1981

Flow of funds modeling for localized financial markets: an application of spatial price and allocation activity analysis models

James Arthur Hoskins
Iowa State University

8122524

HOSKINS, JAMES ARTHUR

FLOW OF FUNDS MODELING FOR LOCALIZED FINANCIAL MARKETS: AN APPLICATION OF SPATIAL PRICE AND ALLOCATION ACTIVITY ANALYSIS MODELS

Iowa State University PH.D. 1981

University
Microfilms
International 300 N. Zeeb Road, Ann Arbor, MI 48106

Flow of funds modeling for localized financial markets: An application of spatial price and allocation activity analysis models

by

James Arthur Hoskins

A Dissertation Submitted to the
Graduate Faculty in Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY

Department: Economics
Major: Economics

Approved:

Signature was redacted for privacy.

In Charge of Major Work

Signature was redacted for privacy.

For the Major Department

Signature was redacted for privacy.

For the Graduate College

Iowa State University
Ames, Iowa

1981

TABLE OF CONTENTS

CHAPTER I. PROBLEM STATEMENT AND OBJECTIVES

> It is the business of economics as of almost every other science, to collect facts, to arrange and interpret them and to draw inferences from them. 'Observation and description, definition and classification are preparatory activities. But what we desire to reach thereby is a knowledge of the interdependence of economic phenomena.. . . Induction and deduction are both needed for scientific thought as the right and left foot are needed for walking.'[1]

A series of private and government directed study groups, initiated during the past 20 years, have resulted in a variety of proposed policy and regulatory changes to the U.S. financial system.[2] One of the more controversial banking issues confronted in these studies is the impact of branch banking on the flow of funds between regions and thus funds availability in rural areas (127). Proponents of branch banking offer evidences suggesting the continued reliance on unit banking through restrictions on or prohibition of branch banking restricts flow of funds into rural areas. This leads to a net flow of funds from rural areas to more profitable urban areas, thus, making continued financing of the

---

[1]Alfred Marshall (119, p. 29) quoting Schmoller in the article on Volkswirtschaft in Conrad's Handworterbuch.

[2]For example see (3, 16, 165, 166, 167, 168, 169).

agriculture and agri-business sector difficult. Opponents contend the opposite, that liberalization of restrictions in fact results in serious deposit drains from rural areas. These contradicting results are indicative of analyses directed at many of the proposed changes and existing inefficiencies in the financial system.

While this dissertation was prompted by conflicting research findings surrounding proposed liberalization of commercial bank branching laws, its appeal is to a broader class of problems concerned with effective local financial intermediation. Research efforts in this area have been primarily confined to econometric and descriptive analysis of a particular geographic area before and after a regulatory or policy change or to comparative analysis of geographic areas differing only in the proposal under consideration. They have not generally taken advantage of the unique economic environments of the areas or successfully dealt with the interactive effects of multiple changes. Econometric studies have been further hampered by the inability to reflect market interaction of competing financial institutions or to adequately specify operational activities of firms at which many of the policy and regulatory changes are directed.[1]

[1]Jones (94), in advocating greater operations research involvement in the financial area, points out that while the regression approach avoids subjective assessment of structural elements of the financial system, at the same time it fails to offer any inspiration for ideas for changing basic structural relationships.

The important issues affecting efficient local financial intermediation, concentrating on those especially important to agricultural finance, are delineated in chapter 2. The role of operations research philosophy in a systematic examination of local financial markets is discussed and the advantageous deductive and inductive properties associated with a mathematical programming representation of local agricultural financial markets are identified.

Although mathematical programming techniques have not been applied in the study of local financial markets, this research void has been recognized. Baker, Hopkin, and Brinegar expressed:

> . . . the need to improve models available to describe the status and functioning of financial markets. This problem will remain even if appropriate and efficient models were available for commercial banks, life insurance companies, cooperative lending agencies, and so on. However, the ready availability of firm models would greatly facilitate research in the area of financial markets, and would emphasize the need for market models to better describe the financial alternatives and constraints relevant to the intermediating firms (5, p. 8).

Referring more specifically to the problems of institutional reform, Boehlje suggested the potential application of spatial price and allocation models:

> Although current discussions are focused on restructuring the full spectrum of financial institutions and electronic funds transfer systems, the issues of banking structure and the implications for flow of funds between rural and urban areas have been with us for many years. A definitive study of these issues possibly

> using the concepts and models of interregional competition analysis would provide useful information to policy makers (21, p. 119).

The application of the spatial activity analysis model of production and allocation, where price and flow quantities are endogenously determined, to local financial markets would meet two principal criticisms of current research efforts. The activity analysis structure provides flexibility and detail in modeling the nature of operational activities of intermediaries, and the spatial aspects of the model combined with endogenously determined prices can be used to reflect the market interaction of competing financial institutions. To indicate the feasibility of this approach, a spatial activity analysis model of financial intermediation in a perfect competition setting is presented in chapter 3.

However, there are problems of extending the perfect competition model to financial markets. Most practical applications of such models have been to agricultural sector problems where perfect competition is a good representation of reality or a reasonable normative goal. They generally deal with well-defined geographic markets for homogeneous final products. Sometimes, they allow markets for intermediate products, but almost always consider raw materials or supplies as provided at a fixed cost. Financial markets, on the other hand, are characterized by oligopolistic behavior; market segmentation and product differentiation; government regulation and intervention; and competition not only in marketing final products, loans and credit, but also competition for funds. A variation of the spatial activity analysis model which reflects these unique characteristics of financial intermediation is developed in chapter 4.

Many of the policy considerations in the intermediation process, whether concerned with banking or other financial institutions, can be analyzed using the common mathematical structure described in chapter 4. A series of prototypes representing the commercial banking structure are presented in chapter 5. The prototypes are used to extend the competitive concepts described in chapters 3 and 4 to include differentiated products, advertising variables, modeling specific noncompetitive environments such as market share solution to the oligopoly problem, and intertemporal modeling.

Recent studies indicate that the allocative efficiency of optimization models of individual financial firms is greatly reduced by the uncertainty involved in predicting data inputs such as interest rates, loan demand, and deposit volume (52, 143). *A priori* one would expect this effect to be magnified when individual firms' portfolios are linked and market interactions are considered. Specification of market loan demand and deposit supply functions must be the first and most important step in data support. Only limited econometric work has been completed in estimating the supply and demand for financial assets and liabilities in the aggregate farm sector. There exists no comprehensive treatment on the microeconomic level of local markets. Theoretical and data acquisition considerations, in estimating the supply and demand for financial assets and liabilities in rural Iowa counties, are presented in chapter 6. Alternative estimation procedures and initial empirical results are given.

To reiterate, this study is designed to be a basic reference for those who wish to do policy analyses of changes impacting local financial intermediation. In addition to providing a comprehensive examination of the recent and proposed institutional and regulatory changes impacting local financial markets and a comprehensive summary of the most important applications of mathematical programming to individual financial intermediaries and financial markets, the principal objective is to develop variations of the spatial activity analysis model which capture the unique characteristics of financial intermediation. The models can be applied not only to regional problems but also to very localized financial activity. Empirical models could be designed and exercised by policy groups or by individual intermediaries desiring insights for improved operational decisions by more comprehensive modeling of their market and interfirm activities.

A few brief examples better illustrate the type of problems on which initial empirical efforts could focus. The impact of branching, for example within or across county lines, could be examined by developing a baseline model structure, exclusive of branch activity, and then comparing price and flow of funds outcomes with results obtained from alternative model formulations including branch activities. The model could then be used to identify parameters and structural elements to which results were most sensitive, or could be used for developing strategies for placement of branch facilities. The effects of electronic funds transfer could be examined in a similar fashion by altering transaction costs and flow of funds channels associated with electronic funds transfer. Finally the impacts on local interest rates and flow of funds due to expanded savings and loan association authorities and phasing out of interest rate ceilings and differentials on deposits could be examined, possibly with focus on changing credit flows to agriculture.

CHAPTER II. FINANCIAL INTERMEDIATION AND OPERATIONS RESEARCH: A NEW DIRECTION

This chapter introduces the complexities of financial intermediation in the United States and the myriad institutional and regulatory changes which financial institutions, especially agricultural financial institutions, face in the 1980s. The potential impact of these changes has not been systematically analyzed by either the financial industry or the government, and there is both an absence of and the need for a comprehensive policy analyses capability. The contributions of operations research to modeling the behavior of individual financial firms and the limited research directed at the financial intermediation system are detailed. Finally, a concise problem statement and description of the general approach of the remainder of this study are given. The approach builds on existing research on individual firms by extending spatial price and allocation models to provide a general analytic framework for policy analyses in local financial markets in general and specifically in rural agricultural financial markets.

Financial Intermediation

Definition

Financial intermediaries perform two essential functions (5). They facilitate transfer of funds from savers to investors and, in so doing, transform the risk and liquidity properties of those funds. In acquiring funds from surplus units--municipalities, corporations, businesses, and individuals--the intermediaries issue claims on themselves, such as deposit, note, certificate, or bond liabilities. They allocate the funds to alternative users in return for claims on those units and payments which are then returned to suppliers of funds or accrue as profits to the intermediaries. The role of the intermediary is better described by developing a simple scenario (108).

Consider an economy where legal tender is the only primary security, the only claim to wealth. Unable to lend or borrow, individuals must allocate current income and past savings among current consumption; current savings; and current capital formation, in anticipation of a future stream of income and consumption. Capital formation is hindered in two ways: (1) individuals with surplus funds are limited by their entrepreneurial abilities; and (2) many large capital projects cannot be undertaken since there is a practical limit on an individual's resource accumulation.

If savers are allowed direct transfer of funds to investors, in the form of lending, more efficient resource utilization and increased income are possible. As potential users compete for surplus funds, saving is encouraged since savers receive a higher return than they could earn in isolation. Some of the inefficiency in resource allocation is corrected as additional worthwhile investment activities are undertaken. Many interferences remain, however, which prevent optimal savings and investment patterns. Ignorant of investment alternatives, savers incur costs in search of maximum potential return. Entrepreneurs' costs include searching out many prospective investors and convincing them of the credit worthiness of the intended capital projects. The resultant transaction, exchange of surplus funds for a primary security, is a compromise. Holders of surplus funds, desiring security in their claims on wealth, are apt to demand liquid, short-term commitments and minimum risk or high premiums for accepting greater risks. Users of funds prefer long-term commitments and minimum payments for risk acceptance.

When financial intermediation is allowed, specialized firms evolve and engage in a type of arbitrage between suppliers and users of funds. Specialization leads to a more accurate assessment of risk and more comprehensive knowledge of investment alternatives. This knowledge, coupled with large transaction volume, reduces risks and permits these middlemen to more readily accept risks that individuals would not accept. The intermediaries acquire funds in exchange for liabilities on themselves. These claims, assets to the individual holders, are characterized by less risk, shorter maturities, and higher return than the individuals generally could negotiate directly. The intermediaries then allocate funds among competing uses in return for assets in the form of primary claims on borrowers. These liabilities to the investors are characterized by longer durations, and lower risk premiums than the entrepreneurs could have generally negotiated directly. The margin or difference, as in any form of arbitrage, between the amount paid to the suppliers of funds and the amount received in payment from the users accrues as profit.

Financial intermediaries

In a modern capitalistic society, nearly all businesses and many individuals play such an intermediary role. However, the term financial intermediary is usually reserved for those firms whose liabilities are almost exclusively financial claims on themselves and whose assets are almost entirely financial claims on others (11). Krooss and Blyn (108) provide a comprehensive history of financial intermediation primarily directed at commercial banks, investment banks, trust companies, mutual savings banks, savings and loan associations, life insurance companies, noninsured pension funds, investment companies, and credit unions. Additionally, the authors include in a broader set of financial intermediaries government agencies--the Federal Reserve System, postal savings system, Federal Farm Credit System, social security funds, and government pension funds--security brokers and dealers, mortgage companies, finance companies and small business investment companies. The relative importance of the major financial intermediary types, as shown in a flow-of-credit diagram for the United States, indicates that the commercial banking system including the Federal Reserve System represents the single most diversified and important part of the United States financial system (29). Much of the discussion that follows focuses on the commercial banking system.

As indicated in table 2.1, commercial banking and the Farm Credit System (FCS) are the principal institutional lenders to agriculture. The banks, associations and cooperatives of the FCS are federally chartered instruments of the United States but are owned by their respective borrowers, who are required to purchase stock in the institutions. The FCS is able to enhance credit availability to American agriculture by acquiring funds, through the sale of bonds and notes, in national money markets and then providing short- and long-term loans at interest rates which are held to the lowest possible level while maintaining a sound financial posture. The FCS is made up of three types of lending institutions: (1) 12 Federal Land Banks (FLB) and their 505 owner Federal Land Bank Associations; 91 percent of FLB loans are used for purchasing new real estate, improving land and buildings, or refinancing previous real estate and short-term loans;

Table 2.1. Farm debt outstanding: By lender as of January 1 (176)

	Percent					
	Farm Real Estate Debt					
	Total[a] ($ Millions)	Commercial Banks	Fed. Land Banks	Life Ins. Companies	Farm Home Administr.	Individuals[a] and Others
1920	8,449	14.3	3.5	11.5	--	70.7
1930	9,631	10.4	12.5	22.0	--	55.1
1940	6,586	8.1	30.5	14.9	.5	45.9
1950	5,579	16.7	16.2	21.0	3.6	42.5
1960	12,082	12.6	19.3	23.3	5.6	39.1
1970	29,183	12.1	22.9	19.6	7.8	37.5
1975	46,288	12.9	29.0	13.6	6.9	37.6
1979	72,978	11.7	33.7	14.4	6.2	33.9
1980	85,850	10.1	34.6	14.2	8.1	33.0
	Nonreal Estate Farm Debt					
	Total ($ Millions)	Commercial Banks	Production Credit Assns.	Other Institutional Debt to Fed. Intermediate Credit Banks	Farm Home Administr.	Individual and Other
1950	5,154	39.8	7.5	1.0	6.7	45.0
1955	7,196	40.8	8.0	.8	5.8	44.6
1960	11,528	41.8	1.8	.8	3.5	42.2
1965	16,366	42.7	13.9	.8	3.9	38.7
1970	21,168	48.8	21.2	1.0	3.7	25.2
1975	35,225	51.8	27.0	1.1	3.0	17.2
1978	51,142	50.3	26.4	.7	6.1	16.4
1979	59,600	47.4	25.2	.9	9.0	17.5
1980	70,300	43.9	25.7	.9	12.8	16.7

[a]Estimated

(2) 12 Federal Intermediate Credit Banks (FICB) and the 425 Production Credit Associations (PCA) which serve as their link with borrowers; PCAs provide short-term credit for operating expenses, livestock purchase and production, equipment purchase, living expenses and real estate; (3) 13 Banks for Cooperatives which provide dependable and continuing financing to over 3000 agricultural cooperatives (176).

Credit-granting services represent only one of two broad classes of products produced by commercial banks. Equally important are deposit-holding services. Thrift institutions--savings and loan associations, mutual savings banks, and credit unions--represent the major competitor group for deposit services. The importance of commercial banking in agriculture is illustrated in table 2.2, which shows its relative importance in both credit-granting and deposit-holding in Iowa.

In order to help understand the potential impacts of proposed changes in the financial system on local agricultural financial markets, appendix A provides a more detailed summary of the characteristics of intermediaries' services to agriculture.[1]

---

[1]Nelson, Lee, and Murray (130) provide a more in-depth description of intermediaries in agricultural finance. Cambridge Research Institution has prepared a quantitative delineation of deposit and lending characteristics of different intermediaries (29).

Table 2.2.

Importance of commercial banking in Iowa (83, 164)

	Percent		
	Farm Real Estate Debt as of 1/1/75	Nonreal Estate Farm Debt as of 1/1/75	Deposits as of 12/31/76
Commercial Banks	6.5	78.6	74.0
Federal Land Banks	20.4	--	--
Life Insurance Co.	15.6	--	--
Farmers Home Administration	4.7	2.2	--
Individuals & Others	52.9	--	--
Production Credit Associations	--	18.8	--
Federal Intermediate Credit Banks	--	.4	--
Savings & Loan Associations	--	--	23.9
Credit Unions	--	--	2.1

Local markets

The interactions of financial intermediaries, savers and investors and the resulting transactions in a myriad of financial instruments constitute the nation's financial markets. This study concentrates on local financial markets delimited by local suppliers and users of funds and the intermediaries that serve them. While the term local financial markets is often used (11, 130), practical delineation of such markets is a difficult and imprecise task. It is unlikely that demand and supply for credit in an isolated market will be equated at a price reflecting a marginal product in use equal to that in other markets. However, markets are not isolated; they are linked by a communications network and a continuous flow of funds between geographically separated suppliers and users of credit. The financial system is in fact a hierarchy of imperfect linkages between local, regional, national, and international intermediaries. Even if the linkages between financial markets were perfect, unique risk characteristics of local markets and the transport or transaction cost of moving funds from surplus areas to net demand areas would result in unequal rates in local markets. However, an absence of imperfections would lead to an optimal allocation of funds as the marginal product of credit in all uses and areas was equalized. To the extent that imperfections prevent such an optimal allocation, they may affect the balance of economic activity in regions or sectors of the economy. Surplus areas, without alternative uses for funds, finance over production with resulting lower returns per unit of resource use; net demand areas, without access to outside funds, forego production possibilities with higher returns per unit resource use (130). In the extreme, financial collapse of an area or sector can result if units cannot meet desired or needed cash flows from normal sources of operating income or from financial intermediaries. Demand units forced to withdraw from the market sell off inventories. The disruption of business activity and fluctuations in market rates can lead surplus units to withdraw from the market, thus affecting still more demanding units (169, p. 394).

The ability of local intermediaries to allocate credit efficiently in local markets depends on the strength of four types of linkages: (1) the linkage between local suppliers of funds and surplus units outside the local market; (2) the linkage between local users of funds and units demanding credit outside the local market; (3) the linkage, primarily through local intermediaries, between local suppliers and users of credit; and (4) the overall linkage between the sector encompassing a number of local markets and the rest of the economy (11). Krooss and Blyn (108) describe improvements in the financial system as a continual process of innovation aimed at (1) encouraging savings, (2) making borrowing easier, and (3) improving the liquidity and geographic mobility of financial instruments so as to narrow the gap between savers and investors. Haley (67) adds an important concept in defining well-functioning financial markets. He contends a system should (1) be efficient in allocation and operation, that is, provide minimum cost services whenever sufficient demand for them exists; (2) be competitive, that is, not exploitive of lenders or borrowers in terms of availability or costs of services; (3) be responsive, that is, willing and able to supply innovative techniques in response to changing customer needs; and (4) be stable, that is, not excessively prone to failure or service curtailment as a result of changing economic conditions. This final consideration has played a major role in the evolution of the current legal, regulatory and supervisory structure of the financial system in the United States.

Current issues affecting local financial markets

The Commission on Money and Credit sponsored by the Committee for Economics Development from 1958 to 1961 recommended relaxation or elimination of a number of the regulatory restrictions enmeshing the U.S. financial system (29, p. 95). Since then, every congressional or presidential directed examination of the financial system--President

Kennedy's Committee on Financial Institutions (Heller report), 1964; President's Committee on Financial Structure and Regulation (Hunt Commission), 1971; President Nixon's Recommendations for Change in the U.S. Financial System, 1975; Financial Institutions Act of 1976; Financial Institutions and the Nation's Economy (FINE) Study, 1976; Financial Institutions Act of 1976; U.S. Senate Committee on Banking, Housing and Urban Affairs' First Meeting on the Condition of the Banking System; Depository Institutions Deregulation and Monetary Control Act of 1980--has attempted to reconcile the conflict between a competitive and stable financial system:[1]

> For well over a century the American public has insisted that its financial institutions be both competitive and sound. The two objectives are not easily reconciled, and yet both must be achieved if we are to avoid, on the one hand, a highly concentrated financial structure and, on the other, a system unable to withstand the vicissitudes of economic change. The public is entitled to the benefits of a dynamic and innovative system responsive to shifting needs. Yet the public also should be able to rely on the strength and soundness of the system (168, p. 291)

In response to a FINE Study questionnaire, the Comptroller of the Currency identified three areas of unreconciled conflict between the concepts of stability and competition: (1) statutes which set interest rate ceilings

---

[1]See (3, 6, 16, 29, 30, 114, 140, 165, 166, 167, 168, 169).

on deposits, allow rate differentials between commercial banks and other financial institutions, and prohibit payment of interest on demand deposits; (2) statutes regulating branching and mergers; and (3) statutes setting limits on the activities of financial intermediaries (168, p. 307). Appendix B reiterates these basic conflicts by identifying and comparing the major recommendations of the Hunt Commission, President Nixon's recommendations, the Financial Institution Act of 1976, and the FINE study.[1]

Though few of the recommendations of any of these studies were enacted into law, they remained critical issues facing the financial system. A list of issues facing banking, identified in a survey prepared for the Senate Committee on Banking, Currency and Urban Affairs (1977), included most of the basic recommendations of earlier groups: (1) electronic banking, (2) one consolidated federal banking regulatory agency, (3) removal of ceiling rates on time and savings deposits, (4) payment of interest on checking accounts, (5) granting checking account powers to savings and loan associations, (6) unlimited statewide branching, (7) branching across state boundaries, (8) continued bank holding company expansion and diversification, (9) increased disclosure of banking data, (10) public

---

[1]The table is not a comprehensive list of recommendations; however, an attempt has been made to include the major recommendations of each report.

disclosure of bank problem lists, (11) public disclosure of bank examination data, (12) operation of U.S. banks in foreign countries, (13) operation of foreign banks in the U.S. (169, p. 539).

The major study groups recognized the importance of treating structural changes in a totality not as a set of disparate actions. Both the Hunt Commission recommendation in 1971 and the FINE study in 1976 represent comprehensive proposals for improving the competitive environment of the financial system and for creating a homogeneity of powers necessary for existing intermediaries to compete successfully. The nearer to legislative enactment, the more piecemeal were the proposals. The FINE report never emerged from House and Senate committee action in 1976. The Financial Institution Act of 1976, which would have allowed demand deposit and expanded lending powers to thrift institutions, was defeated in the House Banking, Currency and Housing Committee in May 1976. Piecemeal bills were tabled by the Senate Banking, Housing and Urban Affairs Committee in September 1976. Vigorous industry actions to push interpretation of existing statutes to their limits and changing state laws allowed thrift institutions to issue interest and noninterest bearing third-party accounts similar to bank demand deposits (114). These advances were not accompanied by balancing legislative change in thrift institutions' lending powers or commercial bank powers for interest payment on demand deposits. In April 1979, a Federal District Court declared illegal three fund-transfer mechanisms which had been approved for commercial banks (automatic transfer from savings to checking), savings and loans (remote service units) and credit unions (share drafts) by federal bank regulators. The Court said only Congress could approve such fund-transfer mechanisms which effectively allowed interest to be paid on checking accounts (6).

The court ban which would have been effective January 1, 1980, and the inflationary pressures of 1979-1980 on existing restrictions, such as interest rate ceilings on deposit accounts and usury ceilings, created an imperative for legislative action. On June 21, 1979, President Carter announced a financial reform bill focused on phasing out interest rate ceilings on deposits at commercial banks and savings and loans, removing the ¼ percent rate differential for savings and loans and savings banks, and allowing interest to be paid on transaction accounts. Much of the administration's proposal was already included in legislation filed in June 1979 by Senators William Proxmire, Chairman of the Senate Banking Committee, and Alan Cranston, Chairman of the Financial Institutions Subcommittee. During 1979, the legislature extended the court-set deadline on fund-transfer mechanisms to March 31, 1980. On March 31, 1980, President

Carter signed into law the Depository Institution Deregulation and Monetary Control Act of 1980. Major provisions of the legislation are as follows: (1) end (phase out) deposit interest rate ceilings and ¼ percent differential for thrift institutions, (2) statutory authority for funds transfer mechanisms, (3) permit nationwide negotiable orders of withdrawal (NOW) accounts, (4) eliminate usury ceilings on home mortgages, (5) increase federal deposit insurance limit, (6) provide access to the Federal Reserve's discount window to all depository institutions, (7) impose universal reserve requirements including required reserves on all transaction accounts at all depository institutions, (8) establish fees for Federal Reserve services, (9) simplify truth-in-lending law and regulations, and (10) expand power of thrift institutions to include allowing Federal credit unions to offer residential real estate loans and to allow savings and loans greater loan flexibility and expanded investment authority (6, 140).

While the Depository Institutions Deregulation and Monetary Control Act of 1980 was landmark legislation, it was less comprehensive in its treatment of major issues facing the financial community than were earlier study groups. For the most part, the legislation was a reaction to the conflict between industry actions and the court ban on fund-transfer mechanisms and to the conflict between interest rate ceilings and high inflation. No systematic analyses of the impact of these changes on the financial community were completed. The frustrations these uncertainties create in the financial community are reflected in the following response to an industry survey conducted by The Bankers Magazine:

> The uncertainty of pending Congressional legislation pertaining to the banking industry and the myriad changes that are inevitably dictated by Federal regulatory agencies interpreting new legislation are critical problems facing the banking industry today. We have a lack of confidence in Congress' ability to understand the nature of our business and to make intelligent decisions that will have a lasting effect on our industry. The uncertainty surrounding these potential legislative changes has a severe impact on our ability to effectively plan for the future (178, p. 47).

There can be no doubt that enactment of broad legislative changes, piecemeal changes, or simply industry actions to effect policy changes all affect the intermediation process in local financial markets. An unending series of uncertainties faces local markets and requires a method for policy analyses. Additionally, agricultural finance markets face a set of specific problems and proposals.

Issues affecting agricultural financial markets

Increased capital and credit requirements for agricultural and agribusiness have generated concern for the existing financial structure's effectiveness in servicing agricultural credit needs. The result has been specific proposals for structural change to financial intermediation systems serving local agricultural finance markets.

In 1973, the American Bankers Association (ABA) Agricultural Credit Task Force identified two major hindrances to commercial bank expansion in agricultural lending: (1) rural banks encounter difficulty in acquiring funds from outside the local market; and (2) the Cooperative Farm Credit System agencies maintain exemption from state usury laws and federal tax exemptions which allow a competitive advantage over commercial banks (3). The task force considered alternatives in four general areas: (1) banking sources of funds, (2) nonbanking sources of funds, (3) bank management and supervisory agency relations, and (4) state and federal law changes (3, p. 13). They supported improvements in channeling funds from urban to rural areas through correspondent relationships, loan participation agreements between banks in neighboring geographic areas, competition for funds in the national financial market through holding company affiliation or establishment of regional finance corporations, increased government loan guarantee programs, discounting loans with Federal Intermediate Credit Banks, and changes in federal and state law to eliminate usury and tax exemption for agencies of the Cooperative Farm Credit System. The task force was ambivalent toward changes in branch banking regulations as a means of improving funds availability in rural areas. The newly created Federal Reserve seasonal borrowing privileges were considered insignificant in light of their nonavailability to a large number of nonmember banks.[1]

The findings of the Federal Reserve Committee on Rural Banking Problems convened from 1971-1975, in general parallel those of the ABA task force. The committee pointed out that rural banks' inability to raise funds in the national financial market had two detrimental consequences: (1) due to the seasonal demands of agriculture and many rural businesses, banks unable to access short-term funds held a disproportionate amount of liquid assets to meet seasonal needs--thus not providing maximum credit to local areas; (2) banks servicing areas with an overall net credit demand could not access outside funds to close the gap between local suppliers and users of funds (16). Specific committee proposals included changes in correspondent relations to allow rural banks to purchase city bank services and thereby retaining funds that would otherwise be tied up in nonearning correspondent balances. Contrary to the ABA suggestion, the committee recommended vigorous promotion of the Federal Reserve seasonal borrowing privilege. Like the ABA

---

[1]The seasonal borrowing privilege was implemented in April 1973. It permitted member banks without access to national money markets and experiencing seasonal outflows exceeding 5 percent of their average total deposits to meet that seasonal need by borrowing from the Federal Reserve.

task force, the committee encouraged holding company affiliation and development of regional agricultural finance corporations and concluded that the evidence of the effects of removing branch banking restrictions was inconclusive.

As with the industry at large, the impact of the many changes of the Depository Institutions Deregulation and Monetary Control Act of 1980 on agricultural financial markets is uncertain. The law preempted state ususry ceilings on all business and agricultural loans of more than $25,000 until April 1, 1983, unless reimposed by state legislation. At the same time, it set a federal ceiling at 5 percentage points above the discount rate plus any surcharge (140). In the short run, this should allow commercial banks more effective competition with the Farm Credit System. The phase out of interest rate ceilings and the preference to thrift institutions and access to the Federal Reserve discount window for nonmember institutions should improve commercial banking competition for deposits and access to funds. Probably most significant for agricultural financial markets was the failure of the Depository Institutions Deregulation and Monetary Control Act of 1980 to address the issue of branch banking. Branch banking is likely to remain a major legislative concern in the 1980s.

Branch banking

Clearly the magnitude of recent and proposed changes to the financial system is great. For the most part the proposals are the result of theoretical economic arguments for greater reliance on the discipline of the marketplace as a means of achieving efficiencies in the intermediation process. On the other hand, empirical evidences of the quantitative and often qualitative effects of specific proposals or groups of proposals are fragmented and often inconclusive. A more detailed discussion of the proposed liberalization of bank branching should provide an insight into the problems of empirical analysis and help identify an improved method for analysis of alternatives.

Since the inception of the Bank of Pennsylvania, chartered by the Continental Congress in 1781, a dual commercial banking system has evolved in the United States. The nation's 14,700 commercial banks are chartered, regulated and supervised by agencies in the 50 states and three Federal agencies--Federal Deposit Insurance Corporation (FDIC), Federal Reserve System (FRS), and Office of the Comptroller of the Currency (OCC). One of the primary provinces of states is regulation of branching within their boundaries. Twenty states allow statewide branching; twelve restrict bank activity to unit banks; and eighteen permit some form of limited branching (169).

Just as alternative proposals affect different elements of the financial system and thus make their net effect difficult to determine, a single change can influence many aspects of effective intermediation. Mote (127) provides a survey of empirical studies regarding the merits of branching and identifies five major issues or areas affected by branching: (1) operating efficiency, (2) availability of banking facilities, (3) competition, (4) prices of services, and (5) lending policies and the mobility of funds.[1]

A priori arguments both supporting and denying cost efficiencies in branch bank operations have been presented. Proponents contend branch bank operations should reflect economies of scale in personnel management, investment portfolio management, general administration and other centrally located functions. Opponents suggest that if such economies exist they are offset by increased costs of supervision and delegation of authority and branch offices. Empirical analyses, primarily descriptive attempts to compare branch and unit operations of a given output size, have been fragmented and inconclusive. Significant efforts have been made in refining the concept of equal output. Comparison of branch operations and unit operations--of equal size in terms of

---

[1] Subsequent discussion of these issues summarizes Mote's analysis. He provides a comprehensive bibliography of empirical analyses of branch banking (127, pp. 4-5).

some aggregate measure such as total assets--generally conclude branch operations are more expensive. Such studies disregard time and transportation costs which are presumably higher to unit bank customers. In an effort to equalize customer inconvenience expenses, studies have compared branch bank operations to a comparable group of unit banks. Results were mixed, dependent on size and output mix. Specific analyses of individual bank functions too gave mixed results. In all the research efforts, the difficulty of characterizing branch and unit banks by the same set of products remained, since branch locations able to access surplus funds from geographically separate branches may be able to offer services a unit bank is unable to support.

