of budget limitations and the fact that intramarginal borrowers will try to appropriate the subsidies for themselves. These programs have income redistribution effects but no resource reallocation consequences. Finally, we have left the entries on FHA insurance and FNMA secondary market operations as uncertain because we have little a priori notions about the elasticities of the unsubsidized sector and are uncertain about the nature of the self-imposed budget, respectively.

12/ See Patric H. Hendershott and Kevin E. Villani, "The Federally Sponsored Credit Agencies: Their Behavior and Impact," in Robert M. Buckley, John A. Tuccillo, and Kevin E. Villani, eds., Capital Markets and the Housing Sector: Perspectives on Reform (Cambridge, Massachusetts: Ballinger Publishing Co., 1977), Chapter 12, pp. 291-309.

SECTION V. CONCLUSIONS: A MENU FOR EMPIRICAL RESEARCH

It should be obvious that definitive answers in column VII of Table 1 can be obtained only through extensive empirical testing. In some sense, column VII is an agenda for empirical analysis. Each of the programs listed in the table should be examined for its impact on the level of mortgage interest rates (relative to some base cost of funds, such as Treasury yields). The impact on mortgage interest rates is crucial to judging the ultimate effectiveness of these credit programs.

The various columns in the table suggest, however, a number of caveats in the empirical analysis. Most important, perhaps, is the nature of the program's subsidy listed in column IV. For implicit subsidies the problem is straightforward: how to proxy the credit program's implicit subsidy. Even for explicit subsidies a complication arises when there are appropriation limits--which in fact exist for all explicit subsidies. The potential impact of such programs on interest rates is some combined effect of explicit subsidy and coverage--in which the latter is determined by the magnitude of the budget limitation.

Two simple examples serve to illustrate these problems. In evaluating the impact of secondary market programs (lines 6a and 6b) we must first isolate the per unit subsidy implied by FNMA, GNMA, and FHLMC operations. The volume of FNMA, GNMA, and FHLMC security issues provides some measure of the marketability effects of these programs, 13/ although the precise nature of the relationship is uncertain. The problem with evaluating the effect of the tandem plans in 4a and 4b is not that the magnitude of the subsidy is unknown, but rather that its distribution is limited by budget appropriations. The impact on interest rates (and housing) is some combination of these two components, although precisely how this combined effect should be represented in unclear. 14/

13/ See Deborah G. Black, Kenneth D. Garbade, and William L. Silber, "The Impact of the GNMA Pass-Through Program on FHA Mortgage Costs," Journal of Finance (May 1981).

14/ See Ronald Utt, "An Empirical Analysis of the GNMA Tandem Plan," in Capital Markets and the Housing Sector, Chapter 14, pp. 347-362.

It is interesting to note that while both the secondary market and tandem credit programs produce per unit subsidies, the empirical investigation of their effects involves the quantity dimension of their program specification. Thus, the potential for confusion listed in column III returns in the empirical evaluation.

Once the interest rate effects of the credit program are ascertained, it remains to determine whether these are consistent with the program objectives listed in column II. As was suggested in our theoretical section, the desired incidence of program benefits sometimes proceeds without market reported interest rate effects. The efficacy of income redistribution programs is clearly enhanced by the absence of movements in market interest rates. Confirming that no part of a program's subsidy is lost through the response of market interest rates requires careful specification of the subsidy. The failure to uncover substantial shifting could easily be attributed to an improperly specified proxy for the implicit subsidy.

Our theoretical structure outlined in Sections I through III and the empirical applications of Section IV leave a substantial agenda for future investigation. The complexity of the underlying theory and the nature of empirical measurement indicate that such investigations must be more than casual inquiries.

APPENDIX

APPENDIX A. A BRIEF DESCRIPTION OF HOUSING CREDIT PROGRAMS

Section 8

The Section 8 program, used heavily since 1974, was developed to reduce the housing costs of lower-income persons and to provide them with physically standard housing. The New Construction/Substantial Rehabilitation portion of this program subsidizes the rents of households occupying approved public and privately developed projects (approval is based on cost, physical adequacy, and location). HUD makes the subsidy payments to the project owner/manager equal to the difference between the government-established Fair Market Rent and 25 percent of tenant income. The Existing Housing component of this program provides assistance on behalf of households occupying adequate rental housing of their own choosing in the private market. Local public housing agencies, under contract to HUD, subsidize the housing costs by paying landlords the difference between a lower-income tenant's rental fee and the tenant's contribution of 15 to 25 percent of their monthly income. The tenant freedom of choice among existing rental units in the private market is a unique feature of this program. Section 8 has had a marked effect on participants' housing costs and has assisted the lowest-income households since income limits are approximately 80 percent of the area median.

Section 235

This homeownership program provides mortgage interest subsidies to lower- and middle-income households purchasing new or substantially rehabilitated homes. HUD makes up the difference between the borrower's payment and the amount due the lender, so that the borrower's payments do not exceed 20 percent of his adjusted income. The actual subsidy varies with the market interest rate, and can continue over the life of the mortgage. Households qualify if income is below the limit of 95 percent of the area median. In 1975, a minimum effective rate of interest to the buyer and a minimum downpayment were enacted to correct flaws in the original program that forced HUD (due to defaults) to acquire approximately 15 percent of the homes purchased under its guidelines.

Section 236

This program subsidizes mortgage interest for rental housing projects in which a portion of the housing units are made available to lower-income persons at reduced rates. It also contains a rent supplement program which makes subsidy payments to the owners of private rental housing on behalf of lower-income tenants. The rent subsidy is most often used in conjunction with the mortgage interest subsidy, thus "piggybacking" the subsidies paid to the project owner. The program has been plagued by defaults.

FHA Insurance

The Federal Housing Administration (FHA) provides mortgage insurance on market-rate single-family and multifamily mortgages and on subsidized mortgages on assisted housing projects. Thus, the mortgage payments by the homeowner to the lender are insured by a federal agency, virtually eliminating all risk of default and covering up to 90 percent of any losses. Statutes and regulations (reviewed and reset periodically) set maximum interest rates, downpayment requirements, and loan amounts. The insurance premium charged on single-family loans (1/2 percent) has generally covered the costs of all FHA programs until recently, when the higher-risk programs experienced high default rates. On balance, however, the program has reduced housing costs for many families by providing somewhat more favorable financing, thus increasing their access to credit.

Tax Incentives

The federal tax code permits the deduction of mortgage interest and state and local real estate payments for owner-occupied housing, thus reducing the cost of buying relative to renting. Because the provisions benefit only those who itemize deductions, and because the benefit is greater for those in higher marginal tax brackets, the bulk of this benefit goes to middle- and upper-income households. Other measures include the deferral of some or all of the capital gains on the sale of a home if another is bought (or started) within 18 months of the sale or the seller is elderly. The problem with this measure is the tendency to promote "buying up" of homes, thus helping to inflate housing costs; if the capital gains are deferred until the owner is in a lower tax bracket, the loss in taxes is greater (but the subsidy is greater also). The above measures aid the occupant of the housing unit directly.

There are also tax incentives that benefit the developer of rental housing. Accelerated depreciation for rental housing is allowed, and there is also favorable treatment of construction-period interest and property tax payments. There is also a program which gives primary mortgage lenders preferential bad debt deduction allowances. The tax subsidies represent a relatively uncontrollable federal subsidy (the dollar magnitude exceeds the direct expenditures on housing) determined by the level of activity of private individuals and institutions eligible for the deductions.

Tandem

GNMA is authorized to agree in advance to purchase, at full face value, mortgages made by private lenders at interest rates lower than market (as low as 7.5 percent). GNMA then resells them as market-yield instruments, absorbing the difference as an interest subsidy. The subsidy is typically 1-1/2 percent below market rates for single-family units and 2 percent for multifamily housing.

A distinction can be drawn among tandem plans regarding the types of mortgages involved in tandem activities. The subsidized tandem plan involves the purchase of FHA mortgages subsidized under Sections 235 and 236 programs. In addition, the program is also available to developers of Section 8 New Construction/Substantial Rehabilitation projects, thus providing them with a financing subsidy along with the rent subsidy. The unsubsidized tandem plan, begun in 1971, refers to a support program involving FHA mortgages that receive no other subsidy except for that offered by GNMA. In 1974, a tandem plan for conventional home mortgages was added.

FNMA

FNMA is a government-sponsored private corporation that purchases and sells privately written mortgages. FNMA finances its activities by issuing bonds to the public. This major support of the secondary market offers lenders a way to liquidate residential mortgages in order to encourage the use of private capital for home loans. Furthermore, the process also improves the geographical distribution of residential mortgage credit. Since FNMA purchases the mortgages, it can also encourage lending in areas where financial institutions do not want to hold and service the mortgages themselves.

FHLB Lending

Advances to member thrifts are made through the 12 Federal Home Loan Banks. The advances are made to alleviate temporary credit shortages, especially during periods of tight money, or to stimulate the expansion of lending activities by the member institutions.

GNMA

The Government National Mortgage Association (GNMA), formed in 1968, is an agency of HUD. The GNMA pass-through program is a guarantor of privately issued securities backed by pools of home mortgages. The private lending institutions purchase government-insured mortgages, form a pool, and then sell securities backed by the pool which promise to pass through monthly payments of principal amortization and interest. The GNMA guarantee of timely payment of principal and interest plus all prepayments is backed by the full faith and credit of the U.S. government. The securities sell at a favorable effective return since the originator retains the servicing function. In addition to increasing the supply of capital available (the program has grown very rapidly), the marketability of the underlying mortgages is increased.

FHLMC

The Federal Home Loan Mortgage Corporation (FHLMC) is a federally chartered corporation created in 1970 under control of the Federal Home Loan Bank Board (FHLBB). FHLMC purchases conventional mortgages from any FHL Bank (or member thereof), packages them, and then originates a pass-through security. The participation certificates in such a pool entitle the holder to monthly payments of principal amortization and interest plus all prepayments, unconditionally guaranteed through the FHLBB. The primary legislative intent of the program is to provide a secondary market for conventional mortgages, and encourage lending by enhancing the marketability of mortgages.

Regulation Q

This Federal Reserve Board regulation maintains a differential between the rates that thrifts and commercial banks are permitted to pay on deposits--with thrifts receiving the higher limit. The differential is now 1/4 percent on both passbook accounts and certificates of deposit (compared with 3/4 percent and 1/4 percent, respectively, in 1966). Since the rate ceilings affect the cost of money for these institutions, the cost of mortgage credit to borrowers is thereby affected. The differential gives S&Ls and mutual savings banks--the primary sources of mortgage credit--a relative advantage over commercial banks in attracting deposits; but also a relative disadvantage during periods of tight money. Since the ceilings are infrequently adjusted, deposit rates can be well below market, resulting in more attractive investments available elsewhere. The flows of savings to thrifts are decreased and a reduction in the supply of mortgage credit results. Thus deposit rate ceilings have been cited as a substantial factor in producing wide swings in mortgage credit availability.

S&L Assets

Federal Home Loan Bank Board member institutions are prohibited from making many kinds of loans, thus ensuring that most funds are made available for residential mortgages. Construction loans, consumer loans, commercial paper and other corporate debt are among the investment categories excluded, so essentially only mortgages and government-backed obligations are held. There are also limitations on the types of activities thrifts can engage in (no checking accounts or demand deposits).

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FEDERAL GOVERNMENT ATTEMPTS TO INFLUENCE THE ALLOCATION OF MORTGAGE CREDIT: FHA MORTGAGE INSURANCE AND GOVERNMENT REGULATIONS

by

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PREFACE

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SECTION I. INTRODUCTION

Since the 1930s the federal government has played an increasingly important role in the allocation of mortgage credit. Instruments of federal policy used for this purpose include or have included Federal Housing Administration (FHA) and Veterans Administration (VA) insured and guaranteed loans; secondary mortgage transactions made by the Federal National Mortgage Association (FNMA), Federal Home Loan Mortgage Corporation (FHLMC), and the Government National Mortgage Association (GNMA); interest rate subsidies; tax expenditures; and direct loans. More recently, federal regulations have been enacted to affect the behavior of mortgage lenders in the pursuit of social objectives. These regulations include the Fair Housing Act (Title VIII), the Equal Credit Opportunity Act (ECOA), the Home Mortgage Disclosure Act (HMDA), and the Community Reinvestment Act (CRA).

Federal housing policies are clearly a part of the stabilization, allocation, and distribution activities of the federal government. The first major federal housing initiatives, enacted in the National Housing Act of 1934, were part of an economic recovery program implemented during the Great Depression. Though stabilization of economic activity has always remained an important objective, allocation and distribution objectives have become increasingly important. Indeed, such aims were explicitly acknowledged in the 1949 Housing Act which proposed a "goal of a decent home and a suitable living environment for every American family."

An implicit but important goal of federal housing policies has been to encourage the acceptance of greater risk in mortgage markets. Encouraging greater risk-taking may be socially desirable for reasons of both economic efficiency and distributional equity. Attitudes toward risk by both private lenders and federal, state, and local financial regulatory agencies, however, may prevent mortgage transactions from occurring that would otherwise be mutually profitable for both borrowers and lenders. In such cases, appropriately designed federal mortgage insurance programs may enhance the efficiency of mortgage markets. Low-income applicants for mortgages are likely, for numerous reasons, to be more risky. Improving the access of such individuals or groups to mortgage credit through government actions can be a means of achieving greater distributional equity.

This paper examines the development and performance of federal housing policies designed to enhance efficiency and/or equity primarily through increasing risk-taking in mortgage markets. Federal initiatives in this realm can be broadly grouped into three phases. The first began with the establishment of FHA Section 203(b) mortgage insurance and lasted into the 1950s. The second phase began with a modest expansion of FHA insurance programs in the 1950s and culminated with further expansion of FHA insurance as well as the provision of interest subsidies and direct loans during the 1960s.

The development and success of these programs are discussed in Section II. Explanations are offered for the initial growth of FHA Section 203(b) mortgage insurance. These explanations also suggest why the results of the initial FHA experiment were not replicated in the second phase.

The third phase of government activity was partly a response to the outcome of second-phase programs. Because second-phase housing initiatives did not fully achieve their goals, various government regulations affecting private lenders were enacted. These regulations were primarily intended to compel conventional lenders to make mortgages more readily available to specific individuals and/or groups thought to have been denied mortgages unjustifiably or granted mortgages at onerous terms. The development and structure of these regulations are discussed in Section III.

As a consequence of recent FHA activity, considerable information has been generated about the relationship between mortgage loan terms, property location, and default risk. This data is quite relevant for evaluating the impact of both government mortgage insurance programs and government regulation of private lenders. A recent analysis of this data and a discussion of policy implications are presented in Section IV. Finally the summary and conclusions of our analysis are presented in Section V.

SECTION II. HISTORY AND EFFECTS OF FEDERAL MORTGAGE INSURANCE PROGRAMS

To assess the impact of federal insurance programs on mortgage markets, one must first identify the main factors that determine the terms of mortgage credit. Following Henry Aaron, we therefore develop a simple model of lender and borrower behavior. 1/

A SIMPLE MODEL OF MORTGAGE TRANSACTION

Consider first the determinants of a lender's offer curve of mortgage credit. For simplicity, we assume that the terms of credit can be summarized by a single measure, the mortgage interest rate, i_m. Two major determinants of i_m are the cost of funds to a lender (i_o) and the expected default loss on a mortgage loan (R). We therefore assume the mortgage rate offered by a lender is given by:

$$(1) \quad i_m = S\ (i_o, R);\ S_{i_o},\ S_R > 0.$$

We further assume that the greater the cost of funds and/or the higher the default loss the greater the lender's "asking rate" will be.

Clearly, the default loss on a mortgage loan cannot be known with certainty *ex ante*. Consequently, lenders must form expectations about the default loss on any given mortgage loan. It is therefore the expected default loss on a loan which actually affects the mortgage rate of interest.

Furthermore, lenders may be concerned not only about the expected default loss but also the variance in that loss. The greater the variance or dispersion in default loss the more uncertainty the lender will have about the actual default loss. Lenders may react to such uncertainty by requiring a compensating increase in the mortgage rate.

For these reasons, R in equation (1) should be viewed as a broad index of default risk measured by the expected default loss

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1/ Our model is based on Henry J. Aaron, *Shelter and Subsidies* (Washington, D.C.: The Brookings Institution, 1972). However, we explicitly analyze the borrower's choice of mortgage terms and type of mortgage loan, that is, conventional or FHA. As will become clearer below, our model, unlike Aaron's, is able to explain the observed differences in mortgage terms within the FHA mortgage portfolio.

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and/or the variance in that loss. This risk of default loss itself depends upon property characteristics (P), neighborhood characteristics (N), borrower characteristics (B), and the mortgage loan terms, particularly the loan-to-value ratio (L/V). This may be expressed more formally as: 2/

(2) $R = F(L/V,N,P,B)$.

Substituting equation (2) into (1) yields the expression:

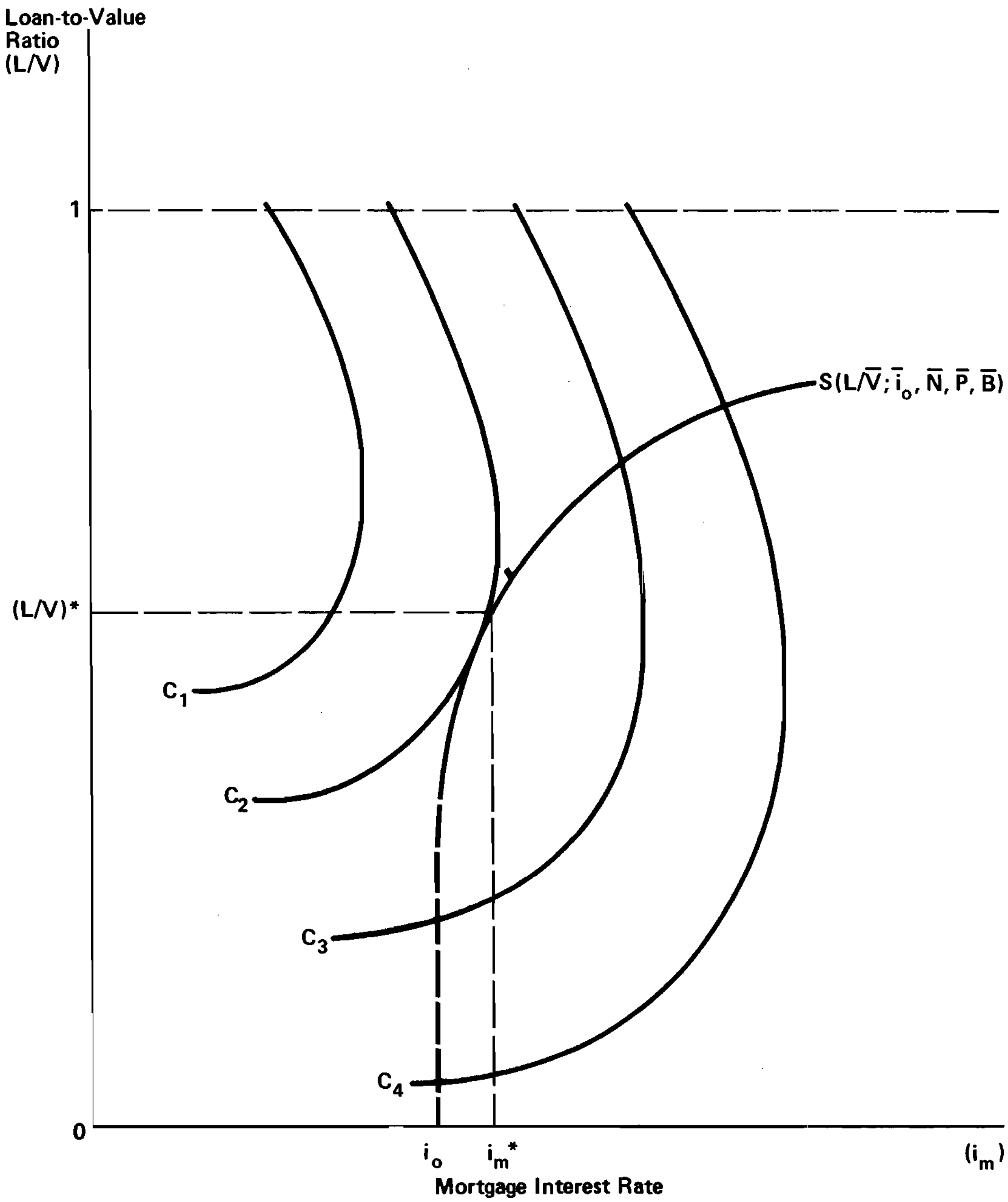
(3) $i_m = S(i_o,L/V,N,P,B)$.

The effect on i_m of changes in the loan-to-value ratio are easily discussed in terms of equation (3). Empirical evidence to date strongly suggests that increasing the loan amount on a dwelling with given value ($\bar{V}$) increases the risk of default. Thus, i_m should rise with a rising loan-to-value ratio. This relationship is depicted by the curve labeled $S(L/\bar{V};\bar{i}_o,\bar{N},\bar{P},\bar{B})$ in Figure 1. This offer curve shows the various interest rates a lender is willing to offer for various loan-to-value ratios given the neighborhood and property characteristics of the dwelling and borrower characteristics. The offer curve also incorporates the effects of regulations that limit risk-taking and interest rates.

We now consider the determinants of borrower behavior. In Figure 1, the borrower's response to the lender's offer is represented by the constant finance cost curves, C_1 through C_4. Along any of these curves, the total cost, including both the mortgage interest cost and the cost of equity capital, is constant. Total finance costs increase as one moves to the right from C_1 to C_4. That is, for a given loan-to-value ($L/\bar{V}$) ratio, the total costs of financing the purchase of a dwelling rises with the mortgage interest rate, i_m.

2/ Based on economic theory, it can be shown that $\partial R/\partial (L/V) > 0$ and $\partial^2/\partial (L/V)^2 > 0$. See Jerry R. Jackson, David R. Kasserman, and Wilson Thompson, "An Equity Model of Home Mortgage Default Risk" (unpublished paper, 1978).

Figure 1.
Determinants of the Equilibrium Loan-to-Value Ratio and Mortgage Interest Rate



The shape of the constant finance cost curves of a particular borrower is determined in the following manner. 3/ Each borrower

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3/ Total finance cost on a housing unit whose sales price is $\bar{V}$ may be written as the sum of the interest cost on the mortgage and the interest cost on equity capital (which may come from the borrower's assets or from secondary borrowing, including consumer credit). In other words,

$$C = i_m L + i_e E = i_m L + i_e (\bar{V}-L),$$

where C is the total finance cost, i_m is the mortgage interest rate, L is loan amount, i_e is the interest rate on equity capital, E is equity capital or the down payment and $\bar{V}$ is the sales price or value of the housing unit. Given this equation, it follows that

$$dC = i_m\, dL + L di_m - i_e\, dL + (\bar{V}-L)\, di_e,$$

since $\bar{V}$ is constant. Assuming that $dC = 0$ and assuming, for the moment, that $di_e = 0$, then one finds that

$$di_m/dL = (i_e - i_m)\, \bar{V}/L,$$

which in words, says that the change in the mortgage interest rate per unit change in the loan-to-value ratio is equal to the reciprocal of the slope of the constant finance curve. Given this, it is clear that the slope of a constant finance curve is positive if i_e is greater than i_m and negative if i_e is less than i_m. When i_e equals i_m, the constant finance cost curve is vertical.

If i_e is permitted to vary such that it increases with the amount of the down payment, that is, $di_e/dL < 0$, then the above expression becomes

$$di_m dL = (i_e - i_m)/L - (\bar{V} - L)\, (di_e/dL)$$

or

$$di_m d(L/\bar{V}) = (i_e - i_m)\, V/L - \bar{V}\, (\bar{V} - L)\, (di_e/dL).$$

Note that the extra term contributed by allowing i_e to vary with L is positive, that is, $-(\bar{V} - L)(di_e/dL) > 0$. This means that the constant finance cost curve may retain its negative slope when i_e is less than i_m if di_e/dL is sufficiently small.

has an opportunity cost of equity capital, i_e, which is assumed to increase with the amount of the equity or down payment made on the housing unit. The slope of a constant finance cost curve at any point is determined by the relative size of i_e and the mortgage interest rate, i_m. Consider the slope of a particular constant finance cost curve at the point where the loan-to-value ratio equals one. Equity is equal to zero at this point and i_e is the opportunity cost of the first dollar of down payment. The finance cost which is held constant along a constant finance cost curve is determined by the initial value of i_m. The slope of the constant finance cost curve as the $L/\bar{V}$ falls below one, is determined by relative size of i_e and i_m. If i_m exceeds i_e, then an increase in equity would lower total finance cost unless i_m increased. Because total finance cost must remain constant along a constant finance cost curve, i_m necessarily rises as $L/\bar{V}$ falls and the slope of the total finance cost curve is negative. This result is illustrated in Figure 1, where the constant finance cost curves have a negative slope at $L/\bar{V}$ ratios close to one.

As the $L/\bar{V}$ ratio falls and down payment increases, i_e will tend to rise above i_m. If i_e exceeds i_m, a decrease in the $L/\bar{V}$ ratio must be accompanied by a decrease in i_m to maintain constant finance cost and the constant finance cost curve will have a positive slope. Figure 1 illustrates this effect as the slope of the constant finance cost curves becomes positive when $L/\bar{V}$ falls substantially below one. Finally the constant finance cost curves are vertical in the knife-edge case where i_e is equal to i_m. Note also that the general shape of constant finance cost curves can be related to borrower access to equity capital. Borrowers with little equity capital and/or those confronted by high borrowing costs would most likely have negatively sloped constant finance cost curves.

The borrower minimizes the total finance costs subject to the constraints embedded in the lender's offer curve. The cost-minimizing combination of i_m and $(L/\bar{V})$ occurs at a point of tangency between a constant finance cost curve and the lender's offer curve. 4/ In Figure 1, this cost-minimizing combination is

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4/ Issues concerning risk preferences of the borrower are ignored here. This analysis also ignores the borrower's aversion to possible capital losses on the unit which could be avoided through default and foreclosure.

obtained at a loan-to-value ratio of $(L/\bar{V})^*$ and a mortgage interest rate of $(i_m)^*$. Clearly, shifts in N,P,B, or i_o would also alter the cost-minimizing combination of i_m and $(L/\bar{V})$.

DEVELOPMENT AND IMPACT OF SECTION 203(b) INSURANCE

Figure 1 is now used to analyze the historical development of federal mortgage insurance programs. 5/ During the 1920s, the U.S. mortgage market was dominated by mutual savings banks, savings and loan associations, insurance companies, and commercial banks. These four types of institutions accounted for 74.4 percent of the total new mortgage loans made on one-to-four family houses during the period 1925-1930. 6/ The typical mortgage terms on loans made by these institutions during this period were quite different from those prevailing in subsequent periods, including the present. As Table 1 shows, during the 1920s mortgages were written with term to maturities not exceeding 12 years and with loan-to-value ratios close to 50 percent. In the 1930s and 1940s, however, these mortgage terms were significantly liberalized. By 1947 the term to maturity approached 20 years and the loan-to-value ratio was roughly 70 percent.

Table 2 presents more recent figures disaggregated by type of mortgage loan (FHA, VA, and conventional) and by type of housing structure (new and existing). This table shows that qualified

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5/ For the descriptive materials regarding FHA mortgage insurance program, we relied heavily upon U.S. Department of Housing and Urban Development (HUD), Housing in the Seventies (1974) and Future Role of FHA (January 18, 1977); Congressional Budget Office, A Budgetary Framework for Federal Housing and Related Community Development Policy (February 1977) and Federal Housing Policy: Current Programs and Recurring Issues (June 1978); and Peter M. Greenstone, C. Duncan MacRae and Carla I. Petrone, The Effects of FHA Activity in Older, Urban, Declining Areas: A Review of Existing, Related Analysis, Research Report (Washington, D.C.: The Urban Institute, February 1975).

6/ See Leo Grebler, David M. Blank, and Louis Winnick, Capital Formation in Residential Real Estate (Princeton University Press, 1956), Table 55, Share of Total New Mortgage Loans Made, by Type of Lender, One-to-Four-Family Houses, Selected Periods, 1925-1950, p. 207.

TABLE 1. AVERAGE CONTRACT LENGTHS AND AVERAGE LOAN-TO-VALUE RATIOS OF MORTGAGE LOANS MADE BY SELECTED FINANCIAL INSTITUTIONS ON ONE-TO-FOUR-FAMILY HOUSES, 1920-1947 a/

	Average Contract Length			Average Loan-to-Value Ratio		
Year	Life Insurance Companies	Commercial Banks	Savings and Loan Associations	Life Insurance Companies	Commercial Banks	Savings and Loan Associations
1920	6.0	2.9	11.3	46	48	59
1921	7.9	1.8	10.6	44	49	56
1922	6.6	2.9	11.5	47	51	58
1923	5.9	2.9	11.2	48	50	57
1924	5.7	3.5	11.1	50	52	58
1925	6.0	3.1	10.9	49	50	60
1926	5.9	3.6	11.2	51	51	57
1927	6.7	2.5	11.4	51	54	56
1928	6.6	3.2	11.4	53	53	60
1929	6.8	3.7	11.2	52	53	61
1930	7.5	3.6	10.8	53	50	59
1931	7.8	3.0	10.8	52	50	59
1932	7.9	3.0	11.3	49	51	64
1933	6.3	2.1	11.1	46	57	56
1934	7.9	2.9	11.7	53	50	61
1935	13.0	9.8	11.9	53	60	60
1936	16.2	9.7	11.4	61	61	62
1937	16.7	9.6	12.8	64	60	62
1938	17.7	13.2	13.7	67	63	64
1939	18.3	14.8	12.9	69	69	64
1940	19.9	16.0	14.6	73	72	68
1941	20.6	14.4	13.9	76	68	68
1942	21.1	12.8	13.5	80	67	68
1943	21.7	12.4	13.4	81	66	70
1944	22.1	10.0	13.6	82	61	73
1945	20.1	9.3	14.3	76	61	73
1946	18.8	12.7	15.0	75	70	77
1947	19.5	14.8	15.2	69	69	74

SOURCE: Leo Grebler, David M. Blank, and Louis Winmick, Capital Formation in Residential Real Estate, Trends and Prospects, National Bureau of Economic Research (Princeton University Press, 1956), Table 67, p. 234 and Table 0-6, p. 503.

a/ Includes conventional, FHA, and VA loans.

borrowers are currently able to obtain mortgage loans with terms to maturity of 30 years and loan-to-value ratios exceeding 90 percent. In sum, since 1947 mortgage loan terms have been liberalized even further both in terms of loan maturity and the loan-to-value ratio.

TABLE 2. AVERAGE CONTRACT LENGTHS, AVERAGE LOAN-TO-VALUE RATIOS, AND AVERAGE AMOUNTS OF MORTGAGE LOANS, BY TYPE OF LOAN AND TYPE OF HOUSING UNIT FOR 1977

Type of Mortgage Loan and Housing Unit	Average Contract Length (In years)	Average Loan-to-Value Ratio (In percents)	Average Amount of Mortgage Loan (In dollars)
FHA			
New Homes	29.9	91.0	34,061
Existing Homes	29.4	93.5	27,345
VA			
New Homes	97.4% of the total number of loans have maturities of 30 years	95.2	39,605
Existing Homes	93.0% of the total number of loans have maturities of 30 years	96.9	34,645
Conventional			
New Homes	27.9	76.3	41,430
Existing Homes	25.8	75.1	35,672
Insured	28.0	89.4	35,178

SOURCE: U.S. Department of Housing and Urban Development, 1977 Statistical Yearbook, Table 27, pp. 128-30, Table 35, p. 378, Table 38, p. 380; and Mortgage Insurance Companies of America, Factbook and Directory, 1979-80 Edition, Table XII, p. 16.

The mortgage terms observed during the 1920s clearly reflected both demand and supply factors. However, the lack of any significant high loan-to-value mortgage activity suggests that supply factors played an important role in eliminating such mortgages.

In terms of Figure 1, lender reluctance to make loans with loan-to-value ratios greater than 50 percent would be represented by an offer curve which bent sharply to the right as $L/\bar{V}$ rose above one-half and approached three-fourths. In Figure 2 a lender offer curve with this characteristic is drawn and labeled $S_{20}(L/\bar{V});\bar{i}_o, \bar{N},\bar{P},\bar{B})$. We assume this offer curve represents that facing the purchaser of an average owner-occupied dwelling in the 1920s.

During the 1930s, the housing industry virtually collapsed and there were numerous bank failures. In the 1930-1933 period, more than 8,800 banks failed. In 1933 alone 3,891 banks suspended operations. 7/ As shown in Table 3, the housing industry fared poorly. Total housing starts fell 70 percent, from 2,383,000 in the 1926-1930 period to 728,000 in the 1931-1935 period. It is also estimated that only 150,000 persons were employed in on-site construction in 1933. 8/ At the same time, approximately one-half of all home mortgages were in default, and foreclosures were occurring at the phenomenal rate of over 1,000 per day. 9/ Nonfarm real estate foreclosures reached a maximum of 252,000 in 1933. Foreclosures declined only slightly at first to 229,000 in 1935, but then more rapidly to 185,000 in 1936, 151,000 in 1937, and 59,000 in 1941. 10/

Among the responses of the federal government to these events were the establishment of the Home Owner's Loan Corporation (HOLC) in 1933 and the passage of the National Housing Act of 1934 which created the Federal Housing Administration (FHA) mortgage insurance

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7/ Board of Governors of the Federal Reserve System, Banking Studies (Baltimore, Maryland: Waverly Press, 1977), p. 419.

8/ U.S. Department of Housing and Urban Development, Future Role of FHA (1977), p. 7.

9/ Ibid.

10/ Leo Grebler, The Role of Federal Credit Aids in Residential Construction, Occasional Paper 39, National Bureau of Economic Research (1953), footnote 3, p. 21.

Figure 2.

Mortgage Offer Curves Under Conventional and FHA Mortgage Insurance

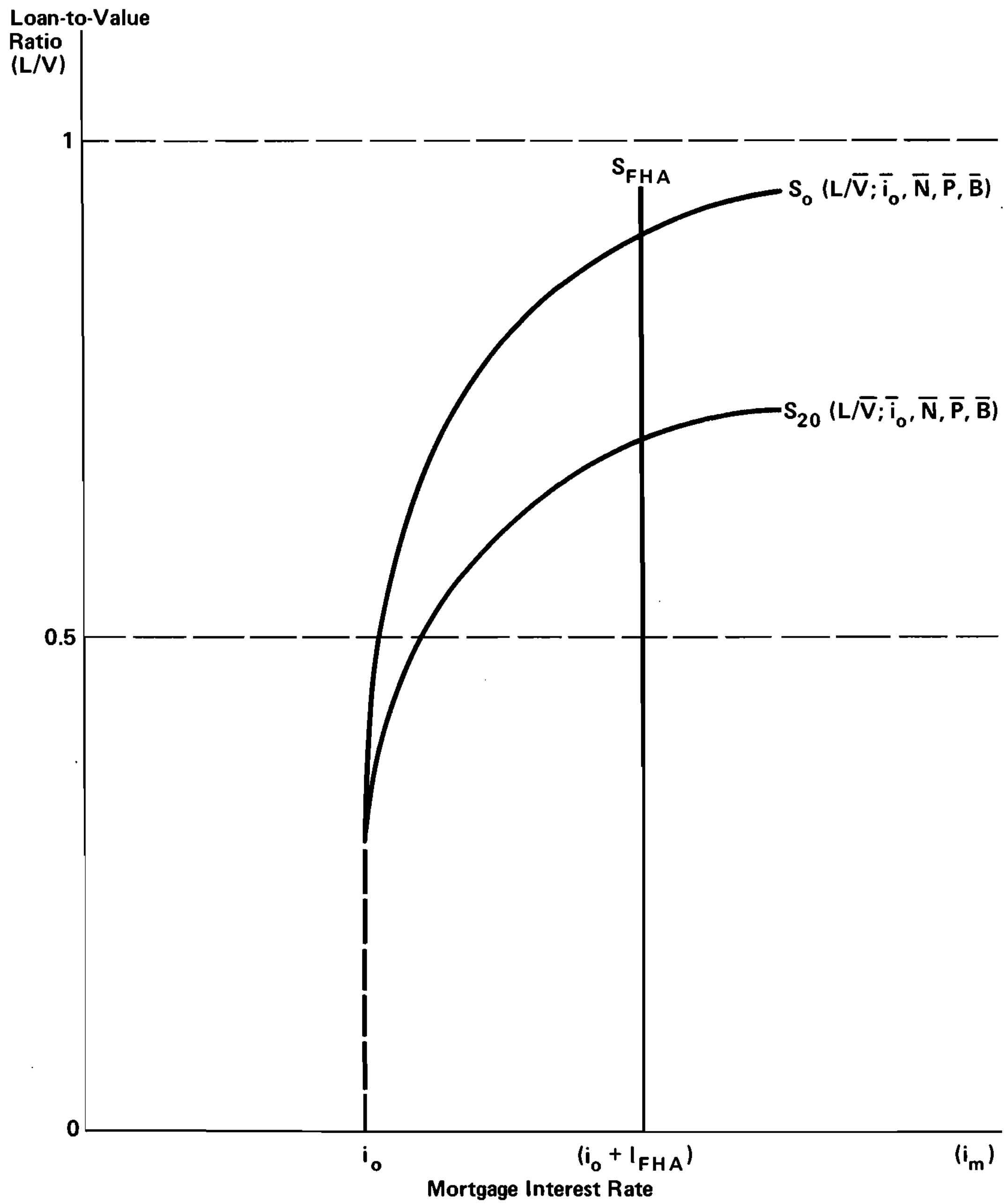


TABLE 3. STARTS OF ONE-TO-FOUR FAMILY NONFARM HOMES, BY TYPE OF LOAN, 1921-1976

Year	Number of Units Started (In thousands) Total	FHA	VA	Conventional a/	Percent Distribution FHA	VA	Conventional a/
1921-1925	3163	--	--	3163	--	--	100.0
1926-1930	2383	--	--	2383	--	--	100.0
1931-1935	728	14	--	714	1.9	--	98.1
1936-1940	1811	566	--	1245	31.3	--	68.8
1941-1945	1557	667	9	881	42.8	0.6	56.6
1946-1950	6527	1042	605	4880	16.0	9.3	74.8
1951-1955	7066	1153	1147	4766	16.3	16.2	67.5
1956-1960	5833	1136	685	4012	19.5	11.7	68.8
1961-1965	5273	876	340	4057	16.6	6.5	76.9
1966-1970	4424	806	257	3351	18.2	5.8	75.7
1971-1975	5772	700	434	4638	12.1	7.5	80.4
1966	817	129	37	651	15.8	4.5	79.7
1967	892	142	52	698	15.9	5.8	78.3
1968	956	148	56	752	15.5	5.9	78.7
1969	878	154	51	673	17.5	5.8	76.6
1970	881	233	61	648	26.4	6.9	73.6
1971	1247	301	94	852	24.1	7.5	68.4
1972	1423	198	104	1121	13.9	7.3	78.8
1973	1226	74	86	1066	6.0	7.0	87.0
1974	938	57	73	808	6.1	7.8	86.1
1975	938	70	77	791	7.5	8.2	84.3
1976	1170	74	92	1004	6.3	7.9	85.8

SOURCE: U.S. Department of Housing and Urban Development, Future Role of FHA (1977), Table 1, p. 9a.

a/ Starts under Farmers Home Administration programs are included in the figures for conventional lending.

programs. HOLC was established to purchase mortgages in default and threatened with foreclosure. It was therefore directly concerned with existing mortgage debt and only indirectly, if at all, with the availability of new mortgage credit. At its peak in 1935 the HOLC held over 15 percent of all U.S. residential mortgage debt. HOLC was expected to incur large losses as a result of its activities--primarily the extension of emergency loans on a long-term, self-amortizing basis. However, when liquidated in the 1940s, HOLC fully repaid all its Treasury borrowings and actually showed a small profit. By contrast, the National Housing Act of 1934 was designed to increase the availability of new mortgage credit and thereby encourage the revival of the housing industry. The principal instrument was Section 203(b). (Since the passage of the 1934 Act, new FHA mortgage programs have been implemented as amendments to this act and are commonly known by their section number and letter.) (See Appendix B for data on the magnitude of the programs implemented by these sections.)