Most often, availability of services has been examined at an aggregate level by comparing the population per office ratios of unit and branching areas. While regression analysis has been used in an attempt to isolate the effects of unique economic characteristics of a particular region, models for the most part have been poorly specified. General conclusions are that ratios are higher in unit than in branching areas--only for locations in excess of 7,500 population. However, criteria like population per office are suspect as measures of available services.

A similar problem of appropriate criterion exists when trying to determine the effects of branching on competition. Nearly all the econometric and comparative analyses use some measure of market concentration as a proxy for competition. Concentration ratios, herfindahl index and gini coefficient are often accepted in economic and legal arguments as measures of potential market power (74). In fact, they are not measures of competition and are affected by many variables besides branching. Findings again prove to be inconclusive concerning the effects of branching on these ratios.

Probably the most important issue to the consumer or public is the effect of branching on prices of bank services. Prices respond to (1) concentration of resources, (2) oligopolistic efforts to exclude competitor entry into the market, (3) operational efficiencies, (4) costs of information, transaction and other impediments to the most productive allocation of funds, and (5) the ability to diversify risk by geographic decentralization of operations. No conclusive empirical studies have been conducted concerning the branch banking effect on these elements. More so, when significant differences have been observed, the causal explanation has not been apparent. For example, are unit banks able to provide demand deposit services at a lower cost because of operational efficiencies, greater competition, or simply because they are able to charge higher interest rates in the asset market?

One of the most controversial issues in branch banking, especially in the agricultural areas, has been branch banking effects on the use and subsequent flow of funds between markets. Opponents of branching claim branches in rural areas serve as siphoning points accessing funds from rural areas and channeling them to urban centers. Reverse arguments are presented by branch banking supporters; that is, because of the unit bank structure, excessive amounts of funds flow from rural areas in terms of federal funds sold, correspondent balances, and net direct balances. Mote (127) correctly points out that these studies fail to recognize that the interest of depositors and borrowers in an area may not coincide. To the extent that returns reflect value in use, economic efficiency may be served by allocation of funds to the highest return.

The brief comments on branch banking allow some general observations:

1. Even a single proposed change to the financial system affects a number of elements of efficient intermediation.

2. Empirical studies have been confined to comparative analysis, economic estimation, and limited econometric based simulation.[1]

---

[1]For an application of simulation in the analysis of alternative branch banking in West Virginia, see (70).

3. Empirical results have provided insight into important aspects of the problem, recognition of many analytical difficulties, and improved measurement criteria but in the net have been inconclusive in determining the effects of branching.

4. No empirical effort has been made to consider all the aspects of the problem simultaneously.

The role of operations research and existing uses of optimization models in the study of financial intermediation process provide a basis for pursuing development of a methodology which alleviates these limitations.

Operations Research

The history of operations research[1] and its methodology[2] have been recorded in detail. The brief comments of this section are a synthesis of a number of those accounts. They are meant to provide a basis (1) for understanding the approach and scope of this dissertation, and

---

[1]One of the earliest accounts of the formal organization and activities of operations research teams prior to and during World War II is given by Crowther and Whiddington (45). Chacko (31) provides a unique discussion combining history and methodology and gives reference to a variety of seminal accounts of operations research published by the British Admiralty during World War II.

[2]While a great number of works are available, the following (2, 15, 28, 31, 77, 141) reflect the breadth of interpretation given to operations research.

(2) for developing a perspective for explaining the void of research into local financial markets.

Definition

The definition accepted by the Operational Research Society of Great Britain, the oldest professional operations research society, follows:

> Operations research is the attack of modern science on complex problems arising in the direction and management of large systems of men, machines, materials, and money in industry, business, government and defense. Its distinctive approach is to develop a scientific model of the system, incorporating measurements of factors such as chance and risk, with which to predict and compare the outcomes of alternative decisions, strategies or controls. The purpose is to help management determine its policy and actions scientifically (15, p. 92).

The definition includes the essential characteristics of operations research; it is (1) multidisciplinary, (2) systems oriented, (3) directed at assisting in the management decision process, (4) scientific in method, and (5) prescriptive.

Essential characteristics

The scientific method[1] (model) is central to operations research (OR), but it is not what makes OR unique. The interaction of the five essential characteristics reflected in the definition define the OR regime.

---

[1]The OR method can be grouped into a number of possible steps, but most groupings include problem identification, model construction, experimentation, implementation and validation.

Figure 2.1 illustrates the nature of the scientific model. The model is ideally an isomorphism, a convergence or one-to-one correspondence of two system representations. One emanates from the managerial realm, the other from the scientific realm. The importance of a multidisciplinary background for the OR scientist or team is first apparent in the need for sufficient familiarity with managerial and organizational concepts to facilitate communication with management and insight into management's decision process. As the managerial problem crystallizes, the scientist begins an analogous conceptualization. The similarity in the conceptual model depends in large part on the scientist's ability to draw innovative formulations from a vast array of disciplinary approaches.

System decisions represents a range from tactical to strategic. Ackoff offers three considerations:

> (1) the longer the effect of a decision and the less reversible it is, the more strategic it is; (2) the larger portion of a system that is affected by a decision, the more strategic it is; (3) the more concerned a decision is with the selection of goals and objectives, as well as the means by which they are to be obtained, the more strategic it is (54, p. 601).

OR has been widely and successfully applied at the tactical level where there is often a single well defined objective. As the problem becomes more strategic, more system components become relevant and the greater is the need for multidisciplinary cooperation in understanding the diverse system components. Much of the future challenge for OR is at higher system levels.

Figure 2.1 emphasizes the rigorous formulation of a model. Often the value to management depends on the conciseness, clarity and accuracy of this model phase. Historically, OR has been characterized by a transformation from the descriptive and qualitative to the quantitative and causal.

Seldom is the isomorphism ideal. Erroneous insights, poorly drawn analogies, and deletion of relevant components in an attempt to quantify the system all may lead to spurious results. Experimentation of empirical validation is the test of the model. If the isomorphism is imperfect and the degree of accuracy not acceptable, the analytic procedure need be repeated. Most important, operations research results are prescriptive. They are dependent on descriptive assumptions and the following warning is ever present:

> The mathematical methods do not claim to provide answers to problems. They merely state that if problem can be put into certain mathematical forms, then the answers are those provided by the method. The caveat "if" is sometimes overlooked, leading enthusiasts to claim that their solutions are what decision-makers should rely upon, while the method may not at all be applicable to the problem (31, p. 28).

The positive or normative interpretation of the results rests with the decision maker. The results may simply reflect what

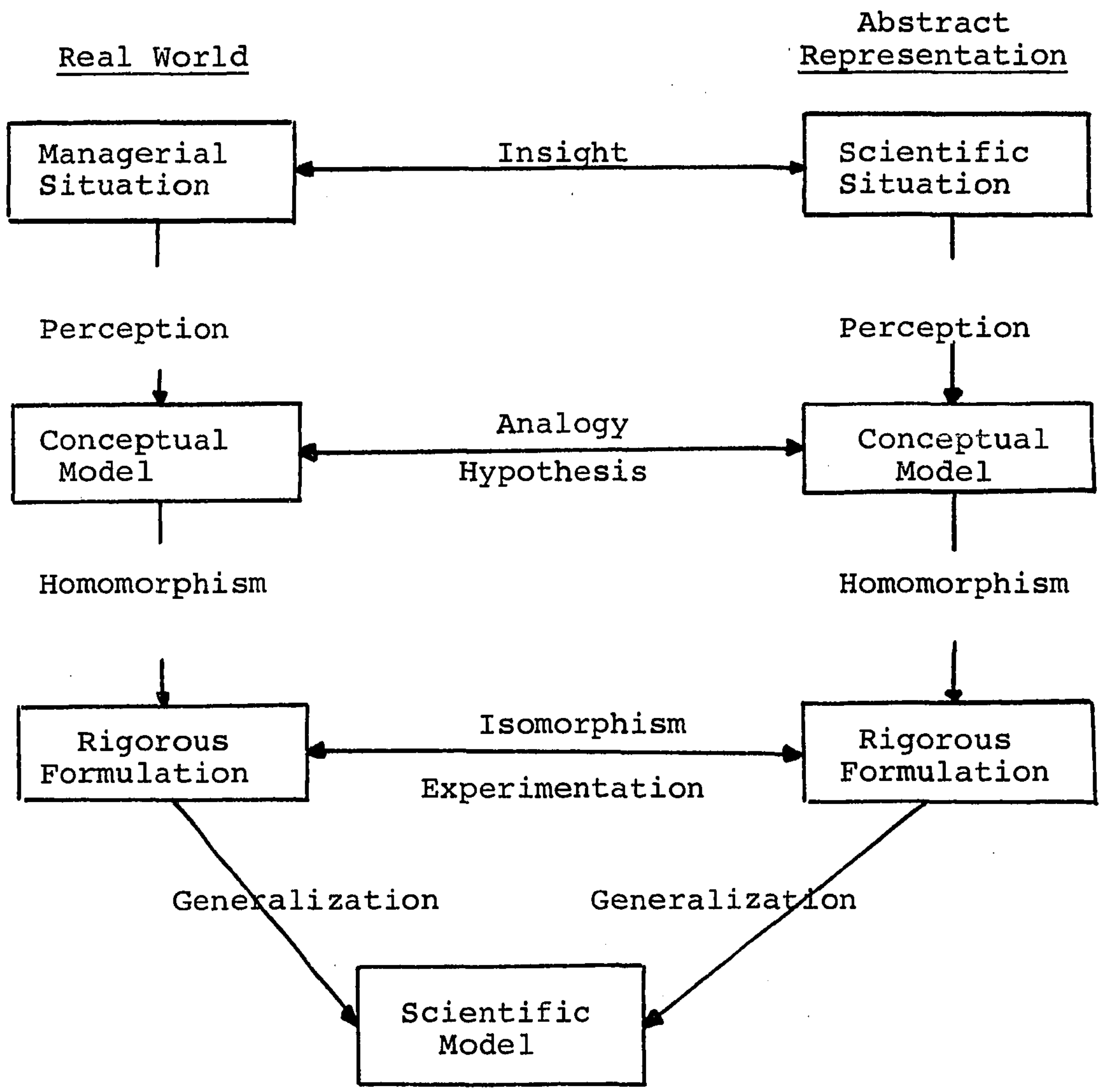

Figure 2.1. Scientific model (15, 39)

is or would be based on the premises of the model. Such a positive or descriptive interpretation is quite different from a normative view which accepts the results as the course of action that ought to be followed based on a judgmental view of the premises of the model. In either case, model results cannot supplant management decisions.

Financial Intermediation and Operations Research

While the main emphasis of this section will be on mathematical programming models, collected papers describing the use of operations research in banking and finance by Cohen and Hammer (41) and Eilon and Fowkes (53) illustrate the wide range of mathematical techniques used in financial management problems. Additionally, econometric models have been developed representing financial markets and the financial intermediaries systems.[1] The Federal Reserve-MIT-Penn Model was used to analyze the potential far-reaching effects of the Hunt Commission recommendations (166). In general, however, econometric modeling is less well suited for assessing the impact on local markets of potential technological and institutional changes than is a mathematical programming

---

[1]See (60, 90, 117, 124, 149, 180, 181). For applications to the agricultural sector, see (22, 59, 76, 115, 133, 153).

formulation. However, econometrics can be of value in conjunction with mathematical programming techniques, and the importance of this connection will become apparent.[1]

Mathematical programming applications to financial markets have followed closely the divergent developments of linear programming. As Dorfman, Samuelson, and Solow (49, p. 4) point out, linear programming applications have proceeded in two directions. The first, led by research efforts at the Carnegie Institute of Technology, concentrates on modeling the managerial aspects of the firm. The second has been the application to economic theory led by T.C. Koopman's general equilibrium analysis. Nearly all the work which has been completed in finance and banking has been directed at the conduct, responsiveness, and productivity of individual financial intermediaries. No doubt this is due in part to the operational or tactical aspects of the problems. They are more readily funded since they have an immediate payoff to the concerned intermediary.[2] Limited work has been done

---

[1]Econometric analysis can be used to provide much of the data support for mathematical programming models: demand functions, cost and production coefficients, etc.

[2]In a sense, there has been an implicit narrow definition of operations research develop in OR application to finance. In fact, at one point in the short history of operations research, it was very narrowly defined in terms of applications and mathematical techniques and resulted in the evolution of Management Science as a related discipline. Now the terminologies operations research and management science are used interchangeably (41).

in modeling a nationwide financial intermediation system. The empirical work that has been completed has been cast in both a general equilibrium framework and in a planning context.

After conducting an exhaustive review of post-World War II literature in agricultural finance and capital markets, Brake and Melichar concluded:

> . . . that the literature has been disproportionately oriented to describing specific institutions--particularly lending institutions--rather than to improving the understanding of rural financial markets in a broader sense, including markets for savings and debt and equity instruments (26, p. 470).

They found that empirical models of rural commercial banks have been completed, but that, "rural financial intermediation systems as a whole, however, have yet to be modeled" (26, p. 466). These findings parallel the applications of operations research to banking and finance in general.

Models of individual intermediaries

Most applications of mathematical programming to financial intermediation have been confined to the operational activities of individual commercial banks. Two main model types have evolved: (1) portfolio selection models emanating from the initial work by Markowtiz, and (2) asset management models first reflected in a linear programming framework by Chambers and Charnes.

Portfolio selection models

In 1952, Markowitz (118) presented the now classic mean-variance (E-V) approach to portfolio selection. The objective is to determine the set of efficient portfolios, such that each efficient portfolio is characterized by the lowest variance of return for a given expected return or the greatest expected return for a given variance. A simple quadratic programming model description follows:

$$\text{Max } \lambda E - V = \lambda \sum_i M_i X_i - \sum_i \sum_j X_i X_j S_{ij}$$

$$\text{Subject to } \sum_i X_i = 1$$

$$X_i \geq 0 \text{ for all } i \qquad (2.1)$$

where:

M_i = expected return from security i

X_i = proportion of portfolio invested in security i

S_{ij} = covariance between the return from security i and return from security j; variance for i=j.

For each value of $\lambda \geq 0$, the solution to the quadratic programming problem yields an efficient portfolio. The problem of selecting the utility maximizing λ remains and thereby a single choice from the set of efficient portfolios.[1] Sharpe (146), hypothesizing that the return on a security can be linearly related to the value of a general market index, offered a simplified version of the model and correspondingly more efficient computational procedures.

Using the basic E-V model, Chen (37) gave the portfolio selection problem a broader interpretation within a model of a commercial bank. Portfolio selection of securities was generalized to asset selection: choice of cash to hold, investments in securities, loans to be granted, and investments in fixed assets. A single period quadratic programming model maximizing E-V wealth at the end of the planning horizon was hypothesized. Allowance was made for stochastic deposit withdrawal and an explicit probabilistic constraint was introduced to specify the probability that stochastic net deposit withdrawals were met by the value of the bank's portfolio at the end of the period. The model was extended to a multiperiod dynamic programming model. No empirical results were given.

More recently Robinson and Barry (143) conducted an empirical analysis of a commercial bank in Texas.[2] An efficient E-V set was generated using quadratic programming.

---

[1]See for example (143).

[2]The bank had approximately $25 million in assets. The time period of the model was three months.

A utility maximizing portfolio was determined from the efficient set and was used as a basis for sensitivity analysis. The methodology was presented as a means to explore the effects of a variety of policy proposals--e.g., government guarantee of loans, secondary markets for farm loans, changing borrowing practices and interest bearing demand deposits--through resulting changes in risk, liquidity and profitability components of bank assets and liabilities. They concluded that bank portfolio response may not be trivial to changes in deposit costs, expected rates of return, variances, loan to deposit feedback rates, and risk aversion.

Asset management models

Asset management models are concerned with an institution's optimal liability, asset and capital structure choices. First formulated as a linear programming problem by Chambers and Charnes in 1959 (32), such models have the general linear programming form.

$$\max U(X_1 \ . \ . \ . \ X_n) \tag{2.2a}$$

$$\text{subject to } \sum_j A_{ij}X_j \leq b_i \quad \forall i=1 \ . \ . \ . \ m \tag{2.2b}$$

$$X_j \geq 0 \qquad \forall j=1 \ . \ . \ . \ n \tag{2.2c}$$

The planning horizon may be single or multi-period. The linear objective function (2.2a) might take a number of forms--e.g. profit, value of stockholders' equity at the end of the planning period, present value of net income plus realized capital gains, realized and unrealized tax adjusted gross revenue and so on. The vector of decision variables (2.2c) represents liability, asset, and capital activities. The linear constraint structure (2.2b) includes restrictions imposed by government regulatory and supervisory bodies, market limitations, and management imposed behavioral and policy restrictions. Major contributions are briefly described below.

The model by Chambers and Charnes was a multiperiod simultaneous analysis of a commercial bank's asset and liability structure. Constraints represented regulatory requirements on bank reserves and liquidity considerations based on Federal Reserve examiners criteria of what constitutes a reasonably safe portfolio. The emphasis was on illustrating the trade-off between optimal yield and liquidity considerations.

Waterman and Gee (175) discussed the importance of uncertainties in loan demand and interest rates and suggested the use of Bayesian statistics for such problems. Although the model ignored intertemporal aspects of bank decisions and considered only fixed liabilities, it represented an operational empirical model with fourteen asset categories and twenty-three constraints reflecting past practices, historical patterns, legal restraints and management policies.

The first detailed report of a complex analytical model, developed and implemented by the Management Science Group at New York's Banker's Trust Company, was given by Cohen and Hammer (40) in 1967. The model considered three possible criteria over a multiperiod planning horizon: (1) maximum value of stockholders' equity during the final period, (2) maximum present value of net income plus realized capital gains over the entire planning period, and (3) a combination of the above two criteria. The model extended the constraint structure from the liquidity constraints used by Chambers and Charnes to include availability constraints (e.g. heuristic limits on selected ratios to ensure bank safety and liquidity), market restrictions (e.g., liquidity buffer, legal reserve requirements and correspondent relationships) and intertemporal constraints (e.g. intertemporal linkages, endogenous capital changes, and loan-deposit feedback mechanisms).

Another important empirical effort was reported by Robertson (142). This multiperiod model was designed, implemented and used in conjunction with a top management committee to allocate assets at the Industrial National Bank of Rhode Island. The model maximized undiscounted profit and included linear constraints on available sources of funds, loan demands, capital adequacy, limits on certain variables groups, asset-deposit feedback relationships, tax considerations, and traditional banking ratios. In addition, it incorporated integer constraints reflecting intertemporal fixed costs, mixed integer switching conditions in some asset categories and an assets equal liabilities budget constraints.

More theoretically oriented models have been developed explicitly to treat probabilistic constraints. Charnes and Littlechild (35), Charnes and Thore (36), and Fried (62) applied chance constrained programming. An example of the constraint types considered in this method is illustrated by a gradually increasing difficulty in borrowing: prob (borrowing $\leq \bar{\beta}$) $\geq = \propto$ (36, p. 650).

Cohen and Thore (42) and Crane (43) extended these concepts to a dynamic context by using two-stage programming under uncertainty. With this method each constraint with an uncertain right-hand side is replaced with a set of linear constraints--one for each discrete value of the right-hand side. Crane, for example, treated future cash flows and interest rates as random variables.

The applications of asset management models to a rural environment have been limited. Frey (61) developed a linear programming model for a rural commercial bank. The multiperiod model considered endogenous capital, loan-deposit feedbacks and both asset and liability management. Hutson (81) developed a model of a rural Oklahoma commercial bank in an effort to evaluate alternative external sources of funds as a means for providing additional loanable funds. Barry and Hopkin (9) presented a more extensive descriptive model of the asset and liability management of a rural bank. Particular attention was given to the extent, timing and method of estimating feedback relationships. Most recently, Fieletz and Loeffler (58) developed a usable mathematical programming model for a medium to large commercial bank. The model was designed to optimize after-tax profit as a result of liquidity management--choice of sources and uses of funds--subject to institutional and managerial considerations.

Echols and Elliott (52) completed a detailed comparison of the predictive problem in parameter identification versus the allocational problem in bank asset management models. The predictive structure used included fourteen econometric equations and the programming model contained thirty-two variables and twenty-eight constraints. The model was applied to a national bank with from $100 to $500 million in total deposits. They concluded:

> . . . that the scope of the predictive problem is larger compared to the allocational problem in bank resource allocation. In our experience, the value of the optimizing logic of our programming structure is reduced due to the predictive errors in future interest ratio, loan demand and deposit levels (52, p. 294).

In conclusion, a number of observations can be made:

1. While the theoretical concepts of both the quadratic programming (E-V maximization) and linear programming approaches to asset and liability management are generally applicable to a wide range of intermediaries, empirical applications have been almost exclusively to commercial banks.

2. Models have evolved into detailed representations of firms' internal decisions and external linkages, and rigorous models have been implemented in the banking sector.

3. Relatively greater emphasis has been on asset management than on liability management.

4. While recent studies concluded that the optimization structure of the models is greatly affected by uncertainties in deposit flows, interest rates, loan demands, etc., no effort has been made explicitly to treat the firm's market powers to influence those quantities.

5. It would appear desirable to take advantage of the experiences and successes of modeling individual financial firms when developing a model to gauge the effect on local financial markets of potential changes in the financial system.

Models of the financial intermediation system

The only mathematical programming formulations of a system of financial intermediaries have been presented in conjunction with development of a programming model for national credit budgeting in Norway (162). The methodology has evolved into a model type[1] which the authors call Programming of Flow-of-Funds Networks (PFOFN).

Thore (157) introduced the concept of translating traditional multiplier models[2] and flow-of-funds tables[3] into a network characterization in order to study the propagation of streams of money and credit in an economy. The simple network representation consisted of nodes defining economic agents--the general public, commercial banks, and other financial intermediaries--and links allowing changes in financial flows over the network which maximized profits of the economic agents subject to (1) Kirchhoff conditions requiring the sum into a node to equal the sum flowing from the node and (2) capacitating constraints establishing limits

---

[1]Charnes and Cooper (34, p. 30) call often used model structure and solution techniques model types and point out most actual applications are usually a mixture of one or more model types. PFOFN are characterized by elements from network theory, portfolio theory and decomposition theory (159).

[2]See for example (147).

[3]For agricultural sector applications, see the survey by Brake and Melichar (26).

on certain flows. The pulsation of cash streams through the network was initiated by an exogenous cash influx and leakages from the system were in terms of excess reserves held by the intermediaries. Thore (158) extended the model to include uncertainty, allowing random movements in deposits by the general public at financial intermediaries. Subsequent work by Thore and Kydland (161) reformulated the network representation emphasizing the decentralization properties of the model. The ultimate sector--source and user of funds--represented the source and sink of the network. The intermediaries--nodes--were considered to solve individual portfolio optimization problems which were embedded in a larger global optimization problem. In the global problem, portfolios were linked by market clearing conditions. The dynamic properties of the credit network and conditions under which the dynamic process converged were considered.[1] These embryonic forms of PFOFN were illustrated by simple model prototypes and some numeric examples intended to illustrate solution procedures.

Story, Thore and Boyer (154) have presented a general statement of PFOFN. The network representation of the

---

[1]The ultimate sector was considered to use funds in one period. After leakages in terms of desired cash holdings, a portion of the funds flowed back into the intermediaries. The process continued in a manner analogous to dynamic credit multiplier analyses (161).

financial intermediation process is analogous to flow-of-credit diagrams. There are (m+n) nodes in the network: m intermediaries or investor portfolios and n markets for financial instruments. The ultimate sector is considered to issue net debt instruments at nominal amounts d^j (j=1 . . .n) and to provide available funds to the intermediaries in the amounts R^i(i=1 . . .m). Each investor or intermediary solves an optimization problem similar to (2.2):

$\max U^i(X^i)$	
$\text{s·t } A^iX^i \leq b^i$	set of linear constraints representing government, market and internal management restrictions
$px^i \leq R^i$	budget constraint or Kirchhoff condition at portfolio nodes
$x^i \geq 0$	(2.3)

where

$U^i(X^i)$ is the intermediary's objective function

$X^i = (X_1^i . . . X_n^i)$	is the vector of intermediary's asset holding, i.e. linkages between portfolio and market nodes
$p = (p_1 . . . p_n)$	is the vector of asset prices
A^i	is matrix of constraint coefficients
b^i	is vector of constraint right hand sides

The individual portfolio problems are coupled by market clearing conditions:

$$\sum_i X_j^i = d_j \qquad j=1. . .n \quad \text{Kirchhoff condition at market nodes}$$

The individual problems can thus be embedded in a global master problem:

$$\max \sum_i U^i(X^i)$$

$$\text{s.t.} \quad A^i X^i \leq b^i \qquad \forall i=1. . .m$$

$$px^i \leq R^i \qquad \forall i=1. . .m$$

$$x^i \geq 0 \qquad \forall i=1. . .m$$

$$\sum_i X_j^i = d_j \qquad \forall j=1. . .n \qquad (2.4)$$

This model has the familiar decomposition characteristics but is formed through the reverse process of embedding individual portfolio problems in a larger master problem.[1]

If the objective function of the individual problems is strictly concave and each choice set is a convex polyhedron, then there exists a set of equilibrium prices. That is a vector of prices which satisfies market clearing conditions and which, when delegated to individual intermediaries, results in optimal asset selections in the

---

[1]In decomposition one is usually trying to decompose a larger problem into smaller problems in order to facilitate solution. See (48, 111).

individual problems and, in total, yields an optimal solution to the global master problem. Story, et al. sketch an elaborate institutional framework introducing dealers who "make markets" in the financial instruments and by their actions determine the set of equilibrium prices (154). By adjusting the initial set of prices, both optimal asset selections and general equilibrium prices can be endogenously determined using the model.

In the case of linear objective functions--e.g., CX^i where $C = (C_1 \ . \ . \ . \ C_n)$ vector of net returns--no such unique equilibrium need exist. Story et al. offer an algorithm directed at finding a vector of net returns which yields unique optima in the individual problems and minimizes the sum of excess demand and excess supply in the n asset markets.

The model has been applied to aggregate financial allocation problems in Norway (162). Two markets exist: treasury bills and bonds. The ultimate sector consists of the domestic private sector and the foreign sector. Six portfolio nodes are included; each represents the aggregate behavior of one intermediary type in the economy: (1) commercial banks, (2) savings banks, (3) insurance companies and other private financial institutions, (4) state banks, (5) postal savings system, and (6) social security funds. The model consists of 96 variables and 89 constraints.

Using current market prices[1] and maximizing individual portfolio choice, both asset markets resulted in disequilibrium. An estimate of equilibrium prices--market clearing prices--was made.

Thore (160) generalized the model to include liability management and introduced the concept of interest rate responsive demand functions for desired investments and desired issues by the ultimate sector.[2] Contrary to earlier efforts which concentrated on the profit maximization behavior of individual intermediaries, emphasis was given in this generalization to efficient intermediation in terms of the global problem. Prices (net returns) were considered targets and the solution to the global problem (2.4) was the objective. The basic assumption was that financial intermediaries will look for an efficient consolidated portfolio and in general will act in accord or can be made to act in accord with the global solution.

In an attempt to represent better the institutional setting in Norway and to identify adequately targets and instruments, Thore developed a goal programming extension

---

[1]The analysis was completed for a "1971 like" economic environment.

[2]While both these important concepts were suggested, no attempt was made to implement them empirically.

of the empirical model discussed above.[1] Interest rates were given as targets and fixed in the model. Credit ceilings for direct loans and funding floors for government bonds were formulated as goals in the model. Monetary and credit policies were incorporated in the constraint structure.

The work by Thore and coauthors has been an important and exclusive effort to develop a methodology to examine the impact of policy alternatives on a national financial system as a whole. They have advantageously capitalized on more than a generation of experiences in modeling financial firm activities. However, there seem to be two essential features missing from their methodology which prevent realistic extension to local financial markets: (1) it is necessary to allow for market interactions and financial intermediary competition in the source of funds markets, and (2) it is necessary to evaluate the effects of alternatives to perfect competition which is less likely in local financial markets than in national markets.

A New Direction

The preceding sections of chapter 2 provide a basis for a concise problem statement and description of the

---

[1]Goal programming was introduced by Charnes and Cooper (34). See Lee (112) for a detailed presentation of goal programming methodology and application.

general approach to solving that problem considered in this dissertation.

Problem statement

A multitude of proposed policy and structural changes face U.S. financial markets. Specific proposals have been directed at local agricultural markets. To a large extent, the proposals are meant to supplement an existing structure of legislative and regulatory restrictions which have evolved in the interest of balancing competition and soundness in the U.S. financial system. The proposed changes can be categorized broadly into three areas: (1) transformation of the productive capabilities of individual intermediaries through changes in their structural form and in the activities in which they may engage; (2) increased reliance on the market place through removal of price control regulations; and (3) increasing efficiency in the many channels or linkages between markets and intermediaries through which credit flows from suppliers to ultimate users of surplus funds in the economy. There has been no systematic examination of the effects of these many proposed changes or of the impact of their piecemeal enactment on local financial markets.

Mathematical programming models have been widely used to reflect the operational activity of individual financial intermediaries. Some modeling has proceeded, in an extremely aggregate form, at the national level in Norway. However, a methodological and applications void exists in modeling local financial markets.

The problem is to develop a general analytic framework for policy analyses in local financial markets in general and specifically in rural agricultural markets. The methodology should be able to consider the detailed specifications of activities of financial intermediaries, the unique demand and supply characteristics of local financial markets, and the flow of funds throughout the many linkages forming the financial intermediation process in local markets.

To the extent that financial intermediaries can be viewed as producing units effecting the flow of credit through the financial system by acquisition, creation, and allocation of asset and liability instruments, spatial price and allocation models can provide a conceptual and mathematical basis for modeling local financial markets.

An approach

Spatial price and allocation models are used to analyze allocation and pricing policies and problems over time and space. The development of operational models has proceeded since 1940.[1] The genesis of empirical models is the classical transportation model first formulated independently by Hitchcock in 1941 (78) and Kontorovich in 1942 and reformulated in linear programming form by Koopmans in 1949 (104). Even this basic model can be used to reflect many of the elements of the financial intermediation process. Efficient financial intermediation could be viewed as meeting demand for credit at minimum cost:

$$\text{Minimize} \quad \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij} X_{ij}$$

$$\text{Subject to} \quad \sum_{j=1}^{n} X_{ij} \leq a_i \quad \text{for every } i=1. . .m$$

$$\sum_{i=1}^{m} X_{ij} \geq b_j \quad \text{for every } j=1. . .n$$

$$X_{ij} \geq 0 \quad \text{for every } i=1. . .m; \; j=1. . .n$$

Where X_{ij} represents the flow of funds from i, one of m sources of funds supply points, to j, one of n uses of funds demand points.

c_{ij} represents the unit cost of the flow X_{ij}.

a_i represents funds availability at i (known supply),

---

[1] International trade economists have provided over a century of major contributions to generalization of economical equilibrium theory to include spatially and temporally separated economic activities. Takayama and Judge (156) provide an historical sketch of those theoretical works from Thunen, 1826, to Kemp, 1964.

e.g., demand and time deposits at commercial banks, time deposits and savings accounts at thrift institutions, accrued reserves of life insurance companies, etc.

b_j represents funds demanded at j (known demand), e.g., government and corporate securities, loans, mortgages, etc.