Mortgages insured under Section 203(b) were secured by the Mutual Mortgage Insurance Fund (MMIF). The creation of the Federal National Mortgage Association (FNMA) in 1938 provided additional impetus to 203(b) mortgage activity since FNMA was authorized to purchase such mortgages. FNMA therefore made FHA mortgages extremely liquid by providing a ready secondary market for the longer-term type of mortgages offered under Section 203(b).

The main feature of Section 203(b) was the provision of mortgage insurance to all borrowers at a uniform premium. Each 203(b) loan was to be evaluated on the basis of economic soundness to insure the solvency of the MMIF. Though no formal definition of economic soundness was provided in the legislation, limits were placed on the maximum mortgage amount and the maximum loan-to-value ratio (see Appendix A). There is, however, a general consensus in the literature that FHA implemented Section 203(b) mortgage insurance by imposing minimum values on neighborhood quality (N), property quality (P), and borrowers' credit worthiness (B). In the case of P, these criteria were implemented by conducting a property inspection. In the case of B, the most important criterion was income, in that maximum permissible values were established for monthly payment-to-income ratios.

Finally, in the case of N, the actual operation of the Section 203(b) program indicated that some urban areas were excluded from FHA insurance. This practice of exclusion was characterized as "redlining" because areas excluded from participation in the Section 203(b) mortgage insurance program were said to be marked by a red line at FHA offices.

The impact of FHA mortgage insurance is illustrated in Figure 2. The offer curve for any mortgage loan satisfying the (implicit) FHA criteria for N, P, and B is the vertical line S_{FHA}. That is, under 203(b) a lender would be willing to make a loan at a constant interest rate for any loan-to-value ratio. The reason is that FHA insurance virtually eliminates the default risk that normally causes the offer curve to bend to the right as $(L/\bar{V})$ rises. The offer curve is vertical at a rate of interest determined by adding the FHA insurance premium (I_{FHA}) to i_o. It is worth emphasizing that this offer curve is only appropriate for those housing units, neighborhoods, and borrowers that qualify for FHA Section 203(b) mortgage insurance. This vertical offer curve, moreover, terminates at the maximum loan-to-value ratio permitted under this program.

The offer curve labeled $S_0(L/\bar{V};i_o,\bar{N},\bar{P},\bar{B})$ in Figure 2 is drawn to represent various combinations of the mortgage interest rate and the loan-to-value ratio which produce an expected profit of zero. This offer curve is, therefore, a zero-profit locus. It divides the $L/\bar{V}$ - i_m space into regions of positive profit and negative profit (that is, loss). 11/ Note that a portion of S_{FHA} extends above S_0, implying that mortgages insured in this region are not actuarially sound. The exact relationship between the upper portion of S_{FHA} and S_0 is an empirical issue discussed later in this paper.

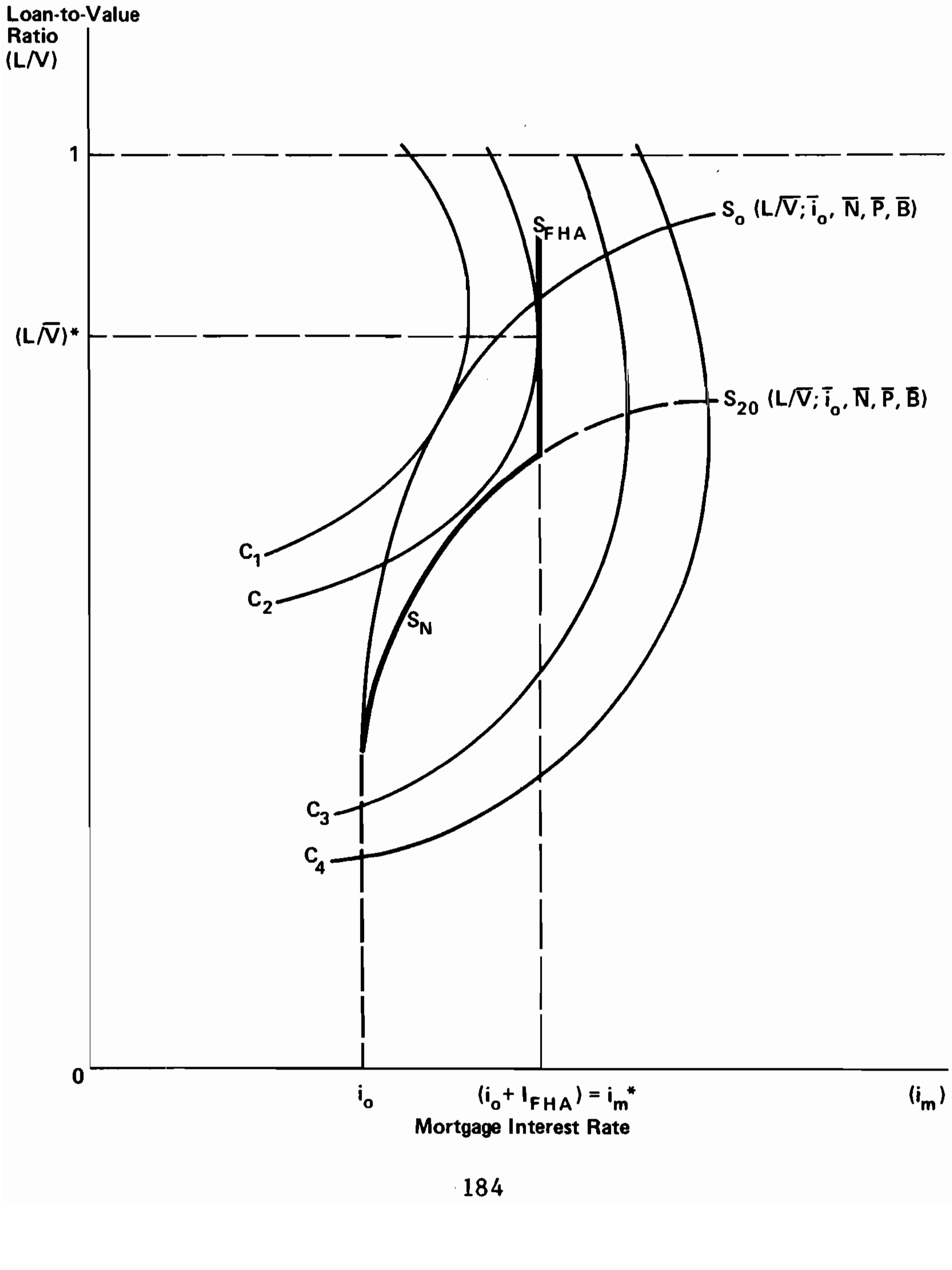
Equilibrium (that is, the actual mortgage terms negotiated on a loan transaction) when both conventional mortgages are offered along S_{20} and FHA Section 203(b) insured loans are offered along S_{FHA} is illustrated in Figure 3. Given the two offer curves, the relevant offer curve from the borrower's perspective consists of the connected segments of S_{20} and S_{FHA} which, at any given loan-to-value ratio, lie farthest to the left. This net offer curve is depicted in Figure 3 by the dark-lined curve S_N. Given the position of S_N, equilibrium obtains at a loan-to-value and interest rate combination of $(L/\bar{V})^*$ and i_m^*. Only at these loan terms does the borrower minimize total finance costs given the terms available from either a conventional or FHA loan.

In the particular case illustrated in Figure 3, the borrower would choose the FHA-insured rather than the conventional mortgage loan. Note also that the transaction lies below the S_0 curve, indicating that the insured mortgage loan exceeds minimum standards

11/ S_0 does not permit risk aversion to affect the lender's mortgage credit decision. Only expected profit, not its variance, influences the position of the curve.

Figure 3.

Determinants of Equilibrium Mortgage Terms Immediately After the Introduction of FHA Mortgage Insurance



of actuarial soundness. The expectation is that the Section 203(b) MMIF would earn a profit on such a loan. If the borrower faced a different set of constant finance cost curves, the equilibrium in Figure 3 could just as easily occur on the portion of S_N above S_0, or on the portion of S_N corresponding to a conventional mortgage loan.

High levels of mortgage insurance activity experienced under Section 203(b) during the 1930s, 1940s, and 1950s (see Table 4), along with sizable surpluses in the MMIF, indicate that, during this period, the bulk of FHA-insured mortgage loans were of the type depicted in Figure 3. Indeed, as shown in Appendix A, as early as 1938 the maximum loan amount and the maximum loan-to-value ratio were increased based upon favorable loss experience. Subsequently, these maximums were further increased. Government insurance transactions generally met or exceeded the criterion of actuarial or economic soundness. Note, however, that Figure 3 clearly indicates it is possible for the average transaction to earn a profit even though the marginal loan transaction, at the highest loan-to-value ratio, may be above S_0 and therefore earn a loss.

The Omnibus Housing Act of 1954 signaled a major change in the motivation for federal government mortgage insurance programs. This legislation referred to the unmet housing goals of the National Housing Act of 1949 as the primary mandate for policy rather than revival of the housing industry or the financial system. Section 221(d)(2) mortgage insurance was to provide insurance for mortgages on new and existing dwellings in urban renewal and concentrated code enforcement areas. It was designed to help private industry provide housing for those displaced by government action. This gave an explicit new dimension to the FHA insurance program. This legislation also introduced the insurance standard of "acceptable risk," which required that the property to be insured "met such standards and conditions as the Secretary shall prescribe to establish the acceptability of such property for insurance under this section."

The 1950s also saw the revival of the private mortgage insurance (PMI) industry, which began to offer insurance for conventional mortgage loans for the first time since the 1930s. As the result of legislation passed in 1956 in Wisconsin, the Mortgage Guarantee Insurance Corporation (MGIC) began operating in 1957. Subsequently, more and more PMIs were permitted to operate as additional states passed enabling legislation permitting this kind of insurance. As Table 5 shows, the PMIs became an increasingly

TABLE 4. HOME MORTGAGES INSURED BY FHA: ALL PROGRAMS AND SECTION 203, 1935-1977 (Amounts in thousands of dollars)

	New Construction			
	Total of All Programs		Section 203	
Year	Units	Amount	Units	Amount
Total	4,801,993	$54,716,756	3,402,882	$40,340,505
1935-39	235,391	1,012,590	218,763	974,676
1940-44	738,051	3,117,345	399,467	1,792,224
1945-49	540,396	3,603,452	187,002	1,324,183
1950-54	783,330	6,114,750	686,657	5,448,175
1955-59	645,084	7,510,749	598,401	7,001,548
1960-64	654,910	9,102,069	574,374	8,121,593
1965-69	462,773	7,933,143	404,101	7,079,629
1970	139,774	2,658,279	55,580	1,198,004
1971	198,223	3,899,650	59,133	1,323,772
1972	169,895	3,459,165	58,393	1,325,558
1973	80,251	1,674,828	28,940	661,297
1974	31,021	751,956	22,559	572,458
1975	39,087	1,148,704	35,946	1,070,132
1976	34,488	1,086,937	32,126	1,024,450
1977	50,581	1,663,669	42,760	1,446,204

(Continued)

SOURCE: U.S. Department of Housing and Urban Development, 1977 Statistical Yearbook, Table 5, pp. 60-62.

important factor in the mortgage insurance market throughout the 1970s.

Several factors contributed to this rapid growth. First, the Federal Home Loan Mortgage Corporation (FHLMC) was established in 1970 to increase the availability of residential mortgage credit by contributing to the further development and maintenance of the secondary market for residential mortgages. Since FHLMC primarily purchases conventional mortgages from savings and loan associations, its creation has increased the liquidity of this type of mortgage loan. More important, however, is the FHLMC policy

TABLE 4. (Continued)

Existing or Refinanced Construction					
		Section 203			
Total of All Programs		Homes		Improvements	
Units	Amount	Units	Amount	Units	Amount
8,020,529	$102,856,602	6,882,293	$87,163,344	2,943	$17,676
278,224	995,187	278,224	995,187	-	-
243,337	999,240	236,737	973,301	-	-
439,055	2,513,302	419,194	2,423,058	-	-
570,502	4,479,249	556,244	4,361,551	-	-
1,024,067	11,084,213	961,227	10,266,811	-	-
1,426,154	17,676,817	1,290,274	16,052,190	1,672	9,184
1,886,788	25,171,858	1,587,541	21,676,932	1,013	6,234
375,368	5,410,380	244,653	3,695,879	79	667
409,943	6,474,892	273,362	4,504,906	28	251
282,852	4,607,892	172,091	2,896,253	11	97
171,385	2,798,475	106,341	1,737,825	2	20
174,145	3,181,749	128,653	2,395,077	3	20
277,907	5,017,411	190,284	4,299,924	5	40
277,902	5,275,183	198,215	4,682,020	68	552
283,015	7,177,167	241,504	6,245,655	16	126

(required by its enabling legislation) of limiting its purchases of conventional mortgages to those in which the borrower has at least a 20 percent equity in the property or in which a lower borrower equity is accompanied by private mortgage insurance, PMI, so that the effective exposure risk is reduced to 80 percent of the loan amount. Clearly, this policy increased the demand for PMI. About the same time that the FHLMC was created, the Emergency Home Loan Financing Act of 1970 authorized FNMA to buy conventional mortgages. Although purchases of conventional mortgages did not begin until February 1972, the purchase volume has risen steadily until this type of mortgage loan now accounts for more than half of the dollar amount of FNMAs recent mortgage purchases and constitutes roughly 30 percent of the dollar amount of its total mortgage holdings. Like FHLMC, FNMA can only purchase high

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TABLE 5. THE ROLE OF PRIVATE AND FEDERAL GOVERNMENT INSURANCE IN THE ONE-TO-FOUR FAMILY NONFARM HOME MORTGAGE MARKET (In billions of dollars)

Year	Total	Conventional Mortgage Debt Outstanding: Insured	Conventional Mortgage Debt Outstanding: Uninsured	Federal Government Mortgage Debt Outstanding: Insured	Federal Government Mortgage Debt Outstanding: Guaranteed	Privately Insured as Percentage of Total Insured
1970	288.1	7.3	193.5	59.9	37.3	7.5
1971	328.3	9.6	213.5	65.7	39.5	8.4
1972	372.2	17.5	241.7	68.2	44.7	13.4
1973	416.2	27.4	272.6	66.2	50.0	19.1
1974	449.4	34.0	294.1	65.1	56.2	22.0
1975	490.8	39.9	323.1	66.1	61.6	23.4
1976	556.5	49.3	373.6	66.5	67.0	27.0
1977	657.2	63.0	452.6	68.0	73.3	30.9
1978 a/	775.0	81.1	491.9	70.0	82.0	34.8

SOURCE: Mortgage Insurance Companies of America, Factbook and Directory, 1979-80 Edition, Table 11, p. 3.

a/ Estimate.

loan-to-value ratio conventional loans if these loans have PMI. FNMA's activities and policies therefore also increased the demand for PMI. 12/ Second, in the early 1970s, regulations were also promulgated permitting thrift institutions to originate mortgages at 95 percent of value when the individual loans are insured.

Third, Congress has traditionally set the maximum mortgage amount that can be insured under FHA programs. At present, under

12/ It should be noted that, under temporary authority granted in 1974, the Government National Mortgage Association (GNMA), which was chartered by federal law in its present form in 1968, also purchased conventional insured mortgages. However, GNMAs general purchase authority is restricted to the purchase of mortgages insured or guaranteed by the federal government.

the basic Section 203(b) single-family mortgage insurance program, the limit is $67,500. Until December 1979 the single family mortgage limit was $60,000, which was in force since 1977. Before then, the limit was $45,000, a limit introduced by the passage of the Housing and Community Development Act of 1974. Until the passage of this act, the mortgage limit was only $33,000. (See Appendix A for a detailed description of these and other limits on the terms of a mortgage loan insured under the FHA Section 203(b) program.) If housing prices rise more rapidly than these Congressionally determined mortgage limits, the maximum permissible loan-to-value ratios must necessarily fall. This reduction in the real value of mortgage limits in inflationary periods will induce borrowers to shift to conventional mortgage loans. 13/ An increase in the demand for conventional loans would also result in an increase in the demand for PMI. Indeed, recent expansion in the FHA lending ceiling will make Section 203(b) more competitive with PMI.

Fourth, PMI was designed to compete with FHA insurance by offering lower insurance premiums to better mortgage risks. Unlike FHA, which generally sets an insurance premium of 0.5 percent of the outstanding mortgage amount, collected over the life of the loan on a current basis, on all its loans, PMI premiums vary according to the loan-to-value ratio of the mortgage, the percentage of the mortgage amount insured, and the choice of prepayment option with fixed length of coverage. In the event of a default on a mortgage, moreover, the default is processed in one to seven days under PMI and in roughly 30 days under FHA insurance. 14/ By offering lower and variable insurance premiums, PMI companies have, therefore, been able to compete successfully with FHA. Of course, these premiums are set lower than the FHA insurance premium because the PMI companies only insure relatively low-risk mortgage loans. FHA is therefore left with relatively high-risk mortgage loans. This phenomenon has been referred to as "cream skimming," a term used to describe the systematic selection of the best risks in the Section 203(b) applicant pool by PMIs. In terms of Figure 3,

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13/ These mortgage limits, which apply nationwide, will also have regional effects due to different rates of growth in housing prices. One might therefore expect more conventional mortgage loans to be made in the East than in the West. This is consistent with the evidence.

14/ See Arthur D. Little Inc., The Private Mortgage Insurance Industry (April 1975), p. 123.

the initial experience of the FHA Section 203(b) program clearly indicated there was a vertical margin between S_{20}, the offer curve for most conventional mortgage lenders, and S_0, the zero-profit locus. That is, FHA demonstrated there were positive profits associated with higher loan-to-value mortgages that were not being exploited by conventional mortgage lenders.

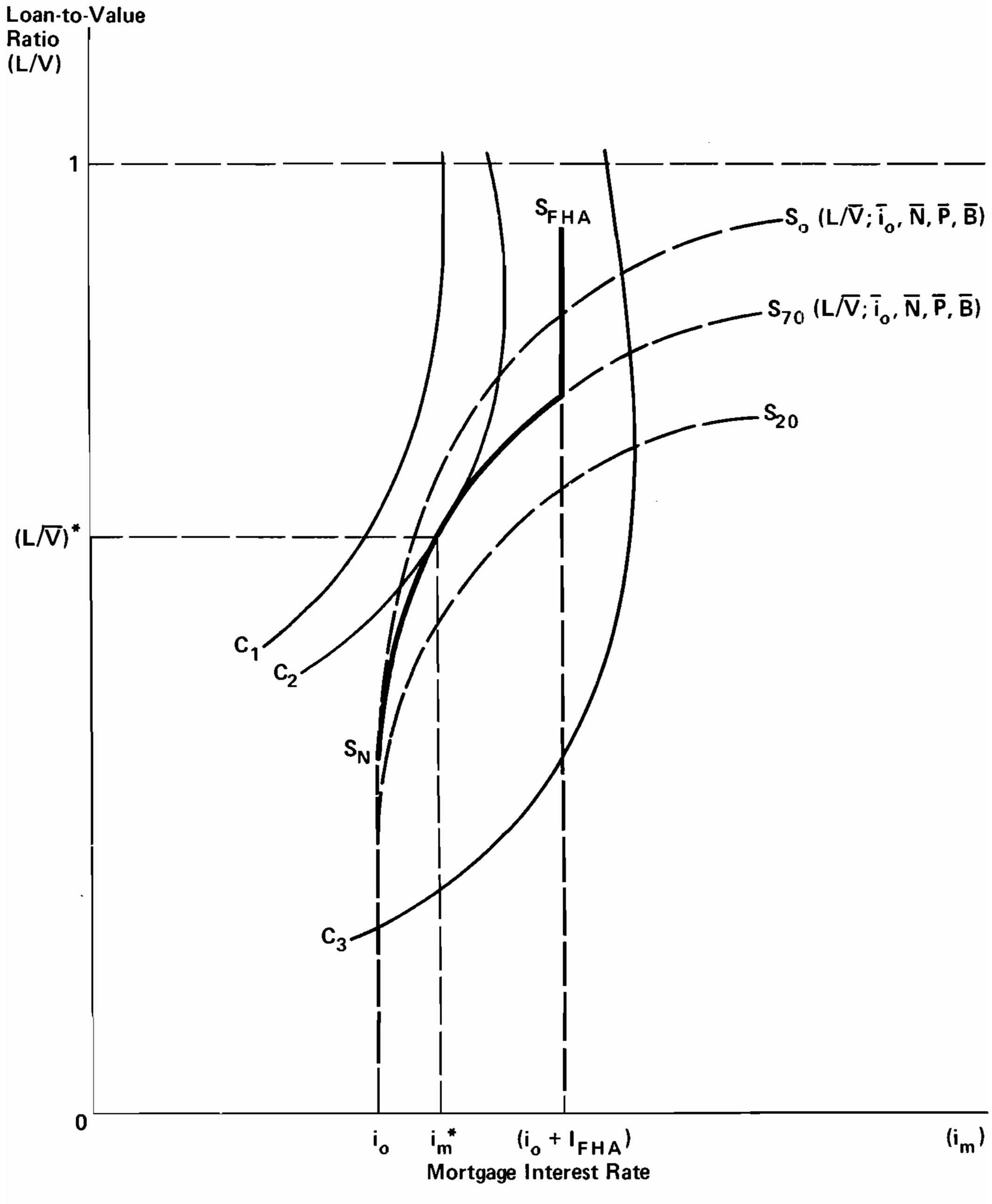
The impact of PMIs on the mortgage credit decision in the typical transaction qualifying for Section 203(b) insurance is illustrated in Figure 4. The offer curve for conventional mortgages, including those insured by PMIs, is depicted by $S_{70}(L/\bar{V}; N,P,\bar{B})$, which lies slightly below S_0, but above S_{20}. Given the position of the curves in Figure 4, the borrower would choose a conventional mortgage loan with a loan-to-value ratio of $(L/\bar{V})^*$and an interest rate of i_m^*.

It is important to note also the impact of the upward shift of the private lender's offer curve, S_{70}, on the actuarial or economic soundness of borrowers who select FHA insurance. Given the shape of the borrower's constant finance cost curves in Figure 4, those borrowers selecting FHA insurance are far more likely to reach an equilibrium on the portion of the S_{FHA} curve above S_0 than before the upward shift in the private sector offer curve due to private mortgage insurance.

Thus, increased PMI activity should decrease the volume of Section 203(b) insurance activity and raise the loss rate, thereby reducing, and perhaps eventually eliminating, the surplus in the MMIF. Both of these outcomes have been observed. This does not mean, however, that the FHA mortgage insurance program has been a failure. FHA has made a number of important contributions. Among these are: assisting in the popularization and standardization of the fully amortized, fixed interest, level payment mortgage; assisting in the lengthening of the term of the mortgage; assisting in the increasing of the loan-to-value ratios on residential mortgages; assisting in the development of minimum property standards, standardized appraisals, and the standardization of the mortgage contract; and assisting in the provision of information on risks of default that was then available to private mortgage lenders and insurers. All of the these factors, of course, contributed toward the development of a truly national mortgage market.

The accomplishments should not, however, be overstated. Aaron, for instance, has noted that the surplus in the MMIF served to demonstrate to private mortgage lenders that relatively high

Figure 4.
Determinants of Equilibrium Mortgage Terms with Both FHA and PMI



loan-to-value ratios were potentially profitable. 15/ It is uncertain, however, whether private lenders could have increased their loan-to-value ratios had they desired to before the introduction of FHA mortgage insurance. In this regard, Leo Grebler states that:

> The restrictions on loan-to-value ratios and maturity of mortgage loans imposed by the National Banking Act do not apply to loans insured by the Federal Housing Administration or guaranteed by the Veterans Administration. This is also true for the limitations in many of the state banking laws. While similar exceptions apply to other mortgage lending institutions, they are more potent in the case of commercial banks because their conventional lending activity is more severely limited by existing laws. 16/

This quotation suggests that private lenders making conventional mortgage loans may have been unable to liberalize their loan terms because of federal, state, and/or local regulations and laws. One may therefore view the vertical margin between S_{20} and S_0 in Figure 3 as representing profits that were not exploitable due to existing laws and regulations. Over time, as these regulations and laws were liberalized, lenders' offer curves shifted upward to take advantage of profitable opportunities flowing from the ability to lend at less restrictive loan terms.

The introduction of PMI also encouraged lenders to make larger loans because with insurance conventional loans could be sold to such institutions as FNMA and FHLMC. Until these institutions were created or were permitted to purchase conventional insured mortgages, however, lenders would have been reluctant to liberalize their loan terms, particularly when faced with usury laws or "soundness" requirements imposed by federal or state regulatory agencies.

15/ Aaron, Shelter and Subsidies.

16/ Grebler, "The Role of Federal Credit Aids," pp. 36-38.

DEVELOPMENT AND IMPACT OF MORTGAGE INSURANCE IN THE 1950s, 1960s, AND 1970s

In the 1950s and 1960s, federal housing policy focused increasingly on special housing problems in inner cities. This represented a basic shift from the primary emphasis placed in the 1930s and 1940s on increasing the supply of adequate housing. This change was initially reflected in the Housing Act of 1954 which, under Section 220, attempted to expand housing credit and production in urban renewal areas, and, under Section 221(d)(2), provided mortgage insurance to families displaced by urban renewal activities. In addition, the Federal National Mortgage Charter Act of 1954 (1954 Mortgage Charter Act) established the first special assistance functions (which require governmental financial support) to be carried out by the Federal National Mortgage Association (FNMA). These new programs were established with their own statutory provisions and insurance funds to permit them to function almost independently of FHA. This was done to insulate the original FHA mortgage insurance fund, supporting programs such as Section 203 single-family home mortgage insurance, from the effects of the relatively liberal underwriting terms of each new program.

Liberalization of mortgage terms relative to those in effect for the regular government mortgage insurance programs was a major feature of both the 1954 Housing Act and the 1954 Mortgage Charter Act. This liberalization was basically achieved in three different ways. First, the "economic soundness" test for the proposed construction was replaced with an "acceptable risk" test. Second, the maximum insurable mortgage loan was based on "replacement cost" rather than the more conservative estimate of long-range "value." Third, the maximum allowable ratio of loan to "replacement cost" was increased. In some cases, the maximum term of the mortgage was also lengthened, thereby permitting lower monthly payments.

The trend toward the liberalization continued with the enactment of Sections 231 and 202 in the Housing Act of 1959 and with the Housing Act of 1961. Section 231 in the 1959 Act provided for generous insurance terms to housing for the elderly. In addition, Section 202 provided loans at subsidized interest rates to developers of private housing for the elderly.

The 1961 Housing Act further liberalized the terms of government mortgage insurance and broadened the coverage of Section 221(d)(2) mortgage insurance generally to include low- and moderate-income families. This section enabled such families to acquire housing at low down payments.

A principal feature of the 1961 Housing Act was the provision for a subsidized, below market interest rate (BMIR) mortgage insurance program. The relevant section is 221(d)(3) which provided loans at low interest rates to nonprofit or limited dividend corporations or cooperatives for the construction of modest housing for moderate-income households. Section 221(d)(3) is nominally structured as an interest subsidy program. However, lenders made such loans only because FNMA (later GNMA) immediately purchased the BMIR mortgage at par. Thus, FMNA (GNMA) was the actual lender. Hence, Section 221(d)(3) incorporated elements of both a public interest subsidy and a direct loan program. Through the provisions of Section 221(d)(3), the 1961 Housing Act thus reduced the reliance placed on mortgage insurance in government housing policy. The one exception to this tendency was the expansion described above of mortgage insurance under Section 221(d)(2).

However, during the mid-1960s, renewed emphasis was placed on the role of federal mortgage guarantee programs in encouraging private lending in declining inner-city areas. This was undoubtedly due in part to the tendency of FHA to follow conventional lenders in "treating loans in older urban areas cautiously--resulting in charges of redlining." 17/ A Congressional study in 1965, for example, argued that only a small fraction of FHA-insured home mortgages were for existing homes purchased in blighted central city areas. 18/

In late 1965, FHA Commmissioner Phillip Brownstein responded to these criticisms by issuing directives to FHA regional offices to change certain practices. 19/ These directives urged that FHA activities in older inner cities not be confined to urban renewal areas and that Section 221(d)(2) mortgage insurance be used in nondeclared urban renewal areas and even in "neighborhoods in which blighting influences have started decay." These directives from the FHA Commissioner helped define the notion of acceptable risk underlying Section 221(d)(2) mortgage insurance. The economic

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17/ HUD, Future Role of FHA, p. 60.

18/ Defaults on FHA-Insured Home Mortgages, Detroit, Michigan, H. Rept. 1152, 92:2 (1965), p. 51.

19/ Real Estate Settlement Costs, FHA Mortgage, Foreclosures, Housing Abandonment, and Site Selection Policies, House Committee on Banking and Currency, 92:2 (1965).

soundness criterion was, however, still used to evaluate mortgage insurance provided under Section 203(b).

In 1966, Section 203(b) mortgage insurance was modified by Section 302 of the Demonstration Cities and Metropolitan Development Act which added Section 203(1) to the National Housing Act of 1934. This new section applied the acceptable risk criterion to Section 203(b) insurance and specifically noted the need for providing mortgage insurance in inner-city areas, including those experiencing or threatened by riots and disorders. Moreover, in the summer of 1967, Commissioner Brownstein urged FHA regional offices not to designate entire areas ineligible for mortgage insurance under particular programs and not to limit FHA activity in the inner city to the Section 221(d)(2) program. In response to these initiatives, FHA approvals in high risk areas rose from 200 to 1,000 per week during 1967. 20/

Section 103 of the Housing and Urban Development Act of 1968 repealed Section 203(1), replacing it with Section 223(e). This section allowed mortgage insurance to be extended under any FHA program in areas where economic soundness or related considerations would normally preclude eligibility.

The 1968 Act designated older, declining, urban areas as worthy of special consideration, including waiver of statutory limitations concerning loan-to-value ratio, size of unit, or maximum mortgage amount. The aim of Section 223(e) was to provide insurance in "older, declining urban areas" where "one or more of the eligibility requirements (for mortgage insurance)...could not be met" provided that (1) "the area [was] reasonably viable," and (2) "the property [was] an acceptable risk." The terms of the mortgages insured under this provision were to be designed with consideration for the needs of "families of low- and moderate-income in such areas."

It was explicitly recognized that Section 203(b) and Section 221(d)(2) mortgage insurance issued pursuant to Section 223(e) would not be economically sound. Consequently, the 1968 Act established a Special Risk Insurance Fund (SRIF) for which appropriations were authorized. This fund was to be used for fulfilling insurance obligations under the subsidized and certain other mortgage insurance programs, including Section 223(e). As expected, losses were immediately incurred under these programs.

20/ Greenstone, et al., The Effects of FHA Activity.

The effects of Section 223(e) were quickly manifested. FHA activity in central cities rose quickly during 1969, with Section 223(e) activity leading the way in declining areas. A dramatic increase in foreclosures and losses followed. In response, FHA attempted to improve the administration of Section 223(e). The resulting administrative changes reduced both default losses and the level of FHA activity. In 1976, fewer than 7,500 mortgages, or less than 14 percent of the program's peak volume in 1969, were insured pursuant to Section 223(e). These efforts notwithstanding, the insurance position of the SRIF--that is, the excess of insurance reserves over estimated reserve requirements--was still a minus $394 million as of June 30, 1975.

Recent FHA insurance activity is tantamount to a large-scale experiment in inner-city mortgage lending. Units which might never have qualified for private or government-insured financing in the past were approved for FHA mortgage insurance. Some outcomes of this experiment are presented in Table 6.

Table 6 presents the aggregate default experience of Section 203(b) and 221(d) programs. It is readily seen that default rates for mortgages insured under Sections 203 and 221 began rising after the passage of Section 223(e) in 1968. These rates peaked in 1972, reaching levels of 2.15 percent for Section 203(b) mortgages and 6.11 percent for Section 221 mortgages. Compared to pre-1968 default rates, these figures represent an increase in 203(b) and 221 defaults of roughly 50 and more than 100 percent, respectively.

Caution should be exercised in attributing these shifts to Section 223(e). However, the orders of magnitude observed for the 203(b) program are quite consistent with cross-section estimates of relative default probabilities obtained from FHA data (see Tables 8 and 9 in Section IV). It is also noteworthy that default rates did decline following the administrative reforms implemented in response to the loss experience under 223(e).

These outcomes promoted considerable debate concerning the purpose of legislation that encouraged, if not forced, FHA to expand its activities in the inner city. Was the mandate simply to stop large-scale redlining (refusal to lend in certain sections of cities)? Alternatively, was the mandate to assume the burden of providing high-risk credit in the hope of saving inner-city neighborhoods?

Whatever the intent, expansion of FHA insurance in the inner city can be viewed as an experiment for determining the influence

TABLE 6. DEFAULT STATUS OF FHA-INSURED HOME MORTGAGES FOR SECTIONS 203 AND 221, SELECTED YEARS, 1960-1977

Year	Section 203			Section 221		
	Insured Mortgages in Force	Total Defaults Number	Total Defaults Percent in Force	Insured Mortgages in Force	Total Defaults Number	Total Defaults Percent in Force
1960	2,697,106	22,490	0.83	21,448	835	3.89
1965	3,584,655	55,343	1.54	167,003	4,154	2.49
1966	3,724,696	52,520	1.41	196,065	4,646	2.37
1967	3,866,836	55,294	1.43	217,938	5,158	2.37
1968	4,021,422	54,380	1.35	248,572	5,282	2.12
1969	4,162,717	60,368	1.45	308,580	8,506	2.76
1970	4,270,264	72,097	1.69	373,239	15,919	4.27
1971	4,329,935	82,858	1.91	450,829	23,430	5.20
1972	4,248,267	91,426	2.15	498,840	30,491	6.11
1973	4,026,849	73,858	1.83	514,390	26,295	5.11
1974	3,915,832	68,837	1.76	519,626	23,353	4.49
1975	3,863,469	64,078	1.66	519,677	22,284	4.29
1976	3,810,802	35,153	0.92	514,637	12,984	2.52
1977	3,755,928	31,849	0.84	507,195	12,413	2.45

SOURCE: U.S. Department of Housing and Urban Development, 1977 Statistical Yearbook, Table 21, pp. 108-09.

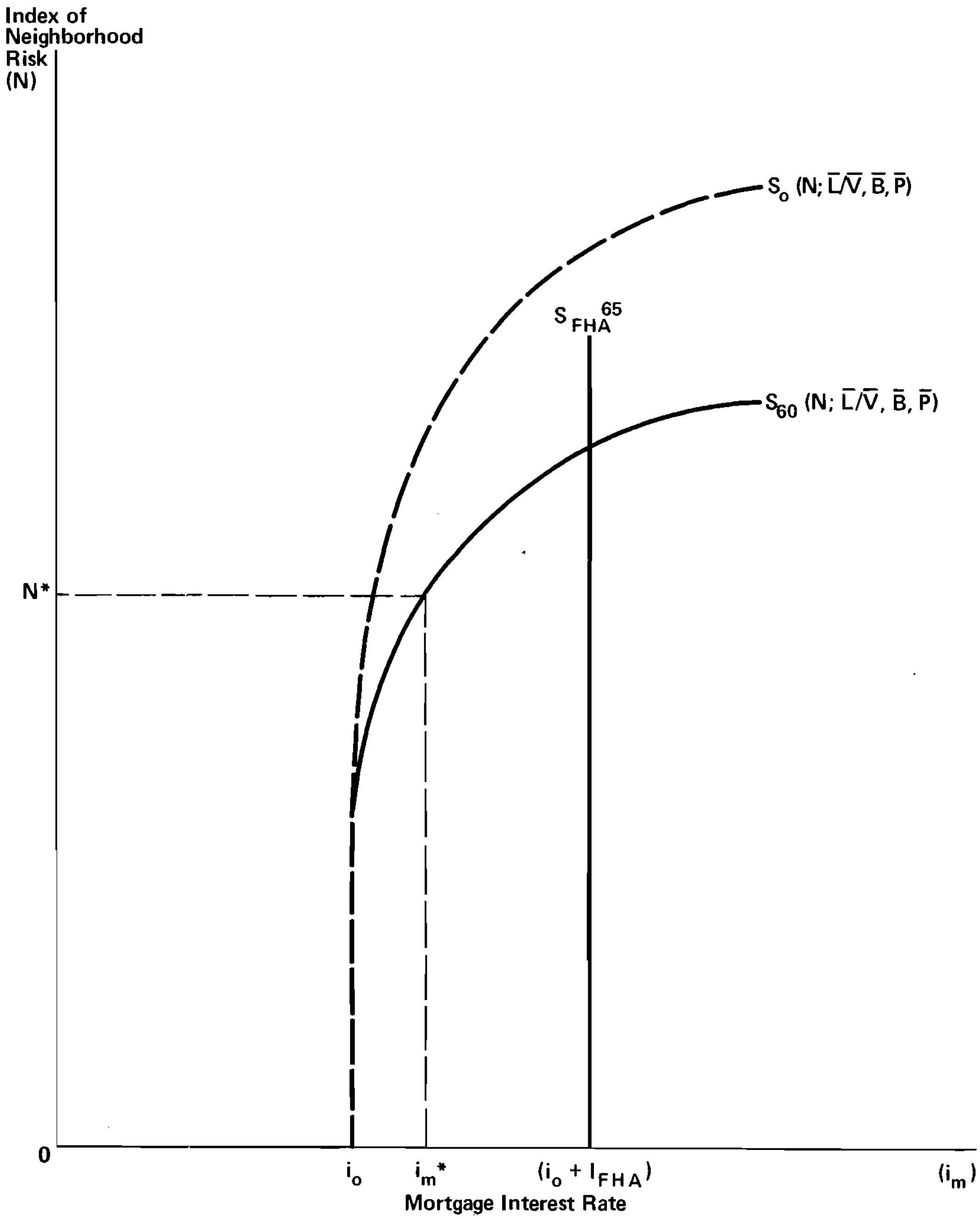
of neighborhood characteristics on default. This experiment may be analyzed in terms of the framework developed earlier.

In this case, we examine the impact of FHA insurance on the supply of mortgage credit to neighborhoods with differing characteristics, holding constant all determinants of the price of credit, other than the mortgage interest rate.

The curve labeled S_{60} in Figure 5 represents the offer curve of a conventional mortgage lender. The vertical line $S_{FHA}{}^{65}$ represents the supply of mortgage credit under FHA mortgage insurance when the economic soundness test excludes inner-city neighborhoods from Section 203(b). The construction of S_{60} assumes that N measures the critical element of neighborhood quality and that risk of default increases monotonically with N. The conventional

Figure 5.