In 1951, Enke (55), using an electric analogue computer, formulated an empirical model to determine equilibrium prices as well as commodity movements when a number of buyers and sellers trade a homogeneous good in spatially separated markets. Enke's model used linear demand relations and unit transportation costs independent of flow volume. However, the model allowed for generalization to include nonlinear demand and flow dependent transportation costs. Samuelson (144) reformulated the Enke model in 1952 as a mathematical programming problem and demonstrated that the Hitchcock-Koopmans transportation model was a special case of the Enke model.

Beckmann and Marschak (14) combined the activity analysis formulation of Koopmans and the interregional or spatial aspects of the Samuelson model. In addition, they extended the concept of allocation to include both production and allocation activities. Takayama and Judge (155) extended the Beckmann-Marshack model to a quadratic programming form which allowed endogenous determination of commodity prices as well as flow quantities and imputed prices for intermediate products and primary resources. Plessner (136) provided an alternative quadratic programming specification which allowed for more general empirical estimates of demand than assumed by Takayama and Judge. This formulation has been successfully used in the agricultural sector to analyze pricing outcomes and commodity flows between various markets and geographic regions and to analyze the implications of policy restrictions on the pricing and flow outcomes.

The remainder of this dissertation is devoted to developing a variation of the Plessner specification which can serve as a basis for a systematic method for analyses of local financial intermediation, and to conducting an initial econometric analysis into the supply of funds to and demand for funds at commercial banks in Iowa.

CHAPTER III. A SPATIAL PRICE AND ALLOCATION ACTIVITY ANALYSIS MODEL FOR LOCALIZED FINANCIAL MARKETS: PERFECT COMPETITION MODEL

The familiar structure of spatial price and allocation models accommodates the essential characteristics of the financial intermediation process. The perfect competition model is presented in this chapter in order to illustrate the methodology, introduce notation and serve as a basis for extensions to more representative models of local financial markets. The perfect competition model can be used to reflect most of the important flow of funds linkages in local financial markets. Subsequent modification to include policy and regulatory constraints provides a mechanism for modeling imperfections of government intervention and institutional policies--perhaps representing risk considerations. Since these constraints alone do not allow the flexibility needed to adequately represent market power of intermediaries in local markets, subsequent chapters consider model extensions necessary to reflect market pricing imperfections. The model gives a prescriptive paradigm for modeling flow of funds and pricing outcomes in localized financial markets and it is dependent on a number of descriptive assumptions.

Scenario

Financial intermediaries are characterized as firms engaging in two product lines: liability management, acquiring funds by issuing claims on themselves; and asset management, allocating funds by acquiring claims on others. In so doing, these firms facilitate the flow of funds from surplus to demanding units in the economy.

The model of financial intermediation presented represents a sector or proper subset of the financial system in a partial equilibrium context. It is assumed that the source and use of funds markets in which intermediaries operate can be identified and that the relationships representing supply and demand for funds by the nonfinancial units of the economy remain stable within the realm of firm operations and alternatives being considered. Focus is on the role of intermediaries in equating sector supply and use of funds.

The intermediaries are linked to one another by competition in source and use of funds markets, by competition for nonfunds resources, and by interfirm transfer of funds. They have no market power and are assumed to maximize net revenue in a perfect competition environment. The model is initially formulated with no government intervention or policy restrictions and then modified to include policy and regulatory constraints.

The activities of a typical intermediary are illustrated in figure 3.1. Mathematically, the intermediary is considered to create a single intermediate product which

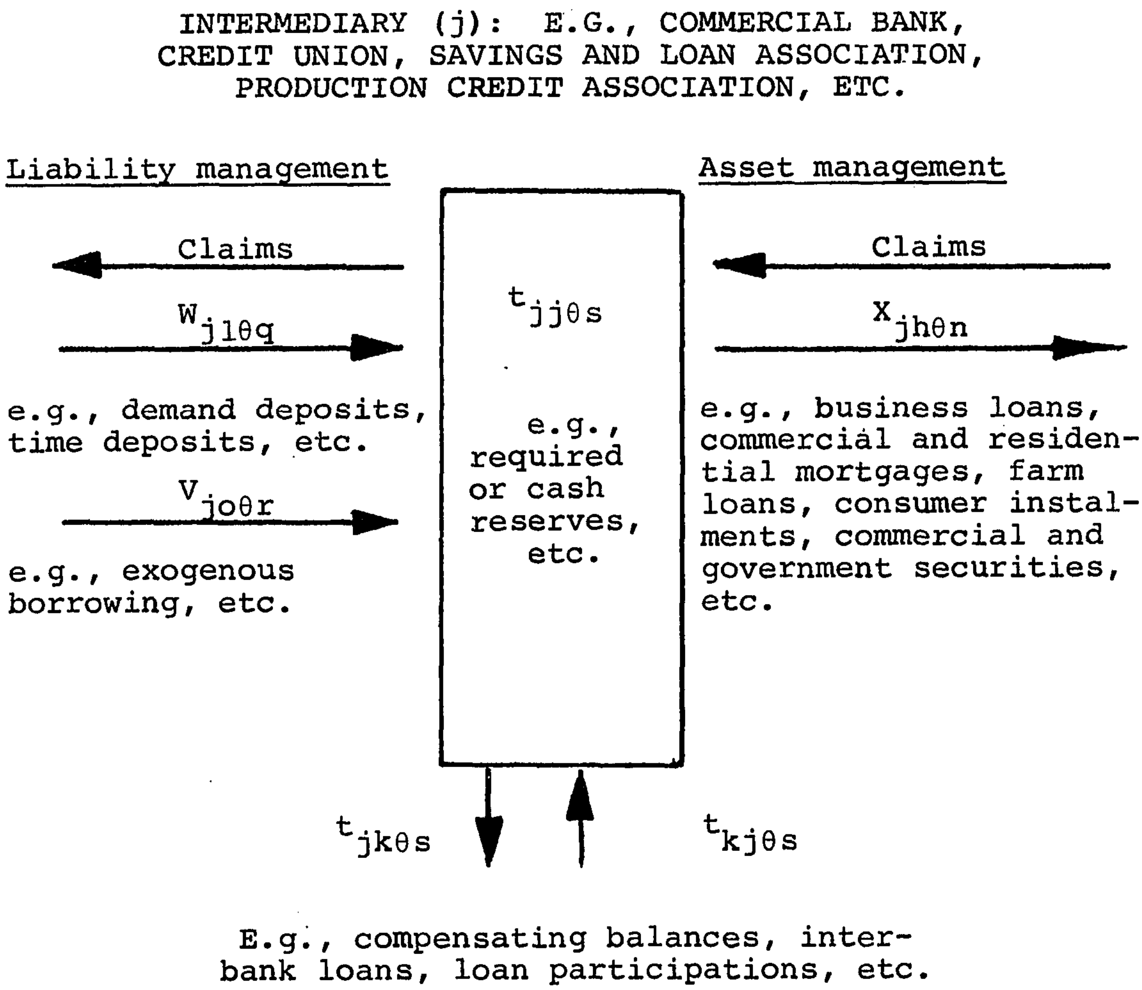

Figure 3.1. Basic intermediary activities

represents the balance sheet function of equating funds obtained from acquisition activities and funds allocated to alternative uses.

The intermediaries acquire funds by competing in spatially separate source of funds markets where funds supply is defined by linear supply relationships. In these markets, the model describes market equilibrium through endogenous determination of optimal price and funds supply quantities. In addition, the intermediary can acquire funds in markets or from firm unique sources with a known supply of available funds. Finally, funds are acquired as a result of transfer activities among intermediaries.

Funds are allocated, internally to uses such as required or cash reserves, transferred to other intermediaries, and allocated to spatially separate and competive asset markets. Demand for funds in these markets may be represented by known demand quantities or be given by linear demand relationships. As in the source markets, the model endogenously determines optimal price and use of funds quantities in these latter markets.

Intermediaries are assumed to use known supplies of nonfunds resources in acquisition, transfer, and allocation activities. Nonfunds resources may be unique to the firm or be acquired in competitive markets.

Notation

Asset markets

$h = 1,2,\ldots, H$ separate use of funds markets.

m, n = 1,2,..., N type of funds demand, e.g., business loans, commercial and residential mortgages, etc.

$Y = (y_{11}, y_{12}, \ldots, y_{1N}, y_{21}, \ldots, y_{hn}, \ldots, y_{HN})'$, where y_{hn} is market h demand for funds type n.

$\Lambda - \Omega Y$ is a system of linear demand relationships, where the demand price for funds type n in market h is given by $\lambda_{hn} - \sum_m \omega_{hnm} y_{hm}$.

$\Lambda = (\lambda_{11}, \lambda_{12}, \ldots, \lambda_{hn}, \ldots, \lambda_{HN})'$, where λ_{hn} is the constant term in the demand price relationship for type n funds demand in market h.

Ω is a matrix of demand coefficients dimensioned (HN) χ (HN). Letting ε_{hn} represent the demand price for funds type n in market h, ω_{hnm} is the (h-1)N + m th element of the (h-1)N + nth row of Ω and is equal to $-\frac{\partial \varepsilon_{hn}}{\partial y_{hm}}$ nonspecified elements are zero.

$\Delta = (\delta_{11}, \delta_{12}, \ldots, \delta_{hn}, \ldots, \delta_{HN})'$, where δ_{hn} is the imputed market equilibrium price in use of funds market h for funds type n.

I_Y is an (HN)χ(HN) identity matrix.

Liability markets

l = 1,2, ..., L separate source of funds market where the supply price is given as a linear function of the quantity of funds supplied.

p, q = 1,2, ..., Q type of funds supply, e.g., demand and time deposits, etc.

$Z = (z_{11}, z_{12}, \ldots, z_{1Q}, z_{21}, \ldots, z_{lq}, \ldots, z_{LQ})'$, where

z_{lq} is market l supply of funds type q.

$\Pi+\Phi Z$ is a system of linear supply relationships, where the supply price for funds type q in market l is given by $\pi_{lq} + \sum_p \phi_{lqp} z_{lp}$.

$\Pi = (\pi_{11}, \pi_{12}, \ldots, \pi_{1q}, \pi_{21}, \ldots, \pi_{lq}, \ldots, \pi_{LQ})'$, where

π_{lq} is the constant term in the supply price relationship for funds type q in market l.

Φ is a matrix of supply coefficients dimensioned $(LQ)\chi(LQ)$.

Letting ε_{lq} represent the supply price for funds in market l, ϕ_{lqp} is the $(l-1)Q$ + pth element of the $(l-1)Q$ + qth row of Φ and is equal to $\frac{\partial \varepsilon_{lq}}{\partial z_{lp}}$; nonspecified elements are zero.

$\Gamma = (\gamma_{11}, \gamma_{12}, \ldots, \gamma_{1Q}, \gamma_{21}, \ldots, \gamma_{lq}, \ldots, \gamma_{LQ})'$, where λ_{lq}

is the imputed market equilibrium price in source of funds market l for funds type q.

$o = 1, 2, \ldots, O$ separate markets or sources with known available supply of funds unique to a single intermediary or available to several intermediaries.

$r = 1, 2, \ldots, R$ type of known available funds supply, e.g., exogenous borrowing, capital account, etc.

$E = (e_{11}, e_{12}, \ldots, e_{1R}, \ldots, e_{or}, \ldots, e_{OR})'$, where e_{or} is

the known available supply of funds type r at source o.

I_z is an $(LQ)\chi(LQ)$ identity matrix.

Nonfunds resources markets

$F = (f_1, f_2, \ldots, f_u, \ldots, f_U)'$, where f_u is the known available quantity of resource u. Resources may be available to a number of intermediaries in competition or unique to a single intermediary.

$\Sigma = (\sigma_1, \sigma_2, \ldots, \sigma_u, \ldots, \sigma_U)$, where σ_u is the imputed value of nonfunds resource u.

Intermediaries

j,k = 1, 2, ..., J intermediaries, e.g., commercial banks, savings and loan associations, production credit associations, etc.

$W = (w_{11\theta 1}, w_{11\theta 2}, \ldots, w_{11\theta Q}, w_{12\theta 1}, \ldots, w_{jl\theta q}, \ldots, w_{JL\theta Q})'$, where $w_{jl\theta q}$ is acquisition of funds type q from market l by intermediary j -- using process θ.

$V = (v_{11\theta 1}, v_{11\theta 2}, \ldots, v_{11\theta R}, v_{12\theta 1}, \ldots, v_{JO\theta R})'$, where $v_{jo\theta r}$ is acquisition of funds type r from source o by intermediary j -- using process θ.

$X = (x_{11\theta 1}, x_{11\theta 2}, \ldots, x_{11\theta N}, x_{12\theta 1}, \ldots, x_{jh\theta n}, \ldots, x_{JH\theta N})'$, where $x_{jh\theta n}$ is allocation of funds type n to market h by intermediary j -- using process θ.

$T = (t_{11\theta 1}, t_{11\theta 2}, \ldots, t_{11\theta S}, t_{12\theta 1}, \ldots, t_{jk\theta s}, \ldots t_{JK\theta S})'$, where $t_{jk\theta s}$ is the transfer of funds type s to intermediary k by intermediary j -- using process θ. Type of funds transfer is given by s = 1, 2, ..., S, e.g., compensating balances, interbank loans, etc. Internally allocated funds are given by $t_{jk\theta s}$ (j=k), e.g., required or cash reserves, etc.

Θ is a set of processes. For notational convenience activities are assumed to be of a single process; intermediaries could be modeled to have a number of candidate processes for a given acquisition, allocation or transfer activity.

$D = (d_1, d_2, \ldots, d_j, \ldots, d_J)'$, where d_j is the initial quantity of funds available for allocation at intermediary j.

$\Psi = (\psi_1, \psi_2, \ldots, \psi_j, \ldots, \psi_J)'$, where ψ_j is the imputed value of funds available for allocation at intermediary j.

$C_w = (c^w_{11\theta 1}, c^w_{11\theta 2}, \ldots, c^w_{11\theta Q}, c^w_{12\theta 1}, \ldots, c^w_{jl\theta q}, \ldots, c^w_{JL\theta Q})'$, where $c^w_{jl\theta q}$ is the explicit unit costs associated with acquisition activity $w_{jl\theta q}$.

$C_v = (c^v_{11\theta 1}, c^v_{11\theta 2}, \ldots, c^v_{11\theta R}, c^v_{12\theta 1}, \ldots, c^v_{jo\theta r}, \ldots, c^v_{JO\theta R})'$, where $c^v_{jo\theta r}$ is the explicit unit costs associated with acquisition activities $v_{jo\theta r}$. Costs could include a known cost of funds, e.g., interest rate on borrowing, in addition to transaction costs.

$C_x = (c^x_{11\theta 1}, c^x_{11\theta 2}, \ldots, c^x_{11\theta N}, c^x_{12\theta 1}, \ldots, c^x_{jh\theta n}, \ldots, c^x_{JH\theta N})'$, where $c_{jh\theta n}$ is the explicit unit costs associated with allocation activity $x_{jh\theta n}$. Costs could include transaction costs as well as transformation costs, associated with altering the liquidity and risk characteristics of funds.

$C_t = (c^t_{11\theta 1}, c^t_{11\theta 2}, \ldots, c^t_{11\theta S}, c^t_{12\theta 1}, \ldots, c^t_{jk\theta s}, \ldots, c^t_{JK\theta S})'$, where $c^t_{jk\theta s}$ is the explicit unit cost associated with activity $t_{jk\theta s}$. For $j \neq k$, $c^t_{jk\theta s}$ can be thought of as the net cost, $(c^t_{jjk\theta s} + c^t_{kjk\theta s})$, associated with transfer activity $t_{jk\theta s}$. The explicit net cost of funds transfer activities may be negative (i.e., net return). For example, letting $t_{jk\theta s}$ be an interbank loan from intermediary j to intermediary k, $c^t_{jjk\theta s}$ might be a return to intermediary j -- such as transaction costs minus interest received from intermediary k. At the same time $c^t_{kjk\theta s}$ might represent costs to intermediary k -- such as transaction costs plus interest rate payment to intermediary j.

P_x is an $(HN)\chi(JHN)$ matrix which can be partitioned into J adjacent $(HN)\chi(HN)$ identity matrices. The matrix reflects efficiency in allocation, i.e., a dollar allocated to asset markets uses a dollar of available funds.

P_w, P_v are respectively $(LQ)\chi(JLQ)$ and $(OR)\chi(JOR)$ matrices which can be partitioned into J adjacent $(LQ)\chi(LQ)$ and $(OR)\chi(OR)$ matrices. They represent efficiency in acquisition, i.e., a dollar acquired in source markets results in a dollar of funds available for allocation.

A_x, A_w, A_v, A_t are respectively $U\chi(JHN)$, $U\chi(JLQ)$, $U\chi(JOR)$, and $U_\chi(JJS)$ matrices which reflect technical efficiency in nonfunds resource use. Intermediary j use of resource u is given as follows: for allocation activity $x_{jh\theta n}$, by $a^x_{jh\theta nu}$, the $(j-1)HN + (h-1)N + n$th element of the uth row of A_x; for acquisition activities $w_{jl\theta q}$ and $v_{jo\theta r}$, by $a^w_{jl\theta qu}$ the $(j-1)LQ + (l-1)Q + q$th element of the uth row of A_w and by $a^v_{jo\theta ru}$, the $(j-1)OR + (o-1)R + r$th element of the uth row of A_v; for internal allocation activity $t_{jj\theta s}$, by $a_{jj\theta su}$ the $(j-1)JS + (j-1)S + s$th element of the uth row of A_t; and finally for transfer activity $t_{jk\theta s}$, by $a^t_{jk\theta su} = (a^t_{jjk\theta su} + a^t_{kjk\theta su})$ the sum of intermediary j and intermediary k use of resource u, the $(j-1)JS + (k-1)S + s$th element of the uth row of A_t.

M_x, M_w, M_v, M_t are respectively $J\chi(JHN)$, $J\chi(JLQ)$, $J\chi(JOR)$ and $J\chi(JJS)$. They reflect efficiency in the intermediaries balance sheet activities. The $(j-1)HN + 1$ to $(j-1)HN + HN$ elements of the jth row of M_x are equal to 1. The $(j-1)LQ + 1$ to $(j-1)LQ + LQ$ elements of the jth row of M_w are equal to -1. Similarly, the (j-1)OR + 1 to (j-1)OR + OR elements of the jth row of M_v are equal to -1. For M_t, the (j-1)JS + 1 to (j-1)JS + JS elements of the jth row are equal to 1; the (k-1)JS + (j-1)S + 1 to (k-1)JS + (j-1)S + S elements of the jth row of M_t are equal to -1, for $k \neq j$. All other elements of the matrices are equal to zero.

Policy and regulatory constraints

B_x, B_w, B_v, B_t are respectively $B\chi$(JHN), $B\chi$(JLQ), $B\chi$(JOR) and $B\chi$(JJS) matrices of technical coefficients in policy and regulatory constraints, where the coefficients of $x_{jh\theta n}$, $w_{jl\theta q}$, $v_{jo\theta r}$ and $t_{jk\theta s}$ in the βth policy or regulatory constraint are respectively $b^x_{jh\theta n\beta}$, the (j-1)HN + (h-1)N + nth element of the βth row of B_x; $b^w_{jl\theta q\beta}$, the (j-1)LQ + (l-1)Q + qth element of the βth row of B_w; $b^v_{jo\theta r\beta}$, the (j-1)OR + (o-1)R + rth element of the βth row of B_v; and $b^t_{jk\theta s\beta}$, the (j-1)JS + (k-1)S + sth element of the βth row of B_t.

$G = (g_1, g_2, \ldots, g_\beta, \ldots g_B)'$, where g_β is the right hand side of the βth policy or regulatory constraint.

$K = (\kappa_1, \kappa_2, \ldots, \kappa_\beta, \ldots, \kappa_B)$, where κ_β is the imputed unit cost of the βth policy or regulatory constraint.

Mathematical Model

Objective function

The objective function is to maximize net revenue for the financial section being modeled:

Maximize

$\sum_h(\sum_n \lambda_{hn} y_{hn} - \sum_n(\sum_m \omega_{hnm} y_{hm}) y_{hn})$: gross revenue from assets

$- \sum_{jhn}\sum\sum c^x_{jh\theta n} x_{jh\theta n}$: explicit allocation costs

$- \sum_{jlq}\sum\sum c^w_{jl\theta q} w_{jl\theta q} - \sum_{jor}\sum\sum c^v_{jo\theta r} v_{jo\theta r}$: explicit acquisition costs

$- \sum_l(\sum_q \Pi_{lq} z_{lq} + \sum_q(\sum_p \phi_{lqp} z_{lp}) z_{lq})$: cost of liabilities

$- \sum_j \sum_{k\neq j} \sum_s (c^t_{jjk\theta s} + c^t_{kjk\theta s}) t_{jk\theta s}$: explicit transfer costs

$- \sum_j \sum_s c_{jj\theta s}\, t_{jj\theta s}$: explicit internal allocation costs

$- \sum_j \psi_j\, d_j$: imputed cost of initially available funds

$- \sum_o \sum_r \varepsilon_{or}\, e_{or}$: imputed cost of known funds supply

$- \sum_u \sigma_u\, f_u$: imputed cost of nonfunds resources

$- \sum_h \sum_n \delta_{hn} \cdot 0 - \sum_l \sum_q \gamma_{lq} \cdot 0$: __[1]

(3.1)

---

[1]No funds have been a priori allocated to asset markets or procured in liability markets in this form of the model. Including constant terms in (3.2a) and (3.2b) could result in nonzero components in the objective function.

Constraint set

The constraint set can be grouped into three constraint types. A series of resource balance constraints reflect the fact that funds and nonfunds resource use may not exceed supplies. A set of pricing conditions ensures that the unit value of an activity cannot exceed the unit cost of the activity--explicit unit costs plus the imputed value of resource use per unit of activity. Finally non-negativity conditions allow only nonnegative activity levels.

Resource balance Funds demanded in asset markets may not exceed the quantity of funds allocated to those markets by the intermediaries:

$$y_{hn} \leq \sum_{j} x_{jh\theta n}; \quad h=1,2,\ldots, H \text{ and } n=1,2,\ldots, N \qquad (3.2a)$$

Similarly funds acquired by intermediaries in liability markets or from known sources may not exceed the quantity of funds supplied in the liability markets or the known quantity of funds available:

$$\sum_{j} w_{jl\theta q} \leq z_{lq}; \quad l=1,2,\ldots, L \text{ and } q=1,2,\ldots, Q \qquad (3.2b)$$

$$\sum_{j} v_{jo\theta r} \leq e_{or}; \quad o=1,2,\ldots, O \text{ and } r=1,2,\ldots, R \qquad (3.2c)$$

An individual intermediary's use of funds in allocation to asset markets, internal allocation, and transfer to other intermediaries cannot exceed funds initially available plus funds acquired in source markets and through transfer from other intermediaries. These are the balance sheet contraints:

$$\sum_{hn}\sum x_{jh\theta n}+\sum_{ks}\sum t_{jk\theta s}\leq d_j+\sum_{lq}\sum w_{jl\theta q}+\sum_{or}\sum v_{jo\theta r}+\sum_{k\neq j}\sum_{s} t_{kj\theta s}$$

$$j = 1, 2, \ldots, J \qquad (3.2d)$$

Finally, nonfunds resources used cannot exceed known available supplies:

$$\sum\sum_{jhn}\sum a^{x}_{jh\theta nu}x_{jh\theta n}+\sum\sum_{jlq}\sum a^{w}_{jl\theta qu}w_{jl\theta q}+\sum\sum_{jor}\sum a^{v}_{jo\theta ru}v_{jo\theta r}+$$

$$\sum_{j}\sum_{k\neq j}\sum_{s}(a^{t}_{jjk\theta su}+a^{t}_{kjk\theta su})t_{jk\theta s}+\sum_{js}\sum a_{jj\theta su}t_{jj\theta s}\leq f_u$$

$$u = 1, 2, \ldots\ U \qquad (3.2e)$$

Pricing conditions The demand price for an asset cannot exceed the imputed market equilibrium price:

$$\lambda_{hn}-\sum_{m}\omega_{hnm}y_{hm} \leq \delta_{hn};\ h = 1,2,\ldots, H \text{ and } n=1,2,\ldots,N \qquad (3.2g)$$

Similarly, the imputed market equilibrium price of a liability cannot exceed the supply price:

$$\gamma_{lq}\leq\pi_{lq}+\sum_{p}\phi_{lqp}z_{lp};\ l=1,2,\ldots, L \text{ and } q=1,2,\ldots, Q \qquad (3.2h)$$

The imputed marginal value of funds allocated to asset markets cannot exceed the marginal cost of funds allocated. Costs include explicit allocation costs plus the imputed cost of available funds and the imputed cost of nonfunds resources:

$$\delta_{hn} \leq c^{x}_{jh\theta n} + \psi_j + \sum_u a^{x}_{jh\theta nu} \sigma_u$$

$j = 1,2,\ldots J;\ h = 1,2,\ldots, H$ and $n = 1,2,\ldots, N$

(3.2i)

The imputed marginal value of funds available for allocation cannot exceed the unit cost of acquisition at each intermediary. Costs include explicit acquisition costs plus the imputed cost of funds from source markets and the imputed cost of nonfunds resources:

$$\psi_j' \leq c^{w}_{jl\theta q} + \gamma_{lq} + \sum_u a^{w}_{jl\theta qu} \sigma_u$$

$j = 1,2,\ldots, J;\ l = 1,2,\ldots, L$ and $q = 1,2,\ldots, Q$

(3.2j)

$$\psi_j \leq c^{v}_{jo\theta r} + \xi_{or} + \sum_u a^{v}_{jo\theta ru} \sigma_u$$

$j = 1,2,\ldots, J;\ o = 1,2,\ldots, O$ and $r = 1,2,\ldots,R$

(3.2k)

Finally, the imputed marginal return from transfer and internal allocation activities cannot exceed the marginal costs of such activities. Costs include explicit activity costs, imputed costs of nonfunds resources, and the imputed cost of available funds at the source intermediary:

$$\psi_j \leq (c^{t}_{jkj\theta s} + c^{t}_{kkj\theta s}) + \sum_u (a^{t}_{jkj\theta su} + a^{t}_{kkj\theta su}) \sigma_u + \psi_k$$

transfer activities $k \neq j = 1,2,\ldots J$ and $s = 1,2,\ldots,S$

$0 \leq c^{t}_{jj\theta s} + \sum_{u} a^{t}_{jj\theta su}\ \sigma_u + \psi_j$

internal allocation activities

j=1,2,..., J and s=1,2,..., S (3.2ℓ)

Nonnegativity conditions The nonnegativity conditions ensure only nonnegative activity levels and imputed prices:

$y_{hn} \geq 0$; $z_{lq} \geq 0$; $x_{jh\theta n} \geq 0$; $w_{jl\theta q} \geq 0$; $v_{jo\theta r} \geq 0$; $t_{jk\theta s} \geq 0$; $\delta_{hn} \geq 0$; $\gamma_{lq} \geq 0$; $\psi_j \geq 0$; $\xi_{or} \geq 0$ and $\sigma_u \geq 0$

h=1,2,..., H; n=1,2,..., N; l=1,2,..., L; q=1,2, ..., Q; j,k=1,2,... J; o=1,2,... O; r=1,2,..., R; s=1,2,..., S and u=1,2,... U (3.3)

Policy and regulatory constraints[1]

The addition of policy and regulatory restrictions to the model requires modification to both the objective function and the constraint set. The objective function is changed to include the imputed cost to the sector of the policy and regulatory constraints:

Objective function (3.1) is modified to include

$- \sum_{\beta} \kappa_\beta\ g_\beta$: imputed cost of constraints (3.1')

The policy and regulatory constraints are added:

---

[1]Rows of an activity analysis structure are normally thought of as using or creating a commodity. Charnes and Cooper (34) discuss a broader view of "commodity" to include policy and legal restraints which may in turn be productive or nonproductive.

$$\sum_{jhn}\sum\sum b^{x}_{jh\theta n}\ x_{jh\theta n}+\sum_{jlq}\sum\sum b^{w}_{jl\theta q\beta}w_{jl\theta q}+\sum_{jor}\sum\sum b^{v}_{jo\theta r\beta}v_{jo\theta r}$$

$$+\sum_{jks}\sum\sum b^{t}_{jk\theta s\beta}\ t_{jk\theta s} \leq g_{\beta};\ \beta=1,2,\ldots,\ B \qquad (3.2f)$$

The pricing conditions must be modified to include per unit activity costs of policy and regulatory constraints:[1]

$$\delta_{hn} \leq C^{x}_{jh\theta n} + \psi_j + \sum_u a^{x}_{jh\theta nu}\ \sigma_u + \sum_\beta b^{x}_{jh\theta n\beta}\ \kappa_\beta$$

$$j=1,2,\ldots,\ J;\ h=1,2,\ldots,\ H \text{ and } n=1,2,\ldots,\ N \qquad (3.2i')$$

$$\psi_j \leq c_{jl\theta q} + \gamma_{lq} + \sum_u a^{w}_{jl\theta qu}\ \sigma_u + \sum_\beta b^{w}_{jl\theta q\beta}\ \kappa_\beta$$

$$j=1,2,\ldots,\ J;\ l=1,2,\ldots,\ L \text{ and } q=1,2,\ldots,\ Q \qquad (3.2j')$$

$$\psi_j \leq c^{v}_{jo\theta r} + \xi_{or} + \sum_u a^{v}_{jo\theta ru}\ \sigma_u + \sum_\beta b^{v}_{jo\theta r\beta}\ \kappa_\beta$$

$$j=1,2,\ldots,\ J;\ o=1,2,\ldots,\ O \text{ and } r=1,2,\ldots,\ R \qquad (3.2k')$$

$$\psi_j \leq (c^{t}_{jkj\theta s}+c^{t}_{kkj\theta s}) + \sum_u (a^{t}_{jkj\theta su}+a^{t}_{kkj\theta su})\sigma_u + \psi_k + \sum_\beta b^{t}_{kj\theta s\beta}\ \kappa_\beta$$

$$k\neq j=1,2,\ldots,\ J \text{ and } s=1,2,\ldots,\ S$$

$$\text{and } 0 \leq c^{t}_{jj\theta s} + \sum_u a^{t}_{jj\theta su}\ \sigma_u + \psi_j + \sum_\beta b^{t}_{jj\theta s\beta}\ \kappa_\beta$$

$$j=1,2,\ldots,\ J \text{ and } s=1,2,\ldots,\ S \qquad (3.2\ell')$$

Finally, the additional nonnegativity constraints are added to (3.3):

$$\kappa_\beta \geq 0;\ \beta = 1,2,\ldots,\ B \qquad (3.3')$$

---

[1]Depending on the sign of the elements of B_x, B_w, B_v, B_t the constraint may increase or decrease the net value of the contributions of activities X, W, V, T (34).

Matrix notation

The perfect competition pricing model with policy and regulatory constraints added can be written in the following matrix notation:

Maximize (3.1')

$$\begin{bmatrix} X \\ W \\ V \\ T \\ \Delta \\ \Gamma \\ \Psi \\ \Xi \\ \Sigma \\ K \\ Y \\ Z \end{bmatrix}' \left[\begin{bmatrix} 0 & 0 & 0 & 0 & P'_x & 0 & -M'_x & 0 & -A'_x & -B'_x & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -P'_w & M'_w & 0 & -A'_w & -B'_w & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & M'_v & -P'_v & -A'_v & -B'_v & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -M'_t & 0 & -A'_t & -B'_t & 0 & 0 \\ -P_x & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & I_y & 0 \\ 0 & P_w & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -I_z \\ M_x & -M_w & -M_v & M_t & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & P_v & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ A_x & A_w & A_v & A_t & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ B_x & B_w & B_v & B_t & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -I_y & 0 & 0 & 0 & 0 & 0 & -\Omega & 0 \\ 0 & 0 & 0 & 0 & 0 & I_z & 0 & 0 & 0 & 0 & 0 & -\Phi \end{bmatrix} \begin{bmatrix} X \\ W \\ V \\ T \\ \Delta \\ \Gamma \\ \Psi \\ \Xi \\ \Sigma \\ K \\ Y \\ Z \end{bmatrix} - \begin{bmatrix} C_x \\ C_w \\ C_v \\ C_t \\ 0 \\ 0 \\ D \\ E \\ F \\ G \\ -\Lambda \\ \Pi \end{bmatrix} \right]$$

Subject to (3.2a - 3.2h) and (3.2i' - 3.2ℓ')

$$\begin{bmatrix} 0 & 0 & 0 & 0 & P'_x & 0 & -M'_x & 0 & -A'_x & -B'_x & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -P'_w & M'_w & 0 & -A_w' & -B'_w & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & M'_v & -P'_v & -A'_v & -B'_v & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -M'_t & 0 & -A'_t & -B'_t & 0 & 0 \\ -P_x & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & I_y & 0 \\ 0 & P_w & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -I_z \\ M_x & -M_w & -M_v & M_t & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & P_v & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ A_x & A_w & A_v & A_t & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ B_x & B_w & B_v & B_t & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -I_y & 0 & 0 & 0 & 0 & 0 & -\Omega & 0 \\ 0 & 0 & 0 & 0 & 0 & I_z & 0 & 0 & 0 & 0 & 0 & -\phi \end{bmatrix} \begin{bmatrix} X \\ W \\ V \\ T \\ \Delta \\ \Gamma \\ \Psi \\ \Xi \\ \Sigma \\ K \\ Y \\ Z \end{bmatrix} \leq \begin{bmatrix} C_x \\ C_w \\ C_v \\ C_t \\ 0 \\ 0 \\ D \\ E \\ F \\ G \\ -\Lambda \\ \Pi \end{bmatrix}$$

and nonnegativity conditions (3.3) and (3.3')

$$[X \; W \; V \; T \; \Delta \; \Gamma \; \Psi \; \Xi \; \Sigma \; K \; Y \; Z]' \geq 0$$

Model Interpretation

The self-dual characteristics of the model (3.1', 3.2a-3.2h, 3.2i'-3.2ℓ', 3.3, 3.3'), can be seen in the matrix formulation presented in the previous section. The constraint matrix is skew-symmetric except for the sub matrix $\begin{bmatrix} -\Omega & 0 \\ 0 & -\phi \end{bmatrix}$, i.e., the matrix equals the negative of its transpose. The constraint vector (right hand side) of the constraint set equals the negative of the coefficient vector of the linear portion of the objective function. Plessner (136) and Hall, Heady, Stoecker and Sposito (69) have shown that models with this structure satisfy, at the optimal, conditions normally associated with perfect competition.[1]

The objective function, net revenue for the financial sector being modeled, reaches its maximum at zero, i.e., no pure economic profits, and, if the problem has a feasible solution, the pricing and flow outcomes expected in a perfect competition environment hold at the optimal.

If imputed market equilibrium prices in source and use of funds markets are positive, the normal market equilibrium conditions equating supply and demand for funds hold:

$$\delta_{hn} \; (y_{hn} - \sum_j x_{jh\theta n}) = 0 \;\; ; \;\; h=1,2,\ldots,H \text{ and } n=1,2,\ldots,N \quad (3.4a)$$

$$\gamma_{lq} \; (\sum_j w_{jl\theta q} - z_{lq}) = 0 \;\; ; \;\; l=1,2,\ldots, L \text{ and } q=1,2,\ldots,Q \quad (3.4b)$$

$$\xi_{or} \; (\sum_j v_{jo\theta r} - e_{or}) = 0 \;\; ; \;\; o=1,2,\ldots, O \text{ and } r=1,2,\ldots,R \quad (3.4c)$$

If the imputed value (cost) of funds available for allocation is positive at an intermediary, then the balance sheet condition ensures that funds initially available to the intermediary plus funds acquired equals funds allocated:

---

[1]The solution is efficient, guarantees gross and net profits for the sector as well as each firm (decentralization), guarantees nonpositive net profits and would be brought about by free market prices so as to equate supply and demand (136). Also, see McCarl and Spreen (116).

$$\psi_j\left(\sum_{h}\sum_{n} x_{jh\theta n}+\sum_{k}\sum_{s} t_{jk\theta s}-d_j-\sum_{l}\sum_{q} w_{jl\theta q}-\sum_{o}\sum_{r} v_{jo\theta r}-\sum_{k\neq j}\sum_{s} t_{kj\theta s}\right) = 0$$

$$j=1,2,\ldots, J \qquad (3.4d)$$

A positive imputed market price for nonfunds resources ensures that nonfunds resource use exhausts initially available supplies:

$$\sigma_u\Big(\sum_{j}\sum_{h}\sum_{n} a^x_{jh\theta nu} x_{jh\theta n}+\sum_{j}\sum_{l}\sum_{q} a^w_{jl\theta qu} w_{jl\theta q} + \sum_{j}\sum_{o}\sum_{r} a^v_{jo\theta ru} v_{jo\theta r}$$

$$+ \sum_{j}\sum_{k\neq j}\sum_{s}(a^t_{jjk\theta su}+a^t_{kjk\theta su})t_{jk\theta s} + \sum_{j}\sum_{s} a^t_{jj\theta su} t_{jj\theta s}-f_u\Big) = 0$$

$$u=1,2,\ldots, U \qquad (3.4e)$$

Similarly, if the imputed cost of a policy or regulatory constraint is positive, then the policy or regulatory constraint is binding:

$$\kappa_\beta\Big(\sum_{j}\sum_{h}\sum_{n} b^x_{jh\theta n\beta} x_{jh\theta n} + \sum_{j}\sum_{l}\sum_{q} b^w_{jl\theta q\beta} w_{jl\theta q}$$

$$+ \sum_{j}\sum_{o}\sum_{r} b^v_{jo\theta r\beta} v_{jo\theta r} + \sum_{j}\sum_{k}\sum_{s} b^t_{jk\theta s\beta} t_{jk\theta s} - g_\beta\Big) = 0$$

$$\beta=1,2,\ldots, B \qquad (3.4f)$$

Finally, perfect competition equilibrium pricing conditions are ensured. If the marginal return from an activity (flow of funds) is less than the marginal cost of the activity, the flow of funds activity level is zero. If the marginal return exceeds the marginal cost, the flow of funds activity level increases until marginal return and marginal cost are equal:

$$Y_{hn} \ (\lambda_{hn} - \sum_m \omega_{hnm} Y_{hm} - \delta_{hn}) = 0$$

$h=1,2,\ldots, H$ and $n=1,2,\ldots, N$ (3.4g)

$$Z_{lq}(\gamma_{lq} - \Pi_{lq} - \sum_p \phi_{lqp} \ Z_{lp}) = 0$$

$\ell=1,2,\ldots, L$ and $q=1,2,\ldots, Q$ (3.4h)

$$X_{jh\theta n} \ (\delta_{hn} - \psi_j - c^x_{jh\theta n} - \sum_u a^x_{jh\theta nu}\sigma_u - \sum_\beta b^x_{jh\theta n\beta}\kappa_\beta) = 0$$

$j=1,2,\ldots, J;$ $h=1,2,\ldots, H$ and $n=1,2,\ldots, N$

(3.4i)

$$w_{jl\theta q} \ (\psi_j - \gamma_{lq} - c^w_{jl\theta q} - \sum_u a^w_{jl\theta qu}\sigma_u - \sum_\beta b^w_{jl\theta q\beta}\kappa_\beta) = 0$$

$j=1,2,\ldots, J;$ $l=1,2,\ldots, L$ and $q=1,2,\ldots, Q$

(3.4j)

$$v_{jo\theta r}(\psi_j - \xi_{or} - c^v_{jo\theta r} - \sum_u a^v_{jo\theta ru}\sigma_u - \sum_\beta b^v_{jo\theta r\beta}\kappa_\beta) = 0$$

$j=1,2,\ldots, J;$ $o=1,2\ldots, O$ and $r=1,2,\ldots, R$

(3.4k)

$$t_{jk\theta s}(\psi_k - (c^t_{jjk\theta s} + c^t_{kjk\theta s}) - \sum_u (a^t_{jjk\theta su} + a^t_{kjk\theta su})\sigma_u$$

$$- \sum_\beta b^t_{jk\theta s\beta} \ \kappa_\beta \ - \psi_j) = 0$$

$j=1,2,\ldots, J;$ $k\neq j=1,2,\ldots, J$ and $s=1,2,\ldots, S$

and $$t_{jj\theta s} \ (-c^t_{jj\theta s} - \sum_u a^t_{jjsu\theta u} - \sum_\beta b^t_{jj\theta s\beta} \ \kappa_\beta - \psi_j) = 0$$

$j=1,2,\ldots, J$ and $s=1,2,\ldots, S$ (3.4ℓ)

For positive demand for funds in use of funds markets, conditions (3.4g and 3.4i) give the following equilibrium conditions:

$$\lambda_{hn} - \sum_m \omega_{hmn} y_{hm} = \psi_j + c^x_{jh\theta n} + \sum_u a^x_{jh\theta nu} \sigma_u + b^x_{jh\theta n\beta} \kappa_\beta$$

$h=1,2,\ldots, H;\ n=1,2,\ldots, N$ and $j=1,2,\ldots, J$

That is the marginal cost of allocation of funds to market h funds type n is equalized across all intermediaries with positive allocation activities and is equal to the demand price for funds type n in market h.

For positive supply of funds in source of funds markets, conditions (3.4h and 3.4j) give the following equilibrium conditions:

$$\pi_{lq} + \sum_p \phi_{lqp} z_{lp} = \psi_j - c^w_{jl\theta q} - \sum_u a^w_{jl\theta qu} \sigma_u - \sum_\beta b^w_{jl\theta q} \kappa_\beta$$

$l=1,2,\ldots, L;\ q=1,2,\ldots, Q$ and $j=1,2,\ldots, J$

That is the marginal return from acquisition of funds type q in market l is equalized for all intermediaries with positive acquisition activities and is equal to the market supply price for funds type q in market l. Similarly, condition (3.4k) ensures that the marginal return from acquisition of funds type r at source o is equalized for all intermediaries with positive acquisition activities and is equal to the imputed market price of funds type r at source o:

$$\xi_{or} = \psi_j - c^v_{jo\theta r} - \sum_u a^v_{jo\theta ru} \sigma_u - \sum b^v_{jo\theta r\beta} \kappa_\beta$$

$o=1,2,\ldots,O;\ r=1,2,\ldots, R$ and $j=1,2,\ldots, J$

Conditions (3.4i and 3.4 ℓ) ensure that each intermediary increases alternative uses of funds to the levels which equalize the marginal return for the alternative uses of funds and which equate them to the marginal cost of funds available for allocation and transfer:

$$\psi_j = \delta_{hn} - c^x_{jh\theta n} - \sum_u a^x_{jh\theta nu}\sigma_u - \sum_\beta b^x_{jh\theta n\beta}\,\kappa_\beta$$

$j=1,2,\ldots, J;\ h=1,2,\ldots, H$ and $n=1,2,\ldots, N$

$$\psi_j = \psi_k - (c^t_{jjk\theta s} + c^t_{kjk\theta s}) - \sum_u (a^t_{jjk\theta su} + a^t_{kjk\theta su})\sigma_u - \sum_\beta b^t_{jk\theta s\beta}\,\kappa_\beta$$

$j=1,2,\ldots, J;\ k\neq j=1,2,\ldots, J$ and

$s=1,2,\ldots, S$

$$\psi_j = -c^t_{jj\theta s} - \sum_u a^t_{jj\theta su}\sigma_u - \sum_\beta b^t_{jj\theta s\beta}\,\kappa_\beta$$

$j=1,2,\ldots, J;$ and $s=1,2,\ldots, S$

Similarly conditions (3.4j - 3.4ℓ) ensure that each intermediary increases alternative acquisition of funds activities to levels which equalize the marginal cost for all alternative sources of funds and which equate them to the marginal return from funds available for allocation and transfer activities:

$$\psi_j = \gamma_{lq} + c^w_{jl\theta q} + \sum_u a^w_{jl\theta qu}\sigma_u + \sum_\beta b^w_{jl\theta q\beta}\,\kappa_\beta$$

$j=1,2,\ldots, J;\ l=1,2,\ldots, L$ and $q=1,2,\ldots, Q$

$$\psi_j = \xi_{or} + c^v_{jo\theta r} + \sum_u a^v_{jo\theta ru}\sigma_u + \sum_\beta b^v_{jo\theta r\beta}\,\kappa_\beta$$

$j=1,2,\ldots, J;\ o=1,2,\ldots, 0$ and $r=1,2,\ldots, R$

$$\psi_j = \psi_k + (c^t_{jkj\theta s} + c^t_{kkj\theta s}) + \sum_u (a^t_{jkj\theta su} + a^t_{kkj\theta su})\,\sigma_u + \sum_\beta b^t_{kj\theta s\beta}\,\kappa_\beta$$

$j=1,2,\ldots J,\ k\neq j=1,2,\ldots, J$ and $s=1,2,\ldots, S$

Taken together conditions (3.4i-3.4ℓ) ensure that each intermediary, for all positive acquisition, allocation and transfer activities, equates the marginal cost of all alternative sources of funds and the marginal return in all alternative uses of funds.

Model Evaluation

Principal structural aspects

The model presented in this chapter provides an improved capability to reflect the topology of localized financial markets. There are two key structural aspects of the model: (1) activity analysis formulation of individual firm operations, and (2) simultaneous determination of pricing and flow of funds patterns in spatially separate source and use of funds markets. These elements allow significant detail in modeling the financial intermediation process in localized markets. At the same time, the model has the flexibility for considerable policy analyses of pending legislative proposals and industry initiative by determining changes in the acquisition, transfer, allocation and pricing outcomes associated with changing industry structure, changing degree of market and intermediary integration and independence, changing competitive environment, and changing pricing and flow of funds restrictions.

The activity analysis formulation for intermediaries is a logical extension of asset management models. Detailed models of single institutions have been structured, evaluated and implemented in an operational environment and will provide information directly applicable to the model of financial intermediation presented.

The spatial price and allocation activity analysis structure has been successfully demonstrated in other applications (95). Application to financial intermediation in localized markets allows for detailed linkages among intermediaries and local source and use of funds markets. This aspect of the model should allow useful insights to the crucial determinants in flow of funds, utilization of financial and nonfinancial resources, as well as pricing outcomes associated with flow of funds levels in local markets.

Limitations and extensions

A number of characteristics of the model represent limitations and at the same time offer prospects for enhancement of the model: (1) limiting assumptions of perfect competition; (2) data intensity; and (3) limitations of partial equilibrium, single period analysis.

Assumptions of perfect competition Many aspects of the financial intermediation process in localized markets are not realistically reflected in the perfect competition model as presented. Three assumptions need to be examined in greater detail: (1) profit maximizing behavior; (2) price equals marginal cost and price equals marginal return pricing in use and source of funds markets; and (3) market clearing conditions equating supply and demand for funds in asset markets.

Profit maximization, while a good representation of the behavior of commercial banks, is less applicable to nonbank intermediaries. However, the assumption of profit maximization should not prove to be a serious limitation for three reasons. First, initial applications of the model are likely to concentrate on the commercial banking structure which represents the most diversified and important part of the United States financial system. Profit maximization could be a good proxy for the behavior of some nonbank intermediaries. Finally and most important, sufficing behavior of individual intermediaries can be explicitly modeled by using appropriate policy restrictions. The imputed cost of such behavioral restraints directly enter the objective function and pricing conditions.

The model describes market equilibrium through the simultaneous determination of price and flow of funds brought about by perfect competition pricing. One of the principal issues concerning financial intermediation in localized markets is the degree of concentration of intermediaries and their potential for market power. Localized financial markets are most accurately characterized by varying degrees of oligopolistic behavior. Such pricing considerations can be incorporated into the model. Chapters 4 and 5 describe a number of model alternatives to perfect competition pricing: (1) monopoly pricing; (2) varying degrees of competitive pricing between the extremes of perfect competition and monopoly; (3) oligopolistic pricing in some product lines and perfect competition pricing in others; and (4) generalization to include advertising and differentiated product demand.

The validity of market clearing conditions equating supply and demand in asset markets must also be questioned. Existing price distortions in the financial system, e.g., interest rate ceilings, have led to a degree of nonprice rationing in financial markets (72). The degree to which such activity limits the usefulness of the spatial equilibrium model is mitigated by a number of considerations. Credit rationing functions mainly involve the activities of intermediaries and these distortions can be reflected in the activity analysis structure of the model. Combined with reliable estimates of demand for credit, the model should provide a good representation of market activity. Chapter 6 considers the problem of obtaining empirical estimates of the demand for credit based on data which reflects markets in disequilibrium.

Harris (72, p. 239) suggests another consideration, "As banks make particular changes in loan terms, borrowers will react to such changes through the demand functions." If such nonprice factors are significant, demand relationships could be extended to include quantifiable factors and the model even extended to include endogenous determination of nonprice factors, e.g., advertising.

Finally, the model is directed at policy analyses of changes to the financial system. Many of the changes are aimed at eliminating price restrictions and creating greater reliance on market determination of price.

Data intensity The difficulties in estimating market demand and supply for financial instruments are accentuated by the problems in delineating financial markets. Mathis, Harris and Boehlje define a financial market,

> ...as an area encompassing all of those economic units that exert and react essentially to the same set of competitive forces influencing the price or quality of a specific product or service (121, p. 602).

Based on this definition, the authors discuss alternative approaches to delineation of rural financial markets and offer an approach based on firms response times in price adjustments. As with most delineation procedures, the reliability of demand and supply estimates will ultimately be a function of the accuracy of available financial data.

The data intensity of the model is not confined to the market relationships and represents the greatest potential disadvantage of the model. However, sufficient data for successful implementation of single firm models indicate that data requirements, in terms of technical coefficients in the activity analysis structure and in terms of cost parameters, can be met. Current interest in developing more comprehensive and accurate financial data series provides the prospect for improved identification and estimation of market relationships (122). Finally, as discussed in chapter 5, sensitivity analyses of results to changes in model coefficients can aid in identifying key data inputs as well as accounting for uncertainty in estimates of model parameters.

<u>Partial equilibrium, single period analyses</u>. Sensitivity analyses can also play an important role in circumventing the short run nature of a fixed technology set in firm operations. Structural parameters could be varied over a range of short run alternatives. Two other important

short run features of the model, partial equilibrium and single modeling period, can also be mitigated.

The partial equilibrium nature of the model and implied constancy of other sectors of the economy is not as significant a limitation in modeling localized financial markets as in application to an entire sector or larger subset of the economy. It does restrict the amount of detail allowed in modeling external linkages between local financial markets and other sectors of the economy or hierarchial levels of the financial system. However, exogenous factors can be reflected in the demand and supply specifications. For example, consider the simple demand price relationship $\varepsilon = f(y,\bar{\bar{F}})$ where $\bar{\bar{F}}$ represents exogenous factors fixed in the short run and thus "lumped" into the constant term, λ, in the linear demand function, $\varepsilon = \lambda - \omega y$. Changing exogenous impacts in the short run could be accomplished by parameterization of λ or elements comprising λ. Also the activity analysis structure which allows linkages between intermediaries and external financial institutions to the local market could be varied in the analyses; e.g., parameterization of a fixed quantity of available funds.

Asset management models which have been extended to a multiperiod or recursive programming framework have provided improved representation of the decision process of financial intermediaries--especially risk considerations.

Intertemporal spatial price and allocation models have been developed and applied to nonfinancial problems (95). Extending the model presented in this chapter to a recursive programming structure could provide improved capabilities in two important areas: (1) balance sheet management could explicitly model the "financing" of assets by liabilities with similar maturities;[1] and (2) intertemporal cross linkage between asset and liability markets could be modeled.

In conclusion, combined with the extensions discussed in this section, the spatial price and allocation activity analysis model should provide a practical, comprehensive and flexible framework for modeling financial intermediation in localized markets.

---

[1]The importance of this balance sheet function in strategic planning and policy making in banks is discussed by Adolfse and Vervoordeldonk (1). In a single period model, the balancing of assets and liabilities with similar maturities could be accomplished to some degree through policy constraints in the model.

CHAPTER IV. EXTENDING THE SPATIAL PRICE AND ALLOCATION MODEL OF LOCALIZED FINANCIAL MARKETS: ALTERNATIVE COMPETITIVE ENVIRONMENTS

Only a few empirical applications of spatial price and allocation models have included conditions of imperfect competition. These efforts have focused almost exclusively on demand markets (95, 138). While perfect competition is a reasonable proxy for market behavior in many applications, especially those in agriculture, this is most often not the case in financial intermediation.

Many proposed changes to existing restrictions in the United States financial system concern the potential market power of financial intermediaries in local markets. Therefore, a useful model for policy analyses of localized financial intermediation requires the capability to reflect alternative competitive frameworks. Specific market assumptions could be modeled or, when the exact form of obligopolistic or oligopsonistic behavior is difficult to specify, the impact of proposed policy changes could be analyzed across the spectrum of market behavior from perfect competition to collusion. Viewing a policy proposal across varying degrees of competition should prove useful in identifying those elements of the financial system on which assumptions concerning market competition have the greatest impact.

This chapter summarizes existing methods for reflecting conditions of imperfect competition in spatial price and allocation models. Building on existing concepts, the perfect competition model presented in chapter 4 is extended to allow alternatives to perfect competition in both demand (asset) and supply (liability) markets.

Methods for Modeling Imperfect Competition

Using the notation introduced in chapter 3, the following general quadratic programming problem can be specified:

Maximize

$$\begin{bmatrix} X \\ W \\ V \\ T \\ Y \\ Z \end{bmatrix}' \left[\lambda/2 \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -\Omega & 0 \\ 0 & 0 & 0 & 0 & 0 & -\Phi \end{bmatrix} \begin{bmatrix} X \\ W \\ V \\ T \\ Y \\ Z \end{bmatrix} - \begin{bmatrix} C_x \\ C_w \\ C_v \\ C_t \\ -\Lambda \\ \Pi \end{bmatrix} \right]$$

Subject to

$$\begin{bmatrix} -P_x & 0 & 0 & 0 & I_y & 0 \\ 0 & P_w & 0 & 0 & 0 & -I_z \\ M_x & -M_w & -M_v & M_t & 0 & 0 \\ 0 & 0 & P_v & 0 & 0 & 0 \\ A_x & A_w & A_v & A_t & 0 & 0 \\ B_x & B_w & B_v & B_t & 0 & 0 \end{bmatrix} \begin{bmatrix} X \\ W \\ V \\ T \\ Y \\ Z \end{bmatrix} \leq \begin{bmatrix} O \\ O \\ D \\ E \\ F \\ G \end{bmatrix}$$

$$[X\ W\ V\ T\ Y\ Z]' \geq O \qquad (4.1)$$

The constraint set in problem (4.1) is simply the resource balance, policy/regulatory, and nonnegativity constraints specified for the perfect competition model, i.e., (3.2a-3.2f) and the relevant portion of (3.3). Alternative specifications of the objective function (by allowing the parameter λ to vary) will be discussed after a brief description of the solution to problem (4.1).

The solution to problem (4.1) is the solution to an equivalent saddle value problem (152), where $[\Delta\ \Gamma\ \Psi\ \Xi\ \Sigma\ K]'$ is a vector of lagrangian multipliers. The saddle value problem (4.2) is shown in figure 4.1. The necessary conditions for $[\bar{X}\ \bar{W}\ \bar{V}\ \bar{T}\ \bar{Y}\ \bar{Z}]'$ and $[\bar{\Delta}\ \bar{\Gamma}\ \bar{\Psi}\ \bar{\Xi}\ \bar{\Sigma}\ \bar{K}]'$ to be a saddle value solution to problem (4.2) are given by

$$
\begin{bmatrix} X \\ W \\ V \\ T \\ Y \\ Z \end{bmatrix}'
\left[\lambda/2
\begin{bmatrix}
0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & -\Omega & 0 \\
0 & 0 & 0 & 0 & 0 & -\Phi
\end{bmatrix}
\begin{bmatrix} X \\ W \\ V \\ T \\ Y \\ Z \end{bmatrix}
-
\begin{bmatrix} C_x \\ C_w \\ C_v \\ C_t \\ -\Lambda \\ \Pi \end{bmatrix}
\right]
+
\begin{bmatrix} \Delta \\ \Gamma \\ \Psi \\ \Xi \\ \Sigma \\ K \end{bmatrix}'
\left[
\begin{bmatrix} O \\ O \\ D \\ E \\ F \\ G \end{bmatrix}
-
\begin{bmatrix}
-P_x & O & O & O & I_y & O \\
O & P_w & O & O & O & -I_z \\
M_x & -M_x & -M_v & M_t & O & O \\
O & O & P_v & O & O & O \\
A_x & A_w & A_v & A_t & O & O \\
B_x & B_w & B_v & B_t & O & O
\end{bmatrix}
\begin{bmatrix} X \\ W \\ V \\ T \\ Y \\ X \end{bmatrix}
\right]
$$

$$[\Delta\ \Gamma\ \Psi\ \Xi\ \Sigma\ K]' \geq 0 \qquad (4.2)$$

Figure 4.1. Equation 4.2

the Kuhn-Tucker conditions.[1] Using an abbreviated notation to represent (4.2), $L = x' (\lambda/2\ Qx-c) + p'(b-Ax)$, the Kuhn-Tucker conditions are as follows:

$$\lambda/2\ (Q' + Q)\ -c\ -A'\overline{p} \leq 0$$

$$b - A\overline{x} \geq 0$$

$$[\lambda/2\ (Q' + Q)\ -c\ -A'\overline{p}]'\ \overline{x} = 0$$

$$(b-A\overline{x})'\ \overline{p} = 0$$

Monopoly/monopsony model

When $\lambda=2$, problem (4.1) becomes the monopoly/monopsony model of localized financial intermediation. The objective function is to maximize gross profits, $Y(\Lambda-\Omega Y)-Z'(\Pi+\Phi Z)-X'C_x-W'C_w-V'C_v-T'C_t$, subject to resource balance, policy/regulatory, and nonnegativity constraints. When it can be assumed that the collective activity of individual units is represented by the centralized decision making behavior reflected in the objective function, the model gives the collusion solution to the oligopoly/oligopsony problem.

The monopoly/monopsony pricing conditions are reflected in the solution to the saddle value problem. With the exception of 3.2g, 3.4g, 3.2h, and 3.4h, the Kuhn-Tucker conditions are identical to the constraints,

---

[1]Sufficient conditions are that $(Q'+Q)$ be negative semi-definite. For an economic interpretation see (137).

(3.2a-3.2h, 3.2i'-3.2ℓ'), and the optimality conditions, (3.4a-3.4ℓ), for the perfect competition model presented in chapter 3. Conditions 3.2g, 3.4g, 3.2h and 3.4h are replaced by Kuhn-Tucker conditions which reflect monopoly pricing in asset markets and monopsony pricing in liability markets. Taken with equations 3.4i and 3.4j and positive flow of funds activities, they ensure that, in equilibrium, marginal return and marginal cost are equated in both asset and liability markets.

$$\lambda_{hn} - \sum_m \omega_{hnm}\, y_{hm} - \sum_m \omega_{hmn}\, y_{hm} \leq \delta_{hn}$$

$$y_{hn}\,(\lambda_{hn} - \sum_m \omega_{hnm}\, y_{hm} - \sum_m \omega_{hmn}\, y_{hm} - \delta_{hn}) = 0$$

h=1,2,..., H and n=1,2, ... N

$$\gamma_{lq} \leq \pi_{lq} + \sum_p \phi_{lqp}\, z_{lp} + \sum_p \phi_{lpq} z_{lp}$$

$$z_{lq}\,(\gamma_{lq} - \pi_{lq} - \sum_p \phi_{lqp}\, z_{lp} - \sum \phi_{lpq}\, z_{lp}) = 0$$

l=1,2, ..., L and q=1,2, ..., Q

Maruyama-Fuller model

Recognizing that in many cases neither the assumptions of pure competition nor monopoly assumptions provide an adequate simulation of reality, Maruyama and Fuller (120) proposed an alternative model which used, "... parametric quadratic programming procedures as its basic mathematical technique." The basic concept of the Maruyama-Fuller model can be illustrated using the general quadratic programming problem (4.1) when Ω and Φ are symetric. Problem (4.1) is actually more general than the Maruyama-Fuller model which considered imperfect competition conditions only in consumer markets (analogous to asset markets).