Impact of Neighborhood Location on the Lender's Offer Curve



mortgage interest rate therefore increases with N. As in our earlier analysis, the curve S_0 represents zero expected profits on mortgage transactions and serves only as a point of reference. Points above and to the left of this curve represent loan transactions earning negative expected profits (that is, losses) and points below and to the right of this curve represent transactions earning positive expected profits. The $S_{FHA}{}^{65}$ curve terminates below the S_0 curve since prior to the mid-1960s, Section 203(b) insurance was not provided in those neighborhoods where the expected default losses were greater than FHA premiums. The curves in Figure 5 provide a general representation of the mortgage market as it existed in the mid-1960s. There is, however, no detailed empirical study which permits the exact position of these curves to be determined.

Other things equal (including neighborhood location), the relative mortgage interest rate on FHA and conventional loans would determine the borrower's preferred form of financing. Thus, for a unit located in a neighborhood with characteristics summarized by N*, a borrower would choose a conventional mortgage at interest rate i_m^*. In this case, the conventional rate of interest is less than the FHA rate of interest. However, as N increases, a borrower would eventually prefer an FHA-insured mortgage loan. Above a certain N, the private market is no longer competitive with FHA, given the rate of interest required to compensate the lender for the risks associated with loans in such neighborhoods. This is a consequence of the FHA practice of charging the same insurance premium regardless of risk.

Changes in FHA insurance practices that occurred after 1965 extended the FHA offer curve vertically above the limits depicted in Figure 5. Indeed, the evidence reported earlier on FHA default experience in the late 1960s suggests that the FHA curve rose substantially above the S_0 curve.

This pattern of making loans through federal insurance programs that were viewed as "too risky" by private lenders bears a superficial resemblance to the pattern observed in the initial Section 203(b) program during the 1930s. There are, however, at least two major differences between the two historical episodes.

First, expanded FHA activity in risky neighborhoods resulted in the approval of many economically unsound mortgages. Indeed, some community groups alleged that generous FHA-insured mortgages actually accelerated neighborhood decline by removing or reducing incentives for property maintenance. 21/ It is unlikely that private lenders viewed this as an experiment worthy of emulation.

Second, even if lenders wished to follow the FHA example, neighborhood characteristics are more difficult to quantify than loan terms which are easily reduced to a loan-to-value ratio or mortgage term. As a result, it is more difficult to translate neighborhood characteristics into measures of risk.

There has been little formal statistical analysis of the data generated by FHA activity in relatively risky neighborhoods. Such an analysis is necessary if lenders are to draw correct conclusions about the relationship between neighborhood characteristics and defaults on mortgage loans.

It appears that information about the relationship between default risk and mortgage terms generated by federal mortgage insurance played a role in encouraging conventional lenders to offer more liberal terms. However, for the reasons just stated, there is no reason to expect conventional lenders to respond in a similar fashion to expanded FHA lending in inner cities.

SECTION III. GOVERNMENT REGULATION OF CONVENTIONAL MORTGAGE LENDERS

The expansion of both FHA mortgage insurance activities and housing subsidies during the 1960s and 1970s was perceived by many groups as less than completely successful in achieving the social objectives intended. Several reasons were offered for this lack of complete success. Discrimination against racial minorities was cited as one barrier to the efficient and equitable functioning of urban housing markets. Paradoxically, the very increase in FHA activity mandated during the 1960s and 1970s was also criticized as contributing to urban housing problems. Specifically, it was alleged that the liberalization of economic soundness criteria

21/ For a discussion of this issue, see Kenneth F. Phillips and Michael B. Teitz, Housing Conservation in Older Urban Areas: A Mortgage Insurance Approach.

combined with generous FHA insurance terms contributed to neighborhood decline by removing or reducing incentives for property maintenance. This opinion, for example, is reflected in the following statement made in a report prepared by the Congressional Budget Office: 22/

> Prospective buyers or repairers of homes in redlined areas either are unable to finance their desired actions or must use FHA, VA, and Farmers' Home insured or guaranteed financing. Unfortunately, federally underwritten mortgages in central city areas have been subject to abuse, often resulting in overpayment for poor quality housing and later abandonment. Lack of conventional financing thus produces substantial losses for potential buyers and sellers in affected areas and for their neighbors as neighborhood decline is hastened.

Concern about discrimination in housing markets was manifested in the passage of the Fair Housing Act (Title VIII) in 1968 and the Equal Credit Opportunity Act in 1974. Both regulations define criteria that lenders may and may not use in their lending decisions. 23/, 24/ In general, both acts prohibit lenders from

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22/ Congressional Budget Office, Housing Finance: Federal Programs and Issues (September 23, 1976).

23/ If redlining exists or has existed, some may argue that government purchases and sales in the secondary mortgage market may have unintentionally contributed to this phenomenon. The reason is that under its normal procedures, FNMA reviewed the soundness of mortgage loans before it purchased them if the loans were not federally insured or guaranteed or, in the case of loans guaranteed by the Veterans Administration, if the loan was over $55,000 or secured by a two- to four-family property. This review procedure, which involved checking the borrower's credit and the property securing the loan, took a week or more. Many lenders were reluctant to make a mortgage loan until after FNMA approved the loan for its purchase. Recent changes in FNMA guidelines have emphasized, however, that FNMA will not refuse to buy mortgages on the basis that other investors may be or may have been reluctant to lend in the area where the secured properties are denying or limiting credit solely on the basis of race, sex, creed, or national origin. In addition, the Fair Housing Act permits lenders to take some neighborhood characteristics into account, but not others. Characteristics that are permissible include:

- The condition or design of the proposed security property, or of nearby properties that clearly affect the value of that property;
- The availability of neighborhood amenities or city services; and
- The need of the bank to hold a balanced real estate portfolio, with a reasonable distribution of loans in various neighborhoods, types of property, and loan amounts.

However, lenders are enjoined from:

- Denying or restricting mortgage credit in certain neighborhoods in the lender's service area because of race, color, religion, or national origin of the residents;
- Relying on appraisals that assign a lower value to a neighborhood because of a mix of races and national origins;
- Equating a racially mixed neighborhood with a deteriorating neighborhood;
- Incorporating the idea that deterioration of a neighborhood is inevitable;
- Equating age of the property with the value of the property; and
- Prescreening loan applicants.

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located. See Federal National Mortgage Association, A Guide to Fannie Mae (September 1979).

24/ For detailed discussion of the problem of identifying and detecting redlining, see James R. Barth, Joseph J. Cordes, and Anthony M.J. Yezer, "Redlining in Housing Markets: Mortgages and Minorities in the U.S.," The Journal of Social and Political Studies (Winter 1980), pp. 221-42.

Two more recent regulations, the Home Mortgage Diclosure Act (HMDA) of 1975 and the Community Reinvestment Act (CRA) of 1977, are aimed at increasing the volume of conventional loans in redlined areas. HMDA requires conventional lenders to disclose the location of their loans, though interestingly enough, not deposits. CRA represents an increased effort to induce conventional lenders to expand mortgage lending in older and moderate income areas in which they have offices.

Lenders deemed in violation of the Fair Housing Act are assumed, a priori, to violate performance standards of the Community Reinvestment Act. Consequently, the forms of lender behavior described above are also proscribed under the Community Reinvestment Act. However, the range of lender behavior subject to scrutiny is wider under the Community Reinvestment Act than the Fair Housing Act.

In particular, emphasis is given in the Community Reinvestment Act to possible "errors of omission" that discourage potential borrowers from applying for loans. This is in contrast to the Fair Housing Act which singles out errors of commission in the form of prescreening. Prescreening is also viewed with suspicion under the Community Reinvestment Act. However, lenders are also judged on whether they make affirmative efforts to encourage applications for credit. Specific assessment factors are:

- Activities conducted by the institution to ascertain the credit needs of its community, including the extent of the institution's efforts to communicate with members of its community regarding the credit services being provided by the institution;

- The extent of the institution's marketing and special credit-related programs to make members of the community aware of the credit services offered by the institutions; and

- The institution's record of opening and closing offices and providing services at offices.

By implication, lenders that devote more resources to identification of community needs in some neighborhoods than others, or that open (close) offices in some neighborhoods but not in others, could violate the standards of the Community Reinvestment Act.

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The CRA strongly suggests that private lenders not confine their activities in certain areas to the extension of FHA-insured loans. Indeed, an implicit objective of CRA seems to be to induce private lenders to make conventional loans using guidelines similar to the more recent and relatively liberal economic soundness criteria now prevailing under Section 203(b). This suggests that recent default experience of Section 203(b) programs may offer useful lessons for regulators of private mortgage lenders.

SECTION IV. DETERMINANTS OF DEFAULT RISK IN THE SECTION 203(b) MORTGAGE PORTFOLIO'S ESTIMATES AND POLICY IMPLICATIONS

In Section II, we identified several changes made in the FHA concept of economic soundness during the 1960s and early 1970s. One consequence of these changes was that certain neighborhood locations and property characteristics were de-emphasized as criteria for assessing the soundness of mortgages insured by FHA. In effect, these policy changes were an experiment conducted by FHA in expanding the supply of mortgage credit to areas perceived as relatively risky by conventional lenders. The information generated by this policy experiment has only recently begun to be systematically analyzed. In this part of the paper, estimates of the determinants of default in Section 203(b) are presented. Some important policy implications of the estimates are also discussed.

DETERMINANTS OF DEFAULT IN THE SECTION 203(b) PORTFOLIO

Building on previous theoretical and empirical analyses of mortgage credit supply and demand by von Furstenberg, Jackson, Kasserman, Thompson, and Schafer, 25/ Barth, Cordes, and

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25/ George J. von Furstenberg, "Default Risk on FHA Insured Home Mortgages as a Function of the Terms of Financing," Journal of Finance (June 1969), pp. 459-77; Jerry R. Jackson, David L. Kasserman, and Wilson Thompson, "An Equity Model of Home Mortgage Default Risk" (unpublished paper, 1978); and Robert Schafer, Mortgage Lending Decisions: Criteria and Constraints, Joint Center for Urban Studies of the Massachusetts Institute of Technology and Harvard University (December 1978).

Yezer 26/ specified and estimated both single and simultaneous equation models of the determinants of mortgage default of properties insured under Section 203(b). These equations were estimated by Barth, Cordes, and Yezer (BCY) using data from the 1975 Annual FHA-Master Statistical File (FHA-MSF). This data set contains information on FHA mortgage insurance written under various sections of the National Housing Act. The BCY analysis is confined to transactions involving existing units under Section 203(b) because this program most resembles conventional mortgage insurance activity in cities.

The FHA-MSF is a sample of all FHA mortgage insurance activity. Insuring offices are sampled at a rate that varies inversely with the level of insurance activity at each insuring office. Within each office, the sample of insured loans, representing new endorsements, is chosen randomly. In creating the Annual FHA-MSF (F31), detailed data on loan terms, borrower characteristics, and property characteristics are taken from FHA forms 2800, 2900, and 9100. This file is updated annually so that it is possible to observe which mortgages were terminated. Because BCY wished to analyze determinants of default, a 10 percent random sample of endorsements not in default and 100 percent of default terminations were used.

The basic specification used by BCY of the determinants of default is given by:

$$(4) \quad D_i = a_o + a_1(L/V)_i + a_2(TERM)_i + a_3(MP/Y)_i + a_N N_i + a_C C_i + a_B B_i + a_S S_i + u_i \quad ,$$

where

i is an index of individual mortgage transactions, i=1... number of cases,

D_i is a dummy variable equal to 1 if default occurs and 0 otherwise,

(L/V) if the loan-to-value ratio,

26/ Barth, et al., "Financial Institution Regulations," Federal Reserve Bank of Boston, April 1980.

(TERM) is the term to maturity,

(MP/Y) is the monthly payment-to-income ratio,

N is a vector of neighborhood location characteristics including dummy variables for central city and rural location and a dummy variable indicating location in a code enforcement or blighted neighborhood,

C is a vector of city location characteristics, including the rate of new single-family housing starts, fraction of housing built before 1940, SMSA size, city population growth, SMSA income growth, SMSA income per capita, and SMSA percentage black population,

B is a vector of borrower demographic characteristics including dummy variables for minority status, marital status, sex of family head, and multi-worker family status, as well as a continuous variable reflecting years of marriage,

S is a vector of structure condition variables including dummy variables for FHA appraisal as fair or poor structural condition, type of construction, and continuous variables reflecting structure age and the number of housing units in the structure,

a_N, a_C, a_B, and a_S are appropriate vectors of coefficients, and

u_i is an error term.

In equation (4), the loan terms are entered in a form common in the literature on mortgage default. Barth, Cordes, and Yezer argued that location characteristics (both neighborhood and city attributes) influence default because they influence both the current return to housing and the expected change in the asset value of housing. Structure characteristics enter the equation for similar reasons. The borrower characteristics were included for a variety of reasons. First, they represent "prohibited" borrower attributes that may not be used by lenders under equal credit opportunity regulations. Second, they separate groups that may differ systematically in variables omitted from the equation, such as wealth and human capital. Third, they differentiate households that may be subject to discrimination in labor and housing markets.

SINGLE EQUATION ESTIMATION RESULTS

Ordinary least squares estimates of equation (4) are presented in Table 7. When these equations were estimated using a logit procedure, the same basic qualitative results were obtained. Nine different specifications of the default relationship are presented to illustrate the sensitivity of results to inclusion of various categories of regressors. These equations show the impact on default of four categories of explanatory variables: loan terms, borrower characteristics, structure condition, and location characteristics, including both neighborhood and city characteristics. The coefficient of each variable may be interpreted as the marginal change in the probability of default due to changing the value of the variable, holding the impact of other factors constant.

Terms of the loan are almost always significant determinants of default. Both the loan-to-value ratio and the monthly payment-to-income ratio have the expected positive signs. These findings are consistent with those of most existing default studies. The term to maturity is negative and significant in eight of the nine equations, and positive but insignificant in the remaining equation.

Borrower characteristics have mixed effects on default probability. The probability of default is not significantly different for Hispanic mortgagers than for the reference group of white, male-headed, newly married households. The default probability of female-headed households differs from that of the reference group by an amount equal to the sum of the coefficients of the not married and the female-headed family variables. Borrowers who have been married for some time are significantly less likely to default than newly married households. Black borrowers appear to have significantly higher default probability. As noted above, the estimated effects of these demographic variables, particularly race, reflect a variety of omitted factors, including wealth and human capital, and discrimination in labor and housing markets.

Some, but not all, property condition variables have an impact on default probability. Condition of the structure and construction type both significantly affect default. Structures in only fair to poor condition and those constructed out of wood both have significantly higher default probabilitities. However, age of the structure does not have a significant impact on default.

Property location influences default probability through both the neighborhood and city characteristics variables. Neighborhood

TABLE 7. SINGLE EQUATION ESTIMATION OF PROBABILITY OF DEFAULT DEPENDENT VARIABLE - DEFAULT PROBABILITY (One if foreclosed; zero otherwise)

Dependent Variable	Regression Equations Equation R1	Equation R2	Equation R3	Equation R4
Intercept	-0.3957 a/	-0.4204 a/	0.5559 a/	-0.4464 a/
Loan Terms				
Loan-to-value ratio	0.6279 a/	0.6394 a/	0.6193 a/	0.6222 a/
Term-to-maturity (months)	-0.002 b/	-0.0002 b/	-0.0006 b/	-0.0002
Monthly payment-to-income ratio		0.1012 b/	0.1947 a/	0.1359 a/
Borrower Characteristics				
Hispanic				
Black				
Years married				
Not married				
Female head of household				
Property Characteristics				
Structure: fair or poor condition				
Age of structure				
Wood construction				
Neighborhood Characteristics				
Central city				0.0177 a/
Rural				-0.0016
Blighted				0.0411 a/
City Characteristics				
Fraction of new single family starts			-0.8136 a/	
Fraction of pre-1940 housing			-0.4582 a/	
SMSA size			0.0042 b/	
City population growth (1970-75)			-0.5115 a/	
City income growth (1970-75)			-0.0113	
SMSA per capita income (1975)			-0.00000004 a/	
Percentage black population (1970)			-0.0016 a/	
R-square	0.0100	0.0103	0.0315	0.0121
F-statistic	50.56	34.73	31.66	20.56
Sample size	10050	10050	9731	10050
Mean value of the dependent variable	0.1279	0.1279	0.1279	0.1279

(Continued)

SOURCE: James R. Barth, Joseph J. Cordes, and Anthony M.J. Yezer, "Financial Institution Regulations, Redlining and Mortgage Markets," The Regulation of Financial Institutions, Conference Volume 21, Federal Reserve Bank of Boston (April 1980), Table 2.

TABLE 7. (Continued)

Regression Equations				
Equation R5	Equation R6	Equation R7	Equation R8	Equation R9
0.0527	-0.4122	0.0676	-0.4652	0.1062
0.5894 a/	0.6370 a/	0.5776 a/	0.5613 a/	0.5127 a/
-0.0005 a/	-0.0002 b/	-0.0005 a/	0.00002	-0.0004 a/
0.2315 a/	0.1055 b/	0.2442 a/	0.1524 a/	0.2593 a/
			-0.0136	-0.0136
			0.1136 a/	0.1087 a/
			-0.0009 b/	-0.0010 b/
			0.0132	0.0071
			-0.0271 b/	-0.0308 a/
	0.0381 a/	0.0325 a/		0.0316 a/
	-0.0002	-0.0002		-0.0004
	0.0006	0.0213 a/		0.0233 a/
0.0269 a/		0.0265 a/		0.0125 a/
0.0132		0.0096		-0.0120
0.0496 a/		0.0518 a/		0.0338 a/
-0.8261 a/		-0.8398 a/		-0.7597 a/
-0.4996 a/		-0.5053 a/		-0.4688 a/
0.0049 a/		0.0067 a/		0.0043 b/
-0.5573 a/		-0.5579 a/		-0.4883 b/
-0.0112		-0.0089		0.0004
-0.00000004 a/		-0.00000004 a/		-0.00000005 a/
0.0013 a/		0.0014 a/		0.0002
0.0346	0.0113	0.0361	0.0323	0.0525
26.83	19.2	22.7	41.85	25.6
9731	10050	9731	10050	9731
0.1279	0.1279	0.1279	0.1279	0.1279

a/ Denotes significance at the 95 percent level.

b/ Denotes significance at the 90 percent level.

characteristics generally affect the probability of default. More specifically, the default probability is significantly higher if a mortgage loan is made in a central-city or slum area. This finding is invariant with respect to the specification of the default equation in Table 7. Thus, the risk of default on a mortgage does vary significantly and systematically by neighborhood.

City characteristics generally have the expected impact on default. Of the seven variables representing these characteristics, only one is consistently insignificant. This variable is Standard Metropolitan Statistical Area (SMSA) income growth. Four of these variables have a negative and significant effect on the probability of default. These variables are the rate of new single-family housing growth, the fraction of housing built before 1940, city population growth, and SMSA per capita income. Therefore, higher levels of growth of city economic activity reduce defaults. The SMSA size variable has a significant and positive impact on default. The coefficient of the racial composition variable, percentage black population, is positive and highly significant in three of the four regression equations in which it appears. However, if borrower characterstics are controlled for, this variable ceases to be significant.

POLICY IMPLICATIONS OF THE ESTIMATES

The results presented in Table 7 have policy implications both for FHA mortgage insurance and for more recent attempts to regulate the behavior of conventional lenders. Aaron has noted that the FHA practice of charging a constant insurance premium regardless of risk generates cross-subsidies within the FHA program. Aaron's estimates suggest that FHA pricing practices generate a cross-subsidy flowing from higher to lower income FHA borrowers. 27/

The estimates presented in Table 7 imply cross-subsidies between income classes similar to those calculated by Aaron. 28/ Given the recent emphasis on the geographic allocation of mortgage

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27/ See Aaron, Shelter and Subsidies, pp. 85-87.

28/ This is due to the similarity between our results and those of von Furstenberg which are basis for Aaron's calculations. See von Furstenberg, "Default Risk on FHA Insured Home Mortgages."

credit, it is, however, worth noting that FHA insurance pricing policies also imply considerable cross-subsidization between different geographic areas. The pattern of such spatial cross-subsidies is suggested by the calculations presented in Tables 8 and 9, which are based on equation (9) in Table 7. The loan-to-value ratios used in these tables are comparable to those in Table 2.

The number in each column of Tables 8 and 9 is the default probability estimated from equation (9) divided by the average default rate in the sample used to estimate equation (9). These numbers are, therefore, indexes of relative default probability. Values less than one indicate a default probability that is below average within the Section 203(b) program; values greater than one indicate above average default probability. Other things equal, the FHA practice of charging the same insurance premium for all mortgages implies price discrimination against mortgages with below-average default probabilities in favor of those with above-average probabilities.

The calculations in Tables 8 and 9 imply that FHA insurance pricing policies favor: high relative to low loan-to-value mortgages, mortgages made in central cities relative to those made in suburbs, mortgages made in declining relative to nondeclining neighborhoods, mortgages made in large relative to small urban areas, and mortgages made in declining relative to growing cities.

TABLE 8. RELATIVE DEFAULT RISK a/ OF FHA 203(b) MORTGAGES BY LOAN-TO-VALUE RATIO AND SELECTED NEIGHBORHOOD AND PROPERTY CHARACTERISTICS

Loan-to-	Location			Neighborhood		Structure	
Value Ratio	Central City	Suburb	Rural	Blighted	Non-blighted	Fair or Poor	Other
.75	.25	.16	.25	.46	.20	.44	.20
.85	.66	.56	.65	.86	.59	.86	.59
.90	.86	.76	.86	1.06	.80	1.04	.80
.95	1.05	.96	1.05	1.26	.99	1.24	.99
1.00	1.24	1.15	1.25	1.45	1.19	1.44	1.19

a/ The mean default rate of the sample is assigned a value of 1.00.

TABLE 9. RELATIVE DEFAULT RISK a/ OF FHA 203(b) MORTGAGES BY LOAN-TO-VALUE RATIO AND SELECTED CITY CHARACTERISTICS

Loan-to-Value Ratio	SMSA Size (Millions)			City Population Growth (Percent)			SMSA Per-Capita Income (Dollars)		
	9.53	1.86	272	+8	-1 b/	-10	6571	4739 a/	3075
.75	.47	.21	.16	0	.21	.56	. 213	.214	.215
.85	.87	.62	.56	27	.62	.96	.616	.617	.618
.90	1.08	.82	.74	48	.82	1.02	.819	.82	.821
.95	1.27	1.01	.96	67	1.01	1.36	1.015	1.016	1.017
1.00	1.47	1.21	1.16	87	1.21	1.56	1.210	1.211	1.212

a/ The mean default rate of the sample is assigned a value of 1.00.

b/ Values are the mean values for the sample.

However, there does not appear to be significant price discrimination between neighborhoods of different income levels. 29/

These results suggest that policies implemented during the 1960s and 1970s which relaxed economic soundness criteria while simultaneously maintaining a uniform FHA insurance pricing policy had the effect of reallocating mortgage credit within the FHA Section 203(b) program. That is, changes in FHA Section 203(b) insurance practices enacted during the 1960s and 1970s provided implicit subsidies to declining and inner-city areas in addition to explicit housing subsidies provided during the same period.

The recent default experience of the FHA Section 203(b) program also has implications for efforts to regulate the behavior of conventional lenders. First, the patterns of cross-subsidy

29/ Of course since neighborhood income is likely to be correlated with other determinants of default, lower-income neighborhoods will be riskier and individuals in those neighborhoods will enjoy some cross-subsidy.

observed above are likely to be replicated if government regulations require private conventional lenders to both apply the less stringent economic soundness criteria used by FHA and charge uniform mortgage terms. 30/ Thus, if such regulations succeed in replacing FHA with conventional mortgages in inner cities, the financial burden of subsidizing such areas will shift from the public sector to private borrowers and lenders in mortgage markets.

Second, the results of the FHA experiment with inner-city lending are useful for assessing the "reasonableness" of specific regulations imposed on lenders. In general, the results presented in Table 7 indicate that some but certainly not all property and location characteristics affect default.

These characteristics can be grouped into three categories: those prohibited by regulations, those permitted by regulation, and those discouraged by regulation. Currently, lenders are proscribed from limiting credit due to age of the property and racial composition of the neighborhood. Our results indicate that neither prohibited attribute has a significant impact on default once other factors are taken into account. By contrast, the Fair Housing Act allows lenders to take into account both the structural condition of the property itself and the structural condition of nearby properties. Our results indicate these characteristics do significantly affect default rates. Finally, future enforcement of the CRA may make it more difficult for lenders to use neighborhood income as a criterion. Our results indicate that SMSA income per capita is a statistically significant geographical determinant of default. However, the calculations presented in Table 9 suggest that the quantitative significance of this variable may be modest. In sum, the results of the FHA "experiment" suggest that government regulation need not induce conventional lenders to increase their exposure to default risk. However, this may happen in the future if such regulations completely prohibit lenders from using statistically validated neighborhood and property characteristics to assess the economic soundness of mortgages when determining the appropriate loan terms.

30/ So long as risk classes cannot be perfectly defined, there is also some element of cross-subsidy in private mortgage insurance premiums.

SECTION V. SUMMARY AND CONCLUSIONS

This paper has examined the historical impact of the federal government's housing policies on the mortgage market. The main emphasis has been on the basic Section 203(b) insurance program for single-family housing units. In the early years of this program, the program was primarily used as a stabilization tool. The country was in the midst of a great depression and it was believed that government intervention in various forms, including this particular FHA-insured mortgage program, was appropriate presumably on grounds of market failure. Since that time, the government has continued to intervene in the marketplace for stabilization purposes. Some 20 to 30 years later, Section 203(b) was also used to achieve other social goals, including the provision of housing funds for low- and moderate-income persons and for inner-city areas. This development added a distributional equity aspect to the federal government's mortgage insurance program. Even more recently, the government supplemented its mortgage insurance programs with specific regulations designed to restrain the behavior of mortgage lenders when dealing with certain individuals or groups and/or geographic areas.

Some of the more important developments associated with the federal government's mortgage programs are as follows. First, the FHA insurance program has provided useful information on the impact of liberalizing loan terms on the risk of default. This information has no doubt been profitably used by private mortgage lenders. Indeed, such information has contributed to a relaxation of various local, state, and federal regulations constraining the terms of mortgage loans offered by private lenders on conventional loans. Second, the development of a national mortgage market was stimulated by the introduction of standardized lending criteria under FHA mortgage programs as well as the establishment of such institutions as the Federal National Mortgage Association. Third, these federal government mortgage programs have enabled households to obtain financing for the purchase of housing units which they otherwise might not have been able to obtain under conventional lending criteria. Many of these households no doubt have successfully repaid or will repay their FHA insured mortgages.

The federal government mortgage insurance programs also have several important and specific effects on housing and mortgage markets which should be explicitly identified. First, FHA insured mortgage programs provide borrowers with a wider choice of mortgage terms. This means that some borrowers are able to obtain mortgage loans on more favorable terms. Second, some households qualify for mortgage credit who otherwise would not have been able to obtain such credit. Third, the more favorable terms afforded by FHA insured mortgage programs may be capitalized into the selling price of housing units. Fourth, to the extent that the more favorable loan terms under FHA mortgage programs lead to higher default and/or foreclosure rates, there will be higher transaction costs, such as lawyer and court costs, associated with the foreclosures. Furthermore, housing units tend to be undermaintained during the default and/or foreclosure period. Fifth, to meet any claim payments to mortgagees in excess of insurance premiums, particularly as regards the more recent federal government insurance programs, the FHA has open-end borrowing authority from the Treasury. Of its four insurance funds, FHA reported a net loss of $492.7 million during the fiscal year ended September 30, 1977, and $314.9 million during the fiscal year ended September 30, 1978. Furthermore, the funds FHA has borrowed for two of these funds, GIF and SIRF, totaled $1.9 billion and $1.6 billion on September 30, 1977, and $2.2 billion and $1.8 billion on September 30, 1978, respectively. These borrowings affect financial markets and to the extent that these amounts grow over time, the effects should be larger and more important. These larger borrowings due to the government insurance programs may contribute to growing deficits and thereby to some crowding out.

In addition to the effects noted above, the empirical results on mortgage default and foreclosure discussed in Section III indicate that there is an important element of cross-subsidy in the unsubsidized FHA mortgage insurance programs. This cross-subsidy arises because a uniform insurance premium is charged on mortgage loans, regardless of risk. This behavior has stimulated the growth of PMIs which are able to attract the better risks by offering lower cost and more limited coverage insurance. In spite of this growth, however, there remains an element of cross-subsidy within the unsubsidized insurance programs which is difficult to justify on equity or efficiency grounds. The reason is that even the highest-income households within the FHA insured mortgage programs are not upper-income households.

The regulatory programs such as ECOA, HMDA, and CRA, to the extent that they induce private mortgage lenders to make more risky loans than they would otherwise make, may lead to larger default losses which would have to be financed not by Treasury borrowing but by lower profits and/or higher costs of credit. If the costs of credit are raised as a result of such developments, then there may be cross-subsidization in conventional loan markets similar to that recently observed in the Section 203(b) insurance program. To assess the impacts of these regulatory programs, it is important to know the determinants of default and foreclosure within the FHA mortgage insurance programs. More specifically, such information enables one to evaluate the reasonableness and costs of these recent regulatory actions which constrain conventional mortgage lenders by prohibiting or discouraging the use of specific information in the lending decision.

The final point to be made is that the many new mortgage instruments, such as graduated payment mortgages, variable rate mortgages, and tax-exempt bonds issued by localities to finance single-family home mortgages, will also affect mortgage markets. 31/ Section 245 mortgage insurance, for example, covers graduated payment mortgages in which the initial level of monthly payment is less than the interest cost. The principal outstanding on such mortgages rises over time. In the case of the recently passed Section 245(b) mortgage insurance, the loan amount may rise to 113 percent of the initial purchase price. The economic soundness of such loans clearly depends upon the persistence of current inflation and, more specifically, increases in the asset price of housing units. In any event, these newer mortgage instruments merit further study. This is also true of the new regulation establishing goals for FNMA's purchases of conventional mortgages on properties in the central cities of Standard Metropolitan Statistical Areas and of conventional mortgages on housing for low- and moderate-income families. Under this regulation, on March 1 of each year the Secretary of HUD may establish a goal for that year for FNMA purchases of either of these two classes of conventional mortgages if the corporation's purchases of that class during the preceding calendar year were less than 30 percent of all its conventional mortgage purchases. Given the availability of data on the FHA experience in insuring high-risk mortgages, some analysis

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31/ For excellent discussions of some of these developments, see Henry J. Cassidy, "The Changing Home Mortgage Instrument in the United States," Federal Home Loan Bank Board Journal (December 1978), pp. 11-17; and Congressional Budget Office, Tax-Exempt Bonds for Single-Family Housing, prepared for the Subcommittee on the City, House Committee on Banking, Finance and Urban Affairs, 96:1 (April 1979).

of the likely outcome of these new mortgage market programs should precede their introduction, and loss experience in the programs should be analyzed carefully.

APPENDIXES

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APPENDIX A. MAXIMUM LOAN AMOUNT AND LOAN-TO-VALUE RATIO FOR FHA HOME MORTGAGES ON EXISTING UNITS INSURED UNDER SECTION 203(b) OF THE NATIONAL HOUSING ACT OF 1934, AS AMENDED (TABLE A)

JUNE 27, 1934-MARCH 1, 1980

TABLE A. MAXIMUM LOAN AMOUNT AND LOAN-TO-VALUE RATIO FOR FHA HOME MORTGAGES ON EXISTING UNITS INSURED UNDER SECTION 203(b) OF THE NATIONAL HOUSING ACT OF 1934, AS AMENDED (JUNE 27, 1934-MARCH 1, 1980)

Date	Maximum Amount Changed to (In dollars)	Maximum Loan-to-Value Changed to
6/27/34	16,000	80% of maximum mortgage of $16,000
7/19/50	14,000	75% of maximum mortgage of $14,000
10/12/50	14,000	80% of maximum mortgage of $14,000
6/11/52	16,000	80% of maximum mortgage of $16,000
9/16/52	14,000	80% of maximum mortgage of $14,000
1/16/53	16,000	80% of maximum mortgage of $16,000
8/2/54	20,000	90% of estimated value to $9,000 75% of excess value to maximum
7/12/57	20,000	90% of first $10,000 of estimated value 85% of next $6,000 of estimated value 70% of value in excess of $16,000 to maximum
4/1/58	20,000	90% of first $13,500 of estimated value 85% of next $2,5000 of estimated value 70% of value in excess of $16,000 to maximum
9/23/59	22,500	90% of first $15,000 of estimated value 70% of excess value to maximum
6/30/61	25,000	90% of first $20,000 of estimated value 75% of excess value to maximum
9/2/64	30,000	90% of first $20,000 of estimated value 75% of excess value to maximum
8/10/65	30,000	90% of first $20,000 of estimated value 80% of excess (85% for veterans) to maximum

(continued)

TABLE A. (continued)

Date	Maximum Amount Changed to (In dollars)	Maximum Loan-to-Value Changed to
12/24/69	33,000	97% (100% for veterans) of first \$15,000 90% of next \$10,000 of estimated value 80% (85% for veterans) of value in excess of \$35,000 to maximum
8/22/74	45,000	87% (100% for veterans) of first \$25,000 90% of next \$10,000 of estimated value 80% (85% for veterans) of value in excess of \$35,000 to maximum
10/12/77	60,000	97% (100% for veterans) of first \$25,000 95% of amount in excess of \$25,000 to maximum
12/13/79	67,500	97% (100% for veterans) of first \$25,000 95% of amount in excess of \$25,000 to maximum

SOURCE: Chester Foster, Director, Actuarial Division, Office of Housing, Department of Housing and Urban Development.

APPENDIX B. MORTGAGES INSURED BY FHA FOR ONE-TO-FOUR FAMILY HOMES (TABLE B)

1970-1975

TABLE B. MORTGAGES INSURED BY FHA FOR ONE-TO-FOUR FAMILY HOMES, 1970-1975 (In units)

Program (By section)	1970	1971	1972	1973	1974	1975
203	303,773	332,495	230,484	135,281	151,212	226,230
203(K)	33	28	11	2	3	5
213	3	3	--	--	--	--
220	220	136	77	17	27	25
220(h)	--	--	--	--	2	--
221	94,499	115,407	87,587	50,669	34,625	28,045
221(h) BMR	845	327	61	41	7	13
221(i) Condo	--	2	2	1	1	2
222	7,766	8,841	7,036	3,073	2,845	3,932
233	30	30	30	27	56	26
234	3,058	4,292	6,232	3,399	1,647	2,310
235(i)	106,895	144,612	119,524	58,034	14,119	5,912
235(j)	170	821	649	370	197	90
237	827	906	816	631	371	278
240	3	1	--	--	--	--
809	215	265	238	91	54	126
Total, all programs	518,337	608,166	452,747	251,636	205,166	226,994

SOURCE: U.S. Department of Housing and Urban Development, Future Role of FHA (1977), p. 127.

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MORAL HAZARD, ADVERSE SELECTION, AND SBA BUSINESS LOAN GUARANTEES

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The Congress of the United States
Congressional Budget Office

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SECTION I. INTRODUCTION

In recent years there has been significant growth in the amount of business loans disbursed under the auspices of the Small Business Administration (SBA). Since the inception of the SBA in 1954, small businesses have received more than $16 billion under SBA programs. 1/

The SBA's lending efforts are carried out under four basic programs: the Section 7(a) Regular Business Loan Program, the Economic Opportunity Loan (EOL) program, the Development Company Loan (DCL) program, and the Displaced Business Loan (DBL) program. In order to qualify under any of these programs, the small business must be unable to obtain conventional financing. Thus, the loans approved by the SBA are, by nature, riskier than conventional bank loans. However, there must be reasonable assurance of repayment before the SBA will approve a loan application.

Under each of these business loan programs, the SBA engages in three types of lending relationships: direct loans, immediate-participation loans, and guaranteed loans. In direct lending, the SBA lends funds directly to the small business. Under an immediate-participation loan, both the SBA and a commercial bank advance a portion of the loan at the time the loan is made. In a guaranteed loan, the SBA acts as an insurer and guarantees up to 90 percent of the loan principal that a commercial bank extends to a qualifying borrower. In such loans, the agency is liable if the loan has to be purchased from the bank in the case of default by the borrower. Loan guarantees, by far, constitute the most important type of SBA lending activity. As of October 1977, about 82 percent of the dollar amount and 71 percent of the total number of business loans outstanding were of the guaranteed variety. 2/

1/ See, for example, Twenty-Sixth Annual Report, Senate Select Committee on Small Business, 94:1 (1976); and Small Business Administration Programs Priorities, Hearings before the Senate Select Committee on Small Business, 95:1 (1977).

2/ See Small Business Administration, Annual Report (Washington, D.C.: Government Printing Office, 1978).

In this study we examine the SBA guaranteed lending program, in a policy context, with direct reference to the efficiency of pricing and costs of the guarantee arrangement when elements of moral hazard and adverse selection are present. 3/

In simple terms, moral hazard arises in an SBA guaranteed lending relationship when either the borrower, the bank, or both can affect the liabilities of the agency without the agency's knowledge. In other words, the probability of default depends, in large part, on the actions taken by the borrower and the bank and not only on the state of nature. These actions, called the level of care taken by the two parties, can either increase or decrease the probability of default under the relationship. In the latter case, positive costs are incurred with increases in the level of care taken by either party. The question naturally arises as to what are the optimal terms (premium and guarantee level) of a loan guarantee. That is, how should the agency set its premium and level of benefits to induce the maximum level of care from the bank and the borrower? It is obvious that serious moral hazard problems are likely to exist when the costs of default to the borrower and the bank are less than the benefits received. 4/

The problem of adverse selection arises in an insurance relatioship when there is asymmetry of information between the purchaser of insurance and the insuring agent. That is, the purchaser may well have a better idea of the relevant risks than does the insuring agent. In SBA guaranteed lending arrangements, adverse selection arises when the bank has more knowledge of the relevant risk of default than does the SBA. In such cases, the rational profit-maximizing risk-adverse bank can be expected to demand guarantees that are too high given its real risk exposure and insurance premium paid. Given the availability of such guarantees, commercial banks can be expected to exercise a level of care

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3/ For a full discussion of moral hazard and adverse selection, see M. Pauly, "Overinsurance and Public Provision of Insurance: The Roles of Moral Hazard and Adverse Selection," Quarterly Journal of Economics, Vol. 88 (1974), pp. 44-62; and M. Rothschild and J. Stiglitz, "Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information," Quarterly Journal of Economics, Vol. 90 (1976), pp. 629-50.

4/ Many observers would claim that there may well be incentives for borrowers to default given that the SBA attempts to "work with borrowers" whose loans have been purchased from banks.

that is less than desirable from a social welfare point of view. The combined effects of moral hazard and adverse selection in SBA guaranteed lending arrangements are that the social costs of such public provision are likely to be higher than the corresponding private costs of provision.

This paper is divided into eight sections. In Section II, we consider the private provision of loan guarantees. That is, we examine the potential of a competitive insurance industry to provide loan guarantees in the presence of moral hazard and adverse selection. In Section III, we review the current SBA loan guarantee program relative to those shortcomings associated with private provision. Section IV of the paper derives the conditions necessary for the provision of an ideal loan guarantee. This ideal guarantee arrangement is used later as the standard of comparison in cases where moral hazard and adverse selection are present. The problems of moral hazard and adverse selection are formally considered in Section V. Here a simple model of bank behavior under the typical guarantee arrangement is developed and the cost minimizing guarantee arrangement for the SBA is derived. In Section VI, the level of care exercised by the parties to the guarantee is analyzed and the incentive structure of the arrangement is examined. Empirical tests of some of the basic hypotheses suggested by the theoretical analysis and the general conclusions of the study are presented in the final two sections.