As described above, when $\lambda=2$ problem (4.1) becomes the monopoly/monopsony model. When $\lambda=1$ and Φ and Ω are symmetric problem (4.1) represents an alternative specification of the perfect competition model given in chapter 3. The objective function is to maximize net benefits for the sector or subsector being modeled,

$$Y'(\Lambda-1/2\Omega Y)-Z'(\Pi+1/2\Phi Z)-X'C_x-W'C_w-V'C_v-T'C_t,$$

subject to resource balance, policy/regulatory, and non-negativity constraints.[1]

---

[1]Symmetric Ω and Φ are necessary for the existence of the line integrals of the individual demand and supply of funds relationships in the net benefit function:

$$\sum_h \oint \Big(\sum_n (\lambda_{hn}-\sum_m \omega_{hnm} y_{hm})\, dy_{hn}\Big)-\sum_l \oint \Big(\sum_q (\pi_{lq}+\sum_p \phi_{lqp} z_{lp})\, dz_{lq}\Big)$$

$$-\sum_{jhn} c^x_{jh\theta n}\; x_{jh\theta n} - \sum_{jlq} c^w_{jl\theta q}\; w_{jl\theta q} - \sum_{jor} c^v_{jo\theta r}\; v_{jo\theta r}$$

$$-\sum_j \sum_{j\neq k} \sum_s (c^t_{jjk\theta s} + c^t_{kjk\theta s})\; t_{jk\theta s} - \sum_{js} c^t_{jj\theta s}\; t_{jj\theta s}.$$

The Kuhn-Tucker conditions for the saddle value problem associated with problem (4.1), when $\lambda=1$ and Ω and Φ are symmetric, are identical to the constraints, (3.2a-3.2h, 3.2i'-3.2ℓ'), and optimality conditions, (3.4a-3.4ℓ), for the perfect competition model presented in chapter 3.

Maruyama and Fuller suggested the parameterization $1 \leq \lambda \leq 2$, in order to represent varying degrees of competition (not specifically defined) between extremes of pure competition and collusive behavior for the firms being modeled. In particular, they suggested the parameterization as a means to determine the degree of imperfection in markets by comparing model results, for varying values of λ, with real world results. They effected the parameterization in conjunction with the use of Wolfe's algorithm as a solution procedure (135) in an application to the problem of interregional production and distribution of milk for fluid use or manufacturing use in the northeast and north central United States.

Duloy-Norton model

Duloy and Norton (51) proposed a nonlinear programming formulation as an alternative method for varying the degree of competition in spatial price and allocation models. The Duloy-Norton concept can be illustrated using problem (4.1), with $\lambda=1$ and symmetric Ω and Φ matrices, and adding the following nonlinear constraint:

$$\begin{bmatrix} X \\ W \\ V \\ T \\ Y \\ Z \end{bmatrix}' \left[\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -\Omega & 0 \\ 0 & 0 & 0 & 0 & 0 & -\Phi \end{bmatrix} \begin{bmatrix} X \\ W \\ V \\ T \\ Y \\ Z \end{bmatrix} - \begin{bmatrix} C_x \\ C_w \\ C_v \\ C_t \\ -\Lambda \\ \Pi \end{bmatrix} \right] \geq I^* \quad (4.3)$$

The nonlinear constraint (4.3) is used to effect the parameterization from perfect competition to a collusion solution. As I* is varied from zero or some non binding level (perfect competition) to maximum profits (collusion), the solution reflects the pricing and flow outcomes under alternative comeptitive conditions. In addition, the method provides a way to enodgenize monopoly/monopsony profits. The model has been applied to a large scale programming model of Mexican agriculture and, in an effort to utilize the power of the linear programming simplex method, used separable programming techniques to approximate the solution to the nonlinear problem (64). Using a simplified scenario, figure 4.2 provides a graphic comparison of the Maruyama-Fuller and Duloy-Norton approaches. The diagram illustrates a single asset market (y) with demand price given by price = a-1/2 by, a single binding constraint (competitive case) on the amount of y marketed, and a constant marginal cost. Maruyama-Fuller effect a series of solutions by parameterizing the equilibrium condition, a-λ/2 by = explicit marginal cost + imputed marginal cost of the policy constraint, between the competitive case y_c and p_c (λ=1) and the monopoly case y_m and p_m (λ=2). Duloy-Norton effect a series of solutions by parameterizing a nonlinear constraint on profits between the competitive case and the monopoly case. The nonlinear constraint is illustrated by varying the area representing profits from zero pure profit MC-P_c-B-A (this area is the imputed cost of the policy constraint) to monopoly profits MC-P_m-F-E.

Self-dual models

Both the Maruyama-Fuller and Duloy-Norton formulations are restricted by assuming symmetric Ω and Φ matrices as a logical means of specifying an objective function. Plessner (138) has shown that self-dual programming structures, which would not require symetric Ω and Φ, exist which "imitate" imperfectly competitive structures. The models which were developed, represented a leading firm competitive structure and a structure in which some products were marketed under monopoly conditions and others under perfect competition conditions. The models considered only a single consumption region and were applied to the apple and pear industry in Israel.

The self-dual characteristics of the model are achieved by modifying the self-dual quadratic programming model for perfect competition by (1) including the negative

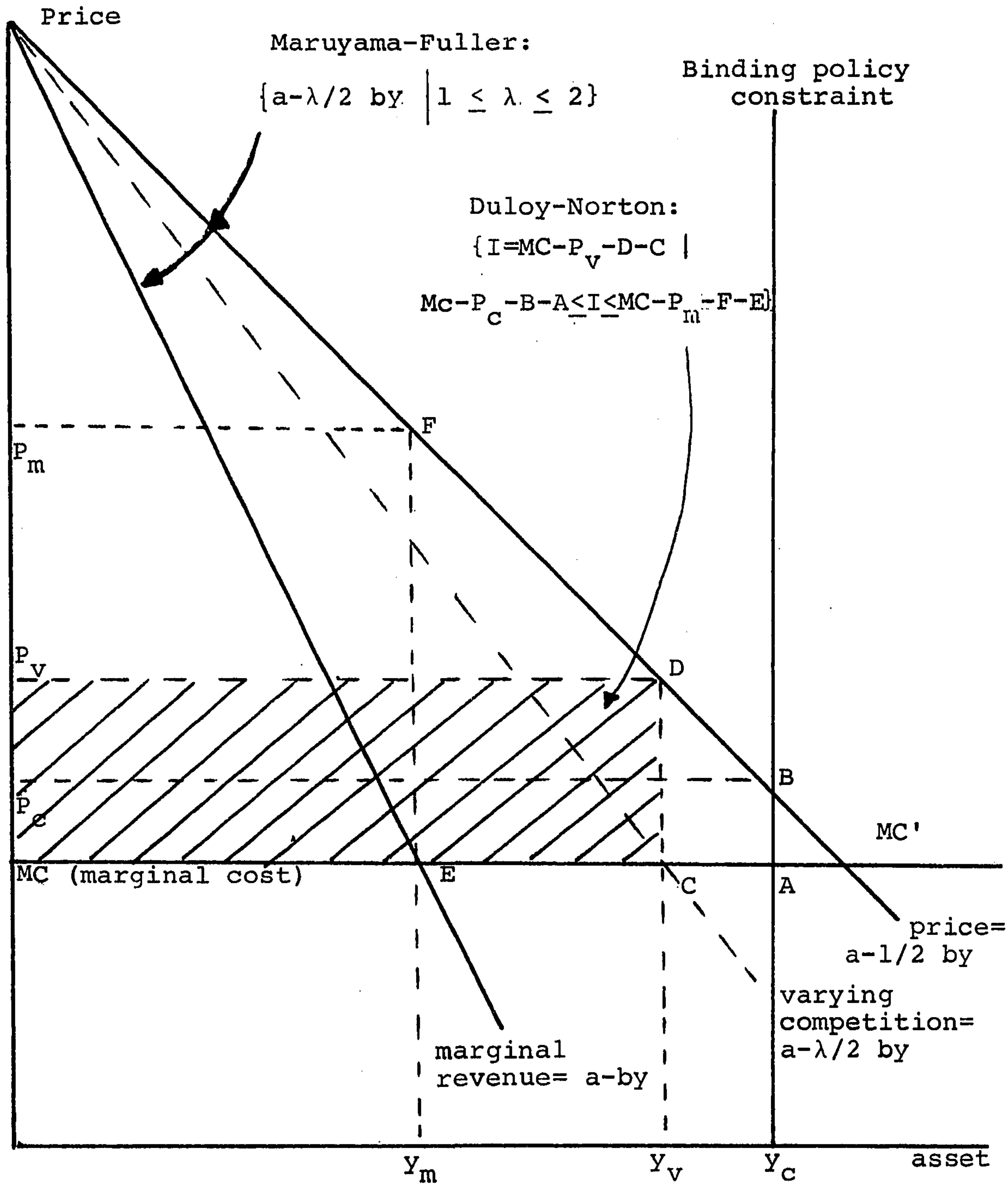

Figure 4.2. Comparison of Maruyama-Fuller and Duloy-Norton approaches

of monopoly profits in the "net profit" objective function, and (2) replacing perfect competition pricing conditions in the constraint set with imperfectly competitive pricing conditions for appropriate markets and products. This basic concept can be used to extend the perfect competition spatial price and allocation activity analysis model of localized financial intermediation to allow alternative competitive environments in both demand (asset) and supply (liability) markets.

An Imperfect Competition Model for Localized Financial Markets

The flexibility to model perfect competition in some markets, while considering imperfect conditions in others, is especially appealing for applications to problems of local financial markets where intermediaries often exhibit market power in some markets and not in others.

Asset markets

Consider the case where intermediaries allocate funds to some asset markets reflecting monopoly pricing conditions. Let the first n_1, assets be acquired in markets $h=1,2, h_1$, reflecting monopoly pricing with the remaining assets acquired in markets reflecting perfect competition pricing. The perfect competition model from chapter 3 can be modified to include monopoly pricing for the appropriate markets and assets. For those asset markets which exhibit monopoly behavior, equations (3.2g) can be replaced by the following pricing conditions:

$$\lambda_{hn} - \sum_{m} \omega_{hnm}\, y_{hm} - \sum_{m=1}^{n_1} \omega_{hmn}\, y_{hm} \leq \delta_{hn}$$

$$h=1,2,\ \ldots h_1 \text{ and } n=1,2,\ \ldots n_1 \qquad (4.4)$$

The self-dual characteristics of the model are maintained by adding the negative of monopoly profits to the objective function:

$$- \sum_{h}^{h_1} \sum_{n=1}^{n_1} \sum_{m=1}^{n_1} \omega_{hmn}\, y_{hm}\, y_{hn} \qquad (4.5)$$

The monopoly pricing conditions, marginal revenue $\leq$ marginal cost, can be seen by comparing conditions (4.4) and the corresponding equations from (3.2i'):

$$\lambda_{hn} - \sum_{m} \omega_{hnm}\, y_{hm} - \sum_{m=1}^{n_1} \omega_{hmn}\, y_{hn}$$

$$\leq \delta_{hn} \leq c^{x}_{jh\theta n} + \psi_j + \sum_{u} a^{x}_{jh\theta nu} \sigma_u + \sum_{\beta} b^{x}_{jh\theta n\beta}\, \kappa_\beta$$

$$h=1,2,\ \ldots,\ H \text{ and } n=1,2,\ \ldots,\ N$$

It can also be shown that, at the optimum, the negative of monopoly profits is given by (4.5). If the optimum solution results in positive allocation of funds to a monopoly asset market, then $y_{hn} > 0$ and some $x_{jh\theta n} > 0$ and marginal revenue equals marginal cost:

$$\lambda_{hn} - \sum_m \omega_{hnm}\, y_{hm} - \sum_{m=1}^{n_1} \omega_{hmn}\, y_{hm} = \delta_{hn} \tag{4.6}$$

$$\delta_{hn} = c^x_{jh\theta n} + \psi_j + \sum_u a^x_{jh\theta nu}\sigma_u + \sum_\beta b^x_{jh\theta n\beta}\,\kappa_\beta \tag{4.7}$$

Multiplying (4.6) and (4.7) by $x_{jh\theta n}$ and summing over all intermediaries gives the following equations:

$$\delta_{hn} \sum_j x_{jh\theta n} = \sum_j \left[x_{jh\theta n} (c^x_{jh\theta n} + \psi_j + \sum_u a^x_{jh\theta nu}\sigma_u + b^x_{jh\theta n\beta}\kappa_\beta) \right] \tag{4.8}$$

and

$$(\lambda_{hn} - \sum_m \omega_{hnm} y_{hm} - \sum_{m=1}^{n_1} \omega_{hmn} y_{hm}) \sum_j x_{jh\theta n} = \delta_{hn} \sum_j x_{jh\theta n} \tag{4.9}$$

Also, from (3.4a), with $\delta_{hn} > 0$ at the optimal:

$$y_{hn} = \sum_j x_{jh\theta n} \tag{4.10}$$

Combining equations (4.8) and (4.9), substituting (4.10) and rearranging terms gives the following equation for monopoly profits in the asset market:

$$y_{hn}(\lambda_{hn} - \sum_m \omega_{hmn} y_{hm}) - \sum_j x_{jh\theta n}(c^x_{jh\theta n} + \psi_j + \sum_u a^x_{jh\theta nu}\sigma_u + \sum_\beta b^x_{jh\theta n\beta}\kappa_\beta) \equiv y_{hn} \sum_{m=1}^{n_1} \omega_{hmn}\, y_{hm} \tag{4.11}$$

The first term on the left hand side of equation (4.11) is the total revenue from allocating funds to asset n in market h; the second term is minus total implicit and explicit costs to the intermediaries for allocating funds to asset n in market h. Summing over appropriate asset/market combinations, total monopoly profits are as follows:

$$\sum_{h=1}^{h_1}\left(\sum_{n=1}^{n_1} y_{hn} \sum_{m=1}^{n_1}\omega_{hmn}\, y_{hm}\right) = \sum_{h}^{h_1}\sum_{n=1}^{n_1}\sum_{m=1}^{n_1}\omega_{hmn}\, y_{hm}\, y_{hn}$$

Liability markets

Monopsony pricing in liability markets can be handled in a fashion similar to monopoly pricing in asset markets. Consider monopsony pricing for liabilities $q=1,2, \ldots q_1$ in markets $l=1,2, \ldots l_1$. Monopsony conditions are reflected by first modifying equations (3.2h) for monopsony markets:

$$\gamma_{lq} \leq \pi_{lq} + \sum_{p}\phi_{lqp}\, z_{lp} + \sum_{p=1}^{q_1}\phi_{lpq}\, z_{lq}$$

$$l=1,2 \ldots l_1 \text{ and } q=1,2, \ldots q_1 \tag{4.12}$$

Also, the negative of monopsony profits are added to the objective function, thus, maintaining the self-dual characteristics of the model:

$$-\sum_{l=1}^{l_1}\sum_{p=1}^{q_1}\sum_{q=1}^{q_1}\phi_{lpq}\, z_{lp}\, z_{lq} \tag{4.13}$$

Monopsony pricing conditions can be seen by comparing (4.12) and the appropriate equations from (3.2j'):

$$\psi_j - c^w_{jl\theta q} - \sum_u a^w_{jl\theta qu}\sigma_u - \sum_\beta b^w_{jl\theta q\beta}\kappa_\beta \leq \gamma_{lq} \leq \pi_{lq} +$$

$$\sum_p \phi_{lqp}\, z_{lp} + \sum_{p=1}^{q_1}\phi_{lpq}\, z_{lq}$$

$$l=1,2, \ldots, L \text{ and } q=1,2, \ldots, Q$$

It also follows that (4.13) represents the negative of monopsony profits at the optimal. For positive pricing and flow quantities, $\gamma_{1q} > 0$ and $z_{1q} > 0$ with some $w_{j1\theta q} > 0$, the following conditions hold at the optimal:

$$\gamma_{1q} = \pi_{1q} + \sum_{p} \phi_{1qp} z_{1p} + \sum_{p=1}^{q_1} \phi_{1pq} z_{1p} \tag{4.14}$$

$$\gamma_{1q} = \psi_j - c^w_{j1\theta q} - \sum_{u} a^w_{j1\theta qu} \sigma_u - \sum_{\beta} b^w_{j1\theta q\beta} \kappa_\beta \tag{4.15}$$

$$z_{1q} = \sum_{j} w_{j1\theta q} \tag{4.16}$$

Multiplying (4.14) and (4.15) by $w_{j1\theta q}$ and summing across all intermediaries gives the following equations:

$$\gamma_{1q} \sum_j w_{j1\theta q} = (\pi_{1q} + \sum_p \phi_{1qp} z_{1p} + \sum_{p=1}^{q_1} \phi_{1pq} z_{1p}) \sum_j w_{j1\theta q} \tag{4.17}$$

$$\gamma_{1q} \sum_j w_{j1\theta q} = \sum_j \left[(\psi_j - c^w_{j1\theta q} - \sum_u a^w_{j1\theta qu}\sigma_u - \sum_\beta b^w_{j1\theta q\beta}\kappa_\beta) w_{j1\theta q}\right] \tag{4.18}$$

Combining equations (4.17) and (4.18), substituting (4.16) and rearranging terms gives the following equation for monopsony profits for the liability market being considered:

$$\sum_j \psi_j w_{j1\theta q} - \sum_j (c^w_{j1\theta q} + \sum_u a^w_{j1\theta qu} \sigma_u + \sum_\beta b^w_{j1\theta q\beta} \kappa_\beta) w_{j1\theta q} -$$

$$z_{1q} (\pi_{1q} + \sum_p \phi_{1qp} z_{1p}) = z_{1p} \sum_{p=1}^{q_1} \phi_{1pq} z_{1p} \tag{4.19}$$

The first term on the left hand side of equation (4.19) is the total return from funds acquired by liability q in market l; the second term is minus total implicit and explicit costs of the acquisition activities; and the third term is minus the cost of funds in the liability market. Summing over appropriate liability/market combinations, total monopsony profits are as follows:

$$\sum_{l=1}^{l_1} \left(\sum_{q=1}^{q_1} z_{lq} \left(\sum_{p=1}^{q_1} \phi_{lpq} z_{lp} \right) \right) = \sum_{l=1}^{l_1} \sum_{q=1}^{q_1} \sum_{p=1}^{q_1} \phi_{lpq} z_{lp}$$

<u>Varying degrees of competition</u>

The concept introduced by Maruyama and Fuller for varying the degree of competition in markets can be introducted into the imperfect competition model for localized financial intermediation. The following general pricing conditions replace equations (3.2g) and 3.2h) in the perfect competition model where α and η replace the parameter λ:

$$\lambda_{hn} - \sum_m \omega_{hnm} y_{hm} - \alpha_{hn} \sum_m \alpha_{hm} \omega_{hmn} y_{hm} \leq \delta_{hn}$$

$$h=1,2, \ldots, H \text{ and } n=1,2, \ldots, N \qquad (4.20)$$

$$\gamma_{lq} \leq \pi_{lq} + \sum_p \phi_{lqp} z_{lp} + \eta_{lq} \sum_p \eta_{lp} \phi_{lpq} z_{lp}$$

$$l=1,2, \ldots, L \text{ and } q=1,2, \ldots, Q \qquad (4.21)$$

As discussed above, when $\alpha_{hn}=0$ funds are allocated to asset n in market h where pricing reflects conditions of pure competition. When $\alpha_{hn}=1$, pricing reflects monopolistic conditions. Parameterization of α_{hn}, $0 \leq \alpha_{hn} \leq 1$, could be used to imitate the range of competition between the two extremes. Similarly, the parameterization of η_{lq}, $0 \le \eta_{lq} \le 1$, could be used to imitate varying degrees of competition in liability markets from perfect competition to monopsony.

The self-dual nature of the model is maintained by adding the negative of monopoly and monopsony returns to the objective function:

$$- \sum_h \sum_n \sum_m \alpha_{hn} \alpha_{hm} \omega_{hmn} y_{hm} y_{hn} \tag{4.22}$$

$$- \sum_l \sum_p \sum_q \eta_{lq} \eta_{lp} \phi_{lpq} z_{lp} z_{lq} \tag{4.23}$$

The self-dual characteristics of the model can be more easily seen from the matrix notation:

Maximize (3.1') + (4.22) + (4.23)[1]

---

[1] α is an $(HN) \chi (HN)$ diagonal matrix whose diagonal elements are α_{11}, α_{12}, ... α_{1N}, α_{21}, ..., α_{hn}', ..., α_{HN}. η is a (LQ) (LQ) diagonal matrix whose diagonal elements are η_{11}, η_{12}, ..., η_{1Q}, η_{21}, ..., η_{lq}, ..., η_{LQ}.

$$\begin{bmatrix} X \\ W \\ V \\ T \\ \Delta \\ \Gamma \\ \Psi \\ \Xi \\ \Sigma \\ K \\ Y \\ Z \end{bmatrix}' \left[\begin{bmatrix} 0 & 0 & 0 & 0 & P'_x & 0 & -M'_x & 0 & -A'_x & -B'_x & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -P'_w & M'_w & 0 & -A'_w & -B'_w & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & M'_v & -P'_v & -A'_v & -B'_v & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -M'_t & 0 & -A'_t & -B'_t & 0 & 0 \\ -P_x & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & I_y & 0 \\ 0 & P_w & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -I_z \\ M_x & -M_x & -M_v & M_t & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & P_v & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ A_x & A_w & A_v & A_t & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ B_x & B_w & B_v & B_t & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -I_y & 0 & 0 & 0 & 0 & 0 & -(\Omega+\alpha'\Omega'\alpha) & 0 \\ 0 & 0 & 0 & 0 & 0 & I_z & 0 & 0 & 0 & 0 & 0 & -(\phi+\eta'\phi'\eta) \end{bmatrix} \begin{bmatrix} X \\ W \\ V \\ T \\ \Delta \\ \Gamma \\ \Psi \\ \Xi \\ \Sigma \\ K \\ Y \\ Z \end{bmatrix} - \begin{bmatrix} C_x \\ C_w \\ C_v \\ C_t \\ 0 \\ 0 \\ D \\ E \\ F \\ G \\ -\Lambda \\ \Pi \end{bmatrix} \right]$$

Subject to (3.2a-3.2f, 4.20, 4.21), (3.2i'-3.2ℓ'), (3.3), (3.3')

$$\begin{bmatrix} 0 & 0 & 0 & 0 & P'_x & 0 & -M'_x & 0 & -A'_x & -B'_x & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -P'_w & M'_w & 0 & -A'_w & -B'_w & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & M'_v & -P'_v & -A'_v & -B'_v & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -M'_t & 0 & -A'_t & -B'_t & 0 & 0 \\ -P_x & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & I_y & 0 \\ 0 & P_w & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -I_z \\ M_x & -M_w & -M_v & M_t & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & P_v & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ A_x & A_w & A_v & A_t & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ B_x & B_w & B_v & B_t & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -I_y & 0 & 0 & 0 & 0 & 0 & -(\Omega+\alpha'\Omega'\alpha) & 0 \\ 0 & 0 & 0 & 0 & 0 & I_z & 0 & 0 & 0 & 0 & 0 & -(\phi+\eta'\phi'\eta) \end{bmatrix} \begin{bmatrix} X \\ W \\ V \\ T \\ \Delta \\ \Gamma \\ \Psi \\ \Xi \\ \Sigma \\ K \\ Y \\ Z \end{bmatrix} \leq \begin{bmatrix} C_x \\ C_w \\ C_v \\ C_t \\ 0 \\ 0 \\ D \\ E \\ F \\ G \\ -\Lambda \\ \Pi \end{bmatrix}$$

$[X \; W \; V \; T \; \Delta \; \Gamma \; \Psi \; \Xi \; \Sigma \; K \; Y \; Z]' \leq 0$

Model evaluation

The model presented in this chapter presents a convenient structure for modeling perfect competition in some asset and liability markets and collusion solutions in others. In addition, parameterization of the values of α and η can be used to "imitate" imperfect competition conditions other than the collision solution to the monopoly/ monopsony problem. While the parameterization of α and η does not allow specific definition of the degree of imperfection, the self-dual concept can be used to model specific oligopolistic or oligopsonistic behavior. A series of prototype models are presented in chapter 5 which illustrate how the model can be extended to consider additional elements of imperfect competition, including differentiated product demand and market shares solution to the oligopoly problem.

CHAPTER V. SPATIAL PRICE AND ALLOCATION MODELS FOR COMMERCIAL BANKING MARKETS: SOME PROTOTYPES

A number of prototypes for commercial banking are described in this chapter. The prototypes have been designed (1) to demonstrate that the basic model structure described in chapters 3 and 4 can accommodate the most common constraints encountered in programming models of individual commercial banks,[1] and (2) to illustrate that the basic model structure is flexible enough to allow extensions which model specific characteristics of imperfect competition which may be known or assumed to exist in local financial markets. Finally, extensions to the model to include multiperiod programming and separable programming are discussed.

A Prototype for Commercial Banking Markets

The basic prototype, described below, models two separate market areas. The first market area reflects a simple scenario showing the interactions in a competitive multibank market. This portion of the prototype will be modified in subsequent sections in order (1) to reflect

---

[1]Models of individual banks provide examples of constraint structure as well as sources of coefficient values. Also see (19, 20, 97, 98, 99, 100, 101, 102).

banks facing a differentiated product demand in the use of funds market, (2) to include advertising variables, and (3) to show examples of specific types of imperfect competition including the leading firm, monopolistic competition and market share solutions. The second market area reflects the activities of a single commercial bank in more detail. The constraint structure includes most of the major types of constraints encountered in models of individual commercial banks.

Initially, the market areas are not linked so that the prototype can be separated and illustrated in two distinct parts. However, transfer activities could easily be introduced to represent correspondent relationships, loan participation agreements, branch affiliation and other activities which describe greater bank and market interaction. An example of a correspondent relationship between a bank in the multibank market and the bank in the single bank market illustrates how such linkages can be modeled. The basic notation described in chapters 3 and 4 will be followed as closely as possible; however, specific parameters will be described in more detail as necessary.

Multibank market

Market one, $h=l=o=1$, is assumed to be a multibank market with two intermediaries, $j=1,2$, competing in a single use of funds market, y_{11}, and a single source of funds market, z_{11}. No additional sources or uses of funds, nonfunds resource constraints nor policy and regulatory constraints are considered. The parts of the objective function and constraint set associated with market one follow:

MAXIMIZE OBJECTIVE FUNCTION =

$$\{(\lambda_{11}-\omega_{111}\ y_{11})y_{11}-(\pi_{11}+\phi_{111}\ z_{11})z_{11}$$

$$-\sum_{j=1}^{2}(c^{x}_{j1\theta1}x_{j1\theta1}+c^{w}_{j1\theta1}w_{j1\theta1})-\alpha^{2}_{11}\ \omega_{111}y^{2}_{11}-\eta^{2}_{11}\ \phi_{111}\ z^{2}_{11}\}$$

Subject to

$$y_{11}\leq\sum_{j=1}^{2}x_{j1\theta1}$$

$$\sum_{j=1}^{2}w_{j1\theta1}\leq z_{11}$$

$$x_{j1\theta1}\leq w_{j1\theta1}\quad\text{for } j=1,2$$

$$\lambda_{11}-\omega_{111}\ y_{11}-\alpha^{2}_{11}\ \omega_{111}\ y_{11}\leq\delta_{11}$$

$$\gamma_{11}\leq\pi_{11}+\phi_{111}\ z_{11}+\eta^{2}_{11}\ \phi_{111}\ z_{11}$$

$$\delta_{11}\leq c^{x}_{j1\theta1}+\psi_{j}\quad\text{for } j=1,2$$

$$\psi_{j}\leq c^{w}_{j1\theta1}+\gamma_{11}\quad\text{for } j=1,2$$

$$(x_{11\theta 1}, x_{21\theta 1}, w_{11\theta 1}, w_{21\theta 1}, \delta_{11}, \gamma_{11}, \psi_1, \psi_2,$$

$$y_{11}, z_{11}) \geq 0$$

The self dual characteristics of this portion of the prototype can be seen in figure 5.1.

Single bank market

Market two, h=l=o=2, contains a single commercial bank, j=3. The bank's source and use of funds activities are described in table 5.1.

Table 5.1. Sources and uses of funds

Acquisition/ Allocation Activities	Market Demand/ Supply	Description
$x_{32\theta 1}$	y_{21}	new loans
$x_{32\theta 2}$	y_{22}	existing loans (held)
$x_{32\theta 3}$	y_{23}	short-term government securities
$x_{32\theta 4}$	y_{24}	long-term government securities
$w_{32\theta 1}$	z_{21}	time deposits
$v_{32\theta 1}$	e_{21}	borrowing from Federal Reserve (1)
$v_{32\theta 2}$	e_{22}	borrowing from Federal Reserve (2)
$v_{32\theta 3}$	e_{23}	government demand deposits
$v_{32\theta 4}$	e_{24}	existing loans (marketed)
$t_{33\theta 1}$	-	cash

ACTIVITIES

OF	$x_{11\theta1}$	$x_{21\theta1}$	$w_{11\theta1}$	$w_{21\theta1}$	δ_{11}	γ_{11}	ψ_1	ψ_2	y_{11}	z_{11}	
- quadratic									$-(1+\alpha_{11}^2)\ \omega_{111}$	$-(1+\eta_{11}^2)\ \phi_{111}$	
- linear	$-c^w_{11\theta1}$	$-c^x_{21\theta1}$	$-c^w_{11\theta1}$	$-c^w_{21\theta1}$	0	0	0	0	λ_{11}	$-\pi_{11}$	
constraint set					1		-1				$\leq c^x_{11\theta1}$
					1			-1			$\leq c^x_{21\theta1}$
						-1	1				$\leq c^w_{11\theta1}$
						-1		1			$\leq c^w_{21\theta1}$
	-1	-1							1		≤ 0
			1	1						-1	≤ 0
	1		-1								≤ 0
		1		-1							≤ 0
					-1				$-(1+\alpha_{11}^2)\ \omega_{111}$		$\leq -\lambda_{11}$
						1				$-(1+\eta_{11}^2)\ \phi_{111}$	$\leq \pi_{11}$

Figure 5.1. Prototype - Multibank market

The bank acts as a monopolist in the market for new loans and as a monopsonist in the market for time deposits. The demand price for new loans and the supply price for time deposit equations are respectively $\lambda_{21} - \omega_{211} y_{21}$ and $\pi_{21} + \phi_{211} z_{21}$. Alternative uses of funds--existing loans (held), short-, and long-term government securities--are assumed to provide fixed returns given respectively by λ_{22}, λ_{23} and λ_{24}.

Commercial banks often have access to funds with a limited availability at a fixed cost and additional funds available only at an increased cost. To illustrate modeling such a limitation, e_{21} is assumed to be the maximum borrowing from the Federal Reserve discount window at an initial rate. Funds acquired at a higher rate cannot exceed e_{22}, assumed to be a management set limit on total Federal Reserve borrowing minus e_{21}. With $c^{v}_{32\theta 2} > c^{v}_{32\theta 1}$, and $v_{32\theta 1}$ and $v_{32\theta 2}$ treated identically in the constraint set, $v_{32\theta 2}$ will not enter the optimal solution unless the limit e_{21} has been reached. The market limit on the supply of government demand deposits is given as e_{23}. The sale of existing assets in primary or secondary markets can provide a source of funds. This concept is illustrated by the marketing of existing loans; the market limit on the resale of loans is given as e_{24}, a percent of total loans existing at the beginning of the period.