SECTION II. MORAL HAZARD, ADVERSE SELECTION, AND PRIVATE PROVISION OF LOAN GUARANTEES

It is natural, at the outset, to consider whether a market equilibrium has shortcomings that might make SBA guarantees desirable. In simple terms, we want to characterize the provision of loan guarantees (or any insurance policy) by a purely competitive insurance industry. By a competitive insurance industry we refer to an industry with many firms, with free entry and exit, and in which each unit of insurance is sold at a price that is unaffected by the amount of insurance purchased. First, we take up the issue of moral hazard and briefly review some of the seminal studies in this area.

MORAL HAZARD

The competitive allocation of insurance under conditions of moral hazard has been examined extensively in the literature. Studies by Arrow, Pauly, Shavell, Spence and Zeckhauser 5/ are representative of the view that a competitive equilibrium cannot be a first-best optimum under plausible conditions. 6/ The essential argument runs as follows. When the cost of providing a good or service depends on the behavior of the purchaser, as is obvious for loan guarantees or insurance, and the supplier cannot observe this behavior, the price to be charged for the good or service cannot depend upon the behavior which affects costs. That is, for the loan guarantee or insurance policy, the guarantee fee or insurance premium does not depend on the level of care exercised by the purchaser. Thus, the social costs of an individual's or institution's actions exceed the costs borne by the individual or institution (private costs) and equilibrium cannot be a first-best optimum.

Under private provision, the inability of each firm (seller) to monitor the amount of insurance purchased by the individual or

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5/ K. Arrow, "The Economics of Moral Hazard: Further Comment," American Economic Review, Vol. 58 (June 1968), pp. 537-39 and "Welfare Analysis of Change in Coinsurance Rates," in The Role of Health Insurance in the Health Services Sector, R. Rosett, ed. (Universities-National Bureau Conference Series, 1976); M. Pauly, "Overinsurance and Public Provision," S. Shavell, "On Moral Hazard and Insurance," Quarterly Journal of Economics, Vol. 93 (November 1979), pp. 541-62; M. Spence and R. Zeckhauser, "Insurance, Information, and Individual Action," American Economic Review, Vol. 61 (1971), pp. 381-87; and R. Zeckhauser, "Medical Insurance: A Case Study of the Tradeoff Between Risk Spreading and Appropriate Incentives," Journal of Economic Theory, Vol. 2 (1970), pp. 10-26.

6/ The moral hazard problem has also been considered, although in a slightly different context, by K. Arrow and R. Lind, "Uncertainty and the Evaluation of Public Investments," American Economic Review, Vol. 60 (1970), pp. 364-78; J. Mayshar, "Should Government Subsidize Risky Private Projects?," American Economic Review, Vol. 67 (1977), pp. 20-28; and M. Stewart, "Should Government Subsidize Risky Private Projects?: Comment," American Economic Review, Vol. 69 (1979), pp. 459-61.

the number of loan guarantees purchased by a financial institution can lead to a competitive equilibrium that is not Pareto optimal relative to the set of policies or loan guarantees that do not involve observation of the level of care undertaken. To see this requires an examination of the necessary conditions for a competitive equilibrium. 7/ With price taking behavior on the part of purchasers of guarantees or insurance, fees and premiums are unaffected by the number of guarantees or quantity of insurance purchased. Purchases of additional guarantees or insurance serve as signals to insurers that the expected losses of the individual or financial institution are increasing. However, the only way a single insurer can identify a given purchaser as having larger expected losses is to observe the total number of guarantees or amount of insurance purchased. In a purely competitive industry such observations are not possible. Each insurer knows how much he has sold to the purchaser but he does not know how much the purchaser has bought from others. If any insurer attempts to change his premium or fee based on the total quantity purchased from him, the insured will behave rationally by buying the first unit from the insurer, at the lower price, and buying other units from other insurers. Rational guarantee or insurance arrangements require that the premiums or fees vary directly with expected loss. However, in competitive equilibrium fees and premiums are uniform over the number of guarantees or quantity of insurance purchased and do not vary with expected loss. Thus, there are externalities generated by the purchase of additional guarantees or insurance.

If all purchasers are identical in the sense of precluding problems of adverse selection, mandatory public guarantees or insurance could solve the nonoptimality problems of private provision. 8/ Under such an arrangement, all individuals or institutions seeking insurance would be required to purchase an amount of insurance or number of guarantees equal to that amount or number

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7/ The following discussion draws heavily from Pauly, "Overinsurance and Public Provision;" and Rothschild and Stiglitz, "Equilibrium in Competitive Insurance Markets."

8/ For an extended discussion of the merits of compulsory public provision, see G. Ackerlof, "The Market for Lemons: Qualitative Uncertainty and the Market Mechanism," Quarterly Journal of Economics, Vol. 84 (1970), pp. 488-500; and K. Arrow, "Political and Economic Evaluation of Social Effects and Externalities," in J. Margolis, ed., The Analysis of Public Output (New York: Columbia University Press, 1970).

that would have been purchased privately had premiums and fees been allowed to vary directly with underlying risk. The optimum can also be achieved by taxing guarantee or insurance purchases. Such a tax would be set equal to the marginal externality generated when an institution or individual purchases an additional guarantee or unit of insurance as this would imply taking less care and increasing the cost to the private insurer.

Shavell considers the impact of moral hazard on competitive equilibrium using general utility concepts. 9/ He shows that the competitive equilibrium is optimal when consumers or firms can purchase insurance from a single insurer that offers a single policy on a take it or leave it basis. However, once one generalizes beyond a single policy or single insurer, the competitive equilibrium can fail to be optimal. In such a situation, it may be possible to tax or subsidize other activities which affect the probability of loss and thus the cost of provision. For example, in the case of loan guarantees, subsidization of bank-initiated programs of managerial assistance should improve welfare. By altering behavior in a way to reduce the costs of providing guarantees or insurance, definite welfare improvements can be achieved. Next we consider the issue of adverse selection.

ADVERSE SELECTION

The problem of adverse selection has been studied under a variety of economic situations. 10/ It can generally be concluded that a competitive equilibrium may not exist when the problem is present. Even when a competitive equilibrium does exist, it may have rather perverse properties. Whenever the market consists of two or more different kinds of customers, with respect to their

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9/ Shavell, "On Moral Hazard and Insurance."

10/ See, for example, K. Arrow, "Uncertainty and the Welfare Economics of Medical Care," American Economic Review, Vol. 53 (1963), pp. 941-69; Ackerlof, "The Market for Lemons"; Pauly, "Overinsurance and Public Provision;" Rothschild and Stiglitz, "Equilibrium in Competitive Insurance Markets"; J. Salop and S. Salop, "Self Selection and Turnover in the Labor Market," Quarterly Journal of Economics, Vol. 90 (1976), pp. 619-28; and M. Spence, "Job Market Signaling," Quarterly Journal of Economics, Vol. 87 (1973), pp. 355-74.

degree of risk-proneness, the insurer will have imperfect information. If each individual purchaser is the only one who knows the true probability of loss, the problem of adverse selection arises. An individual who has a high probability of loss has an incentive to purchase the insurance policy or guarantee designed for another whose probability of loss is low. If the individuals are indistinguishable during the contracting period, then the low-risk individual will not be able to allocate his wealth in an efficient manner. Under such conditions, if more than one contract or guarantee plan is offered, only one will survive the competitive process and low-risk individuals will either subsidize high-risk individuals or rationally reject insurance.

Rothschild and Stiglitz show that under conditions of imperfect information a competitive insurance market can have only two types of equilibria: a pooling equilibrium and a separating equilibrium. 11/ Under a pooling equilibrium, all individuals will purchase the same policy, whereas, under a separating equilibrium, different individuals purchase different contracts tailored specifically to their probability of loss. Rothschild and Stiglitz prove that there cannot be a pooling equilibrium of the Cournot-Nash type. 12/ This is especially due to the type of behavior discussed above. On the other hand, if there is an equilibrium, it must be of the separating type where each individual purchases a different contract.

Rothschild and Stiglitz also characterize the conditions under which an equilibrium does not exist. An equilibrium will not exist if the costs to the low-risk individuals of pooling are small--that is, if there are only a few high-risk individuals who have to be subsidized or if the subsidy per individual is small, as would be the case when the probability of loss for the different groups are not too different or the cost of separating the groups are large. 13/ From a welfare perspective, the negative externalities caused by the high-risk individuals are dissipative. That

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11/ Rothschild and Stiglitz, "Equilibrium in Competitive Insurance Markets."

12/ Essentially, the notion of the Cournot-Nash equilibrium is one where each firm assumes that the contracts its competitors offer are independent of its own actions. See ibid., pp. 633-38.

13/ This is likely to be the case for loan guarantees to new small businesses that have little in the way of a track record.

is, while low-risk individuals suffer losses, the high-risk individuals are no better off than they would be if they were in isolation. Thus, if the high-risk individuals were known, Pareto improvements could be made. That is, all individuals would be made better-off without anyone being worse-off. 14/

The question of whether government actions can result in Pareto improvements in insurance markets characterized by imperfect information has been debated in the literature. 15/ Generally, public provision of compulsory insurance is often suggested as one method of improving welfare. Pauly examines the potential of welfare improvements under compulsory public provision. 16/ This analysis suggests that under compulsory provision, with all individuals purchasing identical contracts, both low-risk and high-risk individuals gain in welfare by permitting low-risk individuals to limit the purchases of high-risk individuals. 17/ Pauly also shows that a plan involving a compulsory minimum purchase and supplementary coverage will also improve overall welfare. Here the purchase of supplementary coverage by high-risk individuals serves as a perfect indicator of what type person the individual is, even though his type cannot be observed directly. The compulsory minimum purchase, which would be set equal to that amount which maximized the utility of the low-risk individual, precludes the possibility that a high-risk individual, by purchasing only a small amount of insurance from a given seller, will induce the seller to think that he is really an individual who buys small amounts of insurance in total, that is, a low-risk individual. It follows that under such a compulsory system, each seller of insurance or guarantees knows that every prospective purchaser has at least a minimum amount of public insurance or public guarantees, so that any purchase of additional guarantees or insurance from him provides evidence that the purchaser is really a high-risk individual and therefore a bad risk with respect to his level of care.

14/ While the separating equilibrium appears to be optimal under imperfect information, Rothschild and Stiglitz show that even it may not be Pareto optimal relative to the information that is available.

15/ See Akerlof, "The Market for Lemons"; and Arrow, "Political and Economic Evaluation of Social Effects and Externalities."

16/ Pauly, "Overinsurance and Public Provision."

17/ The detailed argument leading to this result can be found in ibid., pp. 56-60.

On the basis of these findings we can conclude that the government can improve resource allocation in insurance and loan guarantee markets with judicious intervention. This could be through taxation or through subsidizing other activities that affect the probability of loss under the guarantee relationship or through some form of compulsory provision.

SECTION III. THE CURRENT SBA LOAN GUARANTEE PROGRAM

Having reviewed the more important literature on the failure of a competitive insurance or guarantee market to achieve a Pareto optimal allocation of resources, we now examine the current SBA guarantee program in light of these shortcomings. 18/

It is clear from the existing literature that a central factor preventing private competitive insurance or guarantee industries from obtaining a Pareto optimum is the inability of private insurers to obtain information on the total insurance or guarantee purchases of the agents in the market. Another is the inability to distinguish high- and low-risk purchasers. As seen above, this first problem leads to the second. That is, without such information sellers cannot distinguish among high- and low-risk individuals. The basic problem is that the seller cannot observe the behavior of the buyer, and thus premiums and fees charged cannot depend on the behavior that affects the expected costs of the insurer.

This problem does not exist under the structure of the current SBA loan guarantee program. The agency does have information on the total purchases of participating banks (and borrowers). Thus, fees could be based on the underlying behavior of participants (banks and borrowers) assuming that additional purchases are accurate signals to the agency that the expected losses of the bank are increasing. It is important to note that under the current program guarantee fees do not vary in the required manner. Even though the total fee does vary with the size of the guarantee and

18/ The specific program we consider here and throughout this paper is the guaranteed participation program.

guaranteed portion of the loan, all banks currently pay a fixed fee of $.01 per dollar of principal guaranteed by the agency. This fixed fee could be a small incentive for participating banks to exercise care. However, this care is more likely induced by the presence of coinsurance rather than the fee paid and should be considered as self-protection. As long as the agency guarantees less than 100 percent of the outstanding loan principal, then it is to be expected that some care will be exercised. The higher the guarantee level the less are bank incentives for exercising care.

The importance of the lessening of incentives depends upon the extent to which the guarantee covers all costs of default (leaves the bank with the same utility as before default). With limited financial compensation and no compensation for lost opportunities and administrative costs, banks still have incentives to take care. However, the level of care is almost entirely self-selected by the participating bank. As such, it may not provide the information required to signal the agency of an increase in the expected losses of the bank's SBA loan portfolio. What is needed under the current program is a guarantee fee schedule that varies with the total number of loans guaranteed at the bank or with the total dollar volume of guaranteed lending relative to the total dollar volume of loans outstanding in the bank's loan portfolio or simply with the level of guaranteed lending. This would result in a guarantee fee which does depend on the behavior of the bank which affects the costs of the agency.

One obvious approach for implementing such a fee schedule is for the agency to observe directly the behavior of participating banks. This would mean that the agency would experience-rate each participating bank so that an accurate experience-related fee could be assessed. We note that this approach does have its drawbacks. First, the information needed to evaluate the level of care may be difficult and expensive to obtain. Furthermore, it is difficult to define exactly what constitutes risky behavior. It is also true that the risks involved, once defined, may need to be adjusted for the type of business making the application, the borrower's economic and personal characteristics, and the nature of the local economy in which the business will operate, among others. Since the probability of default will depend jointly on the behavior of the bank and the borrower, equity considerations must also be addressed in the experience-related fee assessment. As far as a new bank participating in the program, average bank characteristics may have to be used in assessing the potential care level of the bank. However, an individual bank's care behavior may vary significantly from aggregate measures, depending on factors not captured by such variables as bank size, capital ratios, etc.

Despite these difficulties, the variable fee schedule based on experience-ratings has much appeal. Once developed, the rating process is likely to decrease the costs associated with moral hazard and adverse selection. Experience-rating participating banks could simplify much of the administrative apparatus associated with the current program. By licensing those banks that exercise a level of care "above normal," the agency could turn over the bulk of the screening and approval process to the bank, eliminating much of the red tape associated with the program and perhaps improve its loss experience by relying on the expertise of banks that have become efficient in appraising risks in this segment of the loan market. The SBA's new Bank Certification Program appears to be based upon this type of thinking. Needless to say, there could still be serious problems of moral hazard and adverse selection associated with bank's having the ability to commit the agency to guarantees. We will not analyze the moral hazard and adverse selection problems for this program, although the conclusions reached with respect to the regular guaranteed participation program will generally apply to this new program.

SECTION IV. IDEAL LOAN GUARANTEES

In this and the next two sections, we formally consider those problems discussed earlier. First, we model the loan guarantee relationship in the absence of moral hazard and adverse selection. This is done in order to derive the necessary condition for the provision on an ideal guarantee by a public agency such as the SBA. This ideal guarantee will be utilized as the standard of comparison in cases where moral hazard and adverse selection are present. 19/

19/ On the concept of ideal insurance, see Arrow, "Uncertainty and the Welfare Economics of Medical Care."

To begin the analysis, we take the case where a borrower has satisfied all necessary criteria and obtains an SBA guaranteed loan with a commercial bank. After the loan is made, let the bank have an expected total dollar return of r and a utility function μ (r). In case of default by the borrower, let the bank's utility after default be v(r), where the post default level of utility may or may not be the same as the predefault level.

In the absence of a guarantee with no change in the level of wealth of the lending bank, the expected utility of the bank is given by

(1) $E[U] = (1-\pi)\ u(r) + \pi v(r)$

where E is the expectations operator and   is the probability of default. Since an SBA loan guarantee transfers funds to the bank in the case of default, it is natural that a guarantee fee be paid. If a fee of K is paid to receive the benefit B in case of default, the agency's expected benefit payments must equal the receipt of fees if the guarantee operation is to break even. 20/ This break-even relationship is given by

(2) $K = \pi B$

When the benefit is based on a variable guarantee the break-even condition can be written as

(3) $K = \phi\pi L$

where ϕ is the level of the guarantee and L is the amount of the loan principal.

Given these payments and associated benefits, expected utility becomes

(4) $E[U] = (1-\pi)\ u(r-K) + \pi v(r-K+\phi L)$

The design of an efficient loan guarantee program involves setting the guarantee fee and guarantee level so that expected utility is

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20/ Here we ignore administrative costs which are zero in an ideal system. The problems of moral hazard and adverse selection are also absent in the ideal system.

maximized subject to the break-even condition (3). For the risk-averse lender the choice of the optimal guarantee level can be expressed as the unconstrained maximization problem 21/

$$(5) \quad E[U] = (1-\pi)\ u(r-\pi\phi L) + \pi v(r+(1-\pi)\ L)$$

where we have substituted (3) into the definition of expected utility (4). The first-order condition for the maximization of (5) with respect to the guarantee level requires that

$$(6) \quad u'(r-\pi\phi\ L) = v'(r+(1-\pi)\phi L)$$

Thus, the first-order condition for the provision of an ideal loan guarantee requires that the marginal utility of dollar return in the case of no default equals that in the case of default. When the only loss to the bank is the loss of principal, the optimal plan is to have the same total dollar return net of this loss of principal whether or not default occurs--that is, to set the benefit equal to the entire loan principal.

It should be noted that the first-order condition for ideal guarantees equates marginal utility levels in the two states of nature and not the actual utility levels. This condition could lead to serious moral hazard problems. First, the guarantee can make the cost of default to the bank (and/or borrower) less than the social cost. Depending upon the behavior of the bank (and/or borrower), this can be expected to lead to some over-consumption of the guarantee services of the SBA. A similar problem involves the borrower purposely defaulting on the loan to obtain more favorable terms from the SBA once the agency buys back its portion of the loan from the commercial bank. Most notable among the more favorable terms are lower effective interest rates and extended repayment schedules. With respect to the pure moral hazard problem discussed earlier, rational value maximizing banks may be expected to demand guarantees that are too high given their true risk exposure and fees paid. Given the availability of guarantees under such circumstances, commercial banks can be expected to exercise a level of care that is less than desirable from a social welfare perspective. As noted earlier, this problem is particularly acute

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21/ The assumption of risk-aversion requires that $u(\cdot)$ and $v(\cdot)$ exhibit diminishing marginal utility of total dollar return.

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when the fee paid does not vary directly with the true underlying risk of loss, as is the case under the current guaranteed participation program.

These problems can be reduced somewhat through the use of coinsurance. That is, the guarantee level will ordinarily set at less than 100 percent of the outstanding loan principal. This is the case under the current program where guarantees range to 90 percent. In addition, it has been previously noted that as long as the benefits do not cover all the costs of default (forgone opportunities, etc.) banks should still have incentives to take care. However, while these problems may be diminished by coinsurance, they are still likely to persist as long as guarantee fees are not based on behavior that affects the probability of loss and the costs of the agency.

SECTION V. LOAN GUARANTEES IN THE PRESENCE OF MORAL HAZARD AND ADVERSE SELECTION

In general, we expect to find the moral hazard and adverse selection problems occurring together. In the analysis which follows, no attempt will be made to analyze explicitly the impact of these problems on loan guarantees separately in the strictest sense. Instead, we concentrate on their implications for the efficiency of the guarantee arrangement.

For simplicity, assume a one-period economy in which the participating bank has available two types of business loan opportunities--one free of default risk with total dollar return s and one that is risky with expected dollar return r and probability of default of π. 22/ Let the SBA provide insurance for the risky loan in the form of a loan guarantee which pays the bank $M = \phi L$ in the

22/ We take one lending opportunity to be riskless to simplify the analysis. We could analyze two risky lending opportunities where one had a lower probability of default. However, the general conclusions reached with one riskless opportunity still hold for this case although the analysis is a bit more complicated.

case of default, where ϕ is the guarantee level and L is the loan principal. To obtain the guarantee, the bank pays a fee $P = \gamma\phi L$, where γ is a fixed percentage fee and ϕ and L are as previously defined. Here we assume that M is not so large that the bank prefers default. We also assume that the bank correctly perceives the probability of default.

Equilibrium under this set of conditions requires that the participating bank be indifferent between the safe loan with its return s and the package consisting of the risky loan with its probability of default, guarantee, and guarantee payment (r, π, M, P). 23/ If we write the indirect utility function as Ω, we have the condition

(7) $\Omega(s, 0, 0, 0) = \Omega(r, \pi, M, P)$

We assume that the bank is an expected utility maximizer, so that the components of (7) can be written as

(8) $\Omega(r, \pi, M, P) = (1-\pi)u(r-P) + \pi v(M-P)$

and in the case of the safe loan, as

(9) $\Omega(s, 0, 0, 0) = u(s)$

By implicitly differentiating (7) and (8) the equilibrium guarantee fee can be related to the level of the guarantee benefit

(10) $(dP/dM) = - (\delta\Omega/\delta M)/(\delta\Omega/\delta P)$

(11) $(dP/dM) = \pi v'(M-P)/(1-\pi)u'(r-P) + \pi v'(M-P)$

Ignoring administrative costs, the total expected costs, C, of the guarantee to the SBA can be written as (π M-P). Given this formulation we can compute the change in the agency's cost for a change in benefits paid. That is, in the expected utility case

(12) $(dC/dM) = \pi - (dP/dM)$

23/ The analysis that follows parallels that of P. Diamond, "Insurance Theoretic Aspects of Workers' Compensation," in A. Blinder and P. Friedman, eds., Natural Resources, Uncertainty, and General Equilibrium Systems: Essays in Memory of Rafael Lusky (New York: Academic Press, 1978).

Substituting (11) into (12) yields

$$(13)\quad (dC/dM) = \{\pi 1 - [v'(M-P)/(1-\pi)u'(r-P) + \pi v'(M-P)]\}$$

Thus, (13) tells us that the cost minimizing guarantee program for the SBA is the provision of an ideal guarantee as discussed previously. As can be seen in (13), whatever the level of guarantee benefits provided by the arrangement, it must accurately reflect private costs, including the behavior of the bank which affects the probability of default. 24/

It is possible that the SBA will misperceive the probability of default. It is in such cases that the problem of adverse selection arises. Retaining our assumption that the fee paid by the bank does vary with the level of benefits, we now assume that the SBA perceives the probability of default as $\hat{\pi}$ where $\hat{\pi}<\pi$. This could be a result of the agency's lack of expertise in risk analysis or to bank inducements during the application process. Replacing the true probability with the agency's perceived probability and repeating our computations, we have

$$(14)\quad (dC/dM) = \hat{\pi} - [\hat{\pi}\, v'(M-P)/(1-\hat{\pi})u'(r-P) + \hat{\pi}\, v'(M-P)]$$

which is larger than (13) since $\hat{\pi}$ is smaller than π. Thus, the agency's costs increase faster with inaccurate probabilities since benefits still depend on the correct higher probability of default and the agency's fees are smaller. If the SBA were to select the guarantee benefit to minimize costs, it would select a higher level than that which would be selected given correct perceptions. Thus, the social costs of providing the loan guarantee is higher than the private cost. In this case we have too many risky loans being guaranteed and too many defaults. The divergence between the social and private costs can obviously be reduced by decreasing the guarantee benefits.

24/ That is, the guarantee fee paid by the bank must vary correctly with the true probability of loss which is in turn dependent upon the level of care exercised by the bank.

SECTION VI. THE LEVEL OF CARE AND THE SBA LOAN GUARANTEE

In this section we analyze the level of care exercised by the parties to the SBA loan guarantee.

BANK CARE

Consider the case in which the bank has control over actions that affect the probability of default under the guarantee relationship. As noted previously, coinsurance is one way of increasing care.

To characterize bank care, we assume that under the relationship the bank faces two possible states of nature. 25/ If state one occurs, the loan does not default. If state two occurs, the loan defaults and the bank suffers a loss of r dollars where r is as previously defined and we still assume a one-period economy. By varying the level of care under the loan relationship, the bank can affect the probability of default . In taking care let the bank incur a cost of one dollar per unit of care exercised, , which is not observed by the SBA. The level of care function can thus be written as $\pi = \pi(\alpha)$, where $\pi'(\alpha) < 0$. The bank purchases the loan guarantee by paying the fee P, and receives the payment M if default occurs.

The bank can be thought of as making its guarantee purchase in two steps. First, the bank determines the utility maximizing level of care, α, for every value of M. Then the bank chooses the utility maximizing value of M, given the associated fee P, and the utility maximizing α. Under this set of conditions the expected utility of the bank is given by

$$(15) \quad E[U] = (1-\pi(\alpha))\, u(r-\alpha-P) + \pi(\alpha)\, u(M-\alpha-P)$$

With M and P given, the utility maximizing value of α satisfies

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25/ The analysis of bank care which follows is based on the work of Pauly, "Overinsurance and Public Provision."

$$(16) \quad (1-\pi(\alpha))\, u'(r-\alpha-P) + \pi(\alpha)\, u'(M-\alpha-P) = [u(M-\alpha-P) - u(r-\alpha-P)]\, \delta\pi/\delta\alpha$$

This optimizing condition requires that the price of additional care, in expected utility terms, equals the effect of additional care on the bank's expected utility level. It is clear from this condition that if the guarantee benefit fully compensates the bank for its losses, including forgone opportunities, then the level of care will be set equal to zero. We recall, however, that if M is not fully compensatory then the bank is expected to exercise some care.

The most interesting thing about (16) is that it is entirely possible for the level of care to be zero even if M is less than fully compensatory. That is, even if M is less than r, as is the case under the current guarantee arrangement, the bank may not exercise any care. Examining (16), if M = r, then the left-hand side becomes $u'(\cdot)$ which is positive while the right-hand side becomes zero. As M is reduced below r, although the bank is exposed to some loss, there must be some ranges of M over which the right-hand side of (16) is still less than the left-hand side. Here the potential loss borne by the bank over that range is still too small to make it worthwhile to spend anything on care. Thus, over the range of corner solutions, a range that must exist as long as $u'(\cdot)$ is positive, it must be that $\delta\alpha/\delta M=0$. The dependence of care on the bank's expected losses is clear. Determining the critical guarantee level which induces care for a given loan is an empirical question.

BORROWER CARE

In this section we consider the impact of the loan guarantee on efficiency from the viewpoint of the borrower. To analyze this situation we begin with an extreme case. First, to illustrate the type of analysis to be conducted, assume that the borrower can purchase the loan guarantee from the SBA with benefits payable to the bank in case of default. The SBA is assumed to be fully aware of both the personal and firm characteristics that determine the risk of default. With the guarantee fee varying correctly with the underlying risks and with the borrower responsible for any unguaranteed losses of the bank, there will be full incentives for proper care. Under this same set of conditions, the borrower will also have full incentive to seek out a commercial bank which has a comparative advantage in dealing with the borrower's type of business and its inherent risks--that is, a bank that exercises "good" care. Since the search for such a bank is costly (assuming that the bank is not the borrower's regular bank), there is a reasonable tradeoff between the borrower's cost of search and the benefits associated with finding a bank that takes reasonable care.

In contrast to this case, consider the current arrangement in which it is the bank that purchases the loan guarantee and bears the bulk of the unguaranteed losses associated with default. Here our general conclusions must be modified. If the borrower is fully aware of his own capabilities, but banks are now unable to distinguish between good and bad borrowers, then we have the same moral hazard and adverse selection problems as existed between the SBA and the bank. Even if the bank could obtain some information that allowed it to better distinguish among borrowers, as long as it cannot base interest rates or other terms of lending on the underlying behavior of the borrower that affects the probability of default and the bank's expected costs, then efficiency problems are certain to arise. On one hand, it is natural for banks, given their uncertainty, to seek the largest guarantee available so as to substitute the guarantee benefits for their own care. On the other hand, borrowers have little incentive to either take care or seek out banks with a comparative advantage in handling their type of loan. Borrowers are likely to search randomly for banks and a considerable misallocation is likely to result.

This analysis has been based on a somewhat extreme set of conditions. Actual circumstances are likely to be somewhat less extreme, reflecting a partial ability of banks to distinguish among borrowers and for borrowers to take care and to seek out efficient banks. The present arrangement probably leaves both banks and borrowers preferring the absence of default and exercising care at least at some self-protection level.

INCENTIVES FOR TAKING CARE AND EFFICIENT CARE

In this section we examine general incentives for banks and borrowers to exercise care under the guarantee relationship. We denote the efforts of the bank to prevent default as α and the efforts of the borrower to prevent default by β. Examples of bank care might include periodic visits to the borrower's place of business by the bank loan officer and managerial and technical advice offered to the borrower by the bank. Borrower care includes such activities as participation in managerial workshops and seminars and utilization of other programs of assistance such as those offered through the SBA itself.

In this section we relate the incentives for taking care to the assignment of the costs of default to each party. Again, to set up the analysis, we invoke an extreme set of assumptions. Assume that the number of banks and guaranteed borrowers are given and that all banks and borrowers are the same. For both parties, the only relevant costs of default are those that are not covered by the guarantee contract. As a first pass simplifying assumption, we take this cost to be equal to the unguaranteed portion of the loan principal. We assume that this cost can be assigned to either the bank or the borrower.

Let $B(\alpha)$ be the aggregate cost of having banks take care level α, $A(\theta)$ the aggregate cost of having borrowers take care level θ, and $\hat{\alpha}$ and $\hat{\theta}$ the levels of care that minimize these aggregate cost functions. 26/ If we let $L(\alpha, \theta)$ be the expected value of default costs given care levels α and θ, then total unguaranteed social costs can be written as the sum of these three elements:

$$(17) \quad S(\alpha, \theta) = B(\alpha) + A(\theta) + L(\alpha, \theta)$$

If banks bear the costs of default, then borrowers can be expected to choose care level $\hat{\theta}$ and the total costs for banks are

$$(18) \quad B(\alpha) + L(\alpha, \hat{\theta})$$

When banks bear the expected unguaranteed costs, let their optimum level of care be denoted by α^*. Equilibrium relative to unguaranteed costs is then described by the pair $(\alpha^*, \hat{\theta})$. If borrowers bear the expected unguaranteed costs, banks can be expected to choose care level $\hat{\alpha}$ and the borrowers' total costs will be

$$(19) \quad A(\theta) + L(\alpha, \hat{\theta})$$

The optimizing level of care in this situation will be denoted

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26/ As noted earlier, $\hat{\alpha}$ and $\hat{\theta}$ could possibly be zero. In this section we assume that they are greater than zero since both parties will at least exercise care at some self-protection level.

by θ * and the corresponding equilibrium is described by the pair (α, θ *).

The efficiency of the above situation can be evaluated by comparing the unguaranteed social costs of the two equilibrium relationships $S(\hat{\alpha}, \theta^*)$ and $S(\alpha^*, \hat{\theta})$. It is very easy to see that placing these costs on the party whose expenditures on care (above the self-protection levels $\hat{\alpha}$ and $\hat{\theta}$) are more efficient results in the more efficient equilibrium. For example, if banks are more efficient than borrowers in making additional default cost avoidance expenditures, then

$$(20) \quad S(\hat{\alpha} + \Delta, \hat{\theta}) \leq S(\hat{\alpha}, \hat{\theta} + \Delta)$$

where represents additional care expenditures. The equilibrium occurring when banks bear these costs is the more efficient one. That is

$$(21) \quad S(\alpha^*, \hat{\theta}) \leq S(\hat{\alpha}, \theta^*)$$

Two things should be noted at this point. First, neither of these equilibria is fully efficient since either the bank or the borrower bears all the important costs. For a full efficiency, both parties should be concerned with total costs. Also, it must be remembered that here we are only considering unguaranteed losses. Thus, the efficiency concept we discuss is a qualified one.

When the expected losses above the guarantee benefit are not assigned to either the bank or the borrower, both parties will generally bear part of the costs. In this case it is in the interest of both parties to negotiate a contractual relationship that at best minimizes their portion of expected losses. The bank would rationally seek some security in the relationship while the borrower would seek to obtain an unsecured loan. What is clear from this analysis is that, when the costs of default above the guarantee level are clearly placed on one party, the other will have little incentive to exercise care above the self-protection level. To the extent that banks can write off their losses against other income, thus reducing their net true losses, incentives for their taking care will be further reduced. To the extent that the bank or the SBA cannot liquidate any collateral that secures the loan (in cases of default), borrower incentives for taking care are reduced. Finally, it must be noted that the bulk of the loans under the current program are not single period loans, as we have assumed in our theoretical analysis. Thus, at the time of default it will generally be true that some loan principal has been repaid. This means that the true loss exposure of the bank, once one takes account of tax savings, principal repayment, and security interests, may be minor and care set at self-protection levels.

SECTION VII. AN EMPIRICAL ANALYSIS OF THE CURRENT GUARANTEED PARTICIPATION PROGRAM

The theoretical analysis of moral hazard and adverse selection in SBA guaranteed loan relationships has shown the potential for serious misallocation problems to arise when guarantee fees are invariant with respect to underlying risks. The extent to which these problems will occur under a given set of loan relationships is an empirical question. In this section, we analyze a set of guaranteed loans in an attempt to assess the importance of these problems for public policy considerations.

To carry out the empirical analysis, a random sample of 200 guaranteed participation loan cases was collected from the SBA's Atlanta, Georgia, district office. Information collected included repayment status, size and terms of the loan, guarantee level, financial and economic characteristics of the borrower and the participating bank, and use of managerial and technical assistance from the SBA and the bank. Of the 200 total loan cases, 198 were found to have complete data for our empirical analysis. Of these cases roughly one-half were liquidated under the default procedures of the SBA. The other cases were paid in full. These loans represent program activity over the five-year period 1973-1978.

As a useful means of predicting loan defaults, we first analyze those characteristics that correlated highly with actual loan defaults. If we view default and nondefault as two options of SBA borrowers, then we can estimate the probability of default using one of several binary choice models in the literature.

Binary choice models assume that individuals are faced with a choice between two alternatives and that the choice they make depends on the characteristics of the alternatives. 27/ Given information about the attributes of each of the individuals and the choices they make, it is natural to ask whether we can estimate an equation that will predict the choices of individuals not in the original sample. In the following tests, we will restrict our analysis to cases in which prediction is to occur over the same set of choices available during the period of model estimation. If we assume that the probability of a borrower defaulting is a linear function of the attributes existing under the loan relationship, then we may estimate the probability of default using the linear probability model. 28/

The regression form of the model is given by

(22) $Y_i = \quad + \underline{\beta}'\underline{X} + e_i$

where

Y_i = 1 if the ith loan has defaulted
0 if the ith loan is paid in full

α = a regression constant

$\underline{X}$ = a vector of relevant attributes for the ith loan case

$\underline{\beta}'$ = a vector of coefficients to be estimated

e_i = an independently distributed random variable with zero mean.

27/ Individuals are to be considered as any decisionmaking entity, e.g., households, firms, cities, etc.

28/ For a discussion of the linear probability model and an application of the technique to predicting the probability of default of general obligation municipal bonds, see D. Rubinfeld, "An Econometric Analysis of the Market for General Obligation Municipal Bonds" (unpublished doctoral dissertation, Massachusetts Institute of Technology, June 1972).

The interpretation of (22) as a linear probability model comes about when we take the expected value of each dependent variable observation Y_i. Since Y_i can take on only two values, 1 and 0, the probability distribution of Y can be described by letting P_i = Prob(Y_i=1) and (1-P_i) = Prob(Y_i=0). Then,

$$(23) \quad E[Y_i] = 1(P_i) + 0(1-P_i) = P_i$$

Thus, the regression equation may be interpreted as describing the probability that an individual loan will default, given characteristics of the loan case. 29/

More formally, the model can be written as

$$(24) \quad P_i = \begin{array}{lll} + \underline{\beta}'\underline{X} & \text{when } 0 < \alpha + \underline{\beta}'\underline{X} < 1 \\ 1 & \text{when } + \underline{\beta}'\underline{X} \quad \overline{1} \\ 0 & \text{when } + \underline{\beta}'\underline{X} \quad 0 \end{array}$$

The sample data provides a number of variables concerning the borrower's financial position, characteristics of the participating banks, characteristics of the principal owner of the borrowing firm and other relevant variables which should be related to the probability of default. The definitions of the variables included in the empirical analysis are listed in Table 1. While most of these variables have straight-forward interpretations, some do deserve additional comment.

Care variables are binary and take on the value one when evidence of care was present in the case history of the loan relationship and zero when no evidence of care was found. Bank

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29/ It should be noted that the error term in this model is heteroscedastic. This results in a loss of efficiency, but does not in itself result in either biased or inconsistent parameter estimates. Another weakness of the linear probability model concerns its use of forecasting. That is, there is generally a problem of predicting values of the dependent variable outside the (0, 1) range. For forecasting purposes, alternative specifications, such as logit or probit, are required. Since we do not attempt to predict outside the sample data, the linear model will be utilized. Given additional sample data and appropriate grouping of the variables in the sample, probit or logit analysis could be conducted.

TABLE 1. DEFINITIONS OF VARIABLES

Definition	
DEFAULT	Status of loan default: Yes = 1, No = 0
RACE	Minority = 1, Nonminority = 0
BKCARE	Management assistance provided by bank: Yes = 1, No = 0
USE	Use of loan proceeds: Regular = 0 Regular and/or Repayment of debt = 1
TOTASS	Total assets of borrowing firm (000's)
YRSBUS	Number of years business has been operating
GUARANTE	Percent of loan principal guaranteed by SBA (nondecimal)
CRRATE	Credit rating of business: Good = 1, Bad = 0
PRESBA	Previous SBA borrower: Yes = 1, No = 0
ACARE	Borrower care: Yes = 1, No = 0
SBACARE	SBA Management assistance provided: Yes = 1, No = 0
ROI	Borrower's return on investment (decimal percent)
EMULT	Borrower's equity multiplier (ratio of assets to owner's equity)
SALENW	Turnover of owner's equity
REGBK	Borrower had previous bank relationship with participating bank: Yes = 1, No = 0
BROI	Bank's return on investment (decimal percent)
CAPAS	Ratio of bank's capital accounts to total assets (decimal percent)
CILOAN	Ratio of bank's commercial and industrial loans to total loans (decimal percent)
USFASS	Ratio of U.S. government securities and federal funds sold to total bank assets (decimal percent)
LONDEP	Ratio of loans to total deposits (decimal point)
NLLLOANS	Ratio net loan losses to total loans (decimal point)
SPREAD	Bank's return on loans minus yield on U.S. government securities portfolio (decimal percent)
EFFTAX	Bank's effective tax rate before extraordinary items (decimal percent)
BASS	Total bank assets (millions)
NOEMP	Borrower's total number of employees
NW	Net worth of borrowing business (000's)

care was considered to be present under the loan relationship when there was documented evidence in the case file of efforts initiated by the bank to either prevent default or merely give managerial or technical assistance to the borrower above and beyond any simple program reporting requirements. SBA care consists mainly of advice and assistance offered to the borrower by the SBA Management Assistance staff. These efforts are also documented in each loan case file. Borrower care includes documented voluntary participation by the principal owner(s)/manager(s) in programs emphasizing the development of managerial and technical or functional skills and expertise.

Borrower financial variables represent three ratio categories: leverage, activity or efficiency, and profitability. These are in addition to measures of size, credit worthiness, race, use of the loan proceeds, number of years in the business, and previous utilization of SBA loan programs.

Bank variables include standard report of condition ratios and a measure of market power, in addition to care.

REGRESSION MODELS

A total of five functions are estimated. The first four functions correspond to the linear probability model outlined above, while the fifth function is a regular multiple regression equation.

In Model 1, we estimate the default probability function. Our a priori expectations with respect to the signs of the explanatory variables in Model 1 are given in Table 2 along with the expected signs for Model 2--the bank care function; Model 3--the borrower care function; Model 4--the SBA care function; and Model 5--the guarantee function.

The signs which are of particular interest are those associated with the variable GUARANTE in the first three models. While we have no sure a priori expectations about the sign and significance of the guarantee variable, a positive sign in Model 1 would be supportive of the presence of moral hazard elements in the sample loan relationships. In Model 2 and Model 3 a negative sign on the guarantee variable would be supportive of the presence of moral hazard and adverse selection elements.

TABLE 2. EXPECTED SIGNS OF ESTIMATED COEFFICIENTS

Independent Variable	Expected Sign
MODEL 1: DEFAULT	
REGBK	−
RACE	±
BKCARE	−
USE	+
TOTASS	−
YRSBUS	−
GUARANTE	±
CRRATE	−
PRESBA	−
ACARE	−
SBACARE	−
ROI	−
EMULT	−
SALENW	−
MODEL 2: BK CARE	
RACE	±
REGBK	+
YRSBUS	−
GUARANTE	±
PRESBA	−
ROI	−
BROI	±
CAPAS	−
CILOAN	±
USFASS	±
LONDEP	+
NLLOAN	+
SPREAD	−
EFFTAX	+
BASS	−
MODEL 3: ACARE	
RACE	±
USE	+
TOTASS	±

(Continued)

TABLE 2. (Continued)

Independent Variable	Expected Sign
MODEL 3: ACARE (continued)	
YRSBUS	±
GUARANTE	±
CRRATE	±
NOEMP	±
PRESBA	+
REGBK	-
SBACARE	+
NW	-
ROI	-
SALENW	-
MODEL 4: SBACARE	
RACE	±
USE	+
TOTASS	-
YRSBUS	-
GUARANTE	+
CRRATE	-
NOOWN	-
PRESBA	+
ROI	-
EMULT	+
MODEL 5: GUARANTE	
RACE	±
YRSBUS	-
REGBK	-
PRESBA	-
BROI	±
CAPAS	-
CILOAN	±
LONDEP	+
NLLLOAN	+
SPREAD	-
EFFTAX	+
BASS	-

EMPIRICAL RESULTS

The results of the estimation of each model are given in Table 3, along with the standard errors of the estimated coefficients, R^2, and sample size. The goal of the estimations for the first four models is to find a subset of characteristics of borrowers and banks which best allows one to predict probabilities.

From Table 3 we see that Model 1 has an R^2 of .54 which suggests that a good deal of the variability in default incidence is explained by the independent variables included in the function. All coefficient signs agree with our expectations with the exception of the credit rating variable and the return on investment variable. Of these two exceptions, only the credit rating variable is significant. The coefficient on the bank care variable is negative and significant, implying that, ceteris paribus, the presence of bank care will lower the probability of default by 15 percent. The total size of the borrowing firm also appears to be a good predictor of defaults. The coefficient on this variable is negative and significant, implying that, ceteris paribus, a $1,000 increase in the total assets of the borrowing firm will lower the probability of default by one-half percent. The other significant predictor in Model 1 is the turnover of owner's investment. A ceteris paribus increase in SALENW of one lowers the probability of default by .02 percent.

The probability of default is also reduced when the loan is made through the borrower's regular bank, when the borrowing business is an older firm, when borrower and SBA care is present under the relationship, and when the borrower has had a previous SBA loan. The probability of default is increased when the borrower is a minority, when some of the loan proceeds are used to repay existing debt, and when the borrowing firm has higher leverage.

The sign on the guarantee variable is positive, although not significant. This positive relationship supports the notion that elements of the moral hazard/adverse selection problem are present in the sample set. The relationship implies that, ceteris paribus, an increase in the guarantee level of one percent will raise the probability of default by 2.5 percent. It is also interesting to note the relationships between the care variables in the equation. The bank care variable is about one and one-half times the size of the SBA care variable and about 8 times the size of the borrower's care variable. It is also the only significant

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TABLE 3. ESTIMATED REGRESSION EQUATIONS (Standard Error In Parentheses)

Model 1

DEFAULT = .833 - .073 REGBK + .159 RACE - .150 BKCARE + .115 USE
(.179) (.203) (.07)* (.084)

- .005 TOTASS - .014 YRSBUS + .025 GUARANTE
(.001*) (.01) (.018)

+ .195 CRRATE - .223 PRESBA - .019 ACARE - .101 SBACARE
(.042)*+ (.101) (.181) (.085)

+ .025 ROI + .176 EMULT - .0002 SALENW
(.018) (.151) (.0001)*

R^2 = .54
N = 198

- -

Model 2

BKCARE = -.288 - .021 RACE + .283 REGBK + .013 YRSBUS
(.138) (.107)* (.009)+

- .067 GUARANTE + .076 PRESBA - .036 ROI + 13.8 BROI
(.005)* (.147)+ (.027) (9.89)

- 1.25 CAPAS - .665 CILOAN + 2.48 USFASS + 1.17 LONDEP
(2.98) (.541) (2.43) (.833)

- 16.6 NLLLOAN - .83 SPREAD + .067 EFFTAX - .07 BASS
(9.31)* (.241) (.208) (.001)*

R^2 = .49
N = 198

- -

(Continued)

TABLE 3. (Continued)

<u>Model 3</u>

$$
\begin{aligned}
\text{ACARE} = -.029 &- \underset{(.080)}{.056}\ \text{RACE} - \underset{(.059)+}{.018}\ \text{USE} + \underset{(.011)*}{.03}\ \text{TOTASS} - \underset{(.005)}{.007}\ \text{YRSBUS} \\
&- \underset{(.028)}{.013}\ \text{GUARANTE} + \underset{(.065)}{.073}\ \text{CRRATE} + \underset{(.001)*}{.0059}\ \text{NOEMP} + \underset{(.021)*}{.048}\ \text{PRESBA} \\
&- \underset{(.151)}{.092}\ \text{REGBK} + \underset{(.062)*}{.60}\ \text{SBACARE} - \underset{(.001)*}{.162}\ \text{NW} - \underset{(.052)}{.048}\ \text{ROI} \\
&- \underset{(.001)*}{.033}\ \text{SALENW}
\end{aligned}
$$

$R^2 = .72$

N = 198

- -

<u>Model 4</u>

$$
\begin{aligned}
\text{SBACARE} = -.415 &+ \underset{(.152)}{.03}\ \text{RACE} + \underset{(.112)}{.014}\ \text{USE} - \underset{(.0001)*}{.006}\ \text{TOTASS} - \underset{(.042)}{.034}\ \text{YRSBUS} \\
&+ \underset{(.062)}{.08}\ \text{GUARANTE} + \underset{(.384)+}{.15}\ \text{CRRATE} + \underset{(.060)+}{.09}\ \text{NOOWN} + \underset{(.101)*}{.235}\ \text{PRESBA} \\
&- \underset{(.03)}{.02}\ \text{ROI} - \underset{(.095)+}{.013}\ \text{EMULT}
\end{aligned}
$$

$R^2 = .19$

N = 198

- -

(Continued)

TABLE 3. (Continued)

Model 5

$$\begin{aligned}
\text{GUARANTE} = {} & 77.9 + \underset{(2.26)}{2.44\ \text{RACE}} - \underset{(.452)}{.351\ \text{YRSBUS}} - \underset{(2.78)*}{7.33\ \text{REGBK}} \\
& - \underset{(2.42)}{1.75\ \text{PRESBA}} - \underset{(286.3)}{114.40\ \text{BROI}} + \underset{(48.2)+}{20.6\ \text{CAPAS}} + \underset{(8.67)}{5.95\ \text{CILOAN}} \\
& + \underset{(13.26)}{.429\ \text{LONDEP}} - \underset{(268.4)}{66.5\ \text{NLLLOAN}} + \underset{(5.3)*}{10.4\ \text{SPREAD}} \\
& - \underset{(3.41)+}{.892\ \text{EFFTAX}} + \underset{(.042)+}{.02\ \text{BASS}}
\end{aligned}$$

R^2 = .17
N = 198

* Coefficient significant at .10 level or higher.

\+ Sign disagrees with expected sign.

care variable in the model. These relationships imply that bank care tends to be most effective in reducing default probability. This suggests that banks are more efficient than borrowers and the SBA in making default cost avoidance expenditures and that the provision assistance programs would be more effective if handled through the lending bank.

Model 2 is the bank care probability function. This function has an R^2 of .49 which suggests that a good deal of the variance in bank care is still unexplained. Nevertheless, the model does show some interesting results. The signs on the estimated coefficients agree with our expectations with the exception of the years in business variable and previous SBA experience variable. Neither of these coefficients is significant, however. The coefficient on the regular bank variable is positive and significant. This implies that, ceteris paribus, the utilization of the borrower's regular bank for the SBA loan participation increases the probability of bank care by 28.3 percent. This result is not surprising since banks are expected to take more care with their regular customers.

The coefficient on the guarantee variable is negative and significant. This implies that, ceteris paribus, an increase in the guarantee level of 1 percent will reduce the probability of bank care by 6.7 percent. This relationship suppports the moral hazard/adverse selection arguments advanced in theoretical analysis. If one compares the result with that of Model 1 it becomes evident that there is a causal relationship between default probability, bank care, and the guarantee level. This relationship appears to run from the guarantee level to bank care to default probability. That is, bank care is reduced by the guarantee level and the probability of default is increased by the reduction in bank care. Utilization of the borrower's regular bank also figures in these relationships since it can offset the negative impact of the guarantee level on bank care. For example, the model suggests that the guarantee level would have to increase by about 4 percentage points to negate the influence of the bank relationship. Thus, it appears that the bank relationship is a particularly strong factor in the SBA lending program. The coefficient on the ratio of net loan loss to total loans is significant and negative. This implies that banks with higher ratios of loan losses to loans take less care. The other significant coefficient in Model 2 is bank size which is measured by the bank's total assets. The coefficient is negative and implies, ceteris paribus, that an increase in bank assets of $1 million lowers the probability of bank care by 7 percent. Thus, the larger banks in the sample exercised lower levels of care on average.

Other factors that tend to be associated with a lower probability of bank care are minority status, higher capital to assets ratios, higher ratios of commercial and industrial loans to total loans and larger spreads between the bank's loan rate and return on U.S. government securities.

Factors that tend to be associated with higher probabilities of bank care are number of years in business, previous SBA loan experience, bank return on investment, the ratio of U.S. government securities and federal funds sold to total assets, the loan-to-deposit ratio, and the effective tax rate.

Model 3 is the borrower's care probability function. The R^2 of .72 indicates that a significant amount of the variance in borrower care is explained by the independent variables in the function. The total assets variable is positive and significant and indicates that for a $1,000 increase in the asset size of the business the probability of borrower care increases by 3 percent, other things constant. The number of employees variable is also significant and positive. It implies that an addition of one employee increases the probability of borrower care by about 0.6 percent. These two variables are obviously highly correlated and both relate to the size of the business. The coefficient on the previous SBA experience is positive and significant. This implies that previous SBA loan experience increases the probability of borrower care by 4.8 percent, other things equal. This relationship is to be expected since borrowers with previous SBA loans are more likely to be voluntary participants in assistance programs offered by the agency itself.

The coefficient on SBACARE is positive and highly significant. It suggests that the presence of SBA care increases the probability of borrower care by 60 percent, other things equal. Its large influence is due to the fact that SBA care is extremely difficult to separate from borrower care since a major form of borrower care is participation in programs sponsored by the SBA itself. Although borrower care was measured by voluntary efforts of the borrower, it is probably true that many if not most SBA borrowers view participation in the agency's own programs as a necessary activity.

Other significant variables in Model 3 are borrower's net worth and the turnover of this net worth. Both have negative signs indicating that, ceteris paribus, increases in each lower the probability of borrower care. The model also suggests that, on average, increases in the guarantee level tend to reduce the probability of borrower care. However, this coefficient is not significant and is of small magnitude when compared with the guarantee coefficient in Model 2. While the negative sign is consistent with moral hazard elements, the relative magnitude and lack of significance suggest that the moral hazard and adverse selection problems between the bank and borrower are of a lower order of magnitude than those between the bank and the SBA. The other variables in the equation have the correct expected signs.

Model 4, the SBA care functon, has an R^2 of .19 which indicates that a good deal of the variance in SBA care is still unexplained. Only two of the variables are significant in the function and three have signs that differ from our a priori expectations, although none is significant. The coefficient of the total assets variable is negative and significant. This implies that, ceteris paribus, a $1,000 increase in the borrower's assets lowers the probability of SBA care by 0.6 percent. The coefficient of PRESBA is positive and significant. It implies that being a previous SBA loan recipient increases the probability of SBA care by 23.5 percent, other things equal. The model also shows that the borrower is likely to receive SBA care if he is a member of a minority group, uses some or all of the loan proceeds to repay existing debt, and obtains a large guarantee level. On the other hand, the longer the firm has been in business and the higher the firm's return on investment, the less likely is the firm to receive SBA care.

Model 5 is a regular regression function explaining the guarantee level of the SBA loan. The R^2 of .17 indicates that a great deal of the variance in the model is still unexplained. Nonetheless, we can still use the results of the model to study the economic factors which correlate highly with the guarantee level. First, the coefficient on the regular bank variable is negative and significant. This implies that, ceteris paribus, utilization of the borrower's regular bank lowers the guarantee level by 7.33 percentage points. The result is consistent with the fact that bank care is negatively related to default and that use of the borrower's regular bank increases the likelihood of bank care.

The coefficient on the spread variable is positive and significant. This implies that a 1 percent increase in the bank's spread will increase the guarantee level by 10 percentage points, other things constant. Since the spread between a bank's loan rate of return and return on U.S. government securities is reflective of the bank's market power, this result suggests that, on average, the sample banks with market power are being over-subsidized by the SBA. That is, these banks may be using as their target rate of return, loan rates that have built in monopoly power premiums. Since the SBA places limitations on the rate of interest banks can charge borrowers, the only way for these banks to find participation economically feasible based on these target loan yields is to lower their expected costs of default by requesting larger guarantees. This speculation is somewhat supported by the fact that the net loan loss to loans ratio is also negative, although not significant. This coefficient implies that a 1 percent increase in this ratio reduces the guarantee level by 6.65 percent. This result appears perverse. However, if one accepts the argument that gurantee levels have a built-in cushion then it makes more sense. In fact, the results from Models 1 and 2, that higher guarantees reduce bank care and increase the probability of default, also support this speculation. Only when bank costs are related directly to behavior which affects the probability of loss can bank care be expected to increase with the guarantee level.

SECTION VIII. CONCLUSIONS

The analysis in this paper shows how the problems of adverse selection and moral hazard can arise in the SBA's Guaranteed Participation Loan Program. The analysis also shows how serious misallocations of resources can result in the presence of these problems. The central problems result when bank and borrower costs do not depend on the behavior that affects the probability of loss and the expected costs of the guarantor. As currently constituted, the SBA's loan program does have the structure necessary to minimize these problems. However, the guarantee fee schedule must be revised in the direction of a variable fee rate if proper incentives for bank and borrower care are to be established.

The analysis also shows that care expenditures are best placed with the party whose care activities are more efficient. Currently the bulk of the formal managerial assistance available to SBA borrowers comes through the agency's own programs. Based on the results of this study, careful consideration should be given to ways of increasing bank provision of assistance since it appears to be considerably more effective.

The empirical analysis presents evidence on the presence of moral hazard and adverse selection in the current guaranteed participation program. This evidence also dispels the simple argument that default incidence and guarantee level are positively correlated and significant because only high-risk loans receive higher guarantees. Instead, the evidence shows that it is bank care which is a very significant deterrent of default and that the guarantee level is a significant determinant of bank care. Thus, large guarantees tend to be associated with defaults, not because these loans are necessarily more risky but because large guarantees reduce bank care which is a very significant determinant of default probability.

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THE EFFECTS OF FEDERAL LOAN GUARANTEES ON SMALL ENTREPRENEURS: FOCUS ON COMMERCIALIZATION OF ELECTRIC AND HYBRID VEHICLES

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PREFACE

This study was prepared for the Congressional Budget Office's Conference on the Economics of Federal Credit Activity, Washington, D.C., April 10 and 11, 1980. Motivation for the research was derived from an earlier study by Commonwealth Research Group, Inc. (CRG), entitled Factors Affecting the Commercialization of Electric and Hybrid Vehicles. This prior work was performed in support of Purdue University's Opportunity and Risk Assessment Project in 1977. This study focuses upon one aspect of the electric and hybrid vehicle commercialization effort--the financial incentives presented to vehicle manufacturers by a federal loan guarantee program.

A number of Commonwealth Research Group's researchers made useful suggestions in the course of the study. These include Dr. Ernest T. Kendall, President of CRG; Ms. Eliana Vilallonga; and Mr. James Bresler. Some very helpful information and insights were provided by Mr. Russell F. Smith of OAO Corporation. Production of the report was capably handled by Mr. Barry D. Waldman of CRG. Opinions expressed in the report are those of the author, who bears sole responsibility for any remaining errors.

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SECTION I. INTRODUCTION

OBJECTIVE OF THE ANALYSIS

The question of whether Congress should authorize a $1.5 billion loan guarantee to rescue the Chrysler Corporation recently received considerable public attention. Like the publicity generated by the $650 million loan guarantee made to Lockheed several years ago, this debate has contributed to the impression that the federal loan guarantee is a "bailout" instrument. While this has been one of its uses, the major role of the loan guarantee in public policy is to encourage new endeavors judged to be in the national interest. For example, the problem of ensuring adequate energy supply has led to the enactment of several loan guarantee programs in the general area of alternative energy technologies. This study examines the problems and probable consequences likely to be encountered in implementing loan guarantee programs aimed at encouraging development of alternative energy technologies, focusing in particular on guarantees to small producers of electric and hybrid vehicles.

The development of a national energy policy has involved many departures from the pre-oil embargo status quo, among them the creation of a single Department of Energy in October 1977. Even before the establishment of this Cabinet-level department, various federal agencies were charged with numerous responsibilities in the fields of energy conservation, research and development, and regulation. One such agency was the Energy Research and Development Administration (ERDA), established by the Energy Reorganization Act of 1974 and merged into the Department of Energy in 1977.

Among the responsibilities placed in ERDA's domain was the first comprehensive statement of federal policy toward several emergent technologies, including solar energy, geothermal energy, alternative fuels, and electric and hybrid vehicles (EHVs). 1/ An important goal of that policy was the stimulation of private sector activity in these innovative, entrepreneurial fields. To that end,

1/ See National Energy Conservation Policy Act, P.L. 95-619; (Continued) loan guarantee programs were established to aid entrepreneurs lacking sufficient capital, or access to capital, to proceed in the development of these energy alternatives.

A high degree of uncertainty has characterized the establishment and administration of these loan guarantee programs. Although there have been similar federal programs for some time--such as the Small Business Administration's loan guarantee program--applications to the alternative energy field have been quite unlike traditional extensions of federal credit. The primary difference is the extremely risky nature of the underlying technology. Whereas many small entrepreneurial efforts may fail due to undercapitalization, inadequate management, or poor judgment of market demand, most are involved with well-developed technologies. In the alternative energy field, the technical feasibility of the product is in many cases unproven; and even many technically feasible products have not yet been shown as economically feasible. Federal credit assistance, in the form of loan guarantees, has been structured to bridge the gap between federal subsidy of research and development and commercial production of alternative energy technologies without federal intervention.

This study analyzes the effects of federal loan guarantees on small, entrepreneurial firms engaged in the research, development, or commercial production of alternative energy products. It focuses upon the loan guarantee program established for electric and hybrid vehicles (EHVs). This is a convenient area of study, as these products are entering the very large, well-defined market for personal and commercial transportation. Like most of the alternative energy fields, the "industry" has been characterized by a large number of extremely small, entrepreneurial firms. The inadequate capitalization of many firms and the unproven nature of advanced technology components have combined to cause a high turnover rate among firms in the industry. High market interest rates and the unstable financial outlook facing most of these firms have made private sources of credit understandably reluctant to extend the needed capital to firms in this field.

1/ (Continued) Geothermal Energy Research, Development, and Demonstration Act of 1974, P.L. 93-410; Federal Nonnuclear Energy Research and Development Act of 1974, as amended by Department of Energy Act of 1978--Civilian Applications, P.L. 95-238; and Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976, P.L. 94-413.

Conceptually, the federal loan guarantee program would seem to offer the solution to this capital shortfall. A major issue, addressed below, is the extent to which guarantees may indeed be expected to provide this solution, and the reasons why they may prove inadequate. Serious questions arise as to the appropriateness of federal credit activity in this context, as an inadequate program may be more damaging to society than no program at all.

OUTLINE OF THE STUDY

The plan of the study is as follows. Background information on the design of the EHV loan guarantee program and some indication of the program's current status is given in Section II. The analytical framework to be utilized in studying a prototypical firm's behavior is introduced in Section III. This framework consists of a detailed financial simulation model of an entrepreneurial manufacturing firm. This model contains a number of underlying assumptions regarding the strength of demand for its product and the nature of its costs. The model is dynamic, based upon annual data over a horizon of 10 to 15 years. Analysis of the firm's behavior may be performed by parametric changes in several factors faced by the firm, including demand and cost conditions and the amount of federally guaranteed credit available.

In Section IV, the particular simulation experiments to be studied are presented in detail. A "most plausible" case, generated using predicted demand and cost parameters and the currently authorized level of loan guarantees, is established as the baseline simulation. Several alternatives are compared, involving alterations in the market demand for the firm's product, the characteristics of cost, and the authorized level of federal credit guarantees. Conclusions drawn from the simulation experiments are discussed in Section V. The likelihood that objectives of the loan guarantee program--including establishment of financially viable entrepreneurial firms--will be achieved is weighed, and some recommendations are given. The overall impact and appropriateness of this form of federal credit in fields similar to EHV development are discussed in the concluding remarks.

SECTION II. APPLICATION OF LOAN GUARANTEES TO ELECTRIC AND HYBRID VEHICLE DEVELOPMENT

HISTORY OF THE ENABLING LEGISLATION

The federal involvement in electric and hybrid vehicle (EHV) development dates from the Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976, Public Law 94-413, passed in September of that year. However, previous proposals to authorize research, development, and demonstration of electric vehicles were introduced during the 89th, 90th, 92nd, and 93rd Congresses. 2/ In its final form, the 1976 Act was the result of considerable Congressional debate. Its mandate for government involvement in a historically private activity resulted in its veto by President Ford. Congressional support for the program was demonstrated by the overriding of the veto, by margins of 307 to 101 in the House of Representatives and 53 to 20 in the Senate. 3/

The original act authorized a federal program of research, development, and demonstration to promote electric vehicle technologies and to demonstrate the commercial feasibility of electric vehicles. Various sections considered the technical aspects of this field, mandating research and development in battery design, vehicle control systems, the development of state-of-the-art data, performance standards, and safety evaluations. The commercialization of EHVs was encouraged by sections of the act authorizing the purchase or lease of electric vehicles and a fairly large-scale demonstration program in the public and private sectors.

Most important for the purposes of this research are the provisions of Sections 9 and 10 of the act. Section 9, "Encouragement and Protection of Small Business," explicitly mandated the accessibility of the EHV program to small businesses. The Administrator of ERDA, the supervising agency, was required "to assure

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2/ U.S. Department of Energy, Electric and Hybrid Vehicle Program Information Bulletin, No. 501 (June 1979), p. 1.

3/ Ibid.

that small business concerns have a realistic and adequate opportunity to participate in the project." 4/ This was stated to imply that "a reasonable portion of the funds made available" 5/ must be reserved for small business set-asides, and that contract terms should not unduly burden small business concerns. To encourage their participation, a program of planning grants was established to aid small businesses in preparing contract proposals. All of these provisions quite clearly indicated the Congressional intent to provide stimulus to the private sector--in particular, the small businesses currently comprising (and expected to comprise) the EHV industry.

The major financial provisions of the act were those developed in Section 10, "Loan Guarantees," which reemphasized participation of small businesses:

> (b) In order to encourage the commercial production of electric and hybrid vehicles, the Administrator is authorized to guarantee principal and interest on loans made by lenders to qualified borrowers, primarily small business concerns . . . (Emphasis added.) 6/

Several legitimate purposes for federal credit assistance were stated in the act, without any indication of priorities. These purposes included research and development, prototype development, construction of related capital equipment, and "initial operating expenses associated with the development and production" of EHVs and components. 7/ The amount of the guarantee was limited to 90 percent of the cost of an activity, the interest rates on loans must have been judged "reasonable," and full repayment within 15 years was required.

Several stipulations were made by the act governing the conditions for loan eligibility. First, the amount of the loan, added to other available capital, must be judged sufficient to carry out the supported activity--that is, without danger of severe

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4/ Electric and Hybrid Vehicle Research, Development and Demonstration Act of 1976, P.L. 94-413, Section 9(b).

5/ Ibid.

6/ Ibid., Section 10(b).

7/ Ibid., Section 10(b)(4).

undercapitalization. This will be a major focus of the analysis presented in Section IV. Second, there must be "reasonable assurance of repayment" by the borrower. 8/ Third, and in contrast to the last point, no loan shall be guaranteed unless "no other reasonable means of financing or refinancing is reasonably available to the applicant." 9/ Limitations on individual guarantees of $3 million per loan were imposed by the act, with the overall limitation of $60 million for the entire program. The extension of guarantees under the act was limited to the five-year period ending September 17, 1981.

Additional conditions prescribing the nature of federal expenditures that might be necessitated were stated by the act. In the case of default, attempts were to be made to recover any federal outlays by attachment of the assets or other surety. At the same time, the administrator of the program was authorized to pay interest charges on behalf of a financially unstable borrower under certain conditions. These conditions included the finding that the project was in the public interest, and that the "probable net cost to the federal government in paying such interest will be less than that which would result in the event of a default." 10/ Therefore, actual expenditures could be made to prevent default under these conditions, or to cover losses resulting from default and less than full recovery of the guaranteed amount.

REVISIONS MADE TO EHV LOAN GUARANTEE PROGRAM

Several structural changes in the administrative environment took place prior to the establishment of the EHV loan guarantee program. First, the Department of Energy was established in October 1977, absorbing the functions of the Energy Research and Development Administration (ERDA), whose administrator originally held responsibility for the EHV program. Second, federal regulations had to be drafted, presented for public comment, and established to govern the administration of the loan guarantee program. Third, before the rulemaking process was complete, major revisions to the 1976 EHV Act were made by amendments contained in Title VI of the Department of Energy Act of 1978--Civilian Applications,

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8/ Ibid., Section 10(d)(4).

9/ Ibid., Section 10(d)(5).

10/ Ibid., Section 10(g)(1)(a).

Public Law 95-238, enacted February 25, 1978. These amendments altered the timing of vehicle procurement and demonstration and increased the total numbers of vehicles to be purchased and/or leased.

Major alterations were also made to the EHV loan guarantee program by these amendments. The authority for direct federal payments to prevent default was extended to permit payments of principal as well as interest, again utilizing the concept of "probable net cost" to the government. 11/ It should be noted that this significantly increased the possible financial exposure of the government. Although such payments in the borrower's behalf are meant to be restricted to cases of clear benefit and low risk, the very risky nature of the technology may make that restriction difficult to apply in practice.

The second major alteration made to the loan guarantee program was the establishment of an Electric and Hybrid Vehicle Development Fund, a trust fund in the U.S. Treasury, to be used by the administrator to finance the loan guarantee and principal and interest assistance program. 12/ The initial payments into the fund were to be made from annual appropriations, with the balance available until expended. If funds proved inadequate, borrowing to the extent specified by appropriations acts was permitted, without fiscal year limitation. The establishment of this trust fund did not free the program from Congressional control. Concern over the Department of Energy's guarantee programs led to a blockage of funds for these programs until fiscal year 1979. Two other significant alterations in the loan guarantee program were the extension of guarantee authority to September 1983; 13/ and the pledging of the "full faith and credit of the United States" 14/ to the payment of the obligations incurred.

11/ Department of Energy Act of 1978--Civilian Applications, P.L. 95-238, Title VI, Section 603(b).

12/ Ibid., Title VI, Section 603(a)(1).

13/ Ibid., Title VI, Section 603(c).

14/ Ibid., Title VI, Section 603(a)(2).

Four months after the amendments to the 1976 act were passed, the final rules for implementing Section 10 of the act were established as Title 10, Part 791, "Electric and Hybrid Vehicle Research, Development, Demonstration and Production Loan Guarantees" of the Code of Federal Regulations. These rules established several priorities and preferences governing the extension of loan guarantees. First priority consideration was given to applications directly related to the "early commercial production of electric and hybrid vehicles or components thereof." 15/ Second priority was given to development of prototype vehicles or components; and third priority was directed to research and development efforts. Thus, the focus on commercialization was made eminently clear. Within these priorities, preferences were given to borrowers footing more than 10 percent of the cost; to lenders accepting less than 100 percent guarantee; to borrowers paying royalties, using the fruits of federal research and development, or designating rights to the government; and, as the last criterion, the identification of the borrower as a small business. The definition of a small business for this program was stated to include primarily domestic firms possessing less than 5 percent share in the passenger car market. The criterion for nonpassenger car vehicle producers was 1,000 or fewer employees; and, for producers of batteries, components, systems, and the like, the criterion was 500 or fewer employees. 16/

Other specific clauses in Part 791 delineated loan guarantee conditions. The repayment term was limited to 15 years or 75 percent of the "expected average useful economic life of the major physical assets," 17/ whichever is the shorter term. Although the guarantee for a single loan was maintained at $3 million, the total amount available to a qualified borrower for separate projects was stated as $6 million. 18/ A specific set of criteria for the filing of applications, indicating the detailed information to be provided to the government, was also stated in the rules established by Part 791.

15/ "Electric and Hybrid Vehicle Research, Development, Demonstration and Production Loan Guarantees: Final Rule," 10 Code of Federal Regulations 791, Section 791.6(a).

16/ 13 Code of Federal Regulations 121.310.

17/ 10 Code of Federal Regulations 791(i).

18/ Ibid., Section 791.9(m).

CURRENT STATUS OF THE PROGRAM

A great deal of bureaucratic activity has surrounded the establishment of the loan guarantee program under the Chief, Demonstration and Incentives Branch, Division of Transportation Programs, in the Office of the Assistant Secretary for Conservation and Solar Energy of the Department of Energy (DOE). The organizational structure of this hierarchy has been in considerable flux since the establishment of DOE; the most recent statement of authority is shown in Figure 1.

Considerable effort has been expended on the drafting and redrafting of the Part 791 regulations. Much of this work was performed in the private sector, under contract to DOE. The private firms involved are also engaged in performing the evaluations of borrowers' applications for loan guarantees. It has been suggested that only 10 to 15 percent of this private activity has been concentrated upon the actual evaluation process; most of the roughly $600,000 expended has gone toward drafting and redrafting of the governing regulations.

The current status of the program, and its progress, has been somewhat disappointing. In August 1979, a DOE report stated:

> The initiation of the EHV Loan Guaranty Program was delayed until passage of an appropriations act in October of 1978. As of July, 1979, ten project summaries, the first step in applying for a loan guaranty, and four formal applications have been received. While no loan guaranty award has been made to date, the response to this program reflects an unusually high degree of interest. 19/

Several roadblocks have appeared in the actual workings of the program. Although no actual expenditures are involved in a guarantee approval, the authority to extend a guarantee does not lie at the program manager level. Although a program manager would generally have fiscal authority over actual expenditures of the guarantee's magnitude, these nonexpenditures must be approved

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19/ U.S. Department of Energy, Office of Transportation Programs, Electric and Hybrid Vehicle Quarterly Report No. 7, (April-May-June 1979) (U.S. Government Printing Office, 1979), p. 3.

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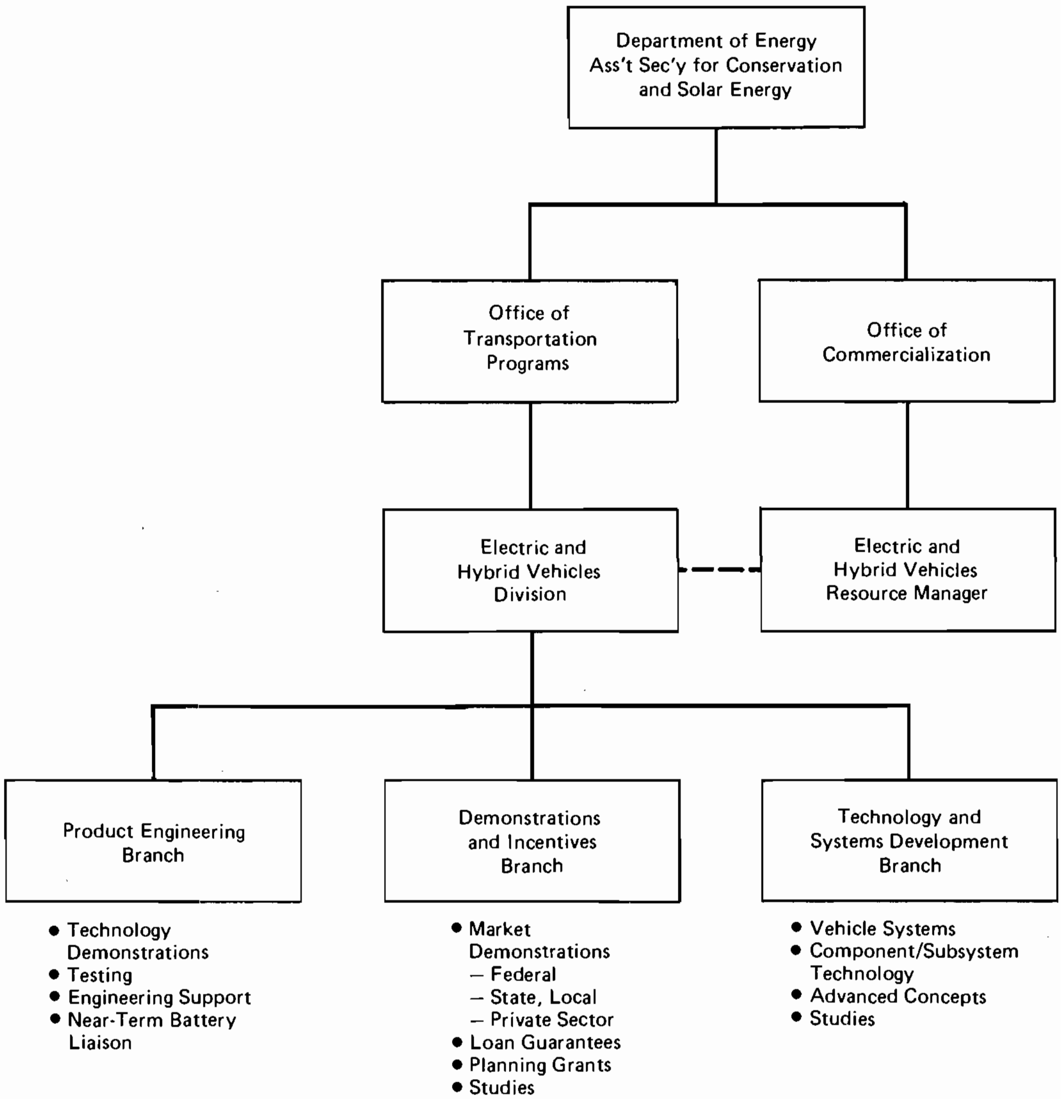
Figure 1.

Electric and Hybrid Vehicle Program Organization



SOURCE: U.S. Department of Energy, Office of Transportation Programs, *Electric and Hybrid Vehicle Quarterly Report No. 7,* April-May-June, 1979 (U.S. Government Printing Office, 1979), p.7.

at the Secretary's level. 20/ The numerous levels of command between the program manager and the Cabinet-level Secretary present a substantial roadblock to timely action.

An even more fundamental obstacle has appeared at the program manager's level. While a loan guarantee application is being evaluated by the project manager, it must also be processed and jointly approved by the Office of General Counsel (GC), the Office of Environment (EV), the Office of the Controller (CR), and the Office of Procurement and Contracts Management (PR). 21/ The numerous points of contact between the project manager's office and these other entities are illustrated in an overall view of the loan guarantee process, shown in Figure 2.

Contacts with the program manager's office have revealed that there is a serious imbalance between the program goals and the attitudes taken by the four other offices responsible for processing. The legal, controller's, and contracts offices do not view themselves as bound by the Congressional mandate to advance EHV activity, and thus to make guarantees in a timely fashion. Rather, they have emerged as bottlenecks, reviewing applications at a leisurely pace. This well-meaning concern for fiscal responsibility appears to be substantially at odds with the overall goals of the EHV Program. Several applicants have been characterized as extremely undercapitalized, and run the risk of bankruptcy before action is taken. Although sound management of the guarantee program might seem to encourage denial of guarantees to such applicants, it must be remembered that applicants must demonstrate lack of access to private credit, and thus are likely to be seemingly poor risks.

At this point, a lending ceiling of roughly $17.5 million has been established; roughly 20 percent of that amount, or $3.5 million, has been paid into the trust fund to cover possible

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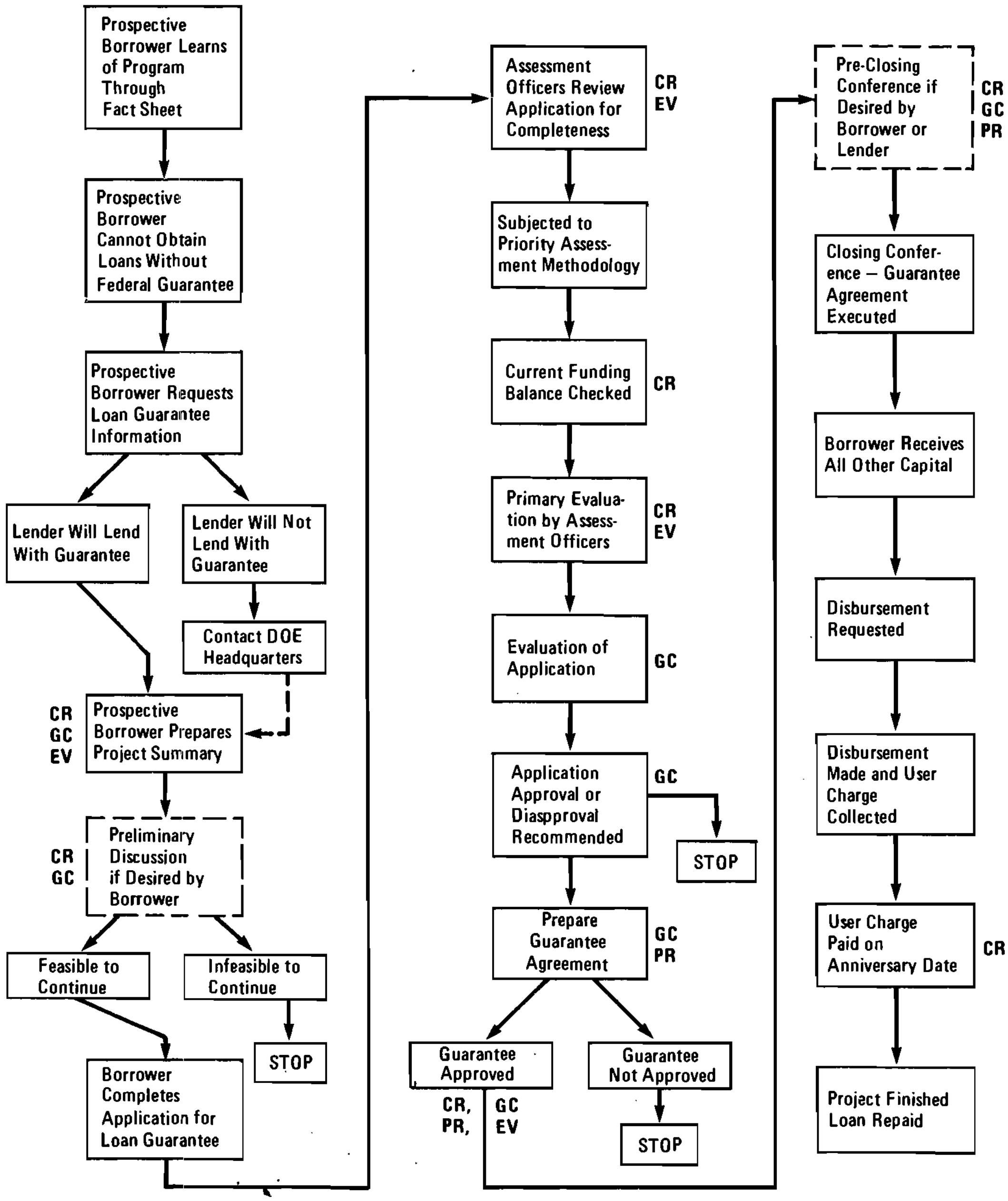
20/ Telephone conversation with Russell F. Smith, Director, Management Advisory Services Division, OAO Corporation, Washington, D.C., January 16, 1980, (202) 466-6335.