The resource balance and balance sheet constraints are as follows:

$$y_{2n} - x_{32\theta n} \leq 0 \quad \text{for } n=1,2,3,4$$

$$w_{32\theta 1} - z_{21} \leq 0$$

$$v_{32\theta r} - e_{2r} \leq 0 \quad \text{for } r=1,2,3,4$$

$$\sum_{n=1}^{4} x_{32\theta n} + t_{33\theta 1} - w_{32\theta 1} - \sum_{r=1}^{4} v_{32\theta r} \leq 0$$

Models of individual commercial banks often include limits on the use of labor, capital equipment, capacity and other nonfunds resources (142). For example, the following constraint limits labor units available to manage government securities, f_1:

$$\sum_{n=3}^{4} a^{x}_{32\theta n1} x_{32\theta n} \leq f_1$$

The coefficients $a^{x}_{32\theta 31}$ and $a^{x}_{32\theta 41}$ indicate labor productivity in managing government securities, i.e., labor units used per dollar of government securities held. Let $a^{x}_{32\theta 31} = A$ and $a^{x}_{32\theta 41} = B$.

In addition to nonfunds resource constraints, commercial bank models will include policy and regulatory constraints which generally are restrictions required by law, imposed or suggested by government regulatory agencies, or imposed by bank management.[1] Regulatory restrictions include collateral or pledging constraints as well as legal reserve requirements. Commercial banks may be required to hold certain assets portions of which may serve as collateral for acquiring certain liabilities. For example, the following collateral constraint reflects a pledging requirement--for borrowing from the Federal Reserve discount window and for government demand deposits--which is met by government securities and partially met by loans:

$$-\sum_{n=1}^{4} b^{x}_{32\theta n1}\, x_{32\theta n} + \sum_{r=1}^{3} b^{v}_{32\theta r1}\, v_{32\theta r} \leq 0$$

Where, $b^{x}_{32\theta 31} = b^{x}_{32\theta 41} = b^{v}_{32\theta 11} = b^{v}_{32\theta 21} = b^{v}_{32\theta 31} = 1$, and $b^{x}_{32\theta 11} = b^{x}_{32\theta 21} = .8$. A legal reserve requirement on time deposits and government demand deposits can also be shown:

$$b^{w}_{32\theta 12}\, w_{32\theta 1} + b^{v}_{32\theta 32}\, v_{32\theta 3} - b^{t}_{33\theta 12}\, t_{33\theta 1} \leq 0$$

Where, $b^{w}_{32\theta 12} = .03$ is the required reserve on time deposits and the required reserve on government demand deposits is $b^{v}_{32\theta 32} = .175$; $b^{t}_{32\theta 12} = 1$. Federal Reserve examiners'

---

[1]See (9, 32, 39, 40, 47, 52, 58, 61, 81, 142, 175).

guidelines for balanced risk-portfolio composition could also be reflected in similar linear constraints (9, 32).

Unlike regulatory constraints which apply to all financial intermediaries in a given class, policy constraints reflect the unique characteristics of individual bank management. Management behavior can be approximated by restricting acquisition and allocation activities to conform to criteria which bank managers feel are accepted indicators of sound bank management in balancing risk, growth and profitability. Portfolio composition constraints can be used to reflect management judgements of maximum or minimum acceptable levels of certain assets and liabilities. Constraints could also restrict the ratio of one group of financial instruments to another, e.g., loan to deposit ratio. Such constraints are commonly used to match liquidity and maturity characteristics of sources of funds with asset purchases for which the funds are used. The following example of a portfolio composition constraint limits the ratio of government securities to total assets:

$$\sum_{n=1}^{4} b^{x}_{32\theta n3}\, x_{32\theta n} + b^{t}_{33\theta 13}\, t_{33\theta 1} \leq 0$$

Let $b^{x}_{32\theta 13} = b^{x}_{32\theta 23} = b^{t}_{33\theta 13} = C$; where C is the minimum accepted ratio of government securities to total assets and where $b^{x}_{32\theta 33} = b^{x}_{32\theta 43} = C-1$.

Besides limits on absolute values or ratios of financial instruments, limits on activities may take other forms such as maturity and liquidity constraints. Fielitz and Loeffler (58) suggest the use of maturity constraints as one means to represent management's subjective evaluation of future economic conditions. For example, the following constraints establish an upper, g_4, and lower, g_5, limit on the average maturity of government securities:

$$\sum_{n=3}^{4} b^{x}_{32\theta n4} \; x_{32\theta n} \leq g_4 \qquad \text{and}$$

$$-\sum_{n=3}^{4} b^{x}_{32\theta n5} \; x_{32\theta n} \leq -g_5$$

where the maturity coefficient for short-term government securities is given as $b^{x}_{32\theta 34} = b^{x}_{32\theta 35} = D$, and the maturity coefficient for long-term government securities by $b^{x}_{32\theta 44} = b^{x}_{32\theta 45} = E$. A liquidity constraint, requiring liquid assets to be held in excess of reserve requirements for time and demand deposits and to cover Federal Reserve borrowing, can be written as follows:

$$-\sum_{n=3}^{4} b^{x}_{32\theta n6} \; x_{32\theta n} - b^{t}_{33\theta 16} \; t_{33\theta 1} + b^{w}_{32\theta 16} \; w_{32\theta 1} +$$

$$\sum_{r=1}^{3} b^{v}_{32\theta r6} \; v_{32\theta r} \leq 0$$

Where, $b^x_{32036} = b^x_{32046} = b^t_{33016} = b^v_{32016} = b^v_{32026} = 1$; $b^w_{32016} = .23$, the reserve requirement plus liquidity buffer on time deposits; and $b^v_{32026} = 1.175$, the reserve requirement plus liquidity buffer on government demand deposits.

Policy constraints can also be included simply for accounting purposes in the model. The following constraint reflects the balancing condition for loans existing at the beginning of the modeling period:

$$b^x_{32027}\ x_{3202} + b^v_{32047}\ v_{3204} \leq g_7$$

Where $b^x_{32027} = b^v_{32047} = 1$ and g_7 = total loans at the beginning of the period.

Finally, pricing conditions are as follows (previously defined values for coefficients have been substituted where appropriate):

$$-2\omega_{211}\ y_{21} - \delta_{21} \leq -\lambda_{21}$$

$$-\delta_{22} \leq -\lambda_{22}$$

$$-\delta_{23} \leq -\lambda_{23}$$

$$-\delta_{24} \leq -\lambda_{24}$$

$$\gamma_{21} - 2\phi_{211}\ z_{21} \leq \pi_{21}$$

$$\delta_{21} \leq c^x_{3201} + \psi_3 - .8\kappa_1 + C\kappa_3$$

$$\delta_{22} \leq c^{x}_{32\theta 2} + \psi_3 - .8\kappa_1 + C\kappa_3 + \kappa_7$$

$$\delta_{23} \leq c^{x}_{32\theta 3} + \psi_3 + A\sigma_1 - \kappa_1 + (C-1)\kappa_3 + D\kappa_4 - D\kappa_5 - \kappa_6$$

$$\delta_{24} \leq c^{x}_{32\theta 4} + \psi_3 + B\sigma_1 - \kappa_1 + (C-1)\kappa_3 + E\kappa_4 - E\kappa_5 - \kappa_6$$

$$\psi_3 \leq c^{w}_{32\theta 1} + \gamma_{21} + .03\,\kappa_2 + .23\kappa_6$$

$$\psi_3 \leq c^{v}_{32\theta 1} + \xi_{21} + \kappa_1 + \kappa_6$$

$$\psi_3 \leq c^{v}_{32\theta 2} + \xi_{22} + \kappa_1 + \kappa_6$$

$$\psi_3 \leq c^{v}_{32\theta 3} + \xi_{23} + \kappa_1 + .175\,\kappa_2 + 1.175\,\kappa_6$$

$$\psi_3 \leq c^{v}_{32\theta 4} + \xi_{24} + \kappa_7$$

$$0 \leq c^{t}_{33\theta 1} - \kappa_2 + C\kappa_3 + \psi_3$$

The model structure for this portion of the prototype is illustrated in figure 5.2.

Market linkages

Models of individual intermediaries generally treat linkages with other financial institutions as exogenous. However, the model structure described in chapters 3 and 4 provides greater flexibility to explicitly model interactions among financial institutions. Most importantly, the impact of activities describing bank and market

OF	$\ddot{x}_{3201}$	$\ddot{x}_{3202}$	x_{3203}	x_{3204}	w_{3201}	v_{3201}	v_{3202}	v_{3203}	v_{3204}	t_{3301}	δ_{21}	δ_{22}	δ_{23}	δ_{24}	γ_{21}	ψ_3	ξ_{21}
linear	$-c^x_{3201}$	$-c^x_{3202}$	$-c^x_{3203}$	$-c^x_{3204}$	$-c^w_{3201}$	$-c^v_{3201}$	$-c^v_{3202}$	$-c^v_{3203}$	$-c^v_{3204}$	$-c^t_{3301}$	0	0	0	0	0	0	$-e_{21}$
quadratic																	
constraints											1					-1	
												1				-1	
													1			-1	
														1		-1	
															-1	1	
																1	-1
																1	
																1	
																1	
																-1	
	-1																
		-1															
			-1														
				-1													
					1												
	1	1	1	1	-1	-1	-1	-1	-1	1							
						1											
							1										
								1									
									1								
			A	B													
	-.8	-.8	-1	-1		1	1	1									
					.03			.175		-1							
	C	C	C-1	C-1						C							
			D	E													
			-D	-E													
			-1	-1	.23	1	1	1.175		-1							
		1							1								
											-1						
												-1					
													-1				
														-1			
															1		

Figure 5.2. Prototype--Single bank market

ξ_{22}	ξ_{23}	ξ_{24}	σ_1	κ_1	κ_2	κ_3	κ_4	κ_5	κ_6	κ_7	y_{21}	y_{22}	y_{23}	y_{24}	z_{21}		
$-e_{22}$	$-e_{23}$	$-e_{24}$	$-f_1$	0	0	0	$-g_4$	g_5	0	$-g_7$	λ_{21}	λ_{22}	λ_{23}	λ_{24}	$-\pi_{21}$		
											$-2\omega_{211}y_{21}$				$-2\emptyset_{211}z_{21}$		
				.8		-C										$\leq$	c^x_{3201}
				.8		-C				-1						$\leq$	c^x_{3202}
			-A	1		1-C	-D	D	1							$\leq$	c^x_{3203}
			-B	1		1-C	-E	E	1							$\leq$	c^x_{3204}
					-.03				-.23							$\leq$	c^w_{3201}
				-1					-1							$\leq$	c^y_{3201}
-1				-1					-1							$\leq$	c^y_{3202}
	-1			-1	-.175				-1.175							$\leq$	c^y_{3203}
		-1								-1						$\leq$	c^y_{3204}
					1	-C			1							$\leq$	c^t_{3301}
											1					$\leq$	0
												1				$\leq$	0
													1			$\leq$	0
														1		$\leq$	0
															-1	$\leq$	0
																$\leq$	0
																$\leq$	e_{21}
																$\leq$	e_{22}
																$\leq$	e_{23}
																$\leq$	e_{24}
																$\leq$	f_1
																$\leq$	0
																$\leq$	0
																$\leq$	0
																$\leq$	$-g_4$
																$\leq$	$-g_5$
																$\leq$	0
																$\leq$	$-g_7$
											$-2\omega_{211}$					$\leq$	$-\lambda_{21}$
																$\leq$	$-\lambda_{22}$
																$\leq$	$-\lambda_{23}$
																$\leq$	$-\lambda_{24}$
															$-2\emptyset_{211}$	$\leq$	π_{21}

interaction, (e.g., correspondent relationships, loan participation agreements, branch affiliation), on endogenously determined pricing and flow quantities can be examined. The following example illustrates how such linkages can be modeled.

Bank one in the multibank market is assumed to maintain a specified correspondent balance, $t_{13θ5}$, with bank three in the single bank market. In return, bank three provides certain services to bank one, including borrowing privileges, $t_{31θ6}$. These considerations can be included in the prototype by modifying the balance sheet conditions for both bank one and bank three to account for the transfer activities and by introducing new activities and constraints to reflect limits and pricing conditions on the transfer activities. The modified balance sheet conditions are as follows:

$$x_{11θ1} - w_{11θ1} + t_{13θ5} - t_{31θ6} \leq 0$$

$$\sum_{n=1}^{4} x_{32θn} + t_{33θ1} - w_{32θ1} - \sum_{r=1}^{4} v_{32θr} + t_{31θ6} - t_{13θ5} \leq 0$$

The required correspondent balance can be written in terms of two inequality constraints, where $g_8=g_9$ is the specified balance:

$$t_{13θ5} \leq g_8 \quad \text{and} \quad -t_{13θ5} \leq -g_9$$

The limit on borrowing is g_{10}:

$$t_{31\theta 6} \leq g_{10}$$

Finally, the pricing conditions associated with transfer activities, $t_{13\theta 5}$ and $t_{31\theta 6}$, are given:

$$-\psi_1 - \kappa_8 + \kappa_9 + \psi_3 \leq F$$

$$\psi_1 - \kappa_{10} - \psi_3 \leq G$$

where, $F = c^t_{313\theta 5} + c^t_{113\theta 5}$ and $G = c^t_{131\theta 6} + c^t_{331\theta 6}$ are the explicit net unit costs associated with the transfer activities.

Particularly in branch and holding company affiliations, bank three may provide nonfunds resources. Assume that activity $x_{11\theta 1}$ by bank one uses the same specialized labor as activities $x_{32\theta 3}$ and $x_{32\theta 4}$ in bank three and at the same rate as $x_{32\theta 3}$. The capacity constraint on available labor units can be modified:

$$Ax_{32\theta 3} + Bx_{32\theta 4} + Ax_{11\theta 1} \leq f_1$$

The pricing constraint associated with $x_{11\theta 1}$ must also be modified to include the implicit cost of the constraint on labor:

$$\delta_{i1} - \psi_1 - A\sigma_1 \leq c^x_{11\theta 1}$$

Figure 5.3 illustrates these market linkages. Only the relevant parts of the prototype shown in figures 5.1 and 5.2 are shown. The dotted lines signify modified constraints (only new coefficients are shown). More complex interactions can be modeled in a similar fashion (97, 98, 99).

Prototypes for Product Differentiation

The spatial price and allocation activity analysis model has been used to demonstrate the perfect competition, monopoly, and varying oligopoly solutions in financial markets when intermediaries are assumed to provide homogeneous products. Commercial banks, as well as other financial intermediaries, are often considered to face a distinct demand curve for their products (148). That is, individual bank's demand price can be given as a function not only of the quantity of its own product but also the quantity of similar products marketed by competitors. Market one of the prototype, presented in the previous section, can be modified to illustrate how the basic structure of the spatial price and allocation model can be used to reflect product differentiation.[1]

---

[1]Data sources and examples of coefficients for constraints introduced in the prototype thus far are readily available in the literature cited on models of endurdual financial institutions. The coefficients in the constraints

CONSTRAINTS			Multibank Prototype: x_{1101}	Multibank Prototype: ψ_1	New: t_{1305}	New: κ_8	New: κ_9	New: t_{3106}	New: κ_{10}	Single Bank Prototype: ψ_3	Single Bank Prototype: σ_1	
Objective Function					$-F$	$-g_8$	g_9	$-G$	$-g_{10}$			
	Multibank	Pricing Condition									$-A$	
	Multibank	Balance Sheet			1			-1				
	New			-1		-1	1			1		$\leq F$
	New				1							$\leq g_8$
	New				-1							$\leq -g_9$
	New			1					-1	-1		$\leq G$
	New							1				$\leq g_{10}$
	Single Bank	Balance Sheet			-1			1				
	Single Bank	Labor Capacity	A									

Figure 5.3. Prototype--Market linkages

The approach is to simply treat each firm's allocation activity as contributing to a unique product market. Assume that the intermediaries, j=1,2, in market one face distinct demand curves in the use of funds market. The demand for funds at intermediary, j=1, is given as y_{11} and the demand at intermediary, j=2, is given by y_{12}. The demand price functions are as follows:

$$\lambda_{11} - \omega_{111}\, y_{11} - \omega_{112}\, y_{12} \tag{5.1a}$$

$$\lambda_{12} - \omega_{121}\, y_{11} - \omega_{122}\, y_{12} \tag{5.1b}$$

The objective function and constraint set can be modified as follows:

Maximize: Objective Function =

$$\{ \sum_{n=1}^{2} (\lambda_{1n} - \sum_{m=1}^{2} \omega_{1nm}\, y_{1m})\, y_{1n} - (\pi_{11} + \phi_{111}\, z_{11})\, z_{11}$$

$$- \sum_{j=1}^{2} \sum_{n=1}^{2} (c^{x}_{j1\theta n}\, x_{j1\theta n}) - \sum_{j=1}^{2} c^{w}_{j1\theta 1}\, w_{j1\theta 1}$$

$$- \sum_{n=1}^{2} \sum_{m=1}^{2} \alpha_{1n}\, \alpha_{1_m}\, \omega_{1mn}\, y_{1m}\, y_{1n} - \eta^{2}_{11}\, \phi_{111}\, z_{11}^{2} \} \tag{5.2}$$

---

in this section are not readily available. Instead, coefficient estimates are part of the major task of estimating appropriate market source and use of funds functions for any specific model application.

Subject to

$$y_{11} \leq x_{11\theta 1} \quad (5.3a)$$

$$y_{12} \leq x_{21\theta 2} \quad (5.3b)$$

$$\sum_{j=1}^{2} w_{j1\theta 1} \leq z_{11} \quad (5.3c)$$

$$x_{11\theta 1} \leq w_{11\theta 1} \quad (5.3d)$$

$$x_{21\theta 2} \leq w_{21\theta 1} \quad (5.3e)$$

$$\lambda_{11} - \sum_{m=1}^{2} \omega_{11m}\, y_{1m} - \alpha_{11} \sum_{m=1}^{2} \alpha_{1m}\, \omega_{1m1}\, y_{1m} \leq \delta_{11} \quad (5.3f)$$

$$\lambda_{12} - \sum_{m=1}^{2} \omega_{121}\, y_{1m} - \alpha_{12} \sum_{m=1}^{2} \alpha_{1m}\, \omega_{1m2}\, y_{1m} \leq \delta_{12} \quad (5.3g)$$

$$\delta_{11} \leq c^{x}_{11\theta 1} + \psi_{1} \quad (5.3h)$$

$$\psi_{12} \leq c^{x}_{21\theta 1} + \psi_{2} \quad (5.3i)$$

$$\psi_{1} \leq c^{w}_{11\theta 1} + \gamma_{11} \quad (5.3j)$$

$$\psi_{2} \leq c^{w}_{21\theta 1} + \gamma_{11} \quad (5.3k)$$

$$\gamma_{11} \leq \pi_{11} + \phi_{111}\, z_{11} + \eta^{2}_{11}\, \phi_{111}\, z_{11} \quad (5.3\ell)$$

$$(y_{11},\ y_{12},\ z_{11},\ x_{11\theta 1},\ x_{21\theta 2},\ w_{11\theta 1},\ w_{21\theta 1},$$

$$\delta_{12},\ \delta_{12},\ \gamma_{11},\ \psi_{1},\ \psi_{1}) \geq 0 \quad (5.4)$$

Advertising

Producers of a differentiated product commonly face demand that is a function of firm unique variables such as advertising. The following prototypes include advertising. The intermediaries now face not only the choice of optimal allocation and acquisition activities but also advertising levels. Optimal price, quantity and advertising levels are endogenously determined in the model.

The intermediaries' demand price functions can be modified to include advertising levels. Where A_{11} is advertising by intermediary, j=1, and A_{12} is advertising by intermediary, j=2; the q's are coefficients in the linear demand price functions:

$$\lambda_{11} - \omega_{111}\, y_{11} - \omega_{112}\, y_{12} + q_{111}\, A_{11} + q_{112}\, A_{12} \qquad (5.1a')$$

$$\lambda_{12} - \omega_{121}\, y_{11} - \omega_{122}\, y_{12} + q_{121}\, A_{11} + q_{122}\, A_{12} \qquad (5.1b')$$

The objective function can be modified to include advertising. Where c^A_{11} and c^A_{12} represent the unit costs of A_{11} and A_{12} respectively:

Maximize: Objective Function =

$$\{\sum_{n=1}^{2}\left(\lambda_{1n}-\sum_{m=1}^{2}(\omega_{1nm}\; y_{1m}-q_{1nm}A_{1m})\right)y_{1n}-(\pi_{11}+\phi_{111}z_{11})z_{11}$$

$$-\sum_{j=1}^{2}\sum_{n=1}^{2}(c^{x}_{j1\theta n}\; x_{j1\theta n})-\sum_{j=1}^{2}(c^{w}_{j1\theta 1}\; w_{j1\theta 1}+c^{A}_{1j}\; A_{1j})$$

$$-\sum_{n=1}^{2}\sum_{m=1}^{2}\alpha_{1n}\alpha_{1m}\omega_{1mn}y_{1m}y_{1n}+\sum_{n=1}^{2}\sum_{m=1}^{2}\alpha_{1n}\alpha_{1m}q_{1mn}A_{in}y_{1m}$$

$$-\eta_{11}^{2}\;\phi_{111}\;z_{11}^{2}\} \qquad (5.2')$$

Resource constraints on advertising must also be included in the model. While there are several ways of doing so, the simplest constraints are limits on the absolute levels of advertising, (MAX_{1j}), available to the intermediary:

$$A_{11} \leq MAX_{11} \qquad (5.3m)$$

$$A_{12} \leq MAX_{12} \qquad (5.3n)$$

The pricing conditions (5.3f - 5.3g) are modified as follows:

$$\lambda_{11}-\sum_{m=1}^{2}(\omega_{11m}y_{1m}-q_{11m}A_{1m})-\alpha_{11}\sum_{m=1}^{2}\alpha_{1m}\omega_{1m1}y_{1m}\leq\delta_{11} \qquad (5.3f')$$

$$\lambda_{12} - \sum_{m=1}^{2} (\omega_{12m}y_{1m}-q_{12m}A_m) - \alpha_{12} \sum_{m=1}^{2} \alpha_{1m}\omega_{1m2}y_{1m} \leq \delta_{12} \quad (5.3g')$$

Finally the conditions, ensuring that the marginal return from advertising is less than or equal to the marginal cost of advertising, are included in the pricing conditions:

$$\alpha_{11} \sum_{m=1}^{2} \alpha_{1m}\, q_{1m1}\, y_{1m} \leq \rho_{11} + c_{11}^{A} \quad (5.3o)$$

$$\alpha_{12} \sum_{m=1}^{2} \alpha_{1m}\, q_{1m2}\, y_{1m} \leq \rho_{12} + c_{12}^{A} \quad (5.3p)$$

Collusion and leading firm solutions

As with the case of a homogeneous product, α_{11} and α_{12} could be varied to represent varying degrees of imperfect competition in the case of a differentiated product. Specifically the collusion solution is given when $\alpha_{11} = \alpha_{12} = 1$.

The theory of partial monopoly can also be shown. The leading firm selects its funds activity and advertising levels in the same manner as a pure monopolist, while the remaining firms adjust funds activities and advertising in the same manner as perfect competitors (75). For example, let intermediary, j=1, be the leading firm and intermediary, j=2, act as a perfect competitor. The leading firm solution is given by $\alpha_{11} = 1$ and $\alpha_{12} = 0$.

Monopolistic competition

The spatial price and allocation model can be modified to reflect yet another specific type of imperfect competition, monopolistic competition. Monopolistic competition is assumed to exist in commercial banking markets when the number of intermediaries is sufficiently large so the actions of a single intermediary do not affect perceptibly the actions of competitors. However, each intermediary is assumed to face a distinct demand curve for its product. Monopolistic competition can be represented by substituting α^m_{hn} for α_{hn} and α^n_{hm} for α_{hm} in the model. For h, n, m referring to markets with product differentiation, the following values for α^m_{hn} and α^n_{hm} are used to represent the short run equilibrium for monopolistic competition:

$$\alpha^m_{hn} = \alpha^n_{hm} = \begin{cases} 1 \text{ if } n=m \\ 0 \text{ if } n\neq m \end{cases}$$

Market-share solution

An intermediary may desire to maintain at least a certain share of the market for its differentiated product regardless of the competitive scenario or impact on short run profits. As described in previous sections, such sufficing behavior can be represented by including constraint in the model:

$$sx_{11\theta 1} + (s-1)\ x_{21\theta 2} \leq 0 \qquad (5.3q)$$

Where intermediary, j=2, desires to maintain at least s share of the market. The pricing conditions (5.3h - 5.3i) are modified and the nonnegativity constraint on the imputed unit cost of the market share constraint is added as follows:

$$\delta_{11} \leq c^{x}_{11\theta 1} + \psi_1 + s\kappa_1 \qquad (5.3h')$$

$$\delta_{12} \leq c^{x}_{21\theta 1} + \psi_2 + (s-1)\ \kappa_1 \qquad (5.3i')$$

$$\kappa_1 \geq 0 \qquad (5.4')$$

Figure 5.4 illustrates the prototype for product differentiation including advertising variables and the market-share constraint. The quadratic portion of the objective function is given as follows:

$$\begin{bmatrix} A_{11} \\ A_{12} \\ y_{11} \\ y_{12} \\ z_{11} \end{bmatrix}' \begin{bmatrix} 0 & 0 & A & B & O \\ 0 & 0 & C & D & O \\ q_{111} & q_{112} & E & F & O \\ q_{121} & q_{122} & G & H & O \\ 0 & 0 & O & O & I \end{bmatrix} \begin{bmatrix} A_{11} \\ A_{12} \\ y_{11} \\ y_{12} \\ z_{11} \end{bmatrix}$$

Where the following substitutions have been made:

$A = (\alpha^1_{11})^2 q_{111}$; $B = \alpha^1_{11}\alpha^1_{12} q_{121}$; $C = \alpha^2_{12}\alpha^2_{11} q_{112}$;

$D = (\alpha^2_{12})^2 q_{122}$; $E = -(\omega_{111} + (\alpha^1_{11})^2 \omega_{111})$;

ACTIVITIES

	$x_{11\theta 1}$	$x_{21\theta 2}$	$w_{11\theta 1}$	$w_{21\theta 1}$	ρ_{11}	ρ_{12}	δ_{11}	δ_{12}	γ_{11}	ψ_1	ψ_2	κ_1	A_{11}	A_{12}	Y_{11}	Y_{12}	Z_{11}	
OF Linear	$-C^x_{11\theta 1}$	$-C^x_{21\theta 2}$	$-C^w_{11\theta 1}$	$-C^w_{21\theta 1}$	$-MAX_{11}$	$-MAX_{12}$	0	0	0	0	0	0	$-C^A_{11}$	$-C^A_{12}$	λ_{11}	λ_{12}	$-\pi_{11}$	
5.3h'							1			-1		-s						$\leq C^x_{11\theta 1}$
5.3i'								1			-1	1-s						$\leq C^x_{21\theta 2}$
5.3j									-1	1								$\leq C^w_{11\theta 1}$
5.3k									-1		1							$\leq C^w_{21\theta 1}$
5.3m													1					$\leq MAX_{11}$
5.3n														1				$\leq MAX_{12}$
5.3a	-1														1			≤ 0
5.3b		-1														1		≤ 0
5.3c			1	1													-1	≤ 0
5.3d	1		-1															≤ 0
5.3e		1		-1														≤ 0
5.3q	s	s-1																≤ 0
5.3σ					-1										A	B		$\leq C^A_{11}$
5.3p						-1									C	D		$\leq C^A_{12}$
5.3f'							-1						q_{111}	q_{112}	E	F		$\leq -\lambda_{11}$
5.3g'								-1					q_{121}	q_{122}	G	H		$\leq \lambda_{12}$
5.3l									1								I	$\leq \pi_{11}$

Figure 5.4. Prototype--Product differentiation with advertising and market share constraint

$$F = -(\omega_{112} + \alpha^1_{11}\ \alpha^1_{12}\omega_{121});\ G = -(\omega_{121} + \alpha^2_{12}\alpha^2_{11}\omega_{121});$$

$$H = -(\omega_{122} + (\alpha^2_{12})^2\omega_{122});\ I = -(\emptyset_{111}(\eta_{11})^2).$$

Multiperiod Programming

The concepts presented so far concerning the application of the spatial price and allocation activity analysis model to local financial intermediation can be extended to the problem of optimal pricing and acquisition/allocation over time. Pfaffenberger and Walker (135) describe two basic programming approaches for optimal decision making over time: (1) recursive programming and (2) dynamic programming. For recursive programming, the solution to an N time period problem requires the solution to N sequential models of the type presented so far. That is, the optimal decision vector at time n is a function of current data, given the decisions of time period n-1. The principle of optimality on which dynamic programming is based is not required for recursive programming (65).

The dynamic programming framework would require that the pricing and activity decisions at each time period be mutually optimal with the decisions of all other time periods. The explicit introduction of time into the quadratic programming framework of spatial price and allocation activity analysis models is discussed in detail by

Takayama and Judge (156). Introducing time into models of localized financial intermediation can be thought of simply as subscripting all the variables, parameters and constraints of the model with a time dimension. In general, the model would require the maximization of the present value of net revenue for the sector being modeled subject to resource balance, pricing conditions, and policy and regulatory constraints in all time periods--where discount factors have been appropriately introduced to the model.

Separable Programming

As operational models of financial intermediation are developed, the size of the problems--given existing quadratic programming computer algorithms--may become a limitation of the methodology. However, recent computer advances[1] and the potential application of separable programming suggest that the size of most problems would not be debilitating to the methodology. Separable programming is an application of linear programming to nonlinear programming problems in which the nonlinear functions are approximated by linear segments (7, 13, 50, 65, 177). Many

---

[1]In addition to computer hardware advances, Russian mathematician, L.G. Khachian, has reported a polynomial time algorithm applicable to linear programming. Theoretically the algorithm could result in significant computer efficiency compared to the commonly used Simplex method which is an exponential time algorithm. Additionally, the Khachian method does not require linear functions (103).

linear programming software packages include a separable programming option--for example, International Business Machines' MPSX (82).

The reformulation of spatial price and allocation activity analysis models of local financial intermediation in a separable programming framework could have two principal advantages: (1) improved capability for sensitivity analysis of model parameters--due to access to linear programming algorithms, and (2) improved modeling capabilities by allowing nonlinear constraints. Nonlinear constraints could provide an improved capability to model risk and uncertainty as well as policy limitations involving net revenue, e.g., tax considerations.

CHAPTER VI. LOAN DEMAND AND DEPOSIT SUPPLY AT COMMERCIAL BANKS IN IOWA: AN ECONOMETRIC ANALYSIS

As with most models of complex systems, the formulation of operational spatial price and allocation activity analysis models of localized financial intermediation will require substantial amounts of data. The activity analysis structure of the model allows for the transfer of experiences gained in designing and implementing models of individual financial intermediaries as well as the transfer of actual data used to support those models. However, empirical estimates of market relationships representing the supply and demand of funds by the nonfinancial units in the economy are not readily available for local financial markets.

The basic premise of the spatial price and allocation activity analysis model of localized financial intermediation is the simultaneous endogenous determination of asset and liability quantities and prices, across intermediary types. Logically these same simultaneities should be accounted for when setting hypotheses for estimating market relationships to be used as inputs to the models.