21/ Bradford National Corporation, "Internal Procedures Affecting Other DOE Staff: Electric and Hybrid Vehicle Program" (Rockville, Md.), draft report presented to U.S. Department of Energy, pp. 3-5.

Figure 2.

Electric and Hybrid Vehicle Loan Guarantee Processing



SOURCES: Original flowchart from U.S. Department of Energy, Division of Transportation Energy Conservation, Demonstration and Incentives Branch, *Electric and Hybrid Vehicle Loan Guarantee Information Guide,* p. 8.

Acronyms added from Bradford National Corporation, "Internal Procedures Affecting Other DOE Staff: Electric and Hybrid Vehicle Program" (Rockville, Md.; draft report presented to U.S. Department of Energy), pp. 3-5.

NOTES: GC – Office of General Counsel; EV – Office of Environment
CR – Office of the Controller; PR – Office of Procurement and Contracts Management

defaults. 22/ There is some feeling that this 20 percent provision for "bad debts" may not be sufficient. Given the turmoil among EHV producers in the last five years, a much higher payout may be required. At this writing, no loan guarantees have actually been made. Sources close to the program suggest that two guarantees are to be extended, and are in the final evaluation stages. Other applicants have apparently not demonstrated the characteristics of a "qualified" borrower.

Thus, to date, the EHV loan guarantee program has consumed substantial resources and has not provided any direct incentive to EHV commercialization. However, incentives may be provided in the near future to at least two applicants. Issues remaining to be addressed involve the appropriateness of the detailed characteristics of the program--in particular, the level of assistance available. The general model to be used in analyzing those issues will be described in the next section of this study.

SECTION III. THE ENTREPRENEURIAL FIRM MODEL

OVERVIEW OF THE MODEL

This section presents the characteristics of the financial simulation model utilized to analyze the effects of loan guarantees on small entrepreneurs. This model is dynamic in nature and not specific to this study, as it may be used to examine other characteristics of entrepreneurial firms' behavior. The model generates an income statement and balance sheet forecast for any number of periods, with the values of exogenous variables being provided, or forecasted by the user, for each simulation period.

The remainder of this section discusses the general assumptions underlying the entrepreneurial firm model, presents the particular specification used in the analysis of loan guarantees to EHV producers, and considers the techniques to be used in simulation of the model.

22/ Telephone conversation with Russell F. Smith, OAO Corporation, January 16, 1980.

DISCUSSION OF THE UNDERLYING ASSUMPTIONS

The entrepreneurial firm model differs in several ways from financial simulation models of larger firms. It is assumed that the most important characteristic of an entrepreneurial firm is its role as a price-taker in both output and factor markets. This role, coupled with modest size and rapid change in financial condition, serves to define an enterprise with some similarity to the textbook model of perfect competition. Although this resemblance may be tenuous, it is perhaps more reasonable than a parallel to an oligopolistic firm with considerable market power.

Several definitional assumptions illustrate the essential features of the model. First, the firm is assumed to face a constant price for its product. Although the particular characteristics of its product may be unique, that product is assumed to possess numerous gross substitutes. The extent of the market for this category of products is assumed to be sufficient to render the firm's share insignificant. Second, the factors generating demand for the product are assumed to be exogenous. The quantity sold is assumed to vary along the expansion path of the firm; all units produced are sold at the constant price. This expansion path levels off when the quantity produced reaches the capacity constraint for the production facility. This assumption removes the quantity produced from the decision set of the firm; regardless of financial conditions, it is assumed to proceed along its expansion path. The qualifying assumption implicit here is that the firm is always above the shutdown point--that is, that each unit produced is covering average variable costs.

The model is configured to calculate cost categories based upon the level of production. The base materials cost per unit is assumed exogenous, with a declining cost at the margin for larger-volume materials orders. The direct labor cost is designed to reflect discontinuities in the productive technology of the small-volume producer. The labor requirements are assumed to increase discretely as higher production levels are reached and additional workers are added to the production process. Indirect labor costs are calculated as a percentage of direct labor expenses. General, administrative, and sales expenses are calculated as a function of total revenue and the level of sales. Research, development, and engineering expenditures are also assumed to vary with total revenue.

The above assumptions describe most of the firm's income statement categories. Definitions used to describe the firm's financial behavior are outlined below. A number of balance sheet categories are linked directly to total revenue. These include cash assets, investments, accounts receivable, prepaid expense, accounts payable, and accruals. Inventories of materials are assumed to reflect materials costs.

In this study's implementation of the entrepreneurial firm model, the assumptions regarding debt and equity finance are crucial. The tentative and uncertain nature of the entrepreneurial firm is assumed to rule out additional equity finance. The firm has presumably exhausted the venture capital provided at its inception, so that additional cash flow requirements must be debt financed. The model allows specification of an arbitrary credit line of long-term debt--in the case of this study, the amount of federal guaranty available. Once that long-term credit is drawn down, all future financing must be performed with short-term debt. The repayment period for long-term debt is adjustable to reflect the characteristics of the entrepreneurial firm and its market. One financial ratio--the "current ratio"--is calculated within the model to aid in evaluating the firm's financial stability.

SPECIFICATION OF THE MODEL

A number of specific assumptions regarding firms in the infant EHV industry were made to adapt the general entrepreneurial model for this study. The analysis is conducted on an annual basis for 13 years, with the first year representing the start of commercial production. The potential producer is assumed to have a fully developed production prototype vehicle at the outset of the analysis. This implies that substantial expenditures have already been made to design, engineer, and test a prototype. This would also encompass the safety testing and certification required by the National Highway Traffic Safety Administration for compliance with the Federal Motor Vehicle Safety Standards. In the case of a hybrid vehicle (one containing an internal combustion as well as electric power source), emissions and fuel economy testing by the Environmental Protection Agency would also be required.

In the context of most EHV production to date, the design has not been a "from the ground up" task, but has involved only modification of an existing vehicle, such as the Chevette, Pacer, or Rabbit. Assuming that the producer is following this course, the production prototype stage could probably be reached with a $10 million expenditure. The costs for this design, development, and testing of production prototypes are assumed to be treated as current expense items. Thus, the firm has $10 million of capital assets in the form of a certified prototype vehicle, and a $10 million deficit in the retained earnings account. Its net worth at the beginning of the financial simulation is accordingly assumed to be zero dollars.

It should be noted that the venture capital utilized to finance prototype development has not been treated as capital investment, but rather as current expense. This provides favorable tax treatment to the venture capitalists; although some of these funds might have to be capitalized according to tax regulations, most may legitimately be treated as expense items. There is, under this assumption, no carryover from the prototype development period, and the simulation may begin independently of the particular initial conditions of that period.

The specific modeling assumptions implied by this framework are now presented. Since the vehicle producer's units of output are few in number--especially in the early stages of the firm's evolution--there is considerable "lumpiness" in the schedules of quantities sold, labor employed, and capital invested. The assumed demand characteristics are given in Table 1. Some economies of volume purchases are assumed to exist for the vehicle components, reflecting technological improvement as well. The components of materials cost and assumed volume discounts are given in Table 2. Direct labor requirements, including manpower and salary levels, are given in Table 3. The assumptions of materials costs, labor requirements, and vehicle price are based upon recent evaluations of current EHV manufacturers' experience, as well as the characteristics of small-volume conventional automobile producers. General information from these sources was used to evaluate the plant and equipment requirements and capital market factors facing firms of this type. To simplify the discussion, the remaining assumptions made about the entrepreneurial firm's income statement are summarized in Table 4.

In the balance sheet, the most crucial assumptions are those relating to the availability of long-term debt. Although the EHV Act permits a guaranteed loan payback period of 15 years, or 75 percent of the assets' useful life, it is unlikely that lenders would be willing to extend even guaranteed credit for this interval. Several financial institutions involved in the EHV

TABLE 1. QUANTITY SOLD AND PRICE ASSUMPTIONS

Year	Quantity Sold (in Units)	Price (in dollars)
1980	50	7,000
1981	150	7,000
1982	420	7,000
1983	780	7,000
1984	1,500	7,000
1985	2,170	7,000
1986	3,000	7,000
1987	5,000	7,000
1988	5,000	7,000
1989	5,000	7,000
1990	5,000	7,000
1991	5,000	7,000
1992	5,000	7,000

SOURCE: Derived by Commonwealth Research Group, Inc., Boston, Mass.

NOTE: Baseline Case figures in 1977 dollars. This schedule can be varied for each case if desired.

TABLE 2. MATERIALS COST ASSUMPTIONS

Component	Unit Price (in 1977 dollars)
Chassis and Shipping Costs	2,280
Motor	1,200
Controller	1,300
Battery Pack	720
Charger	1,000
Total	6,500

Materials cost per vehicle (MCV) decreases with quantity sold (QS) in the following manner:

If $QS \leq 250$	$MCV = 0.9 \times$ original MCV
If $250 < QS \leq 500$	$MCV = 0.8 \times$ original MCV
If $500 < QS \leq 750$	$MCV = 0.7 \times$ original MCV
If $QS > 750$	$MCV = 0.6 \times$ original MCV

SOURCE: Derived by Commonwealth Research Group, Inc., Boston, Mass.

TABLE 3. DIRECT LABOR ASSUMPTIONS

Quantity Sold (vehicles)	Direct Labor (in dollars)	Assumptions
0-50	12,000	1 factory worker ($12,000/year)
51-150	24,000	2 factory workers ($12,000/year)
151-300	44,000	3 factory workers ($12,000/year) + 1 stockperson ($8,000/year)
301-500	62,000	3 factory workers ($12,000/year) + 1 stockperson ($8,000/year) + 1 supervisor ($18,000/year)
501-1,000	106,000	6 factory workers ($12,000/year) + 2 stockpersons ($8,000/year) + 1 supervisor ($18,000/year)
1,001-5,000	$106 per unit	Same as above

SOURCE: Derived by Commonwealth Research Group, Inc., Boston, Mass.

program have stated that loans of eight years' duration would be the longest term available. Thus, an eight-year payback period was specified for long-term debt.

The second ruling assumption is that of the amount of long-term debt subject to guarantee. The act, as amended, limits individual loans to a $3 million guarantee, and the sum of loans to a firm to a $6 million guarantee level. It is assumed that the latter figure is relevant, and that the entrepreneurial firm is able to acquire a guarantee for at least two projects. This could involve, for example, the guarantee of funds for a commercialization effort, as well as a second guarantee for further prototype research, development, and engineering. Thus, the base simulation utilizes the $6 million figure as the credit line available.

The firm is permitted to draw upon the guaranteed credit to cover cash flow and capital investment requirements. When and if

TABLE 4. INCOME STATEMENT FORECASTING ASSUMPTIONS

Entry	Method of Calculation	Assumptions
Total Revenue	Vehicle selling price x quantity sold	See Table 1
Materials Expense	Materials cost per vehicle x quantity sold	See Table 1 for quantity sold; Table 2 for materials cost
Direct Labor Expense	Varying amount	See Table 3
Warranty Expense	Warranty per vehicle x quantity sold	$200 warranty; see Table 1 for quantity sold
Freight Expense	Freight per vehicle x quantity sold	$200 freight; see Table 1 for quantity sold
General, Administrative, and Sales	Percentage of total revenue that would be derived from particular sales volumes	5 percent; 500 vehicles for the first 4 years; 2,000 for the next 3 years; 4,000 for the last 6 years
Depreciation and Amortization	Percentage of previous year's property, plant, and equipment	5 percent; plant is rented, equipment depreciates over 20 years
Research and Development	Varying amount	$100,000 for the first 5 years; 5 percent of total revenue thereafter
Indirect Labor Expense	Percentage of direct labor	50 percent
Rent and Miscellaneous Overhead	Constant amount	$350,000 ($2 per square foot for a 100,000 square foot plant, $150,000 miscellaneous overhead)
Interest Income	Percentage of previous year's ending cash surplus	6 percent
Interest Expense	Percentage of previous year's long- and short-term debt	12 percent
Income Taxes	Percentage of pretax profit, less carry-forwards and investment tax credit	17 percent of first $25,000; 20 percent of next $25,000; 30 percent of next $25,000; 40 percent of next $25,000; 46 percent of adjusted pretax profit over $100,000
Common Dividends	Percentage of net income	0 percent
Retained Earnings	Retained earnings for the previous year plus net income less common dividends	No assumptions

SOURCE: Derived by Commonwealth Research Group, Inc., Boston, Massachusetts.

the cumulative withdrawals hit the guarantee ceiling, long-term debt is neutralized and is no longer available as a balancing item. Since the repayment schedule begins in the first year of the loan, the amount of long-term debt actually outstanding at year's end may never reach the ceiling. When the limit is reached, all future cash deficits must be covered by the issuance of short-term debt. The financial viability of the firm, and its ability to continue production, is then dependent upon bankers' willingness to extend credit without a federal guarantee. A rule of thumb implemented in the model involves the "current ratio," or ratio of current assets to current liabilties. If this ratio is above 2.0, the firm's ability to obtain short-term debt in times of normal credit availability is likely. If the current ratio is consistently below 2.0 and little profit potential has been demonstrated, the firm's access to short-term funds is doubtful. In the case of a firm in a risky and untested segment of the transportation market, demonstrated financial soundness is likely to be prerequisite to short-term capital availability.

The roles of short-term and long-term debt in the model are assumed to rule out the possibility of additional equity finance. It is considered that the riskiness of the venture would make investors unwilling to advance additional funds to an enterprise that has absorbed $10 million in venture capital in addition to the federally guaranteed long-term funds, and then returned to the credit markets for additional financing. Given the scenario of projected demand, long-range profit forecasts should be favorable, but they are largely contingent upon several uncertain factors. The major uncertainty is the ultimate commercialization of EHVs; more threatening to the firm may be the possibility that a major automobile manufacturer may enter the market if market growth is substantial.

The balancing item in the firm's balance sheet is specified as long-term debt, as available, superseded by short-term debt if the guarantee limit is reached. The balance sheet components thus reflect the firm's requirements, or demand, for short-term funds. The availability of those short-term funds is not considered in the model, but rather should be evaluated when the requirements are viewed in conjunction with net income and the current ratio. To summarize the definitions of balance sheet components, the remaining assumptions made regarding these components are listed briefly in Table 5.

TABLE 5. BALANCE SHEET FORECASTING ASSUMPTIONS

Entry	Method of Calculation	Assumptions
Cash	Fraction of total revenue	Total Revenue/48 (two weeks of revenue)
Investments	Fraction of total revenue	Total Revenue/48 (two weeks of revenue)
Accounts Receivable	Fraction of total revenue	Total Revenue/12 (one month's revenue)
Inventory	Percentage of materials cost	8.33 percent (one month's supply)
Prepaid Expense	Percentage of total revenue	2.9 percent a/
Land, Plant, and Equipment	Capital invested in assets	$2.0 million worth of capital equipment in the first year; $100,000 each year following; an additional $3.0 million invested the first year that quantity sold equals or exceeds 300 units; $250,000 each year following.
Accumulated Depreciation (AD)	Previous year's AD plus this year's depreciation	Not applicable
Accounts Payable	Percentage of total revenue	8.33 percent (one month's revenue)
Short-Term Debt (STD)	Difference between total assets and total known liabilities	See Long-Term Debt
Current Maturity Long-Term Debt	Principal due on loans	8-year repayment period on loan
Taxes Payable	Percentage of income tax	50 percent a/
Accruals	Percentage of total revenue	6.8 percent a/
Long-Term Debt (LTD)	Previous year's LTD less current maturity LTD plus new LTD	Once the loan guarantee is used up, further debt accrues in STD.
Paid in Capital	Fixed amount	$10,000,000
Net Working Capital	Total current assets less total current liabilities	Not applicable
Current Ratio	Total current assets as a fraction of total current liabilities	Not applicable

SOURCE: Derived by Commonwealth Research Group, Inc., Boston, Massachusetts.

a/ Reflecting typical internal combustion engine (ICV) vehicle manufacturers' experience.

EXPERIMENTAL TECHNIQUES USED IN MODEL SIMULATION

This section briefly outlines the experimental techniques used in specifying and operating the entrepreneurial firm model. The assumptions discussed above have been explicitly stated in equation form, with each variable to be determined within the model appearing on the left-hand side of one equation. The current implementation of the model contains 49 such equations and corresponding endogenous variables.

Each equation of the model expresses its endogenous or left-hand variable as a function of parameters, other endogenous variables, exogenous variables, predetermined variables, and decision rules. Parameters serve to express the numerical relation between left-hand and right-hand variables; for instance, accounts payable are assumed to represent one month's revenue, or 0.0833 of revenue. Revenue in this case is an endogenous variable appearing on the right-hand side of the equation. Exogenous variables in the model include the vehicle price, the schedule of quantities sold, the base materials cost, and the limit on guaranteed debt. Each may be independently manipulated to judge its effects upon the model's solution. Predetermined variables refer to prior values of endogenous or exogenous variables; for instance, depreciation is based upon the prior year's property. Decision rules are heavily utilized in this model; for instance, direct labor is not a linear function of quantity sold, but rather is a step function depending upon several key production levels.

The model is then solved for the simultaneous determination of all the variables pertaining to the first year of the simulation range. The method used is the Gauss-Seidel solution algorithm, in which multiple evaluations of the set of equations are made until convergence is achieved. This technique allows the equations to be nonlinear, or even discontinuous, permitting use of step functions. Although convergence is not guaranteed, the entrepreneurial firm model has shown no signs of instability over a wide range of inputs.

Following convergence for the first year, the solutions become the starting values for the next year's solution, and the process is repeated. The entrepreneurial firm model as implemented for this study has a maximum lag of one year, so that the dynamics of the model are quite tractable. After the solution has been calculated for each year in the simulation range, the results are presented as a balance sheet and income statement for the particular case. Alternative simulations are readily performed by modifying one of the exogenous variables and comparing the resultant solution to the baseline solution. This comparison will quantify the effect of modifying the exogenous variable upon the characteristics of the baseline. The next section presents the results of simulation experiments performed with the entrepreneurial firm model for EHV producers.

SECTION IV. ANALYSIS OF THE EHV LOAN GUARANTEE PROGRAM

OVERVIEW OF SIMULATION EXPERIMENTS

In this section, the simulation experiments performed with the entrepreneurial firm model are presented and analyzed in detail. This analysis consists of an examination of the baseline simulation, in which all exogenous variables take on their most reasonable values, as presented in the previous section. That set of results then serves as a benchmark against which a number of alternatives are compared. The first set of alternatives is designed to examine the model's sensitivity to the economic factors facing the entrepreneurial firm. The strength of market demand for EHVs is proxied by increases in the price at which vehicles are sold. This alteration is a reasonable way to model an increase in public preference for EHVs, as might arise in the case of gasoline shortages and/or marked gasoline price increases. A second alternative case involves a higher base materials cost for the EHV components. This could arise in a number of ways, including cost overruns in battery production, currently the EHV program's stumbling block; slower commercialization of the EHV, postponing or preventing economies of large-scale production; or the imposition of additional federal safety standards involving strengthening of body, chassis, and battery containment structures. This type of alternative focuses on the current EHV producers' role as largely assemblers of components, who are thus extremely sensitive to external cost increases.

The second set of alternatives to be examined focuses upon the effects of the federal loan guarantee magnitude on the entrepreneurial firm's financial outlook. Two alternatives are considered. First, the possibility that the program managers will effectively limit firms to a single $3 million guarantee, despite the regulations permitting $6 million per borrower. Second, the effects of increasing the maximum guarantee above $6 million per borrower are examined. The limit is increased until no short-term debt is required to cover current cash flow needs.

The third set of alternatives considers the possibility that the most appropriate form of federal involvement may not be through the loan guarantee, but rather may involve a purchase guarantee or price support. In this case, no long-term debt is available, and the cash flow deficit indicates the magnitude of the requisite subsidy.

BASELINE SIMULATION RESULTS

The baseline simulation presents a dynamic realization of the assumption presented in the last chapter. Vehicle price is set at \$7,000 per unit, with the base materials cost set at \$6,500 per unit. The limit on the federal loan guarantee is set at \$6 million. The income statement and balance sheet of the entrepreneurial firm are then projected for 1980 through 1992 on an annual basis. These results are shown in Tables 6 and 7.

The income statement illustrates that a loss is projected for the first three years, reaching a maximum of \$963,000 in 1981. Examination of the balance sheet reveals that substantial long-term debt is required immediately to cover cash flow requirements. The guaranteed loan is drawn down by \$2.631 million in the first year of operation; within three years, the credit line of \$6 million has been exhausted. In 1982, the third year, \$1.615 million in short-term debt is required to finance the \$3 million capital expenditure mandated by production volume.

The requirement for additional working capital is somewhat short-lived, as short-term debt is only required for the three years 1982-1984. After that point, net income is sufficient to cover cash flow. In 1985-1986, "carry-forwards" generated by losses and investment tax credits substantially reduce corporate taxes. The likelihood that these three lean years will be successfully weathered is low, given the firm's financial condition. The firm's current ratio for the baseline simulation is illustrated in Figure 3, with the horizontal line corresponding to the 2.0 criterion. In 1982, when the firm must raise \$1.615 million in short-term debt, it has been in business for three years without showing a return. Modest profits in the years to come are contingent upon the availability of adequate financing, and the interest expense associated with that additional financing will be substantial in comparison to gross profit. The current ratio in 1982 is 0.25, and has been steadily declining from the first year's 1.48. Although modest improvement is projected for 1983-1984, the substantial short-term debt will hold the current ratio below 0.6. Even the excess cash on hand in 1985-1992--reflected as negative short-term debt--will not bring the current ratio above 2.0 until 1988. This is caused by large debt service expenditures for the

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TABLE 6. BASELINE INCOME STATEMENT (By calendar year, in thousands of dollars)

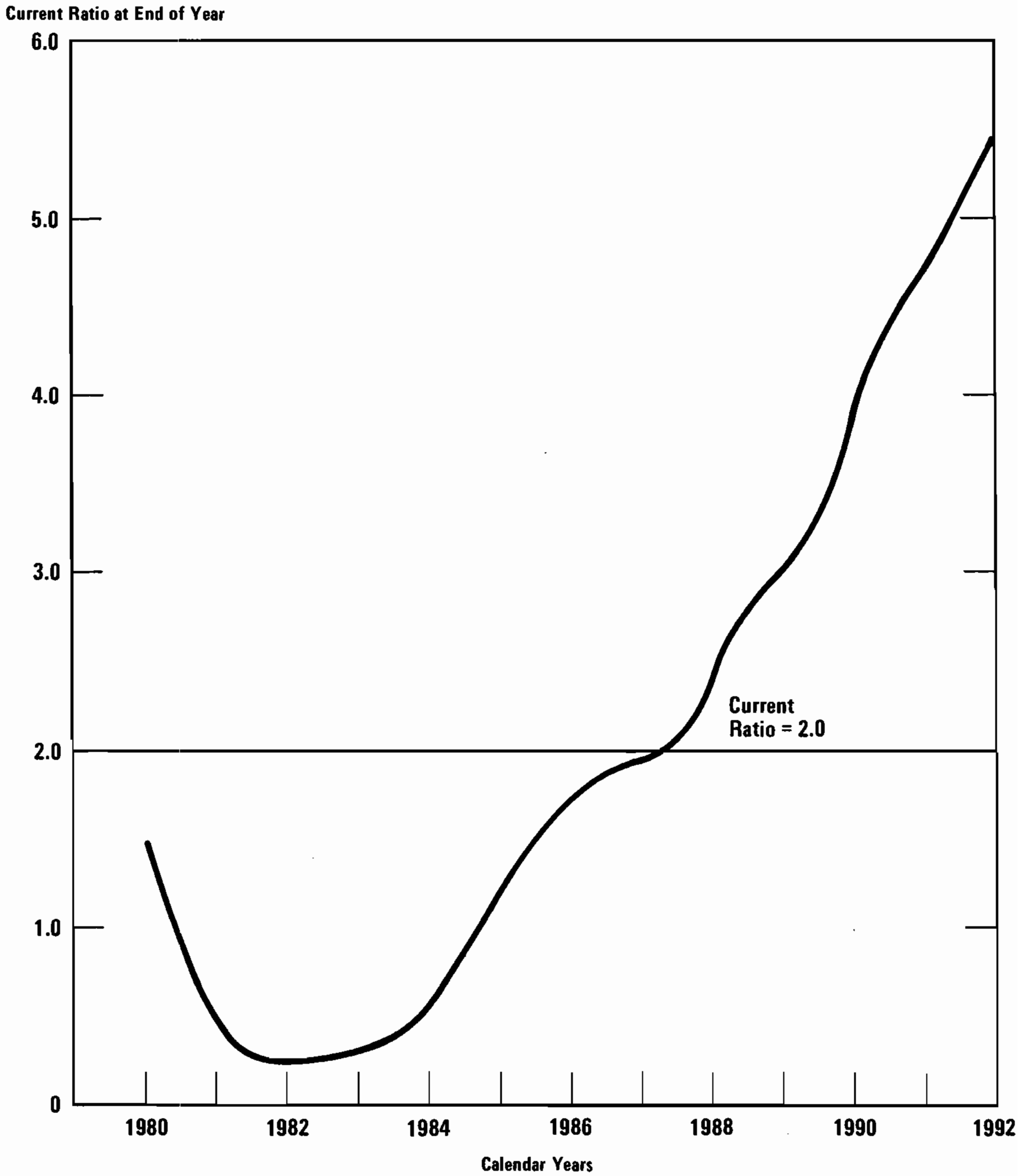
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Total Revenue	350	1050	2940	5460	10500	15190	21000	35000	35000	35000	35000	35000	35000
Costs													
Variable costs													
Materials expense	292	877	2184	3042	5850	8463	11700	19500	19500	19500	19500	19500	19500
Direct labor expense	12	24	62	106	159	230	318	530	530	530	530	530	530
Warranty expense	10	30	84	156	300	434	600	1000	1000	1000	1000	1000	1000
Freight expense	10	30	84	156	300	434	600	1000	1000	1000	1000	1000	1000
Fixed costs													
General, admin. & sales	175	175	175	175	700	700	700	1400	1400	1400	1400	1400	1400
Depreciation & amort.	100	100	105	255	267	280	292	305	317	330	342	355	367
Research & development	100	100	100	100	100	759	1050	1750	1750	1750	1750	1750	1750
Indirect labor expense	6	12	31	53	79	115	159	265	265	265	265	265	265
Rent and misc. overhead	350	350	350	350	350	350	350	350	350	350	350	350	350
Total costs	1055	1698	3175	4393	8106	11766	15769	26100	26112	26125	26137	26150	26162
Gross Profit	-705	-648	-234	1067	2394	3424	5230	8900	8887	8875	8862	8850	8837
Interest income	0	0	1	4	7	13	19	26	44	44	44	44	44
Interest expense	0	316	398	820	763	594	277	-197	-872	-1537	-2241	-2911	-3710
Pretax profit	-705	-963	-631	251	1638	2844	4973	9124	9804	10457	11148	11806	12592
Income taxes	0	0	0	0	0	0	1553	4172	4485	4785	5103	5406	5767
Net Income	-705	-963	-631	251	1638	2844	3419	4952	5319	5672	6045	6400	6825
Common Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Retained Earnings	-10705	-11668	-12300	-12049	-10411	-7567	-4148	803	6122	11794	17839	24239	31064

TABLE 7. BASELINE BALANCE SHEET (End of calendar year, in thousands of dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Assets													
Current assets													
Cash	7	22	61	114	219	316	437	729	729	729	729	729	729
Investments	7	22	61	114	219	316	437	729	729	729	729	729	729
Accounts receivable	29	87	245	455	875	1266	1750	2917	2917	2917	2917	2917	2917
Inventory	24	73	182	253	487	705	975	1624	1624	1624	1624	1624	1624
Prepaid expense	10	30	85	158	304	440	609	1015	1015	1015	1015	1015	1015
Total current assets	78	235	635	1094	2104	3044	4209	7014	7014	7014	7014	7014	7014
Property													
Land, plant & equipment	2000	2100	5100	5350	5600	5850	6100	6350	6600	6850	7100	7350	7600
Accum. depreciation	100	200	305	560	827	1107	1400	1705	2022	2352	2695	3050	3417
Net property	1900	1900	4795	4790	4772	4742	4700	4645	4577	4497	4405	4300	4182
Total assets	1978	2135	5430	5884	6877	7787	8909	11659	11592	11512	11419	11314	11197
Liabilities and Equity													
Current liabilities													
Accounts payable	29	87	245	455	875	1265	1749	2915	2915	2915	2915	2915	2915
Short-term debt	0	0	1615	1892	1235	-658	-3861	-8739	-13533	-18684	-24266	-30922	-38045
Curr. mat. L-T debt	0	329	456	750	750	750	750	750	750	715	0	0	0
Taxes payable	0	0	0	0	0	0	777	2086	2242	2393	2552	2703	2884
Accruals	24	71	200	371	714	1033	1428	2380	2380	2380	2380	2380	2380
Total current liabilities	53	488	2515	3469	3573	2390	842	-608	-5245	-10281	-16419	-22924	-29866
Long-term debt	2631	3316	5215	4465	3715	2965	2215	1465	715	0	0	0	0
Total Liabilities	2684	3804	7731	7934	7289	5355	3058	857	-4529	-10281	-16419	-22924	-29866
Net worth													
Paid in capital	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Retained earnings	-10705	-11668	-12300	-12049	-10411	-7567	-4148	803	6122	11794	17839	24239	31064
Total net worth	-705	-1668	-2300	-2049	-411	2432	5851	10803	16122	21794	27839	34239	41064
Total Liabilities and Equity	1978	2135	5430	5884	6877	7787	8909	11659	11592	11512	11419	11314	11197
Notes													
Capital expenditures	2000	100	3000	250	250	250	250	250	250	250	250	250	250
Investment tax credit	200	10	300	25	25	25	25	25	25	25	25	25	25
Long-term debt repayment	0	0	329	456	750	750	750	750	750	750	715	0	0
Net working capital	25	-252	-1879	-2373	-1468	655	3366	7623	12260	17296	23434	29939	36881
Credit line utilized	2631	3645	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
Current ratio	1	0	0	0	1	1	2	2	2	3	4	5	5

Figure 3.

Current Ratio of the Entrepreneurial Firm—Baseline Simulation



SOURCE: Table 7.

long-term obligations, as well as substantial tax burdens after the carry-forwards are exhausted.

The baseline simulation thus illustrates an unlikely scenario: an entrepeneurial firm in an extremely risky, high-technology field is unlikely to meet its cash flow requirements through short-term debt issuance. The forecasted financial conditions are therefore misleading, as they are wholly conditional upon the availability of adequate debt. The firm in this situation would be severely hard-pressed, and would not be able to continue operations as projected. Its existence, and its ability to repay the $6 million federally guaranteed loan, would be imperiled. In the case of default, the Department of Energy would be obligated to repay the lender in full, and would then attempt to recover the guaranteed amount through bankruptcy proceedings. Alternatively, the Department of Energy could prevent technical default by paying principal and interest on the borrower's behalf. In either case, substantial likelihood of federal expenditure would result. The baseline simulation thus projects a "most likely" set of results which would involve either financial collapse of the entrepreneurial firm or bailout by federal action. Neither alternative is particularly attractive as the outcome of a federal guaranteed loan program.

EFFECTS OF DIFFERENT DEMAND AND COST CONDITIONS

The sensitivity of the baseline simulation's results to the underlying assumptions is examined in this section. There is considerable uncertainty at the present time about the probable cost of EHV technology, as well as the strength of demand for an alternative to the petroleum-powered vehicle. Therefore, two alternative simulations were performed to consider the effects of higher vehicle prices. Two additional simulations examine the efects of higher materials costs, given a constant vehicle price.

In the simulations performed with higher vehicle prices, the effects may be considered wholly demand effects. Sufficient demand for EHVs is presumed to exist to sell the assumed quantities at a factory price of $8,000 or, alternatively, $9,000, rather than the baseline price of $7,000. The base materials cost is assumed constant. A number of cost factors are driven by total revenue--among them general, administrative, and selling expenses; research and development costs; and accounts payable. Nevertheless, the impact of the higher vehicle price should primarily appear as an increased margin, and thus an increased profit potential.

The results for these two demand alternative simulations are given in Tables 8 and 9 for the $8,000 vehicle price (Case A) and Tables 10 and 11 for the $9,000 vehicle price (Case B). These results show the net income potential improving with higher vehicle prices: 1982 net income is -$631,000 in the baseline simulation, -$218,000 in Case A, and $195,000 in Case B. However, on the financial side, all three cases project the exhaustion of the $6 million federally guaranteed loan by 1982. In Case A, two years of short-term credit are needed to bridge the cash flow gap, with 1982 requirements totalling $1.046 million. The current ratio at that point is 0.35. In Case B, short-term debt is only needed in 1982, when $478,000 is required. The current ratio for that case is 0.52. These cases demonstrate that a sufficiently high selling price could reduce debt requirements to a reasonably acceptable level, given the assumption that materials costs could be held down. The recent history of the industry has suggested just the opposite--that pricing will be wholly cost determined, and that the ultimate commercialization of EHVs may be contingent upon technological breakthroughs in components.

To gauge the impact of cost components on the profit equation, two simulations were performed in which the base materials cost was increased. The baseline simulation's base materials cost figure was $6,500, to which quantity discounts were applied on a sliding scale. Under the alternative cost assumptions, base materials cost was assumed to be $6,750 (Case C) and $7,000 (Case D). In both these cases, the original baseline vehicle price of $7,000 was assumed. These alternatives thus consider the situation of a firm squeezed between consumers unwilling to pay a premium for EHV technology and the high costs of that emerging technology. The Case C results are given in Tables 12 and 13, with the Case D results in Tables 14 and 15.

The results for these two cost alternative simulations predictably illustrate a worsening of profit potential. In Case D, the $7,000 base materials cost causes negative net income to result through 1983, with a $15,000 loss recorded in that year. In both cases, the $6 million federal guarantee is drawn down in 1982. The initial short-term debt needed rises from the baseline figure of $1.615 million to $1.759 million in Case C and to $1.904 million in Case D. In the baseline simulation, short-term debt is required in the years 1982-1984; in these more pessimistic cases, additional debt is required through 1985. Debt needs peak at $2.180 million in Case C, and $2.467 million in Case D--with a current ratio of 0.28. These higher materials cost alternatives thus illustrate the firm's sensitivity to cost conditions.