Only limited work has been reported on estimating the demand for assets (22, 59, 133, 153) and liabilities (22, 59, 76, 115, 153) by the nonfinancial units in the farm sector. Most do not take into account empirically (1) the simultaneous determination of the quantity of alternative financial assets and liabilities, (2) the simultaneous determination of acquisition and allocation activities of alternative financial institutions--e.g., commercial banks, production credit associations, or even (3) the simultaneous determination of price and quantity in equating supply and demand for a given financial instrument. Penson (133) provides a theoretical model that explicitly treats or is flexible enough to incorporate all of these simultaneities. On the basis of portfolio balance theory, he specifies three categories of simultaneous relationships for nonfinancial units in the agricultural sector: (1) desired stocks of financial assets, (2) desired stocks of physical assets, and (3) desired stocks of debt. He also considers the supply of debt by financial intermediaries in the sector.[1] The extent to which all these issues can practically be accounted for will depend on data availability and the scope of the specific application of the spatial activity analysis model.

---

[1]Penson used two stage least squares to estimate only the time and demand deposit supply functions at rural commercial banks.

The emphasis of this chapter is on estimating the demand and supply for nonreal estate agricultural loans at commercial banks in Iowa counties. Banks within a county are assumed to provide a homogenous product (credit) and county boundaries are used to define market areas. Even though financial data are available for individual banks, economic and production data are not generally available for nonpolitical boundaries.

While the data used in the econometric analysis represent a combination of time series and cross-sectional information, the data base was primarily cross-sectional in nature. A total of 297 observations were available for each of the variables defined in subsequent sections--three annual observations (1973-75) for each county in Iowa (99 counties).

Since the period for which data were available has been characterized as a period of continued increase in loan demand coupled with slowed deposit growth, the hypothesis of markets in disequilibrium is examined.

As can be expected with cross-sectional data, the hypothesis of homogeneity of variances of the error term in the structural equations is rejected and the structural equations are reestimated after correcting for heteroskedasticity.

Finally, some limited results estimating the supply of deposits at commercial banks are given.

Demand for Agricultural Loans

The structural equations for the supply and demand for nonreal estate agricultural credit at commercial banks are based on previous studies (59, 76, 115, 133) of the demand and supply for loans in the agricultural sector and on the general theory of the demand and supply of commercial bank loans given by Melitz and Pardue (124). Melitz and Pardue define the dollar value of credit demanded by households, firms and corporations as a function of the interest rate on credit, permanent income of borrowers, transitory income of borrowers, measurable indices of the taste for and productivity of credit, and factors which will affect the desired ratio of commercial bank credit. The supply of commercial bank loans is defined as a function of the yield on commercial bank loans, the yield on alternative commercial bank earnings assets, the cost per dollar of bank deposit liabilities and a scale constraint.[1]

---

[1]Unlike previous studies, Melitz and Pardue specify the demand function in real terms and the supply function in nominal terms. However, they provide estimates for the case of both equations specified in nominal terms.

Given the availabile data, the demand for non-real estate agricultural loans (L^d) at commercial baks in Iowa is hypothesized to be a function of the interest rate on loans (R), net taxable income (I), the expected returns from crops and livestock (as an Index of the productivity of credit), and a time trend (T). The expected return from crops (C) is the weighted average of expected returns from the different crops produced in the county (acres times the difference in the expected return per acre and cost per acre). The expected return per acre is based on the previous year's yield and the current year's prices. Cost are direct costs. No data on the expected return from livestock are available so the value of livestock as of December (S) is included in the equation--but in a covariance fashion to account for fluctuating prices of feedstock and livestock during the 1973-75 period--where D74, and D75 are respectively dummy variables for 1974 and 1975. Since the data base was essentially cross-sectional, the equation is specified in nominal terms; however, the time trend is included to account for any underlying trend components of the data.

The supply of agricultural loans (L^s) by commercial banks is hypothesized to be a function of the interest rate on loans (R), the one bank concentration ratio for farm loans for the county (CR), the rate of return from securities (RS), the unit cost of deposits (CF), total deposits (D), and the loan to deposit ratio (LDR). The one bank concentration ratio is included as a proxy for monopolistic power. Total deposits and the loan to deposit ratio are included as scale factors. The next section describes the data sources and financial variables in more detail.

Data description and definition of variables

Financial data were aggregated by county from individual bank Call Reports of Condition and Consolidated Reports of Income which are collected periodically from each insured commercial bank in the United States. Individual bank data were obtained on magnetic tape from the Board of Governors of the Federal Reserve System (17, 18). Semi-annual Call Reports, from December 1972 through December 1975, were used to calculate annual quantities of assets and liabilities:[1]

(L) nonreal estate agricultural loans--secured and unsecured loans to farmers except loans secured by real estate.

(D) deposits--total time, savings and demand deposits (15 day average).[2]

---

[1]Average annual quantities were calculated as follows: (data from the previous year December Call Report + 2 x data from the current year June Call Report + data from the current year December Call Report)/4.

[2]For the 15 calendar days ending with the call date.

(CR) one bank concentration ratio for farm loans--the share of county loans to farmers held by the largest county lender to farmers.

(LDR) loan to deposit ratio--total loans (15 day average) divided by total deposits (15 day average).

Data from the annual Consolidated Reports of Income, from December 1973 through December 1975, were combined with the variables calculated from the Call Reports in order to approximate the following variables:

(R) interest rate on nonreal estate agricultural loans--interest and fees paid on loans divided by total loans.

(RS) rate of return from securities--interest and dividends on investments divided by annual average quantity of investments (includes U.S. Treasury securities, obligations of other U.S. Government agencies and corporations, obligations of State and political subdivisions, and other securities).

(CF) unit cost of deposits--interest paid on deposits minus service charges on deposits divided by total deposits (15 day average).

County net taxable income and crop and livestock data were taken or calculated from published data compiled by the Iowa Department of Agriculture (85), the Iowa Department of Revenue (86, 87, 88), and the Iowa Development Commission (89).

Estimates of the structural equations

Two stage least squares was used to estimate the coefficients of the following structural equations:[1]

$$L^d = 26{,}211 - 502{,}769(\hat{R})^* + .36(S)^{**} + .36(S)(D74)^{**} + .1(S)(D75) + .00011(C)^{**} + .000017(I)^{**} + 2{,}477(T)^{**} \quad (6.1)$$

and

$$L^s = -76{,}043 + 1{,}075{,}201(\hat{R})^{**} + .005(D) - 28{,}624(CR)^{**} - 16{,}826(RS) - 320{,}716(CF) + 54{,}302(LDR)^* \quad (6.2)$$

where (**) indicates that the coefficient is significantly different from zero at the α=.01 confidence level, and (*) indicates the α=.05 level of significance.

In terms of providing data input to spatial price and allocation models of localized financial intermediation, the principal concern is with the relationship between loan demand and the rate of interest. However, correct specification of the entire system can impact the validity of that estimate.

---

[1]The necessary condition for identifiability of the equations is met--that is the number of predetermined variables excluded from the equation must be at least as great as the number of endogenous variables included less one (93). The estimate of ($\hat{R}$) is obtained from the first stage regression of R on the exogenous variables at the system.

The interest rate coefficient has the expected sign in both the demand and supply equation and both are significant at the α=.05 level. Interest elasticities of demand and supply, calculated at the means, indicate both functions are fairly elastic:

$$\frac{\partial L^d}{\partial R}\frac{\bar{R}}{\bar{L}^d} = -2.3 \quad \text{and} \quad \frac{\partial L^s}{\partial R}\frac{\bar{R}}{\bar{L}^s} = +4.9$$

It is difficult to judge the magnitude of these estimates, due to limited previous research and the failure of many studies to report results in terms of elasticities. Melitz and Pardue report generally weak results in terms of interest elasticity of demand for commercial bank loans (maximum elasticity of -.12). While they do not report a supply elasticity, the data provided allows an approximate estimate of +.96. Fisher (59), using ordinary least squares to estimate the demand for agricultural production loans at commercial banks in rural Oklahoma counties, does not report as interest elasticity of demand, but he provides data sufficient to make an estimate of -.95. Lins (115), estimating the demand and supply of agricultural real estate loans for various lenders, reports interest elasticities of demand from a low for commercial banks (incorrect sign and not statistically significant) to a high for life insurance companies of -8.37 and interest elasticities of supply from a low for commercial banks of .16 (not statistically significant) to a high for life insurance companies of +6.76.

In general, the demand function appears to be correctly specified since the remaining variables are significant at the α=.05 level, the signs are as expected, and the results are stable for alternative estimation procedures and variable definitions.[1] The demand for loans is expected to be positively related to permanent income of borrowers and negatively related to transitory income (124). Since net taxable income consists of components of both permanent and transitory income, the expected sign cannot be determined. The nature of the data, however, would suggest that the expected sign should be positive. As Kuh (109) and Kuh and Meyer (110) point out, cross sectional estimates are essentially long-run in nature while time series estimates generally represent short-run behavior. The permanent income component is expected to dominate in long-run estimates. Although the coefficient is positive, the function is relatively income inelastic:

---

[1]In addition to estimates based on alternative measures of income, lagged net taxable income and county personal income, estimates of the system were made using three stage least squares and limited information maximum likelihood with similar results.

$$\frac{\partial L^d}{\partial I} \frac{\bar{I}}{\bar{L}^d} = +.12$$

Income elasticity estimates using lagged net taxable income and county personal income gave similar results. The sign of the coefficients of the crop, livestock and time trend variables are as expected.

The results indicate that the supply equation is not as well specified as the demand function. The coefficient of total deposits is positive as expected but not statistically significant. The coefficient of the concentration ratio variable is statistically significant and indicates that the supply of loans is negatively related to an increasing share of loans held by a single bank in the county. This can be interpreted to mean that as a single bank gains monopolistic power, it restricts the supply of loans as would be expected. The coefficient of the rate of return on securities (opportunity cost of lending) is negative as expected but not statistically significantly. Melitz and Pardue suggest that an increase in the unit cost of deposit liabilities indicates an increase in time and savings deposits relative to demand deposits and allows commercial banks to increase their relative share of risky assets (loans). Based on this reasoning, the expected sign of the coefficient for the unit cost of funds is positive. The coefficient, instead, is negative but not statistically significant. The problem probably stems from the fact that the unit cost of deposits and the loan to deposit ratios are attempting to measure the same thing. In addition, since the loan to deposit ratio includes nonreal estate agricultural loans, the dependent variable is, in part, being incorrectly regressed on itself. Future research efforts should be directed at replacing total deposits and the loan to deposit ratio with an alternative scale factor. Melitz and Pardue suggest adjusted assets defined as total assets in excess of legally required reserves minus commercial bank loans.

Subsequent sections consider the goodness of fit of the estimates of the system of demand and supply of nonreal estate agricultural loans, and the special problems associated with markets in disequilibrium and with heteroskedasticity of the variance of the error term in the structural equations.

Goodness of fit

In addition to the magnitude and statistical significance of the regression coefficients which measure the systematic relationship between variables in structural equations, the extent to which these relationships explain the fluctuations of the dependent variables is also of interest (79). Basmann (10) has shown that R^2, the squared multiple correlation coefficient, may fall outside the 0 to 1 range where calculated for simultaneous equation models and thus is not an appropriate indicator of the usefulness of an estimated structural equation (38). On the basis of canonical correlation theory, Hooper (79) developed a generalized correlation coefficient for simultaneous equation systems. The following notation will be used to describe the measures developed by Hooper.

Consider the following system of G structural equations; where Y is the N by G matrix of G jointly dependent variables; X is the N by K matrix of K predetermined variables; U is the N by G matrix of structural disturbances; B' and Γ' are respectively G by G and K by G coefficient matrices; and N is the number of observations:

$$YB' + X\Gamma' = U$$

The reduced form equation can be written as follows; where the matrix of reduced form coefficients is $\Gamma' = -\Gamma'(B')^{-1}$ and the matrix of reduced form disturbances is $V = U(B')^{-1}$:

$$Y = X\Pi' + V$$

Finally, $Y = X\hat{\Pi}' + V$; where $\hat{\Pi}$ and $\hat{V}$ are estimated values.

The measures developed by Hooper have been calculated for the two equation system of demand and supply for agricultural loans presented in the previous section. The matrix generalization of the ratio of the estimated variance of the disturbances to the estimated variance of the dependent variable in a single equation, $1-R^2$, is given as $D = (Y'Y)^{-1}\hat{V}'\hat{V}$. The matrix generalization of R^2 is given as follows, when I is an identity matrix of appropriate rank:

$$I-D = \begin{bmatrix} .654348 & -1.1705E-08 \\ 75049.8 & .999114 \end{bmatrix}$$

The characteristic roots of I-D are the square of the canonical correlations between the dependent and independent variables and represent the vector generalization of R^2:

$$\begin{bmatrix} r_1^2 \\ r_2^2 \end{bmatrix} = \begin{bmatrix} .997 \\ .657 \end{bmatrix}$$

Finally, Hooper describes the scalar generalization of R^2, the square of the trace correlation coefficient--$\bar{r}^2$. The trace correlation coefficient possesses properties similar to the multiple correlation coefficient, i.e., $\bar{r}^2 + (1-\bar{r}^2) = 1$; $0 \leq \bar{r}^2 \leq 1$; and $\bar{r}^2$ is invariant to units in which the variables are measured:

$$\bar{r}^2 = \frac{1}{G}\text{ TRACE } (I-D) = .8267$$

and

$$(1-\bar{r}^2) = \frac{1}{G}\sum_{i=1}^{G} (1-r_i^2) = .1733$$

One interpretation of the results is that 83 percent of the generalized variance of the jointly dependent variables, the volume of agricultural loans and the interest rate on loans, has been accounted for by reduced form regression relationship and that 17 percent remains unexplained (79). Hooper also developed estimates of the variance of the trace correlation under both the assumption that the predetermined variables are fixed variates and the assumption that the predetermined variables are normal random variables. The following equations and estimates are for the two equation system:

$$\text{var } \bar{r}^2 \text{ (random)} = \frac{4}{NG^2} \sum_{i=1}^{2} r_i^2 (1-r_i^2)^2 = .00026$$

$$\text{var } \bar{r}^2 \text{ (fixed)} = \frac{2}{NG^2} \sum_{i=1}^{2} r_i^2 (1-r_i^2)^2 (2-r_i^2) = .000174$$

Markets in disequilibrium

Melichar (122) has characterized the period 1973-1975 as one of increased price instability and thus greater financial risk in agricultural lending and as one during which considerable anxiety was expressed over the ability of banks to finance agriculture. Melichar supported his conclusions with data from the Seventh (Chicago) and Ninth (Minneapolis) Federal Reserve Districts. Data showed continued increase in loan demand during the period while deposit growth slowed, decreased during 1974, and reversed the decline during 1975. The net effect was that institutions found themselves in a significantly changed liquidity position--higher loan to deposit ratio--at the end of 1975 than they were in during 1973. Additional data taken from bankers' responses to the Ninth District quarterly survey of agricultural credit conditions strengthen the hypothesis that agricultural loan markets were in disequilibrium during the period 1973-1975. Responses to questions concerning various aspects of nonreal estate lending for the 1973-1975 period are shown in table 6.1.

A number of econometric studies have attempted to estimate supply and demand functions for markets in disequilibrium (56, 66). The quantitative method described by Fair and Jaffee (56) can be used to test the hypothesis of market disequilibrium for agricultural loans at commercial banks in Iowa for the period 1973-1975. The quantitative method can be described using the following normal demand/supply specifications:

$$D = a_o X^d + a_1 P + u^d \tag{6.3}$$

Table 6.1. Farm loan availability--Ninth District

	PERCENT OF BANKS THAT--				
Date	refused/reduced farm loan request due to funds shortage previous quarter	referred more farm loan requests than normal to nonbank institutions	expected problems in meeting farm loan requests (current period)	regarded loan to deposit ratio as higher than desirable	actively sought new farm loan accounts
1973-Q1	2	2	2	6	75
-Q2	5	2	2	7	78
-Q3	5	3	4	15	71
-Q4	9	5	8	15	62
1974-Q1	6	3	5	15	69
-Q2	4	2	4	11	76
-Q3	18	6	20	27	46
-Q4	35	19	30	39	27
1975-Q1	27	24	14	34	30
-Q2	13	27	14	19	43
-Q3	11	11	4	21	51
-Q4	8	9	4	18	61

$$S = b_o X^s + b_1 P + u^s \tag{6.4}$$

where quantity demanded, D, is a linear function of price, P, and a set of predetermined demand variables, X^d. Quantity supplied, S, is a linear function of price and a set of predetermined supply variables, X^s. The disturbance terms are u^d and u^s. Price is not assumed to adjust each period so as to equate supply and demand. Instead, a change in price from period t-1 to t is assumed to be a positive function of excess demand at time t:

$$\Delta P = k(D-S) \qquad o \leq k \leq \infty \tag{6.5}$$

Based on the assumption of markets in disequilibrium, the demand and supply specifications can be written as follows:

$$Q = D-\frac{1}{k}/\Delta P/ = a_o X^d + a_1 P - \frac{1}{k}/\Delta P/ + u^d \tag{6.6}$$

where $/\Delta P/ = \begin{cases} \Delta P \text{ if } \Delta P \geq 0 \\ 0 \text{ otherwise} \end{cases}$

$$Q = S-\frac{1}{k}\backslash\Delta P\backslash = b_o X^s + b_1 P - \frac{1}{k}\backslash\Delta P\backslash + u^s \tag{6.7}$$

where $\backslash\Delta P\backslash = \begin{cases} -\Delta P \text{ if } \Delta P \leq 0 \\ 0 \text{ otherwise} \end{cases}$

When $\Delta P \leq 0$, the observed quantity, Q, is demand; the demand specification is given by (6.3) and the supply specification is determined as $S-\frac{1}{k}\backslash\Delta P\backslash$. When $\Delta P \geq 0$, the observed quantity is supply; the supply specification is given by (6.4) and the demand specification is determined as $D-\frac{1}{k}/\Delta P/$.

The quantity method can be incorporated into the analysis of agricultural loans by (1) dropping the data points for 1973--in order to calculate changes in interest rate, and (2) including $/\Delta R/$ in the demand equation and $\backslash\Delta R\backslash$ in the supply equation.

Three stage least squares was used to estimate the system of equations. As described by Fair and Jaffee, interest rate lagged one period was added to the set of regressors in the first stage; first stage regression over only that portion of the sample for which $\Delta R \geq 0$ is used to estimate $\hat{R}$ and $/\Delta\hat{R}/$ in the demand equation; likewise, first stage regression over only that portion of the sample for which $\Delta R \leq 0$ is used to estimate $\hat{R}$ and $\backslash\Delta\hat{R}\backslash$ in the supply equation. The second stage regression was then completed using the entire sample. Finally the constraint that the coefficients of $/\Delta\hat{R}/$ and $\backslash\Delta\hat{R}\backslash$ be equal was accounted for in the third stage regression (8).

The coefficient $-\frac{1}{k}$ had the expected negative sign but was not significant at the $\alpha = .1$ level. Thus the hypothesis that the market for agricultural loans was in disequilibrium was not supported. Even though one would expect to reject the hypothesis of markets in disequilibrium based on the survey information collected by the Federal Reserve, these negative results should not be unexpected given the cross-sectional nature of the data. Kuh (109) points out that cross-sectional estimates generally fail to capture inter-firm dynamic factors since disequilibrium among firms tends to be synchronized in response to common market forces and many disequilibrium effects wash out.

Heteroskedasticity

Until now, the classical least squares assumptions concerning the disturbance term in each structural equation have not been questioned: (1) that the expected value of the disturbances is zero, (2) that the disturbances are homoskedastic--have constant variances, and (3) that the disturbances are not autocorrelated. The assumption of constant variance is probably not realistic in the estimation of the demand and supply for agricultural loans when the data is predominantly cross-sectional in nature. To test the assumption of homogeneity of variances of the error term, Johnston (93) suggests applying the standard test for homogeneous variances to the dependent variable when plentiful cross-sectional data are available:

If $\lambda = \prod_{i=1}^{m} (s_i/n_i)^{n_i/2} / (\sum s_i/n)^{n/2}$, then $u = -2\ln\lambda$ is

distributed approximately as χ^2_{m-1} under the hypothesis of homogeneous variances. Where the dependent variable y is divided into m groups according to size; n_i is the number of observations in group i and n is the total number of

observations; $s_i = \sum_{j=i}^{n_i} (y_{ij} - \bar{y}_i)^2$. Johnston points

out that if the regression equation is well specified, the variation of y values about the sample means will be close to the variation about the function. Table 6.2 shows the results of applying the test to agricultural loan volume for the data used to estimate the supply and demand for agricultural loans.

Table 6.2. Tests for homogeneity of variances

m	u	χ^2_{m-1} (α=.01)	Hypothesis of Homogeneous Variances
3	3486	9.21	reject
11	3546	23.21	reject

While methods for correcting for autocorrelated disturbances in simultaneous equation systems are discussed in the literature (96), heteroskedasticity is discussed only in the context of three stage least squares where the disturbances are assumed to have a constant variance within an equation but are considered to vary from one equation to another. Christ (38) briefly describes the application of Aitkin's generalized least squares method for dealing with autocorrelation in simultaneous equation systems when the variance-covariance matrix of the disturbances of the structural equation to be estimated is assumed to be proportional to some known matrix. While Christ does not point it out, the approach is generally applicable to treating heteroskedasticity in simultaneous equation models as well as serial correlation.

Consider the following single structural equation from a simultaneous system:

$$y = y_1\beta + x_1\gamma + u$$

where y is the endogenous variable to be estimated; y_1 is the set of included endogenous variables; and x_1 is the set of included predetermined variables. The vector of disturbances u is assumed to have the following characteristics:

$$E(u) = 0$$

$$E(uu') = \sigma^2\Omega$$

where σ^2 is unknown and Ω is a known symmetric positive definite matrix. The structural equation to be estimated can be transformed by premultiplying the equation by the matrix p^{-1} where $\Omega = PP'$ and $P^{-1}\Omega P^{-1'} = I$:

$$p^{-1}y = p^{-1}y_1\beta + p^{-1}x_1\gamma + p^{-1}u$$

The vector of disturbances in the transformed equation now has the desirable least squares properties:

$$E\ (P^{-1}u) = 0$$

$$E\ (P^{-1}uu'P^{-1'}) = \sigma^2 I$$

The equation is still subject to simultaneous equation bias and can now be estimated using two stage least squares where the included transformed endogenous variables are replaced by their estimated value from a first stage regression on the excluded predetermined variables and the transformed included predetermined variables.

The matrix Ω is typically not known. When the assumption of homoskedasticity has been rejected, Johnston suggests trying a number of simple regressions relating the absolute value of residuals to a variable with which the variance might be associated in order to estimate Ω.

A number of simple regressions relating the residuals from equation (6.1) and total crop acres were tried. The following equation was estimated and used to estimate Ω for the demand for agricultural loan equation:

$$|\text{residual}| = 4\text{X}10^{-8}\ (\text{ACRES})^2$$

$$\sigma^2\hat{\Omega} = \sigma^2 \begin{bmatrix} (4\text{X}10^{-8}\ \text{ACRES}^2)^2_1 & & \\ & \ddots & \\ & & (4\text{X}10)^{-8}\ \text{ACRES}^2)^2_{297} \end{bmatrix}$$

Using the procedure described above, substituting $\hat{\Omega}$ for Ω, the demand for agricultural loan equation was reestimated:

$$L^d = 26{,}890 - 494{,}268\ (\hat{R}) + .23\ (S) + .28\ (S)(D74)$$
$$+ .079\ (S)(D75) + .00017(C) + .00001(I) + 2512(T)$$

Coefficients of all variables were significant at the $\alpha = .01$ level with the exception of (S)(D75) and were essentially unchanged from equation (6.1). The conclusion is that while heteroskedasticity was present, it did not significantly affect the estimates of the structural equation.

The next section provides some limited results of deposit supply estimates.

Deposit Supply Estimates

An attempt was made to estimate the supply of time and demand deposits at commercial banks using the theoretical model described by Penson (133). Although the results were generally unsatisfactory, they are briefly described here for completeness.

Penson hypothesizes that the desired stock of time and demand deposits is in part a function of total physical assets. Only limited information concerning physical assets held is available in the data base. So physical assets are approximated by the expected value of crops produced during the year and the value of livestock--measured as of December.

The supply of demand deposits was assumed to be a linear function of the rate on demand deposits, rate on time deposits, expected value of crops, value of livestock as of December, and income.

The supply of time and savings deposits was assumed to be a linear function of the same set of variables as demand deposits.

Since physical assets were hypothesized to be a function of financial assets (time and demand deposits), the equations are estimated using two stage least squares. The expected value of crops was regressed in the first stage against the exogenous variables included in the deposit supply equations, the exogenous variables from the structural equations for the supply and demand for nonreal estate agricultural loans and the expected net rate of return per acre for crops and the expected return from real estate physical assets (approximated as the rate of growth of land prices). Only the coefficient of the income variable was statistically significant in the supply of demand deposit equation (the income elasticity of supply was +.93). The coefficient of the rate on time deposits was significant in the supply of time deposit equation (the interest rate elasticity of supply was +2.4).

CHAPTER VII. SUMMARY AND CONCLUSIONS

The enactment of Depository Institutions Deregulation and Monetary Control Act of 1980 implements a number of the policy and regulatory changes to the U.S. financial system which have been proposed by a series of private and government directed study groups during the past 20 years. Congressional and industry initiatives are likely to be directed at additional changes during the 1980s. These changes can be categorized broadly into three areas: (1) transformation of the productive capabilities of individual intermediaries through changes in their structural form and in the activities in which they may engage; (2) increased reliance on the market place through removal of price control regulations; and (3) increasing efficiencies in the many channels and linkages between markets and intermediaries through which credit flows from suppliers to ultimate users of surplus funds in the economy. There has been no systematic examination of the effects of these many proposed changes or of their impacts on localized financial markets.

Mathematical programming models have been widely used to reflect the operational activity of individual financial intermediaries--especially commercial banks.

While some modeling of the financial intermediation system has proceeded at a national aggregate level in Norway, local financial markets have not been modeled nor have practical methodologies for doing so been presented.

Using the structure of self-dual quadratic programming models, financial intermediaries are characterized as producing units effecting the flow of funds through the financial system by acquisition, creation, and allocation of asset and liability instruments. A perfect competition spatial price and allocation activity analysis model for localized financial markets is developed and used to reflect most of the flow of funds linkages in local markets. The activity analysis structure of the model provides for flexibility and detail in modeling the nature of operational activities of intermediaries, and the spatial aspects of the model combined with endogenously determined pricing and flow quantities can be used to reflect market interaction of competing firms.

Financial markets are often described by oligopolistic behavior; market segmentation and product differentiation; government regulation and intervention; and imperfect competition not only in marketing final products, credit, but also in competition for funds. The perfect competition model is modified to include policy and regulatory constraints and generalized to allow alternatives to perfect competition in both asset and liability markets. The structure allows for perfect competition in some asset and liability markets and collusion in others. By parameterization of specified coefficients, the model can be used to "imitate" market competition between the extremes of perfect competition and collusion.

A series of prototypes for commercial banking markets is developed to illustrate typical constraints found in models of individual financial intermediaries and to extend the competitive concepts of the model. The prototypes include examples of nonfunds resource constraints, e.g. specialized labor; policy and regulatory constraints, e.g. collateral or pledging constraints, legal reserve requirements, portfolio composition constraints; and management constraints in terms of maturity and liquidity restrictions. Competitive concepts are extended to include differentiated products; advertising; and modeling specific competitive environments such as monopolistic competition and the leading firm and market-share solution to the oligopoly problem.

The experiences gained in designing and implementing models of individual financial intermediaries will provide substantial data support to spatial price and allocation activity analysis models of localized financial intermediation. However, empirical estimates of market relationships representing the supply and demand for funds by nonfinancial units in the economy are not readily available for local markets. An econometric analysis provides some initial estimates of deposit supply and loan demand at commercial banks in Iowa. Results of deposit supply estimates were generally poor and the focus was on estimating relationships for nonreal estate agricultural loans.

Two stage least squares was used to estimate the structural equations for the demand and supply of nonreal estate agricultural loans. Estimates were based on county aggregate economic and production data for the period 1973-1975. Detailed financial data on individual commercial banks were obtained from the Federal Reserve and aggregated to the county level. The coefficient estimates were generally as expected and the analysis should serve as a useful benchmark against which to compare future econometric results. Interest elasticities of demand and supply were respectively -2.3 and 4.9 indicating fairly elastic functions. Even though the period 1973-1975 has been characterized as one in which considerable anxiety was expressed over the ability of banks to finance agriculture, an attempt to estimate markets in disequilibrium failed to reject the hypothesis of equilibrium. Because of the cross-sectional nature of the data, the hypothesis of homogeneity of variances of the error term in the structural equations was tested and rejected. The structural demand equation was reestimated after correcting for heteroskedasticity. However, the coefficient estimates in the structural equation remained essentially unchanged.

Not only do the models developed provide an improved capability to reflect the topology of localized financial markets, a number of specific model elements should prove useful in modeling nonfinancial sectors of the economy. The models provide the most detailed treatment of resource markets in self-dual programming models to date. While the concept of parameterizing between the extremes of perfect competition and collusion in final product markets in quadratic programming models has been shown, it has not previously been incorporated in self-dual quadratic models nor extended to resource markets. The specific prototypes of product differentiation; advertising; and noncompetitive environments such as monopolistic competition can be applied to nonfinancial problems.

Finally, while this research represents a rigorous formulation of the model of localized financial intermediation, its value in terms of financial management can only be validated by successful future empirical applications.

BIBLIOGRAPHY

1. Adolfse, Joop, and Vervoordeldonk, Frans. "Strategic Planning and Policy Making in Banks." Long Range Planning 12 (1979):73-81.

2. Agrawal, R.C., and Heady, Earl O. Operations Research Methods for Agricultural Decisions. Ames, Ia.: Iowa State University Press, 1972.

3. American Bankers Association. Report of the Agricultural Credit Task Force. Washington, D.C.: American Bankers Association, 1973.

4. Baker, C.B., and Holcomb, J.M., eds. Research and Teaching Programs in Agricultural Finance. Agricultural Finance Program Report 2. Urbana-Champaign: Department of Economics, University of Illinois, 1970.

5. Baker, C.B.; Hopkin, J.A.; and Brinegar, G.K. "Research in Financial Intermediation with Respect to Agriculture." In Research and Teaching Programs in Agricultural Finance, pp.2-9. Agricultural Finance Program Report 2. Edited by C.B. Baker and J.M. Holcomb. Urbana-Champaign: Department of Economics, University of Illinois, 1970.

6. "Banking Act Makes Major Changes." Economic Review (Atlanta: Federal Reserve Bank of Atlanta) (March/April 1980):4-5.

7. Baritelle, J.L., and Holland, D.W. "Optimum Plant Size and Location: A Case for Separable Programming." Agricultural Economics Research 27 (1975):73-84.

8. Barr, Anthony J.; Goodnight, James H.; Sall, John P.; and Helwig, Jane T. A Users Guide to SAS 76. Raleigh, N.C.: SAS Institute Inc., 1976.