TABLE 8. CASE A INCOME STATEMENT (By calendar year, in thousands of dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Total Revenue	400	1200	3360	6240	12000	17360	24000	40000	40000	40000	40000	40000	40000
Costs													
Variable costs													
Materials expense	292	877	2184	3042	5850	8463	11700	19500	19500	19500	19500	19500	19500
Direct labor expense	12	24	62	106	159	230	318	530	530	530	530	530	530
Warranty expense	10	30	84	156	300	434	600	1000	1000	1000	1000	1000	1000
Freight expense	10	30	84	156	300	434	600	1000	1000	1000	1000	1000	1000
Fixed costs													
General, admin. & sales	200	200	200	200	800	800	800	1600	1600	1600	1600	1600	1600
Depreciation & amort.	100	100	105	255	267	280	292	305	317	330	342	355	367
Research & development	100	100	100	100	100	868	1200	2000	2000	2000	2000	2000	2000
Indirect labor expense	6	12	31	53	79	115	159	265	265	265	265	265	265
Rent and misc. overhead	350	350	350	350	350	350	350	350	350	350	350	350	350
Total costs	1080	1723	3200	4418	8206	11974	16019	26550	26562	26575	26587	26600	26612
Gross Profit	-680	-523	160	1822	3794	5386	7980	13450	13437	13425	13412	13400	13387
Interest income	0	0	1	4	8	15	22	30	50	50	50	50	50
Interest expense	0	313	380	754	597	240	-233	-845	-1867	-2902	-4003	-5090	-6337
Pretax profit	-680	-835	-218	1072	3205	5161	8236	14326	15356	16378	17466	18541	19775
Income taxes	0	0	0	0	0	2022	3764	6565	7039	7509	8009	8504	9072
Net Income	-680	-835	-218	1072	3205	3139	4472	7761	8317	8869	9457	10037	10704
Common Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Retained Earnings	-10680	-11515	-11734	-10662	-7457	-4317	154	7915	16232	25101	34558	44595	55299

TABLE 9. CASE A BALANCE SHEET (End of calendar year, in thousands of dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Assets													
Current assets													
Cash	8	25	70	130	250	362	500	833	833	833	833	833	833
Investments	8	25	70	130	250	362	500	833	833	833	833	833	833
Accounts receivable	33	100	280	520	1000	1447	2000	3333	3333	3333	3333	3333	3333
Inventory	24	73	182	253	487	705	975	1624	1624	1624	1624	1624	1624
Prepaid expense	12	35	97	181	348	503	696	1160	1160	1160	1160	1160	1160
Total current assets	86	258	699	1214	2335	3378	4671	7784	7784	7784	7784	7784	7784
Property													
Land, plant & equipment	2000	2100	5100	5350	5600	5850	6100	6350	6600	6850	7100	7350	7600
Accum. depreciation	100	200	305	560	827	1107	1400	1705	2022	2352	2695	3050	3417
Net property	1900	1900	4795	4790	4772	4742	4700	4645	4577	4497	4405	4300	4182
Total assets	1986	2158	5494	6004	7108	8121	9371	12429	12362	12282	12189	12084	11967
Liabilities and Equity													
Current liabilities													
Accounts payable	33	100	280	520	1000	1446	1999	3332	3332	3332	3332	3332	3332
Short-term debt	0	0	1046	485	-1737	-4935	-9283	-17057	-24928	-33362	-42424	-52814	-63919
Curr. mat. L-T debt	0	326	437	750	750	750	750	750	750	738	0	0	0
Taxes payable	0	0	0	0	0	1011	1882	3282	3519	3754	4005	4252	4536
Accruals	27	82	228	424	816	1180	1632	2720	2720	2720	2720	2720	2720
Total current liabilities	61	507	1991	2179	828	-547	-3020	-6972	-14607	-22818	-32367	-42510	-53331
Long-term debt	2606	3167	5238	4488	3738	2988	2238	1488	738	0	0	0	0
Total liabilities	2666	3674	7229	6667	4565	2439	-782	-5485	-13869	-22818	-32367	-42510	-53331
Net worth													
Paid in capital	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Retained earnings	-10680	-11515	-11734	-10662	-7457	-4317	154	7915	16232	25101	34558	44595	55299
Total net worth	-680	-1515	-1734	-662	2542	5682	10154	17915	26232	35101	44558	54595	65299
Total Liabilities and Equity	1986	2158	5494	6004	7108	8121	9371	12429	12362	12282	12189	12084	11967
Notes													
Capital expenditures	2000	100	3000	250	250	250	250	250	250	250	250	250	250
Investment tax credit	200	10	300	25	25	25	25	25	25	25	25	25	25
Long-term debt repayment	0	0	326	437	750	750	750	750	750	750	738	0	0
Net working capital	25	-248	-1291	-964	1508	3927	7692	14758	22392	30604	40153	50295	61116
Credit line utilized	2606	3493	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
Current ratio	1	0	0	1	2	2	2	2	3	4	5	6	7

TABLE 10. CASE B INCOME STATEMENT (By calendar year, in thousands of dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Total Revenue	450	1350	3780	7020	13500	19530	27000	45000	45000	45000	45000	45000	45000
Costs													
Variable costs													
Materials expense	292	877	2184	3042	5850	8463	11700	19500	19500	19500	19500	19500	19500
Direct labor expense	12	24	62	106	159	230	318	530	530	530	530	530	530
Warranty expense	10	30	84	156	300	434	600	1000	1000	1000	1000	1000	1000
Freight expense	10	30	84	156	300	434	600	1000	1000	1000	1000	1000	1000
Fixed costs													
General, admin. & sales	225	225	225	225	900	900	900	1800	1800	1800	1800	1800	1800
Depreciation & amort.	100	100	105	255	267	280	292	305	317	330	342	355	367
Research & development	100	100	100	100	100	976	1350	2250	2250	2250	2250	2250	2250
Indirect labor expense	6	12	31	53	79	115	159	265	265	265	265	265	265
Rent and misc. overhead	350	350	350	350	350	350	350	350	350	350	350	350	350
Total costs	1105	1748	3225	4443	8306	12183	16269	27000	27012	27025	27037	27050	27062
Gross Profit	-655	-398	555	2577	5194	7347	10730	18000	17987	17975	17962	17950	17937
Interest income	0	1	2	5	9	17	24	34	56	56	56	56	56
Interest expense	0	310	362	689	431	-39	-626	-1447	-2859	-4264	-5760	-7267	-8960
Pretax profit	-655	-707	195	1893	4772	7404	11382	19482	20904	22296	23779	25274	26955
Income taxes	0	0	0	0	1232	3381	5211	8937	9591	10231	10913	11601	12374
Net Income	-655	-707	195	1893	3540	4023	6171	10545	11313	12065	12866	13673	14581
Common Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Retained Earnings	-10655	-11362	-11168	-9274	-5735	-1711	4459	15004	26317	38382	51248	64921	79501

TABLE 11. CASE B BALANCE SHEET (End of calendar year, in thousands of dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Assets													
Current assets													
Cash	9	28	79	146	281	407	562	937	937	937	937	937	937
Investments	9	28	79	146	281	407	562	937	937	937	937	937	937
Accounts receivable	37	112	315	585	1125	1627	2250	3750	3750	3750	3750	3750	3750
Inventory	24	73	182	253	487	705	975	1624	1624	1624	1624	1624	1624
Prepaid expense	13	39	110	204	391	566	783	1305	1305	1305	1305	1305	1305
Total current assets	94	281	764	1334	2566	3713	5133	8554	8554	8554	8554	8554	8554
Property													
Land, plant & equipment	2000	2100	5100	5350	5600	5850	6100	6350	6600	6850	7100	7350	7600
Accum. depreciation	100	200	305	560	827	1107	1400	1705	2022	2352	2695	3050	3417
Net property	1900	1900	4795	4790	4772	4742	4700	4645	4577	4497	4405	4300	4182
Total assets	1994	2181	5559	6124	7339	8455	9833	13199	13132	13052	12959	12854	12737
Liabilities and Equity													
Current liabilities													
Accounts payable	37	112	315	585	1125	1627	2249	3748	3748	3748	3748	3748	3748
Short-term debt	0	0	478	-921	-4093	-8237	-14326	-25341	-36298	-48013	-60563	-74675	-89759
Curr. mat. L-T debt	0	323	417	750	750	750	750	750	750	750	10	0	0
Taxes payable	0	0	0	0	616	1691	2605	4468	4795	5116	5457	5800	6187
Accruals	31	92	257	477	918	1328	1836	3060	3060	3060	3060	3060	3060
Total current liabilities	68	527	1468	890	-684	-2842	-6886	-13314	-23944	-35339	-48288	-62066	-76764
Long-term debt	2581	3017	5260	4510	3760	3010	2260	1510	760	10	0	0	0
Total liabilities	2649	3544	6728	5400	3074	167	-4626	-11804	-23185	-35329	-48288	-62066	-76764
Net worth													
Paid in capital	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Retained earnings	-10655	-11362	-11168	-9274	-5735	-1711	4459	15004	26317	38382	51248	64921	79501
Total net worth	-655	-1362	-1168	725	4264	8288	14459	25004	36317	48382	61248	74921	89501
Total Liabilities and Equity	1994	2181	5559	6124	7339	8455	9833	13199	13132	13052	12959	12854	12737
Notes													
Capital expenditures	2000	100	3000	250	250	250	250	250	250	250	250	250	250
Investment tax credit	200	10	300	25	25	25	25	25	25	25	25	25	25
Long-term debt repayment	0	0	323	417	750	750	750	750	750	750	750	10	0
Net working capital	26	-245	-703	444	3252	6555	12019	21869	32500	43895	56843	70621	85319
Credit line utilized	2581	3340	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
Current ratio	1	1	1	1	2	2	3	3	4	4	6	7	8

TABLE 12. CASE C INCOME STATEMENT (By calendar year, in thousands of dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Total Revenue	350	1050	2940	5460	10500	15190	21000	35000	35000	35000	35000	35000	35000
Costs													
Variable costs													
Materials expense	304	911	2268	3159	6075	8788	12150	20250	20250	20250	20250	20250	20250
Direct labor expense	12	24	62	106	159	230	318	530	530	530	530	530	530
Warranty expense	10	30	84	156	300	434	600	1000	1000	1000	1000	1000	1000
Freight expense	10	30	84	156	300	434	600	1000	1000	1000	1000	1000	1000
Fixed costs													
General, admin. & sales	175	175	175	175	700	700	700	1400	1400	1400	1400	1400	1400
Depreciation & amort.	100	100	105	255	267	280	292	305	317	330	342	355	367
Research & development	100	100	100	100	100	759	1050	1750	1750	1750	1750	1750	1750
Indirect labor expense	6	12	31	53	79	115	159	265	265	265	265	265	265
Rent and misc. overhead	350	350	350	350	350	350	350	350	350	350	350	350	350
Total costs	1067	1732	3259	4510	8331	12091	16219	26850	26862	26875	26887	26900	26912
Gross Profit	-716	-681	-318	950	2169	3099	4780	8150	8137	8125	8112	8100	8087
Interest income	0	0	1	4	7	13	19	26	44	44	44	44	44
Interest expense	0	317	404	836	796	660	390	-59	-695	-1299	-1937	-2537	-3261
Pretax profit	-716	-998	-720	118	1379	2452	4409	8237	8877	9469	10094	10682	11394
Income taxes	0	0	0	0	0	0	798	3764	4059	4331	4618	4889	5216
Net Income	-716	-998	-720	118	1379	2452	3611	4473	4819	5138	5476	5793	6177
Common Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Retained Earnings	-10716	-11715	-12436	-12318	-10939	-8487	-4875	-403	4415	9554	15029	20823	27000

TABLE 13. CASE C BALANCE SHEET (End of calendar year, in thousands of dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Assets													
Current assets													
Cash	7	22	61	114	219	316	437	729	729	729	729	729	729
Investments	7	22	61	114	219	316	437	729	729	729	729	729	729
Accounts receivable	29	87	245	455	875	1266	1750	2917	2917	2917	2917	2917	2917
Inventory	25	76	189	263	506	732	1012	1687	1687	1687	1687	1687	1687
Prepaid expense	10	30	85	158	304	440	609	1015	1015	1015	1015	1015	1015
Total current assets	79	238	642	1104	2123	3071	4246	7077	7077	7077	7077	7077	7077
Property													
Land, plant & equipment	2000	2100	5100	5350	5600	5850	6100	6350	6600	6850	7100	7350	7600
Accum. depreciation	100	200	305	560	827	1107	1400	1705	2022	2352	2695	3050	3417
Net property	1900	1900	4795	4790	4772	4742	4700	4645	4577	4497	4405	4300	4182
Total assets	1979	2138	5437	5894	6896	7814	8946	11722	11654	11574	11482	11377	11259
Liabilities and Equity													
Current liabilities													
Accounts payable	29	87	245	455	875	1265	1749	2915	2915	2915	2915	2915	2915
Short-term debt	0	0	1759	2180	1789	295	-2711	-7259	-11543	-16147	-21151	-27185	-33643
Curr. mat. L-T debt	0	330	462	750	750	750	750	750	750	708	0	0	0
Taxes payable	0	0	0	0	0	0	399	1882	2029	2165	2309	2444	2608
Accruals	24	71	200	371	714	1033	1428	2380	2380	2380	2380	2380	2380
Total current liabilities	53	489	2666	3756	4128	3344	1615	668	-3468	-7978	-13546	-19445	-25740
Long-term debt	2643	3364	5208	4458	3708	2958	2208	1458	708	0	0	0	0
Total liabilities	2696	3853	7874	8213	7836	6302	3822	2125	-2760	-7978	-13546	-19445	-25740
Net worth													
Paid in capital	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Retained earnings	-10716	-11715	-12436	-12318	-10939	-8487	-4875	-403	4415	9554	15029	20823	27000
Total net worth	-716	-1715	-2436	-2318	-939	1512	5124	9596	14415	19554	25029	30823	37000
Total Liabilities and Equity	1979	2138	5437	5894	6896	7814	8946	11722	11654	11574	11482	11377	11259
Notes													
Capital expenditures	2000	100	3000	250	250	250	250	250	250	250	250	250	250
Investment tax credit	200	10	300	25	25	25	25	25	25	25	25	25	25
Long-term debt repayment	0	0	330	462	750	750	750	750	750	750	708	0	0
Net working capital	26	-251	-2023	-2651	-2004	-271	2631	6409	10546	15056	20624	26523	32818
Credit line utilized	2643	3694	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
Current ratio	1	0	0	0	1	1	2	2	2	3	4	4	5

TABLE 14. CASE D INCOME STATEMENT (By calendar year, in thousands of dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Total Revenue	350	1050	2940	5460	10500	15190	21000	35000	35000	35000	35000	35000	35000
Costs													
Variable costs													
Materials expense	315	945	2352	3276	6300	9114	12600	21000	21000	21000	21000	21000	21000
Direct labor expense	12	24	62	106	159	230	318	530	530	530	530	530	530
Warranty expense	10	30	84	156	300	434	600	1000	1000	1000	1000	1000	1000
Freight expense	10	30	84	156	300	434	600	1000	1000	1000	1000	1000	1000
Fixed costs													
General, admin. & sales	175	175	175	175	700	700	700	1400	1400	1400	1400	1400	1400
Depreciation & amort.	100	100	105	255	267	280	292	305	317	330	342	355	367
Research & development	100	100	100	100	100	759	1050	1750	1750	1750	1750	1750	1750
Indirect labor expense	6	12	31	53	79	115	159	265	265	265	265	265	265
Rent and misc. overhead	350	350	350	350	350	350	350	350	350	350	350	350	350
Total costs	1078	1766	3343	4627	8556	1241	16669	27600	27612	27625	27637	27650	27662
Gross Profit	-727	-715	-402	833	1944	2773	4330	7400	7387	7375	7362	7350	7337
Interest income	0	0	1	4	7	1	1	26	44	44	44	44	44
Interest expense	0	319	409	852	830	725	504	76	-520	-1063	-1633	-2165	-2814
Pretax profit	-727	-1033	-810	-15	1121	2061	3846	7350	7952	8482	9041	9560	10196
Income taxes	0	0	0	0	0	0	34	3356	3633	3877	4134	4372	4665
Net Income	-727	-1033	-810	-15	1121	2061	3812	3994	4319	4605	4907	5187	5531
Common Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Retained Earnings	-10727	-11761	-12572	-12588	-11467	-9406	-5594	-1600	2718	7323	12230	17418	22949

TABLE 15. CASE D BALANCE SHEET (End of calendar year, in thousands of dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Assets													
Current assets													
Cash	7	22	61	114	219	316	437	729	729	729	729	729	729
Investments	7	22	61	114	219	316	437	729	729	729	729	729	729
Accounts receivable	29	87	245	455	875	1266	1750	2917	2917	2917	2917	2917	2917
Inventory	26	79	196	273	525	759	1050	1749	1749	1749	1749	1749	1749
Prepaid expense	10	30	85	158	304	440	609	1015	1015	1015	1015	1015	1015
Total current assets	80	240	649	1114	2142	3098	4284	7139	7139	7139	7139	7139	7139
Property													
Land, plant & equipment	2000	2100	5100	5350	5600	5850	6100	6350	6600	6850	7100	7350	7600
Accum. depreciation	100	200	305	560	827	1107	1400	1705	2022	2352	2695	3050	3417
Net property	1900	1900	4795	4790	4772	4742	4700	4645	4577	4497	4405	4300	4182
Total assets	1980	2140	5444	5904	6914	7841	8984	11784	11717	11637	11544	11439	11322
Liabilities and Equity													
Current liabilities													
Accounts payable	29	87	245	455	875	1265	1749	2915	2915	2915	2915	2915	2915
Short-term debt	0	0	1904	2467	2344	1250	-1565	-5787	-9562	-13620	-18048	-23459	-29254
Curr. mat. L-T debt	0	332	468	750	750	750	750	750	750	700	0	0	0
Taxes payable	0	0	0	0	0	0	17	1678	1816	1938	2067	2186	2333
Accruals	24	71	200	371	714	1033	1428	2380	2380	2380	2380	2380	2380
Total current liabilities	53	491	2817	4043	4682	4298	2378	1935	-1700	-5686	-10685	-15977	-21626
Long-term debt	2655	3412	5200	4450	3700	2950	2200	1450	700	0	0	0	0
Total liabilities	2708	3903	8017	8493	8383	7248	4579	3385	-1000	-5686	-10685	-15977	-21626
Net worth													
Paid in capital	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Retained earnings	-10727	-11761	-12572	-12588	-11467	-9406	5594	-1600	2718	7323	12230	17418	22949
Total net worth	-727	-1761	-2572	-2588	-1467	593	4405	8399	12718	17323	22230	27418	32949
Total Liabilities and Equity	1980	2140	5444	5904	6914	7841	8984	11784	11717	11637	11544	11439	11322
Notes													
Capital expenditures	2000	100	3000	250	250	250	250	250	250	250	250	250	250
Investment tax credit	200	10	300	25	25	25	25	25	25	25	25	25	25
Long-term debt repayment	0	0	332	468	750	750	750	750	750	750	700	0	0
Net working capital	27	-249	-2167	-2928	-2540	-1198	1905	5204	8841	12826	17825	23118	28766
Credit line utilized	2655	3744	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
Current ratio	2	0	0	0	0	1	1	2	2	3	3	4	5

Although the base materials cost variable only alters one component of the firm's variable costs and does not change fixed costs, a significant worsening of financial condition is the forecasted outcome.

The results of this section have provided some perspective for the characteristics of the baseline simulation. It is evident that the qualitative nature of the latter will not be radically altered by reasonable variations in demand or cost conditions. In the most optimistic case--a 28.6 percent increase in average revenue, with constant materials and labor expenses--the firm requires only one year of "bridge" financing. Although the firm's financial condition at that time is not exemplary, reasonable projections might allow extension of the needed debt. In any more pessimistic case, the forecast widens markedly. A 7.7 percent increase in base materials cost causes the debt requirements to approach $2.5 million. Although it would unduly complicate the analysis, the most likely alternative might be one encompassing both higher vehicle prices and higher materials costs. The results above show that unless the average margin is markedly increased, the firm will still find itself with a $0.5 to $2.5 million short-term debt requirement. The likelihood of survival decreases as that requirement looms larger and longer on the firm's horizon.

EFFECTS OF DIFFERENT FEDERAL LOAN GUARANTEE LIMITS

With the sensitivity of the entrepreneurial firm model to the economic conditions established, it is appropriate to consider the effects of the federal loan guarantee limit. The first alternative considered reflects current operating procedure within DOE. Prospective borrowers have been informed that the program's overall lending limits all but preclude more than one $3 million award per borrower. Thus the de facto loan guarantee ceiling appears to be $3 million, despite the $6 million figure authorized in the *Code of Federal Regulations* and described in the previous section. The first simulation considered, Case E, replicates the baseline simulation except for a $3 million limit on guaranteed debt.

The results of Case E are presented in Tables 16 and 17. The $3 million limit is reached in 1981, when an additional $645,000 of short-term debt is required. As in the baseline simulation, positive net income is recorded first in 1983. In that same year, the firm requires $4.822 million in short-term debt--an amount approaching half its original capitalization and surpassing the net value of its fixed assets at the time. This alternative seems to present a totally untenable situation to the firm, with no prospect

TABLE 16. CASE E INCOME STATEMENT (By calendar year, in thousands of dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Total Revenue	350	1050	2940	5460	10500	15190	21000	35000	35000	35000	35000	35000	35000
Costs													
Variable costs													
Materials expense	292	877	2184	3042	5850	8463	11700	19500	19500	19500	19500	19500	19500
Direct labor expense	12	24	62	106	159	230	318	530	530	530	530	530	530
Warranty expense	10	30	84	156	300	434	600	1000	1000	1000	1000	1000	1000
Freight expense	10	30	84	156	300	434	600	1000	1000	1000	1000	1000	1000
Fixed costs													
General, admin. & sales	175	175	175	175	700	700	700	1400	1400	1400	1400	1400	1400
Depreciation & amort.	100	100	105	255	267	280	292	305	317	330	342	355	367
Research & development	100	100	100	100	100	759	1050	1750	1750	1750	1750	1750	1750
Indirect labor expense	6	12	31	53	79	115	159	265	265	265	265	265	265
Rent and misc. overhead	350	350	350	350	350	350	350	350	350	350	350	350	350
Total costs	1055	1698	3175	4393	8106	11766	15769	26100	26112	26125	26137	26150	26162
Gross Profit	-705	-648	-234	1067	2394	3424	5230	8900	8887	8875	8862	8850	8837
Interest income	0	0	1	4	7	13	19	26	44	44	44	44	44
Interest expense	0	316	398	829	809	646	335	-136	-811	-1472	-2136	-2878	-3677
Pretax profit	-705	-963	-631	241	1592	2792	4915	9064	9743	10392	11044	11773	12559
Income taxes	0	0	0	0	0	0	1477	4144	4457	4755	5055	5391	5752
Net Income	-705	-963	-631	241	1592	2792	3437	4919	5286	5636	5989	6383	6807
Common Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Retained Earnings	-10705	-11668	-12300	-12059	-10467	-7675	-4238	681	5967	11603	17592	23974	30782

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TABLE 17. CASE E BALANCE SHEET (End of calendar year, in thousands of dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Assets													
Current assets													
Cash	7	22	61	114	219	316	437	729	729	729	729	729	729
Investments	7	22	61	114	219	316	437	729	729	729	729	729	729
Accounts receivable	29	87	245	455	875	1266	1750	2917	2917	2917	2917	2917	2917
Inventory	24	73	182	253	487	705	975	1624	1624	1624	1624	1624	1624
Prepaid expense	10	30	85	158	304	440	609	1015	1015	1015	1015	1015	1015
Total Current Assets	78	235	635	1094	2104	3044	4209	7014	7014	7014	7014	7014	7014
Property													
Land, plant & equipment	2000	2100	5100	5350	5600	5850	6100	6350	6600	6850	7100	7350	7600
Accum. depreciation	100	200	305	560	827	1107	1400	1705	2022	2352	2695	3050	3417
Net property	1900	1900	4795	4790	4772	4742	4700	4645	4577	4497	4405	4300	4182
Total assets	1978	2135	5430	5884	6877	7787	8909	11659	11592	11512	11419	11314	11197
Liabilities and Equity													
Current liabilities													
Accounts payable	29	87	245	455	875	1265	1749	2915	2915	2915	2915	2915	2915
Short-term debt	0	645	4615	4822	3835	1618	-1939	-7184	-12319	-17810	-23995	-30650	-37755
Curr. mat. L-T debt	0	329	375	375	375	375	375	375	375	46	0	0	0
Taxes payable	0	0	0	0	0	0	739	2072	2228	2378	2528	2695	2876
Accruals	24	71	200	371	714	1033	1428	2380	2380	2380	2380	2380	2380
Total current liabilities	53	1133	5434	6023	5798	4292	2351	557	-4420	-10091	-16172	-22659	-29584
Long-term debt	2631	2671	2296	1921	1546	1171	796	421	46	0	0	0	0
Total liabilities	2684	3804	7731	7944	7345	5463	3147	979	-4374	-10091	-16172	-22659	-29584
Net worth													
Paid in capital	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Retained earnings	-10705	-11668	-12300	-12059	-10467	-7675	4238	681	5967	11603	17592	23974	30782
Total net worth	-705	-1668	-2300	-2059	-467	2324	5761	10681	15967	21603	27592	33974	40782
Total Liabilities and Equity	1978	2135	5430	5884	6877	7787	8909	11659	11592	11512	11419	11314	11197
Notes													
Capital expenditures	2000	100	3000	250	250	250	250	250	250	250	250	250	250
Investment tax credit	200	10	300	25	25	25	25	25	25	25	25	25	25
Long-term debt repayment	0	0	329	375	375	375	375	375	375	375	46	0	0
Net working capital	25	-897	-4799	-4927	-3693	-1246	1858	6457	11436	17106	23187	29674	36599
Credit line utilized	2631	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
Current ratio	1	0	0	0	0	1	1	2	2	3	4	5	5

of acquiring needed cash. The implications for DOE's lending practices should be obvious. Restriction of borrowers to the $3 million level is not likely to push a firm over the hump into commercial production of EHVs, and at worst may very speedily result in financial collapse.

After reaching definite conclusions on the efficacy of a $3 million limit on guaranteed debt, the focus now turns to a normative study of the "ideal" debt limit. In this sense, the ideal limit is one sufficient to provide a likelihood of financial stability for the firm, minimizing both the firm's short-term borrowing needs and the financial exposure of the government. To achieve this end, the baseline simulation was modified to allow a $7 million limit on guaranteed debt. The results of this alternative, Case F, are presented in Tables 18 and 19.

The results are similar to the baseline case, differing in short-term debt requirements. The baseline simulation showed 1982 debt requirements of $1.615 million, continuing above the $1.2 million level through 1984. The $7 million debt limit involves only $615,000 of short-term debt in 1982, $892,000 in 1983, and $345,000 in 1984. Against these lower requirements must be balanced the greater amount of total debt burdening the firm, and accordingly higher repayment requirements. The firm still faces a somewhat unfavorable financial condition in the years of inadequate cash flow.

In the last alternative, the limit on federally guaranteed debt is increased to $8 million. The results of this simulation, denoted Case G, are presented in Tables 20 and 21. The firm's current ratio for this simulation is illustrated in Figure 4, with the horizontal line corresponding to the 2.0 criterion. In this case, the firm is able to avoid cash deficits, drawing $7.892 million of its $8 million federally guaranteed credit line by 1983. Under these conditions, the current ratio exceeds two in 1987, and all debt is repaid by the end of 1991. Considerable cash surpluses are earned in the latter years of the simulation horizon. This alteration to the firm's environment has made financial stability a possibility, while increasing the government's financial exposure by $1.892 million from the baseline case. The firm in this hypothetical situation has adequate financial resources to make the relatively large-scale capital expenditures required for commercial production without incurring a cash deficit. The particular circumstances of a firm may differ from the results presented here, and will include considerable uncertainty about future demand and

TABLE 18. CASE F INCOME STATEMENT (By calendar year, in thousands of dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Total Revenue	350	1050	2940	5460	10500	15190	21000	35000	35000	35000	35000	35000	35000
Costs													
Variable costs													
Materials expense	292	877	2184	3042	5850	8463	11700	19500	19500	19500	19500	19500	19500
Direct labor expense	12	24	62	106	159	230	318	530	530	530	530	530	530
Warranty expense	10	30	84	156	300	434	600	1000	1000	1000	1000	1000	1000
Freight expense	10	30	84	156	300	434	600	1000	1000	1000	1000	1000	1000
Fixed costs													
General, admin. & sales	175	175	175	175	700	700	700	1400	1400	1400	1400	1400	1400
Depreciation & amort.	100	100	105	255	267	280	292	305	317	330	342	355	367
Research & development	100	100	100	100	100	759	1050	1750	1750	1750	1750	1750	1750
Indirect labor expense	6	12	31	53	79	115	159	265	265	265	265	265	265
Rent and misc. overhead	350	350	350	350	350	350	350	350	350	350	350	350	350
Total costs	1055	1698	3175	4393	8106	11766	15769	26100	26112	26125	26137	26150	26162
Gross Profit	-705	-648	-234	1067	2394	3424	5230	8900	8887	8875	8862	8850	8837
Interest income	0	0	1	4	7	13	19	26	44	44	44	44	44
Interest expense	0	316	398	820	748	577	258	-216	-892	-1559	-2268	-2932	-3721
Pretax profit	-705	-963	-631	251	1653	2860	4991	9143	9824	10478	11175	11826	12603
Income taxes	0	0	0	0	0	0	1577	4181	4494	4795	5116	5415	5772
Net Income	-705	-963	-631	251	1653	2860	3415	4962	5330	5683	6060	6411	6831
Common Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Retained Earnings	-10705	-11668	-12300	-12049	-10396	-7536	-4121	841	6171	11854	17914	24325	31156

TABLE 19. CASE F BALANCE SHEET (End of calendar year, in thousands of dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Assets													
Current assets													
Cash	7	22	61	114	219	316	437	729	729	729	729	729	729
Investments	7	22	61	114	219	316	437	729	729	729	729	729	729
Accounts receivable	29	87	245	455	875	1266	1750	2917	2917	2917	2917	2917	2917
Inventory	24	73	182	253	487	705	975	1624	1624	1624	1624	1624	1624
Prepaid expense	10	30	85	158	304	440	609	1015	1015	1015	1015	1015	1015
Total current assets	78	235	635	1094	2104	3044	4209	7014	7014	7014	7014	7014	7014
Property													
Land, plant & equipment	2000	2100	5100	5350	5600	5850	6100	6350	6600	6850	7100	7350	7600
Accum. depreciation	100	200	305	560	827	1107	1400	1705	2022	2352	2695	3050	3417
Net property	1900	1900	4795	4790	4772	4742	4700	4645	4577	4497	4405	4300	4182
Total assets	1978	2135	5430	5884	6877	7787	8909	11659	11592	11512	11419	11314	11197
Liabilities and Equity													
Current liabilities													
Accounts payable	29	87	245	455	875	1265	1749	2915	2915	2915	2915	2915	2915
Short-term debt	0	0	615	892	345	-1439	-4525	-9282	-13961	-19000	-24437	-31013	-38139
Curr. mat. L-T debt	0	329	456	875	875	875	875	875	875	875	90	0	0
Taxes payable	0	0	0	0	0	0	788	2090	2247	2398	2558	2708	2886
Accruals	24	71	200	371	714	1033	1428	2380	2380	2380	2380	2380	2380
Total current liabilities	53	488	1515	2594	2808	1733	315	-1021	-5543	-10432	-16493	-23010	-29958
Long-term debt	2631	3316	6215	5340	4465	3590	2715	1840	965	90	0	0	0
Total liabilities	2684	3804	7731	7934	7274	5323	3030	819	-4578	-10341	-16493	-23010	-29958
Net worth													
Paid in capital	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Retained earnings	-10705	-11668	-12300	-12049	-10396	-7536	4121	841	6171	11854	17914	24325	31156
Total net worth	-705	-1668	-2300	-2049	-396	2463	5878	10841	16171	21854	27914	34325	41156
Total Liabilities and Equity	1978	2135	5430	5884	6877	7787	8909	11659	11592	11512	11419	11314	11197
Notes													
Capital expenditures	2000	100	3000	250	250	250	250	250	250	250	250	250	250
Investment tax credit	200	10	300	25	25	25	25	25	25	25	25	25	25
Long-term debt repayment	0	0	329	456	875	875	875	875	875	875	875	90	0
Net working capital	25	-252	-879	-1498	-703	1311	3894	8036	12559	17447	23509	30025	36973
Credit line utilized	2631	3645	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000
Current ratio	1	0	0	0	1	1	2	2	2	3	4	5	6

TABLE 20. CASE G INCOME STATEMENT (By calendar year, in thousands of dollars)

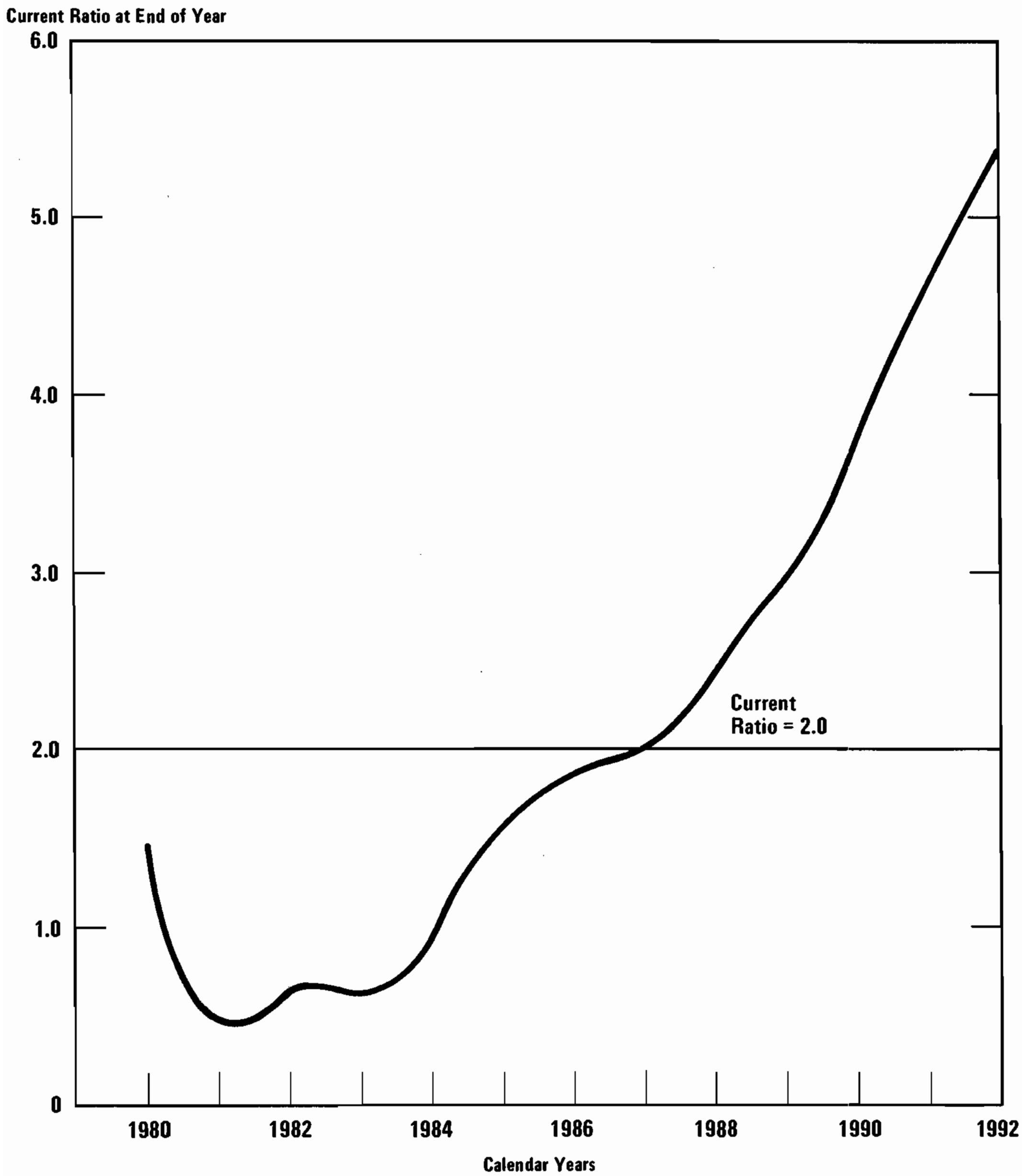
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Total Revenue	350	1050	2940	5460	10500	15190	21000	35000	35000	35000	35000	35000	35000
Costs													
Variable costs													
Materials expense	292	877	2184	3042	5850	8463	11700	19500	19500	19500	19500	19500	19500
Direct labor expense	12	24	62	106	159	230	318	530	530	530	530	530	530
Warranty expense	10	30	84	156	300	434	600	1000	1000	1000	1000	1000	1000
Freight expense	10	30	84	156	300	434	600	1000	1000	1000	1000	1000	1000
Fixed costs													
General, admin. & sales	175	175	175	175	700	700	700	1400	1400	1400	1400	1400	1400
Depreciation & amort.	100	100	105	255	267	280	292	305	317	330	342	355	367
Research & development	100	100	100	100	100	759	1050	1750	1750	1750	1750	1750	1750
Indirect labor expense	6	12	31	53	79	115	159	265	265	265	265	265	265
Rent and misc. overhead	350	350	350	350	350	350	350	350	350	350	350	350	350
Total costs	1055	1698	3175	4393	8106	11766	15769	26100	26112	26125	26137	26150	26162
Gross Profit	-705	-648	-234	1067	2394	3424	5230	8900	8887	8875	8862	8850	8837
Interest income	0	0	1	4	7	13	19	26	44	44	44	44	44
Interest expense	0	316	398	820	739	563	242	-233	-910	-1577	-2288	-2957	-3730
Pretax profit	-705	-963	-631	251	1662	2875	5008	9161	9842	10497	11195	11852	12613
Income taxes	0	0	0	0	0	0	1595	4189	4502	4804	5125	5427	5777
Net Income	-705	-963	-631	251	1662	2875	3413	4972	5340	5693	6071	6425	6836
Common Dividends	0	0	0	0	0	0	0	0	0	0	0	0	0
Retained Earnings	-10705	-11668	-12300	-12049	-10387	-7512	-4099	871	6211	11904	17975	24400	31236

TABLE 21. CASE G BALANCE SHEET (End of calendar year, in thousands of dollars)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Assets													
Current assets													
Cash	7	22	61	114	219	316	437	729	729	729	729	729	729
Investments	7	22	61	114	219	316	437	729	729	729	729	729	729
Accounts receivable	29	87	245	455	875	1266	1750	2917	2917	2917	2917	2917	2917
Inventory	24	73	182	253	487	705	975	1624	1624	1624	1624	1624	1624
Prepaid expense	10	30	85	158	304	440	609	1015	1015	1015	1015	1015	1015
Total current assets	78	235	635	1094	2104	3044	4209	7014	7014	7014	7014	7014	7014
Property													
Land, plant & equipment	2000	2100	5100	5350	5600	5850	6100	6350	6600	6850	7100	7350	7600
Accum. depreciation	100	200	305	560	827	1107	1400	1705	2022	2352	2695	3050	3417
Net property	1900	1900	4795	4790	4772	4742	4700	4645	4577	4497	4405	4300	4182
Total assets	1978	2135	5430	5884	6877	7787	8909	11659	11592	11512	11419	11314	11197
Liabilities and Equity													
Current liabilities													
Accounts payable	29	87	245	455	875	1265	1749	2915	2915	2915	2915	2915	2915
Short-term debt	0	0	0	0	-479	-2167	-5148	-9797	-14375	-19312	-24649	-31093	-38222
Curr. mat. L-T debt	0	329	456	952	987	987	987	987	987	987	237	0	0
Taxes payable	0	0	0	0	0	0	798	2094	2251	2402	2562	2713	2888
Accruals	24	71	200	371	714	1033	1428	2380	2380	2380	2380	2380	2380
Total current liabilities	53	488	900	1778	2095	1117	-187	-1421	-5842	-10628	-16555	-23085	-30038
Long-term debt	2631	3316	6830	6156	5170	4183	3196	2210	1223	237	0	0	0
Total Liabilities	2684	3804	7731	7934	7265	5300	3009	788	-4618	-10392	-16555	-23085	-30038
Net worth													
Paid in capital	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Retained earnings	-10705	-11668	-12300	-12049	-10387	-7512	-4099	871	6211	11904	17975	24400	31236
Total net worth	-705	-1668	-2300	-2049	-387	2487	5900	10871	16211	21904	27975	34400	41236
Total Liabilities and Equity	1978	2135	5430	5884	6877	7787	8909	11659	11592	11512	11419	11314	11197
Notes													
Capital expenditures	2000	100	3000	250	250	250	250	250	250	250	250	250	250
Investment tax credit	200	10	300	25	25	25	25	25	25	25	25	25	25
Long-term debt repayment	0	0	329	456	952	987	987	987	987	987	987	237	0
Net working capital	25	-252	-265	-683	9	1928	4396	8436	12857	17644	23570	30100	37053
Credit line utilized	2631	3645	7615	7892	7892	7892	7892	7892	7892	7892	7892	7892	7892
Current ratio	1	0	1	1	1	2	2	2	2	3	4	5	6

Figure 4.

Current Ratio of the Entrepreneurial Firm—Case G



SOURCE: Table 21.

cost conditions. It appears evident, however, that, within a fairly wide range of the baseline simulation's conditions, the $6 million limit will prove inadequate. The entrepreneurial firm, lacking access to capital markets, will not be able to expand into commercial production unless a higher loan guarantee limit is set. In this deterministic analysis, it appears that an $8 million limit would be a borderline figure, offering a firm of the sort modeled a reasonable chance of success.

EFFECTS OF ALTERNATIVE FEDERAL POLICY OPTIONS

The analyses of the entrepreneurial firm presented above all have made the assumption that the federal loan guarantee program will constitute the major supply-side incentive to the individual electric vehicle producer. In reality, numerous alternative policy options might be used to stimulate EHV commercialization. Direct purchase agreements or price supports might be used to ensure that initially high-cost vehicles would be salable at a price covering costs. Alternatively, the government might contract for the construction of a given number of vehicles, and "market" them to federal agencies--as has been done in various demonstration programs. This study does not attempt to judge the relative efficiency of these mechanisms. It is possible, however, to estimate the magnitude of the federal commitment that would be required.

The assumptions underlying this estimate are as follows. First, no alteration of the demand schedule is permitted, as the cost functions in the model are technologically specific to that output path. Second, the loan guarantee is removed, and in the absence of private financing, no long-term debt is available to the firm. Third, it is assumed that the short-term debt required to balance a cash flow deficit represents the magnitude of the federal subsidy. This is rationalized by considering that the firm could not acquire private financing of this magnitude, and thus all short-term debt requirements would be met by direct federal outlay.

The results of two simulations under these assumptions are presented below. In the first, Case H, the baseline vehicle price of $7,000 is utilized. The overall annual subsidy, subsidy per vehicle, and total subsidy are given in Table 22. In the second simulation, Case I, it is assumed that the vehicle price is increased to $10,000 to reduce the federal outlay. The summary statistics for that simulation are given in Table 23.

TABLE 22. CASE H SUMMARY (by calendar year)

Year a/	Quantity Sold (in units)	Total Subsidy (in millions of dollars)	Subsidy per Vehicle (in dollars)
1980	50	2.631	52,620
1981	150	3.645	24,300
1982	420	7.325	17,440
1983	780	7.207	9,240
1984	1500	5.901	3,934
1985	2170	3.372	1,554
Total Subsidized	5070	30.081	
Average Subsidy per Vehicle			5,933

a/ No subsidies are required after 1985.

TABLE 23. CASE I SUMMARY (By calendar year)

Year a/	Quantity Sold (in units)	Total Subsidy (in millions of dollars)	Subsidy per Vehicle (in dollars)
1980	50	2.556	51,120
1981	150	3.187	21,247
1982	420	5.629	13,402
1983	780	3.043	3,901
Total Subsidized	1400	14.415	
Average Subsidy per Vehicle			10,296

a/ No subsidies are required after 1983.

The results of these two cases indicate the scale of the on-budget outlay that would substitute for the off-budget loan guarantee incentive. In Case H, with the baseline vehicle price of $7,000, six years of cash flow deficits are encountered. The annual subsidy peaks at $7.3 million in the third year of production. The subsidy per vehicle at that point is $17,440--over twice the vehicle's market price, but a fraction of the earlier year's figures. The overall federal commitment involves the subsidization of six years' production of a total of 5,070 units, with a total outlay of $30.081 million, or $5,933 per vehicle.

The second simulation, Case I, reveals that this federal subsidy may be considerably reduced if consumers will accept a $10,000 vehicle price tag. Under that assumption, only four years of subsidy are required, for a total of $14.415 million. Since production volume in those early years is at a low level, the total number of units produced under subsidy is 14,000 for an average subsidy of $10,296--roughly equal to the vehicle price. Thus, a much smaller outlay is required if a higher vehicle price is feasible.

Although these cases do not purport to represent rigorous analyses of the policy alternatives, they suggest the scale of federal involvement, as an on-budget expense, implied by the EHV commercialization effort. The uncertain technology of EHV development and production may require greater direct outlays as an alternative to loan guarantees. Growing concern in the Congress over the magnitude of off-budget federal credit and the unavailability of private credit in today's turbulent financial markets may encourage more rigorous study of these policy options.

SECTION V. CONCLUSIONS AND RECOMMENDATIONS

ANALYSIS OF SIMULATION RESULTS

Analysis of the experiments performed with the entrepreneurial firm model of electric and hybrid vehicle producers has revealed several common findings. First, the baseline simulation projections portray an enterprise with considerable uncertainty about its financial condition. The ability of the firm to achieve commercial production levels is shown to be contingent upon the availability of considerable short-term funding for each of three years. Although the effects of uncertainty are not explicitly modeled, the magnitude of the shortfall clearly implies the inadequacy of projected cash flow.

Second, simulations involving variations in the firm's output and factor market conditions--Cases A, B, C, and D--illustrate that the baseline simulation's results are relatively stable. Sizable alterations in the firm's projected average revenue do not alter the qualitative findings of the baseline case. Although the necessity for short-term funding is reduced in magnitude, the firm's projected condition continues to fall short of accepted lending criteria. In the cases examining modest increases in materials costs, the financial status of the firm is projected to deteriorate rapidly. As materials costs are perhaps the most unpredictable financial component for any alternative energy firm, this finding only reinforces the prior conclusions. Therefore, the model seems to provide a consistent view of a small, entrepreneurial firm with severe financial constraints over a range of alternative demand and cost levels.

Third, results of the simulations involving variation in the limit on federal loan guarantees--Cases E, F, and G--suggest that the current program's operating procedure, effectively limiting firms to a single $3 million guarantee, is liable to place those firms in almost immediate financial jeopardy. An increase in the guarantee limit to $8 million is the smallest change consistent with projected financial stability of the entrepreneurial firm. It must be noted, given the deterministic nature of the analysis, that this projected stability is derived from an optimistic outlook. That is, no demand shortfalls, cost overruns, labor stoppages, or other disruptions of the projected scenario are assumed to intervene. Prudent lenders would be expected to analyze the likelihood of these events, in perspective with the high degree of uncertainty surrounding the development of any innovative technology.

IMPLICATIONS FOR FEDERAL CREDIT POLICY

The use of indirect incentive policies, such as special tax arrangements, subsidies, direct loans, and loan guarantees, has become increasingly controversial as the magnitude of those policies' effects has increased. Focusing on the federal loan guarantee as a policy instrument, a mushrooming growth of guarantee use has attracted considerable attention. As the Committee for Economic Development states:

> Various forms of new federal credit are currently being extended at the rate of a little less than $100 billion per year. The amount

> of credit generated through loan guarantees is slightly greater than the amount generated through direct loans, and the use of guarantees is expanding at a much more rapid rate.

This statement is substantiated by examining the total of new federal credit extensions. Total extensions in fiscal year 1979 were $97.50 billion, of which $53.354 billion represented primary guaranteed loans (that is, excluding interagency guarantees). 24/ There is no doubt that federal loan guarantees have been successful in their primary purpose of attracting "private capital to investments that are judged to be socially worthy." 25/ The magnitude of loan guarantee activity makes a second conclusion inevitable: private capital has been attracted away from other projects. Increasing concern about the possibly adverse effects of the process has led to recent statements in the Administration's fiscal year 1981 budget proposal mandating closer scrutiny of federally extended credit. Ultimately, a control process to reconcile agency requests with the total "appropriate" level of federal credit will be used to curtail credit extensions--similar to the recently developed budget overview process. An official within the Administration was reported to have said "that such credit planning won't be possible for at least five years, however." 26/

The magnitude of the electric and hybrid vehicle (EHV) loan guarantee program may seem quite insignificant in comparison to total federal credit activities. It exemplifies, however, the

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23/ Committee for Economic Development, Research and Policy Committee, Redefining Government's Role in the Market System (New York, N.Y.: Committee for Economic Development, 1979), pp. 51-52.

24/ Budget of the United States Government for Fiscal Year 1979, Special Analysis F, pp. 127, 128, 140.

25/ Committee for Economic Development, op. cit., p. 52.

26/ Wall Street Journal, "Administration Makes Its Initial Move to Curb Government's Loan Activities," January 29, 1980, p. 4.

nature of the recent growth in federal credit. A great deal of the growth in loan guarantee activities has been the proliferation of those programs in numerous sectors of federal involvement. This study's focus on the EHV loan guarantee program has portrayed a $60 million legislative commitment in an extremely risky segment of energy technology. It is indeed likely that adequate federal credit support would reduce the level of risk in the EHV commercialization process. Inadequate support could be much more damaging than no support, however, as it would be likely to augment the perceived riskiness in this sector. Precedents are numerous for the failure of small businesses in risky, high-technology areas, but the failure of a federally supported enterprise might have significantly more damaging repercussions. Failure would not only hamper the EHV Act's objective--the commercialization of EHVs--but it would be likely to cast doubt upon the federal loan guarantee as an effective policy instrument. Although federal credit activity in the EHV industry may be judged societally beneficial, a poorly designed and managed loan guarantee program may be a most inappropriate tool to achieve the social goals of energy conservation and environmental improvement.

SUMMARY AND CONCLUSIONS

This study has focused upon the design, implementation, and likely consequences of the Electric and Hybrid Vehicle Loan Guarantee Program. This program exemplifies a number of federal credit programs directed toward the commercialization of alternative energy technologies. To examine the program's consequences, an entrepreneurial firm model was constructed. This model enabled the dynamic analysis of alternative projections of the prototype EHV producer's financial condition over a 13-year horizon.

Results of the analysis indicated that the firm will require short-term capital funding in excess of the $6 million limit on federally guaranteed long-term debt within the first three years of operation. The firm's financial condition and profit outlook at that point does not meet accepted lending standards. Thus, the firm's position is not viable without alteration in production plans. The current Department of Energy administrative procedure, limiting firms to a single $3 million guarantee, was shown to be totally inadequate.

Analysis of the simulation results indicated that an $8 million guarantee limit is the lowest level consistent with projected financial stability. Policy decisions then must be made regarding the appropriateness of this level of federal support. It was recommended that the EHV loan guarantee limit be modified to provide an adequate level of support; if this is not societally desirable, the program should be terminated.

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VALUATION OF LOAN GUARANTEES

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PREFACE

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SECTION I. INTRODUCTION

Government guarantees of loans made to private corporations are often proposed as integral parts of public policy programs. Examples are the promotion of "essential" economic activity, such as the development of alternative energy sources or the extension of financial assistance to major corporations. Thus, lenders and equity investors are confronted with the problem of assessing the value and impact of the government's guarantees. Merton and Jones and Mason have addressed this problem using contingent claims analysis. 1/ This paper continues the use of the contingent claims method in the evaluation of loan guarantees by considering a number of complexities often encountered in practice but not treated in the earlier work.

Private economic activities, which cost more than the sum of the benefits accruing to private participants but less than their aggregate social benefit, could suggest some form of government financial assistance. Government loan guarantees, as well as direct credit programs and direct subsidies, are examples of financial assistance programs. By guaranteeing a firm's debt, the government has, in essence, issued an insurance policy at no charge. Just as outstanding policies represent liabilities to insurance companies, outstanding loan guarantees represent liabilities to the government. And, just as insurance policies have value to policyholders, the loan guarantee has value to the firm. The guarantee, in principle, is structured so as to minimize the value of the liability borne by the government but still to represent sufficient incremental value so as to attract the participation of private capital suppliers in what would otherwise be an uneconomic activity. Thus, it is important that private investors have some means of evaluating loan guarantee proposals.

1/ R.C. Merton, "An Analytic Derivation of the Cost of Deposit Insurance and Loan Guarantees: An Application of Modern Option Pricing Theory," Journal of Banking and Finance, Vol. 1 (1977), pp. 3-11; and E.P. Jones and S.P. Mason, "Contingent Claims Analysis of Loan Guarantees," Harvard Business School Working Paper, No. 78-51 (1978).

Merton and Jones and Mason evaluate certain loan guarantees, as well as the associated benefits and incentives accruing to the participants in such loans. 2/ This earlier work dealt with the guarantee of a noncallable discount bond (that is, one that pays no coupons) issued by a firm paying no dividends. This case was addressed, in part, because the contingent claims formulation of the problem yields an explicit analytic expression for the value of the guarantee. However, as a matter of practical interest, a more interesting problem would be the evaluation of a guarantee on a callable coupon bond issued by a firm paying dividends. The contingent claims formulation of this problem does not result in an explicit analytic solution, but the solution can be approximated by numerical analysis. This paper presents the results of a numeric treatment of the problem as well as an analysis of the issues of partial versus full guarantees, the guaranteeing of junior debt, and alternative covenants specifying the value of guaranteed debt given "premature" bankruptcy.

The next section of the paper briefly introduces contingent claims analysis and the formulations of the problems to be treated. The third section presents and discusses the numeric approximations. The last section outlines possible extensions to this paper.

SECTION II. CONTINGENT CLAIMS ANALYSIS

The analysis of guaranteed loans in this paper uses the contingent claims valuation model developed by Black and Scholes and Merton. 3/. This is a general methodology for the valuation of

2/ Ibid.

3/ F. Black and M. Scholes, "The Pricing of Options and Corporation Liabilities," Journal of Political Economy, Vol. 81 (1973), pp. 637-59; and R.C. Merton, "A Rational Theory of Option Pricing," Bell Journal of Economics and Management Science, Vol. 4 (1973), pp. 141-83; and R.C. Merton, "On the Pricing of Corporate Debt: The Risk Structure of Interest Rates," Journal of Finance, Vol. 29 (1974), pp. 449-70.

arbitrary contingent claims. Following these authors, assume:

- "Frictionless Markets": There are no transactions costs or differential taxes. Trading takes place continuously in time. Borrowing and lending, at the same interest rate, are unrestricted. Short sales are unrestricted, with full use of proceeds.

- The riskless short-term interest rate, r, is known and constant over time.

- The price history of the firm is always continuous.

- The instantaneous variance of return, σ^2, on asset value, V, is constant over time.

- Total cash payouts, P, to all claimants depend at most upon the asset value of the firm.

Under these assumptions, Black and Scholes demonstrated that any contingent claim whose value can be written as a function of asset value, V, and time is exactly correlated with the underlying asset value over short intervals. 4/ Arbitrage considerations require that the ratio of excess expected return to standard deviation of return--the reward-to-risk ratio--be identical for the contingent claim and the underlying asset value. In a general formulation, Merton 5/ showed that the value of a contingent claim which receives cash payouts over time, such as an issue of unguaranteed debt, $D(V, \tau)$, obeys the partial differential equation:

(1) $$1/2\ \sigma^2 V^2 D_{VV} + (rV-P)D_V - D_\tau - rD + p = 0$$

Where p is the cash payout per unit time to the claim, τ is the maturity of the claim and subscripts denote partial derivatives. Similarly, the value of a contingent claim which receives no cash payouts over time, such as a loan guarantee, $G(V, \tau)$, obeys the equation:

(2) $$1/2\ \sigma^2 V^2 G_{VV} + (rV-P)G_V - G_\tau - rG = 0$$

4/ Black and Scholes, op. cit.

5/ Merton, "On the Pricing of Corporate Debt."

Note the value of the guaranteed debt, $D^*(V,\tau)$, equals the value of the debt without a guarantee plus the value of the guarantee, so $D^* = D + G$.

The valuation logic of the contingent claims model is contained in these differential equations, which depend only on the asset value, V, of the firm; the maturity, τ, of the claim; the variance rate, σ^2, of asset value; the short-term interest rate, r; and cash payouts to claimants P and p. The virtue of the model is that all of the above are observable or readily estimated. In particular, the values of the contingent claims do not depend on the expected rate of return on asset value or on market parameters of risk and return.

Differential equations like (1) and (2) require terminal and boundary conditions to give a unique representation to a contingent claim. The terminal condition gives the value of the claim at maturity, $\tau = 0$, as a function of firm asset value. For example, suppose asset value is equal to or greater than the promised principal, B, at maturity. This implies that $V \geq$ when $\tau = 0$. The debt receives full payment and $D(V,0) = B$. If the asset value is less than the principal, $V < B$, the debt can only be worth as much as the firm, $D(V,0) = V$. Thus, the debt at maturity is worth the minimum of the principal and asset value:

$$\text{(1a)} \quad D(V,0) = \text{Min}\ (B,V)$$

Now consider the value of the guarantee at $\tau = 0$. If the asset value exceeds the promised principal, $V > B$, the guarantee has no value. If the asset value is less than the principal, then the guarantee is worth the difference, $G(V,0) = B-V$. Thus the guarantee is worth the maximum of zero and the principal minus the asset value:

$$\text{(2a)} \quad G(V,0) = \text{Max}\ (0,B-V)$$

A lower boundary condition gives the value of the claims if the firm defaults "prematurely," that is to say, before $\tau = 0$. If the asset value becomes worthless, $V = 0$, at any time prior to maturity, then the debt becomes worthless:

$$\text{(1b)} \quad D(0, \tau) = 0$$

Under the same circumstances, the value of the guarantee is dependent upon the covenant protecting the bondholder in this situation. Most guarantees would specify that the government is liable for the payment of the promised principal, B, in case of "premature" bankruptcy:

(2b) $G(0,\tau) = B$

An alternative covenant would specify that the government is liable for the present value of all future promised payments. This amount can be represented by $R(\tau)$, where:

$$R(\tau) = \frac{c}{r}(1-e^{-r\tau}) + Be^{-r\tau}$$

This would then lead to an alternative lower boundary condition for the guarantee:

(2b) $G(0,\tau) = R(\tau)$

An upper boundary condition gives the value of the claims when the asset value becomes large. The value of the debt will approach the value of a riskless bond, $R(\tau)$, as $V \to \infty$:

(1c) $D(\infty, \tau) = R(\tau)$

The value of the guarantee would become worthless:

(2c) $G(\infty, \tau) = 0$

Consider a single issue of noncallable coupon debt, with a promised coupon of c per unit time and a promised principal, B, due in τ time periods. Assume that the firm will pay dividends of d per unit time over the life of the debt. The value of the unguaranteed debt will obey equation (1) with $P = c+d$ and $p=c$. The value of the guarantee will obey equation (2) with $P = c+d$. The value of the guaranteed debt will simply be the sum of these two values. Equation (1) appended by conditions (1a), (1b), and (1c) is the contingent claims formulation of the unguaranteed debt problem. Equation (2) appended by conditions (2a), (2b), and (2c), or conditions (2a), (2b′), and (2c) when appropriate, is the contingent claims formulation of the guarantee value problem.

A closely related problem is that of partial guarantees. Consider a debt issue which has δ percent of its principal guaranteed. This leads to different terminal and boundary conditions for the value of the guarantee. The appropriate terminal condition is:

(2d) $G(V,0) = \text{Max } (0, \delta B - V)$

which says that if the asset value is greater than δB then the guarantee is worth zero. If the asset value is less than δB then the guarantee is worth the difference between δB and V. The new lower boundary would be:

$$(2e) \qquad G(0,\tau) = \delta B$$

The upper boundary condition would be the same as (2c), which says that the value of a partial guarantee goes to zero as the asset value becomes large. Equation (2), appended by conditions (2c), (2d), and (2e), is the contingent claims formulation of the partial guarantee value problem. The value of the unguaranteed debt is still represented by equation (1) and conditions (1a), (1b), and (1c). The value of the partially guaranteed debt is simply the sum of these two values.

Now consider a firm with two classes of noncallable coupon debt, junior and senior. The junior debt is promised coupons of c per unit time and has a promised principal of B'. The senior debt is promised coupons of c per unit time and has a promised principal of B. Assume that both issues have the same maturity date and that the firm will pay dividends of d per unit time. We examine two cases: first the senior debt is fully guaranteed and the junior debt is unguaranteed; then the senior debt is unguaranteed and the junior debt is fully guaranteed.

The value of the guaranteed senior debt is simply the sum of the value of unguaranteed senior debt plus the value of the guarantee. The value of the unguaranteed senior debt is represented by equation (1) with $P = c+c'+d$, $p=c$ and conditions (1a), (1b), and (1c). The value of the guarantee is represented by equation (2) with $P = c+c'+d$ and conditions (2a), (2b), and (2c).

The value of guaranteed junior debt is, again, simply the sum of the value of unguaranteed junior debt and the value of the guarantee. The value of the unguaranteed junior debt satisfies equation (1) with $P = c+c'+d$ and $p=c'$. The terminal condition says the unguaranteed junior debt receives any residual firm asset value over the senior principal, Max (0,V-B), up to a maximum of the junior principal, B'. This is equivalent to:

$$(1d) \qquad D(V,0) = \text{Min}\ (B', \text{Max}\ (0,V-B))$$

Thus the contingent claims formulation of the unguaranteed junior debt problem is represented by equation (1) appended by conditions (1b), (1c), and (1d).

The value of the guarantee on the junior debt satisfies equation (2) with $P = c+c'+d$. The terminal condition says that the guarantor must pay if the asset value is less than the sum of the junior and senior principal payments, Max $(0,B'+B-V)$, up to a maximum of the junior principal, B'. This is equivalent to:

$$(2f) \qquad G(V,0) = \text{Min}\ (B',\ \text{Max}\ (0,B'+B-V))$$

The formulation of the guarantee value problem is therefore equation (2) appended by conditions (2b), (2c), and (2f).

In the examples above, the debt was noncallable. However, the value of the unguaranteed debt and the guarantee will generally be affected by a call provision. To explore this, consider a firm with a single issue of callable coupon debt which is promised coupons of c per unit time and a principal payment of B in τ time periods. Assume that the firm will pay dividends of d per unit time and that the indenture specifies a schedule of call prices $K(\tau)$. The formulation of this problem is identical to that of noncallable debt with the exception of the upper boundary condition. In the case of callable unguaranteed debt, there will exist a time dependent schedule of firm asset values, $\bar{V}(\tau)$, at or above which it is optimal for the equity holders to call the debt at $K(\tau)$. This schedule of asset values is solved for simultaneously with the determination of the debt's value. The new upper boundary condition for the callable debt problem is:

$$(1e) \qquad D(\bar{V}(\tau),\ \tau) = K(\tau)$$

Therefore, the formulation of the callable unguaranteed debt problem is equation (1) with $P = c+d$, $p=c$ and conditions (1a), (1b), and (1e).

The moment the debt is called, the guarantee has a zero value. Thus, the guarantee value problem has the upper boundary condition:

$$(2g) \qquad G(\bar{V}(\tau),\tau) = 0$$

where $\bar{V}(\tau)$ is the firm asset schedule determined in the callable debt problem. The guarantee value problem is then represented by equation (2) with $P = c+d$ and conditions (2a), (2b), and (2g). The value of guaranteed callable debt is simply the sum of the value of unguaranteed callable debt and the value of the guarantee.

None of the problems posed in this section has known analytic solutions for finite τ. However, there do exist numeric techniques

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that can be used to approximate the solutions. The next section presents and discusses the results of the numerical analysis of these problems.

SECTION III. NUMERIC RESULTS

The method of Markov chains is used to approximate solutions to the problems posed in the previous section. Samuelson proposed a similar technique to test a warrant pricing model. 6/ Parkinson and Mason use Markov chains to approximate solutions to valuation problems similar to the ones considered in this paper. 7/ A single computer algorithm, based on this method, is capable of treating all of the problems posed in this paper plus numerous other contingent claim valuation equations. The numeric results are represented by Tables 1 to 10 (see pages 369-373). These tables do not represent an exhaustive treatment of the problems but serve to demonstrate an application of contingent claims analysis to various loan guarantee problems given specific parametric assumptions.

The tables have been designed to convey as much information as possible and still be easy to interpret. To demonstrate, consider a firm with an asset value of $100 million and a single issue of guaranteed debt. Assume that the debt is promised a principal payment of $50 million in 15 years and carries a coupon rate of 12 percent per year. Let the variance of return on asset value be 20 percent per year and the riskless short-term interest rate be 10 percent per year. Finally, assume that the bond indenture specifies that the firm will pay no dividends over the life of the debt and that in case of "premature" bankruptcy, the government will pay the bondholders their promised principal. Thus, we have:

6/ P.A. Samuelson, "Rational Theory of Warrant Pricing," Industrial Management Review, Vol. 6 (1965), pp. 13-31.

7/ M. Parkinson, "Option Pricing: The American Put," Journal of Business, Vol. 50 (1977), pp. 21-36; and S.P. Mason, "The Numerical Analysis of Risky Coupon Debt Contracts," Harvard Business School Working Paper, No. 79-35 (1979).

$V = \$100,000,000$	$r = 10$ percent per year
$B = \$\ 50,000,000$	$\sigma^2 = 20$ percent per year
$c = \$\ 6,000,000$ per year	$\tau = 15$ years
$d = 0$	$P = \$6,000,000$ per year

Tables 1 to 3 represent a numeric treatment of this problem. Note that each table assumes specific values for the ratios r/σ^2, c/σ^2B, and P/σ^2B. Returning to the example:

$$r/\sigma^2 = 0.5 \qquad c/\sigma^2B = 0.6 \qquad P/\sigma^2B = 0.6$$

Thus, Table 2 represents the numeric treatment of this example. In order to find the proper table entry, it is necessary to compute the quantities $\sigma^2\tau$ and V/B. Given the example:

$$\sigma^2\tau = 3.0 \qquad V/B = 2.0$$

The table values are presented in units of promised principal, B. The first number, 0.902, represents the value of unguaranteed debt and the second number, 0.232, represents the value of the guarantee. The sum of these two numbers, 1.134, represents the value of guaranteed debt. So, for every \$1,000 of promised principal:

$D = \$\ 902$, value of unguaranteed bond

$G = \$\ 232$, value of guarantee

$D^* = \$1,134$, value of guaranteed debt

Note that the bottom line of Table 2 gives the value of a riskless bond, R(T), with the same promised payments. Thus, in the above example in which the short-term interest rate is a constant 10 percent per year, a riskless bond with a promised principal of \$1,000 due in 15 years and an annual coupon rate of 12 percent is worth \$1,155.

The virtue of presenting the results in this form is that the same table represents the numeric analysis of any similar loan guarantee problem with the same parametric assumptions. For instance, returning to the example, if r = 8 percent per year,

σ^2 = 16 percent per year and the debt carried a coupon rate of 9.6 percent per year, then Table 2 represents the numeric treatment of this problem. Indeed, it is possible to represent all the information in Tables 1 to 3 in one table by considering more complex transformations.

Tables 1 to 3 can be used to examine the effects of changing σ^2, the variance of return on asset value. Starting with Table 3, note the value of unguaranteed debt and the value of the guarantee corresponding to the underlined table entries. Now consider the same problem, except the variance has been increased by 50 percent. This would correspond to the underlined entries in Table 2. The value of the unguaranteed debt has gone down and the value of the guarantee has gone up. Table 1 represents a 200 percent increase in σ^2. Again, the value of the unguaranteed debt has decreased and the value of the guarantee has increased. Thus, as the firm becomes more risky, the unguaranteed debt becomes less valuable and the guarantee more valuable.

Note also that the value of the guaranteed debt decreases as σ^2 increases. This is due primarily to the specification of the lower boundary in this problem, which says that, if the firm defaults before the maturity date, then the bondholders receive the promised principal. An alternative specification of this covenant, which is more consistent with the notion of "guaranteed" debt, is that, if the firm defaults, the bondholders receive the present value of all promised future payments. As is evident from Table 4, this will result in the value of a guaranteed bond always being equal to the value of its riskless bond equivalent, R(T).

If the firm is making payouts to other claimants, such as dividends or coupon payments to junior debt, then the value of the unguaranteed debt and the value of the guarantee are affected. Table 5 allows for $P > c$, which says that total firm payouts are greater than that being made to the guaranteed debt. Compare Table 5 with Table 2, where $P = c$. The value of the unguaranteed debt decreases, the value of the guarantee increases, and the value of the guaranteed debt decreases.

Some debt is partially guaranteed; for example, the government guarantees that the bondholder will receive at least X percent of the promised principal in case of default. Table 6 considers a 75 percent guarantee in which the bondholders are assured of receiving 75 cents for every dollar of promised principal. Compare

Table 6 with Table 2, which is, of course, a 100 percent guarantee. The value of the unguaranteed debt is unaffected by the presence of a partial guarantee. The value of a partial guarantee is, as would be expected, worth less than the value of a full guarantee. Note, however, that an X percent guarantee is worth less than X percent of a full guarantee.

Tables 7 to 9 are concerned with the problem of guaranteed junior debt. These tables assume that the junior principal and the senior principal are equal, $B = B'$. The response of the value of unguaranteed junior debt and the value of the guarantee to changes in risk, σ^2, is ambiguous. Note the underlined entries in Table 9. Table 8 represents the same problem as Table 9, except σ^2 has been increased by 50 percent. For high asset values, the value of unguaranteed junior debt decreases and the value of the guarantee increases. This is similar to the behavior of guaranteed senior debt. However, for low asset values, the reverse occurs. The value of the unguaranteed junior debt increases and the value of the guarantee decreases. The same results obtain in comparing Table 8 with Table 7, which represents a 100 percent increase in σ^2.

This phenomenon has an interesting implication for the structure of loan guarantee programs. Assume that a firm has a single class of unguaranteed debt and the government has agreed to guarantee fully a new issue of debt. Further, assume that the guarantee specifies that in the event of a default, the guaranteed debt will receive R(T), the riskless bond equivalent. This means that the guaranteed debt will always trade like a riskless bond, independent of the risk level of the firm, and, therefore, the guaranteed debtholders will have no incentive to monitor the actions of the firm. However, as has been shown, the value of the guarantee will in most cases increase if the risk of the firm increases. Since the guarantee is a liability, the government has an incentive to monitor the firm's behavior. This monitoring function would represent an additional expense to the government, thus it is of interest to ask if it is possible for the guarantee to be structured so that the incentives of the existing unguaranteed debt are consistent with those of the guarantor. For instance, consider positioning the guaranteed debt senior to the existing unguaranteed debt. Will the unguaranteed debt consistently guard against increases in firm risk and, therefore, relieve the government of the task of monitoring the firm? Clearly the answer is no, since it was earlier demonstrated that unguaranteed junior debt will at times benefit from increases in firm risk. What if the guaranteed debt is placed junior to the existing debt? Then it is true that the unguaranteed senior debt will always have the incentive to guard against increases in firm risk. Of course, given a fixed amount of debt to guarantee, it will cost more (the value of the guarantee is larger) to guarantee the junior debt. Table 5 and Table 8 demonstrate this point.

The last problem to be treated is that of callable guaranteed debt. Consider the following call schedule:

$$K(\tau) = \gamma(R(\tau)-B) + B$$

where $0 \leq \gamma \leq 1$. Table 10 represents the value of unguaranteed callable debt and the value of the guarantee when $\gamma = .25$. Table 2 is the noncallable counterpart to Table 10. As is well known, and as is verified by comparing the tables, noncallable unguaranteed debt is more valuable than callable unguaranteed debt. And, as would be expected, the guarantee is less valuable in the case of the callable debt, since the call feature has the effect of taking the guarantor "off the hook."

SECTION IV. EXTENSIONS

This paper has not fully exploited contingent claims analysis or the Markov chains approximation algorithm in analyzing guaranteed loan problems. There are a number of interesting extensions that could be readily treated. For instance, in this paper it was assumed that the government is the guarantor, and, therefore, there was no risk associated with the payment of the guaranteed amount. A possible extension would be to allow for a risky guarantor such as another firm. Callable convertible debt, as well as certain tax effects, might me incorporated into this analysis. This paper also assumed a constant riskless short-term interest rate. It would be possible to allow for stochastic interest rates but this would result in valuation models that would require additional assumptions.

TABLE 1. UNGUARANTEED DEBT VALUES AND GUARANTEE VALUES
$r/\sigma^2 = 0.25 \quad c/\sigma^2 B = 0.30 \quad P/\sigma^2 B = 0.30 \quad T = \sigma^2 \tau$

V/B	3.0	1.5	1.0	0.0
4.00	0.905	0.964	0.992	1.000
	0.195	0.098	0.052	0.000
2.00	0.769	0.835	0.880	1.000
	0.324	0.226	0.163	0.000
1.00	0.595	0.642	0.681	1.000
	0.484	0.416	0.362	0.000
0.50	0.406	0.425	0.442	0.500
	0.652	0.624	0.598	0.500
0.25	0.238	0.242	0.245	0.250
	0.796	0.791	0.787	0.750
0.00	0.000	0.000	0.000	0.000
	1.000	1.000	1.000	1.000
R(T)	1.105	1.062	1.044	1.000

TABLE 2. UNGUARANTEED DEBT VALUES AND GUARANTEE VALUES
$r/\sigma^2 = 0.50 \quad c/\sigma^2 B = 0.60 \quad P/\sigma^2 B = 0.60 \quad T = \sigma^2 \tau$

V/B	3.0	1.5	1.0	0.0
4.00	1.032	1.036	1.039	1.000
	0.115	0.068	0.039	0.000
2.00	0.902	0.918	0.938	1.000
	0.232	0.182	0.140	0.000
1.00	0.700	0.713	0.731	1.000
	0.408	0.378	0.344	0.000
0.50	0.455	0.459	0.465	0.500
	0.616	0.608	0.596	0.500
0.25	0.248	0.248	0.249	0.250
	0.789	0.788	0.787	0.750
0.00	0.000	0.000	0.000	0.000
	1.000	1.000	1.000	1.000
R(T)	1.155	1.105	1.078	1.000

TABLE 3. UNGUARANTEED DEBT VALUES AND GUARANTEE VALUES

$r/\sigma^2 = 0.75 \quad c/\sigma^2 B = 0.90 \quad P/\sigma^2 B = 0.90 \quad T = \sigma^2 \tau$

V/B	3.0	1.5	1.0	0.0
4.00	1.101	1.086	1.076	1.000
	0.070	0.047	0.028	0.000
2.00	0.982	0.979	0.984	1.000
	0.173	0.149	0.120	0.000
1.00	0.760	0.762	0.770	1.000
	0.361	0.348	0.326	0.000
0.50	0.476	0.477	0.479	0.500
	0.600	0.597	0.592	0.500
0.25	0.250	0.250	0.250	0.250
	0.787	0.787	0.787	0.750
0.00	0.000	0.000	0.000	0.000
	1.000	1.000	1.000	1.000
R(T)	1.178	1.135	1.105	1.000

TABLE 4. UNGUARANTEED DEBT VALUES AND GUARANTEE VALUES

$r/\sigma^2 = 0.50 \quad c/\sigma^2 B = 0.60 \quad P/\sigma^2 B = 0.60 \quad LB = R(T) \quad T = \sigma^2 \tau$

V/B	3.0	1.5	1.0	0.0
4.00	1.032	1.036	1.039	1.000
	0.123	0.069	0.039	0.000
2.00	0.902	0.918	0.938	1.000
	0.253	0.186	0.140	0.000
1.00	0.700	0.713	0.731	1.000
	0.455	0.392	0.347	0.000
0.50	0.455	0.459	0.465	0.500
	0.699	0.646	0.613	0.500
0.25	0.248	0.248	0.249	0.250
	0.906	0.856	0.829	0.750
0.00	0.000	0.000	0.000	0.000
	1.155	1.105	1.078	1.000
R(T)	1.155	1.105	1.078	1.000

TABLE 5. UNGUARANTEED DEBT VALUES AND GUARANTEE VALUES

$r/\sigma^2 = 0.50 \quad c/\sigma^2 B = 0.60 \quad P/\sigma^2 B = 1.40 \quad T = \sigma^2 \tau$

V/B	3.0	1.5	1.0	0.0
4.00	0.876 0.254	0.929 0.172	0.978 0.099	1.000 0.000
2.00	0.658 0.444	0.697 0.390	0.759 0.314	1.000 0.000
1.00	0.414 0.650	0.425 0.636	0.449 0.608	1.000 0.000
0.50	0.227 0.806	0.227 0.806	0.229 0.804	0.500 0.500
0.25	0.122 0.894	0.122 0.894	0.122 0.894	0.250 0.750
0.00	0.000 1.000	0.000 1.000	0.000 1.000	0.000 1.000
R(T)	1.155	1.105	1.078	1.000

TABLE 6. UNGUARANTEED DEBT VALUES AND PARTIAL GUARANTEE VALUES

$r/\sigma^2 = 0.50 \quad c/\sigma^2 B = 0.60 \quad P/\sigma^2 B = 0.60 \quad \delta = 0.75 \; T = \sigma^2 \tau$

V/B	3.0	1.5	1.0	0.0
4.00	1.032 0.083	1.036 0.042	1.039 0.020	1.000 0.000
2.00	0.902 0.170	0.918 0.123	0.938 0.083	1.000 0.000
1.00	0.700 0.302	0.713 0.271	0.731 0.232	1.000 0.000
0.50	0.455 0.458	0.459 0.448	0.465 0.433	0.500 0.250
0.25	0.248 0.587	0.248 0.586	0.249 0.584	0.250 0.500
0.00	0.000 0.750	0.000 0.750	0.000 0.750	0.000 0.750
R(T)	1.155	1.105	1.078	1.000

TABLE 7. UNGUARANTEED JUNIOR DEBT VALUES AND GUARANTEE VALUES

$r/\sigma^2 = 0.25$ $c'/\sigma^2 B' = 0.40$ $P/\sigma^2 B' = 0.70$ $T = \sigma^2 \tau$

V/B	3.0	1.5	1.0	0.0
4.00	0.896	0.866	0.870	1.000
	0.381	0.318	0.262	0.000
2.00	0.691	0.653	0.623	1.000
	0.540	0.520	0.507	0.000
1.00	0.465	0.441	0.402	0.000
	0.701	0.702	0.717	1.000
0.50	0.264	0.259	0.246	0.000
	0.833	0.835	0.842	1.000
0.25	0.129	0.129	0.129	0.000
	0.918	0.918	0.919	1.000
0.00	0.000	0.000	0.000	0.000
	1.000	1.000	1.000	1.000
R(T)	1.316	1.187	1.132	1.000

TABLE 8. UNGUARANTEED JUNIOR DEBT VALUES AND GUARANTEE VALUES

$r/\sigma^2 = 0.50$ $c'/\sigma^2 B' = 0.80$ $P/\sigma^2 B' = 1.40$ $T = \sigma^2 \tau$

V/B	3.0	1.5	1.0	0.0
4.00	1.116	1.055	1.015	1.000
	0.275	0.248	0.218	0.000
2.00	0.843	0.809	0.768	1.000
	0.463	0.455	0.453	0.000
1.00	0.524	0.516	0.498	0.000
	0.670	0.670	0.675	1.000
0.50	0.271	0.270	0.269	0.000
	0.830	0.830	0.831	1.000
0.25	0.127	0.127	0.127	0.000
	0.920	0.920	0.920	1.000
0.00	0.000	0.000	0.000	0.000
	1.000	1.000	1.000	1.000
R(T)	1.466	1.316	1.236	1.000

TABLE 9. UNGUARANTEED JUNIOR DEBT VALUES AND GUARANTEE VALUES
$r/\sigma^2 = 0.75 \quad c'/\sigma^2 B' = 1.20 \quad P/\sigma^2 B' = 2.10 \quad T = \sigma^2 \tau$

V/B	3.0	1.5	1.0	0.0
4.00	1.237 0.213	1.180 0.200	1.127 0.184	1.000 0.000
2.00	0.918 0.421	0.896 0.418	0.862 0.417	1.000 0.000
1.00	0.541 0.661	0.538 0.660	0.531 0.662	0.000 1.000
0.50	0.268 0.832	0.268 0.832	0.268 0.832	0.000 1.000
0.25	0.123 0.922	0.123 0.922	0.123 0.922	0.000 1.000
0.00	0.000 1.000	0.000 1.000	0.000 1.000	0.000 1.000
R(T)	1.536	1.405	1.316	1.000

TABLE 10. UNGUARANTEED CALLABLE DEBT VALUES AND GUARANTEE VALUES
$r/\sigma^2 = 0.50 \quad c/\sigma^2 B = 0.60 \quad P/\sigma^2 B = 0.60 \quad \gamma = 0.25 \; T = \sigma^2 \tau$

V/B	3.0	1.5	1.0	0.0
4.00	1.005 0.093	1.009 0.052	1.013 0.025	1.000 0.000
2.00	0.892 0.224	0.909 0.178	0.929 0.136	1.000 0.000
1.00	0.697 0.406	0.710 0.377	0.729 0.343	1.000 0.000
0.50	0.454 0.616	0.458 0.608	0.464 0.596	0.500 0.500
0.25	0.248 0.789	0.248 0.788	0.246 0.787	0.250 0.750
0.00	0.000 1.000	0.000 1.000	0.000 1.000	0.000 1.000
K(T) R(T)	1.038 1.155	1.026 1.105	1.019 1.078	1.000 1.000

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