9. Barry, Peter J., and Hopkin, John A. "Financial Intermediation in Agriculture: A Suggested Analytical Model." Southern Journal of Agricultural Economics 4 (1972):179-83.

10. Basmann, Robert L. "Letter to the Editor." Econometrica 30 (1962):824-26.

11. Baughman, Ernest T. "The Economic Role of Financial Intermediaries--Challenges of a Changing Agriculture." In A New Look at Agricultural Finance Research, pp. 85-92. Agricultural Finance Program Report 1. Urbana-Champaign: Department of Economics, University of Illinois, 1970.

12. Baumol, William J., and Fabian, Tibor. "Decomposition Pricing for Decentralization and External Economies." Management Science 11 (1964):1-32.

13. Beale, E.M.L. Mathematical Programming in Practice. Belfast: Pitman Publishing, 1968.

14. Beckmann, M.J., and Marschak, Thomas. "An Activity Analysis Approach to Location Theory." Proceedings of the Second Symposium in Linear Programming 2 (1955):331-79.

15. Beer, Stafford. Decision and Control: The Meaning of Operations Research and Management Cybernetics. London: John Wiley & Sons, 1966.

16. Board of Governors of the Federal Reserve System. Improved Fund Availability at Rural Banks: Report and Study Papers of the Committee on Rural Banking Problems. Washington, D.C.: Board of Governors of the Federal Reserve System, 1975.

17. ________. Reports of Condition of Insured Commercial Banks and their Consolidated Domestic Subsidiaries. Washington, D.C.: Board of Governors of the Federal Reserve System, [1975].
This document provides documentation of magnetic tape files containing information from the Call Reports of Condition.

18. ________. Reports of Income of Insured Commercial Banks and Their Consolidated Domestic Subsidiaries. Washington, D.C.: Board of Governors of the Federal Reserve System, [1975].
This document provides documentation of magnetic tape files containing information from the Consolidated Reports of Income.

19. ________. Functional Cost Analysis: 1975 Average Banks. Washington, D.C.: Board of Governors and the Federal Reserve System, [1976].

20. ________. Performance Characteristics of High Earning Banks: Functional Cost Analysis--1975. Washington, D.C.: Board of Governors of the Federal Reserve System, [1976].

21. Boehlje, Michael. "Research in Agricultural Finance: Researcher-User Coordination." Agricultural Finance Review 37 (1977):117-21.

22. Boehlje, Michael, and Fisher, Glen. "A Competitive Management Game for Non-Metropolitan Commercial Banks." Journal of Bank Research 7 (1976):56-67.

23. Bonner, James T. "Improving Information on Agriculture and Rural Life." American Journal of Agricultural Economics 57 (1975):754-63.

24. Booth, G. Geoffrey. "Programming Bank Portfolios Under Uncertainty: An Extension." Journal of Bank Research 2 (1972):29-40.

25. Bradley, Stephen P., and Crane, Dwight B. Management of Bank Portfolios. A Wiley Interscience Publication. New York: John Wiley & Sons, 1975.

26. Brake, John R., and Melichar, Emanuel. "Agricultural Finance and Capital Markets." In A Survey of Agricultural Economics Literature. Vol 1: Traditional Fields of Agricultural Economics, 1940s to 1970s, pp. 413-94. Edited by Lee R. Marvin. Minneapolis: University of Minnesota Press for the American Agricultural Economics Association, 1977.

27. Bressler, Raymond G., Jr., and King, Richard A. Markets, Prices and Interregional Trade. New York: John Wiley & Sons, 1970.

28. Byrd, Jack, Jr. Operations Research Models for Public Administration. Lexington, Mass.: D.C. Heath and Co., 1975.

29. Cambridge Research Institute. Trends Affecting the U.S. Banking System. Cambridge, Mass.: Ballinger Publishing Co., 1976.

30. Candilis, Wray O., ed. The Future of Commercial Banking. Forward by Senator John Sparkman. New York: Praeger Publishers, 1975.

31. Chacko, George K. Applied Operations Research/Systems Analysis in Hierarchial Decision-Making. Vol. 1: Systems Approach to Public and Private Sector Problems. Amsterdam: North-Holland Publishing Co., 1976.

32. Chambers, D., and Charnes, A. "Inter-Temporal Analysis and Optimization of Bank Portfolios." Management Science 7 (1961):393-410.

33. Chandler, Lester. "Monopolistic Elements in Commercial Banking." Journal of Political Economy 67 (1959): 1-12.

34. Charnes, A., and Cooper, W.W. Management Models and Industrial Applications of Linear Programming. New York: John Wiley & Sons, 1961.

35. Charnes, A., and Littlechild, S.C. "Intertemporal Bank Asset Choice with Stochastic Dependence." Systems Research Memorandum no. 88. Evanston, Ill.: the Technological Institute, Northwestern University, 1968.

36. Charnes, A., and Thore, Sten. "Planning for Liquidity in Financial Institutions: the Chance Constrained Method." Journal of Finance 21 (1966): 649-74.

37. Chen, Andrew H.Y. "Optimal Bank Portfolio Management." In Applications of Management Science in Banking and Finance, pp. 137-48. Edited by Samuel Eilon and Terrence R. Fowkes. London: Gower Press, 1972.

38. Christ, Carl F. Econometric Models and Methods. New York: John Wiley & Sons, 1968.

39. Cohen, Kalman J., and Hammer, Frederick S. "Operations Research: A New Approach to Bank Decision Making." Bankers Magazine 150 (1965):13-24.

40. Cohen, Kalman J., and Hammer, Frederick S. "Linear Programming and Optimal Bank Asset Management Decisions." Journal of Finance 22 (1967):147-68.

41. Cohen, Kalman J., and Hammer, Frederick S., eds. Analytical Methods in Banking. Homewood, Ill.: Richard D. Irwin, Inc., 1966.

42. Cohen, Kalman J., and Thore, Sten. "Programming Bank Portfolios Under Uncertainty." Journal of Bank Research 1 (1970):42-61.

43. Crane, Dwight B. "A Stochastic Programming Model for Commercial Bank Bond Portfolio Management." Journal of Financial and Quantitative Analysis 6 (1971):955-76.

44. Crosse, Howard D., and Hempel, George H. Management Policies for Commercial Banks. 2nd ed. Englewood Cliffs, N.J.: Prentice-Hall, 1973.

45. Crowther, J.G., and Whiddington, R. Science at War. New York: Philosophical Library, 1948.

46. Dagum, Camilo. "On Methods and Purposes in Econometric Model Building." Zeitschrift fur Nationalokonomie 28 (1968):381-98.

47. Dallenbach, Hans G., and Archer, Stephen H. "The Optimal Bank Liquidity: A Multi-Period Stochastic Model," Journal of Financial and Quantitative Analysis 4 (1969):329-43.

48. Dantzig, George B. Linear Programming and Extensions. Princeton: Princeton University Press, 1963.

49. Dorfman, Robert; Samuelson, Paul A.; and Solow, Robert M. Linear Programming and Economic Analysis. New York: McGraw-Hill, 1958.

50. Duloy, John H., and Norton, Roger D. "CHAC, A Programming Model of Mexican Agriculture." In Multi-Level Planning: Case Studies in Mexico, pp. 291-337. Edited by Louis M. Goreux and Alan S. Manne. Amsterdam: North-Holland Publishing Co., 1973.

51. Duloy, John H., and Norton, Roger D. "Prices and Incomes in Linear Programming Models." American Journal of Agricultural Economics 57 (1975): 591-600.

52. Echols, Michael E., and Elliott, J. Walter. "Forecasting vs. Allocational Efficiency in Bank Asset Planning: An Integrated Evaluation." Journal of Bank Research 6 (1976):283-95.

53. Eilon, Samuel, and Fowkes, Terrance R., eds. Applications of Management Science in Banking and Finance. London: Gower Press, 1972.

54. Encyclopaedia Britanica Macropaedia, 15th ed. S.v. "Operations Research," by Russell L. Ackoff.

55. Enke, Stephen. "Equilibrium Among Spatially Separated Markets: Solution by Electric Analogue." Econometrica 19 (1951):40-47.

56. Fair, Ray C. and Jaffee, Dwight B. "Methods of Estimation for Markets in Disequilibrium." Econometrica 40 (1972):497-514.

57. Fellows, James A., and Beard, Thomas R. "Some Welfare Implications of Legal Restrictions on Commercial Bank Entry." Journal of Bank Research 11 (1980): 159-168.

58. Fielitz, Bruce D., and Loeffler, Thomas A. "A Linear Programming Model for Commercial Bank Liquidity Management." Financial Management 8 (1979):41-50.

59. Fisher, Glen D. "The Development of a Management Game for Oklahoma Rural Banks." M.S. thesis, Oklahoma State University, 1973.

60. Flechsig, Theodore G. Banking Market Structure & Performance in Metropolitan Areas: A Statistical Study of Factors Affecting Rates on Bank Loans. Washington, D.C.: Board of Governors of the Federal Reserve System, 1965.

61. Frey, Thomas L. "Optimal Asset Liability Decisions for a Rural Bank: An Application of Multiperiod Linear Programming." Ph.D. dissertation, University of Illinois, 1970.

62. Fried, Joel. "Bank Portfolio Selection." Journal of Financial and Quantitative Analysis 5 (1970):203-227.

63. Gass, Saul I. Linear Programming Methods and Applications. 2nd ed. New York: McGraw-Hill Book Co., 1975.

64. Goreux, Louis M. and Manne, Alan S., eds. Multi-Level Planning: Case Studies in Mexico. Forward by Holles B. Chenery. Amsterdam: North-Holland Publishing Co., 1973.

65. Hadley, George T. Nonlinear and Dynamic Programming. Reading, Mass.: Addison-Wesley Publishing Co., 1964.

66. Hae-shin, Huang. "A Test of a Disequilibrium Model." Journal of Econometrics 12 (1980):319-33.

67. Haley, Charles W. "Branch Banking and the Public Interest." University of Washington Business Review 30 (1970):22-26.

68. Hall, Harry H.; Heady, Earl O.; and Plessner, Yakir. "Quadratic Programming Solutions of Competitive Equilibrium for U.S. Agriculture." American Journal of Agricultural Economics 50 (1968): 536-55.

69. Hall, Harry H.; Heady, Earl O.; Stoecker, Arthur L.; and Sposito, Vincent A. "Quadratic Programming of Spatial Equilibrium." In Spatial Sector Programming Models in Agriculture, pp. 420-51. Edited by Earl O. Heady and Uma K. Srivastava. Ames, Ia.: Iowa State University Press, 1975.

70. Hamilton, Kenneth N., Jr. "The Impact of Various Banking Techniques on the Banking Structure of West Virginia." Ph.D. dissertation, West Virginia University, 1975.

71. Hanson, M.A. "A Duality Theorem in Non-Linear Programming with Non-Linear Constraints." Australian Journal of Statistics 3 (1961):64-72.

72. Harris, Duane G. "Credit Rationing at Commercial Banks: Some Empirical Evidence." Journal of Money, Credit, and Banking 6 (1974):227-40.

73. Heady, Earl O., and Strivastava, Uma K., eds. Spatial Sector Programming Models in Agriculture. Ames, Ia.: Iowa State University Press, 1975.

74. Heggestad, Arnold A., and Mingo, John J. "Prices, Nonprices, and Concentration In Commercial Banking." Journal of Money, Credit and Banking 8 (1976): 107-117.

75. Henderson, James M., and Quandt, Richard E. Microeconomic Theory. New York: McGraw-Hill Book Co., 1971.

76. Hesser, Leon F., and Schuh, G. Edward. "The Demand for Agricultural Mortgage Credit." Journal of Farm Economics 54 (1962):1583-88.

77. Hillier, Frederick S., and Lieberman, Gerald L. Introduction to Operations Research. 2nd ed. San Francisco: Holden-Day, 1974.

78. Hitchcock, F.L. "Distribution of a Product From Several Sources to Numerous Localities." Journal of Mathematics and Physics 21 (1941):224-30.

79. Hooper, John W. "Simultaneous Equations and Canonical Correlation Theory." Econometrica 27 (1959): 245-56.

80. Hopkin, John A., ed. A New Look at Agricultural Finance Research. Agricultural Finance Report 1. Urbana-Champaign: Department of Economics, University of Illinois, 1970.

81. Hutson, Arthur L. "Economic Analysis of Commercial Bank--Farm Credit System Coordination." M.S. thesis, Oklahoma State University, 1971.

82. International Business Machine Corporation. Mathematical Programming System 360 -(360A-CO-14X), Version 2, Linear and Separable Programming Users' Manual. White Plains, N.Y.: International Business Machine Corporation, 1971.

83. Iowa Credit Union League. Annual Report of Iowa Credit Unions. Des Moines, Ia.: Iowa Credit Union League, 1977.

84. Iowa Department of Agriculture. Iowa Agricultural Statistics, 1975-76.

85. Iowa Department of Revenue. Summary of Real Estate Assessment/Sales Ratio Study, 1971-75.

86. ________. 1973 Individual Income Tax Annual Statistical Report Returns Filed in 1974.

87. ________. 1974 Individual Income Tax Annual Statistical Report Returns Filed in 1975.

88. ________. 1975 Individual Income Tax Annual Statistical Report Returns Filed in 1976.

89. Iowa Development Commission. Statistical Profile of Iowa, 1977.

90. Jacobs, Donald P. Business Loan Costs and Bank Market Structure: An Empirical Estimate of their Relations. National Bureau of Economic Research, Occasional Paper no. 115. New York: National Bureau of Economics Research, 1971.

91. Jacobs, Donald P.; Lerner, Eugene M.; and Moag, Joseph S. "Guidelines for Designing Bank Planning Models and Information Systems." Journal of Bank Research 2 (1971):14-24.

92. Jaffee, Dwight M. Credit Rationing and the Commercial Loan Market: An Econometric Study of the Commercial Loan Market. New York: John Wiley & Sons, 1971.

93. Johnston, J. Econometric Methods. 2nd ed. New York: McGraw-Hill Book Co., 1972.

94. Jones, H.G. "The Scope of OR Type Models in the Financial Area." The Journal of the Operational Research Society 29 (1978):307-313.

95. Judge, George G., and Takayama, Takashi, eds. Studies in Economic Planning over Space and Time. Contributions to Economic Analysis No. 82. Amsterdam: North-Holland Publishing Co., 1973.

96. Kmenta, Jan. Elements of Econometrics. New York: Macmillan Publishing Co., 1971.

97. Knight, Robert E. "Correspondent Banking Part I: Balances and Services." Monthly Review (Kansas City: Federal Reserve Bank of Kansas City) (Nov. 1970):3-14.

98. ________. "Correspondent Banking Part II: Loan Participation and Fund Flows." Monthly Review (Kansas City: Federal Reserve Bank of Kansas City) (December 1970):12-24.

99. ________. "Correspondent Banking Part III: Account Analysis." Monthly Review (Kansas City: Federal Reserve Bank of Kansas City) (December 1971):3-17.

100. ________. "Reserve Requirements Part I: Comparative Reserve Requirements at Member and Nonmember Banks." Monthly Review (Kansas City: Federal Reserve Bank of Kansas City) (April 1974):3-20.

101. ________. "Reserve Requirements Part II: An Analysis of the Case of Uniform Reserve Requirements." Monthly Review (Kansas City: Federal Reserve Bank of Kansas City)(May 1974):3-15.

102. ________. "Account Analyses in Correspondent Banking." Monthly Review (Kansas City: Federal Reserve Bank of Kansas City)(March 1976):11-20.

103. Kolata, Gina B. "Mathematicians Amazed by Russian's Discovery." Science 206 (1979):545-46.

104. Koopmans, T.C., ed. Activity Analysis of Production and Allocation. New York: John Wiley & Sons, 1951.

105. Koot, R.S. "The Demand for Credit Union Shares." Journal of Financial and Quantitative Analysis 11 (1976):133-41.

106. Kornai, Janos. "Thoughts on Multi-Level Planning Systems." In Multi-Level Planning: Case Studies in Mexico, pp. 521-51. Edited by Louis M. Goreux and Alan S. Manne. Amsterdam: North-Holland Publishing Co., 1973.

107. Kreps, Clifton H., Jr. "Characteristics of Local Banking Competition." In Banking and Monetary Studies, pp. 319-32. Edited by Deane Carson. Homewood, Ill.: Richard D. Irwin Inc., 1963.

108. Krooss, Herman E., and Blyn, Martin R. A History of Financial Intermediaries. New York: Random House, 1971.

109. Kuh, Edwin. "Validity of Cross-Sectionally Estimated Behavior Equations in Time Series Applications." Econometrica 27 (1959):197-214.

110. Kuh, Edwin, and Meyer, John R. "How Extraneous are Extraneous Estimates?" Review of Economics and Statistics 39 (1957):380-93.

111. Kutcher, Gary P. "On Decomposing Price-Endogenous Models." In Multi-Level Planning: Case Studies in Mexico, pp. 499-519. Edited by Louis M. Goreux and Alan S. Manne. Amsterdam: North-Holland Publishing Co., 1973.

112. Lee, Sang M. Goal Programming for Decision Analysis. Philadelphia: Auerbach Publishers, Inc., 1972.

113. Lifson, K.A., and Blackman, Brian R. "Simulation and Optimization Models for Asset Deployment and Funds Sources, Balancing Profit, Liquidity and Growth." Journal of Bank Research 3 (1973):239-256.

114. Light, Jack S. "Increasing Competition Between Financial Institutions." Economic Perspectives (Chicago: Federal Reserve Bank of Chicago) 1 (May/June 1977):23-31.

115. Lins, David A. "Determinants of Net Changes in Farm Real Estate Debt." Agricultural Economics Research 24 (1972):1-8.

116. McCarl, Bruce A., and Spreen, Thomas H. "Price Endogenous Mathematical Programming As a Tool for Sector Analysis." American Journal of Agricultural Economics 62 (1980):87-102.

117. Magen, S.D. The Cost of Funds to Commercial Banks: An Econometric Analysis. New York: Dunellen Publishing Co., 1971.

118. Markowitz, Harry. "Portfolio Selection." In Analytical Methods in Banking, pp. 258-71. Edited by Kalman J. Cohen and Frederick S. Hammer. Homewood, Ill.: Richard D. Irwin, Inc., 1966.

119. Marshall, Alfred. Principles of Economics: An Introductory Volume. 8th ed. New York: Macmillan Co., 1952.

120. Maruyama, Yoshikuo, and Fuller, Earl I. "An Interregional Quadratic Programming Model for Varying Degrees of Competition." Agricultural Experimental Station Bulletin 555. Amherst, Mass.: University of Massachusetts Agricultural Experimental Station, 1965.

121. Mathis, Stephen A.; Harris, Duane G.; and Boehlje, Michael. "An Approach to the Delineation of Rural Banking Markets." American Journal of Agricultural Economics 60 (1978):601-608.

122. Melichar, Emanuel. "Overall Measures of Financial Performance." Agricultural Finance Review 37 (1977):79-96.

123. Melichar, Emanuel, and Sayre, Marian. Agricultural Finance Databook: Annual Series. Washington, D.C.: Board of Governors of the Federal Reserve System, 1976.

124. Melitz, Jacques, and Pardue, Morris. "The Demand and Supply of Commercial Bank Loans." Journal of Money, Credit and Banking 5 (1973):669-92.

125. Melnik, Arie. "Short Run Determinants of Commercial Bank Investment Portfolios: An Empirical Analysis. Journal of Finance 25 (1970):639-49.

126. Moag, Joseph S., and Lerner, Eugene M. "Capital Budgeting Decisions Under Imperfect Market Conditions--A Systems Framework." Journal of Finance 24 (1969):613-21.

127. Mote, Larry R. "The Perennial Issue: Brank Banking." Business Conditions (Chicago: Federal Reserve Bank of Chicago)(February 1974):3-23.

128. Murphy, Neil B. "The Implications of Econometric Analysis of Bank Cost Functions for Bank Planning." Journal of Bank Research 4 (1973):203-206.

129. National Credit Union Administration. 1976 Annual Report of the National Credit Union Administration. Washington, D.C.: National Credit Union Administration, 1977.

130. Nelson, Aaron G.; Lee, Warren F.; and Murray, William G. Agricultural Finance. 6th ed. Ames, Ia.: Iowa State University Press, 1976.

131. New York State Banking Department. Branch Banking, Bank Mergers and the Public Interest. January 1964.

132. Olson, Kent D.; Heady, Earl O.; Chen, Carl C.; and Meister, Anton D. Estimated Impacts of Two Environmental Alternatives in Agriculture: A Quadratic Programming Analysis. CARD Report 72. Ames, Ia.: Center for Agricultural and Rural Development, 1977.

133. Penson, John B., Jr. "Demand for Financial Assets in the Farm Sector: A Portfolio Balance Approach." American Journal of Agricultural Economics 54 (1972):163-74.

134. ________. "Research and Communications Issues in Farm Financial Structure." Agricultural Finance Review 37 (1977):68-76.

135. Pfaffenberger, Roger C., and Walker, David A. Mathematical Programming for Economics and Business. Ames, Inc.: Iowa State University Press, 1976.

136. Plessner, Yakir. "Quadratic Programming Competitive Equilibrium Models for the U.S. Agricultural Sector." Ph.D. dissertation, Iowa State University, 1965.

137. ________. "Activity Analysis, Quadratic Programming and General Equilibrium." International Economics Review 8 (1967):168-179.

138. ________. "Computing Equilibrium Solutions for Imperfectly Competitive Markets." American Journal of Agricultural Economics 53 (1971):191-96.

139. Plessner, Yakir, and Heady, Earl O. "Competitive Equilibrium Solutions with Quadratic Programming." Metroeconomica 17 (1965):117-30.

140. "Quick Summary of New Omnibus Banking Law." ABA Banking Journal 72 (May 1980):20-22.

141. Riggs, James L., and Inoue, Michael S. Introduction to Operations Research and Management Science: A General Systems Approach. McGraw-Hill Series in Industrial Engineering and Management Science. New York: McGraw-Hill Book Co., 1975.

142. Robertson, J.M. "A Bank Asset Management Model." In Applications of Management Science in Banking and Finance, pp. 149-58. Edited by Samuel Eilon and Terence R. Fowkes. London: Gower Press, 1972.

143. Robinson, Lindon J., and Barry, Peter J. "Portfolio Adjustments: An Application to Rural Banking." American Journal of Agricultural Economics 59 (1977):311-20.

144. Samuelson, Paul A. "Spatial Price Equilibrium and Linear Programming." American Economics Review 42 (1952):283-303.

145. Saunders, Robert J. "The Sales Maximization Hypothesis and the Behavior of Commercial Banks." Mississippi Valley Journal of Business and Economics 6 (1970):21-32.

146. Sharpe, William F. "A Simplified Model for Portfolio Analysis." In Analytical Methods in Banking, pp. 282-97. Edited by Kalman J. Cohen and Frederick S. Hammer. Homewood, Ill.: Richard D. Irwin, Inc., 1966.

147. Sheppard, D., and Barrett, C. "Financial Credit Multipliers and the Availability of Funds." Economica 32 (1965):198-214.

148. Shull, Bernard. "Commercial Banks as Multiple-Product Price-Discriminating Firms." In Banking and Monetary Studies, pp. 351-68. Edited by Deane Carson. Homewood, Ill.: Richard D. Irwin, Inc., 1963.

149. Silber, William L. Portfolio Behavior of Financial Institutions: An Empirical Study with Implications for Monetary Policy, Interest-Rate Determination, and Financial Model-Building. Holt, Rinehart and Winston Series in Finance. New York: Holt, Rinehart and Winston, 1970.

150. Slovin, Myron B., and Sushka, Marie Elizabeth. Interest Rates and Savings Deposits: Theory, Estimation, and Policy. Toronto: Lexington Books, 1975.

151. Smith, Thomas. "Agricultural Lending in Iowa, 1976." Agricultural Finance Review 37 (1977):24-26.

152. Sposito, Vincent A. Linear and Nonlinear Programming. Ames, Ia.: Iowa State University Press, 1975.

153. Standen, B.J. "Rural Credit Policy and Bank Rural Lending." Australian Journal of Agricultural Economics 22 (1978):41-53.

154. Story, Sverre; Thore, Sten; and Boyer, Marcel. "Equilibrium in Linear Capital Market Networks." Journal of Finance 30 (1975):1197-1211.

155. Takayama, Takashi, and Judge, George G. "An Interregional Activity Analysis Model for the Agricultural Sector." Journal of Farm Economics 46 (1964):349-65.

156. ________. Spatial and Temporal Price and Allocation Models. Contributions to Economic Analysis no. 73. Amsterdam: North-Holland Publishing Co., 1971.

157. Thore, Sten. "Credit Networks." Economica 36 (1969): 42-57.

158. ________. "Programming a Credit Network Under Uncertainty." Journal of Money Credit and Banking 2 (1970):219-46.

159. ________. "Programming Flow-of-Funds Networks: A Survey." Discussion Paper Norwegian School of Economics and Business Administration, Bergen, Norway, 1974. (Mimeographed.)

160. ________. "Programming for Efficient Financial Intermediations." Norwegian School of Economics and Business Administration, Bergen, Norway, 1976. (Mimeographed.)

161. Thore, Sten, and Kydland, Finn. "Dynamic for Flow-of-Funds Networks." In Applications of Management Science in Banking and Finance, pp. 259-76. Edited by Samuel Eilon and Terence R. Fowkes. London: Gower Press, 1972.

162. Thore, Sten, and Vardal, Erling. "A Programming Model for National Credit Budgeting in Norway." Economic Appliquée 27 (1974):423-56.

163. U.S. Department of Agriculture. Commodity Credit Corporation Report of Condition and Cooperation, September 1976.

164. ________. Finance Statistics, 1976.

165. U.S. Department of the Treasury. The Report of the President's Commission on Financial Structure and Regulation, 1971.

166. ________. Recommendations for Change in the U.S. Financial System, September 1973.

167. ________. The Financial Institutions Act of 1975.

168. U.S. Congress. House. Committee on Banking, Currency and Housing. Financial Institutions and the Nation's Economy: Compendium on Papers Prepared for the FINE Study. Committee Print. Washington, D.C.: Government Printing Office, 1976.

169. U.S. Congress. Senate. The Condition of the Banking System. Hearings Before the Committee on Banking, Housing and Urban Affairs, 95th Cong., 1st sess., 1977.

170. U.S. Farm Credit Administration. 43rd Report of the Farm Credit Administration in the Cooperative Farm Credit System, 1975-76.

171. U.S. Farm Credit Service. Farm Credit Banks of Omaha Directory. Omaha: Farm Credit Service, 1976.

172. U.S. Federal Home Loan Bank Board. 1974 Combined Financial Statements: FSLIC-Insured Savings and Loan Associations.

173. ________. A Financial Institution for the Future: An Examination of the Restructuring of the Savings and Loan Industry, March 1975.

174. Walker, John R. Bank Costs for Decision Making: Costing Procedures for Pricing Bank Services. Boston: Bankers Publishing Co., 1970.

175. Waterman, Robert H., Jr., and Gee, Robert E. "A New Tool for Bank Management: A Mathematical Model in Banking." In Analytical Methods in Banking, pp. 55-62. Edited by Kalman J. Cohen and Frederick S. Hammer. Homewood, Ill.: Richard D. Irwin, Inc., 1966.

176. Webb, Kerry. "The Farm Credit System." Economic Review (Kansas City: Federal Reserve Bank of Kansas City)(June 1980):16-30.

177. Wen-yuan, Huang, and Hogg, Howard C. "Estimating Land Use Patterns: A Separable Programming Approach." Agricultural Economics Research 28 (1976):22-33.

178. Wieda, Lorraine. "The Bankers Magazine Survey: Important Problems Facing Banks Today." The Bankers Magazine 163 (May-June 1980):46-48.

179. Wolf, Charles R. "A Model for Selecting Commercial Bank Government Security Portfolios." Review of Economics and Statistics 51 (1969):40-52.

180. Wood, J.H. Commercial Bank Loan and Investment Behavior. Wiley Monographs in Applied Econometrics. London: John Wiley & Sons, 1975.

181. Wrean, William Hamilton. The Demand for Business Loan Credit. Lexington, Mass.: Lexington Books, 1974.

ACKNOWLEDGMENTS

I thank my friends and family who have felt my joys and frustrations during the completion of this research.

Particularly, I thank Professor Mike Boehlje for his synergistic comments and guidance, but most of all for his patience.

Finally, I thank my mother and father, Betty and Blaine, for creating, nurturing and rewarding my desire to learn more.

APPENDIX A. CHARACTERISTICS OF MAJOR INTERMEDIARIES IN AGRICULTURAL FINANCIAL MARKETS

Table A1. Characteristics of intermediaries

COMMERCIAL BANKS: Most diversified of deposit and lending institutions

Principal Sources of Funds

- Demand deposits
- Time and savings deposits
- Capital accounts
- Banker acceptances
- Borrowing
- Interbank deposits

Principal Uses of Funds

- Conventional, FHA, VA, commercial, farm and residential mortgage
- Commercial loans
- Consumer loans
- Farm loans - operating, livestock purchase, equipment purchase
- Corporate and government securities
- Reserves

Regulation/Supervision

- Comptroller of the currency - national chartered
- State Superintendent of Banking or state agencies - state chartered
- Federal Deposit Insurance Corporations Non-Federal Reserve member, state chartered insured banks
- Federal Reserve - state chartered member banks
- FDIC, FRS members subject to regulation regardless of national-state charter

Other Important Characteristics

- Unit banking states are predominantly agricultural states
- From 1971-1975 banks controlled by holding companies increased in number by 52%; deposit volume by 83%

Table A1. (continued)

CREDIT UNIONS: Non-profit organizations of individuals with common bond of occupation, association, or residence

Principal Sources of Funds

Member shares-including interest and noninterest bearing 3rd party accounts similar to negotiable orders of withdrawal
Borrowing from other credit unions and lenders

Principal Uses of Funds

Loans to members primarily for durable goods, personal household and family expenses, and repairs and modernization of residential property
Loans to other credit unions
Government securities

Regulation/Supervision

National Credit Union Administration - if incorporated under U.S. Federal law
State Superintendents of Banking - if incorporated under one of the State's laws

Other Important Characteristics

Fastest growing financial intermediary in consumer installment lending
Favorable tax treatment due to nonprofit status

SAVINGS AND LOAN ASSOCIATIONS: Stock or mutual organizations primarily concerned with deposit needs of members and use of funds for residential mortgages

Principal Sources of Funds

Time and savings deposits - including interest and non-interest bearing NOW accounts
Advances from Federal Home Loan Bank

Principal Uses of Funds

Residential mortgage loans - conventional, VA, FHA
Securities-except private sector debt or equity issues

Table A1. (continued)

Regulation/Supervision

Federal Home Loan Bank Board - if insured by Federal Savings and Loan Insurance Corporation or if not supervised by states
State Superintendents of Banking - if state chartered

MUTUAL SAVINGS BANKS: Similar to savings loan stock institutions

Principal Sources of Funds

Time and savings deposits

Principal Uses of Funds

Mortgage loans - especially VA, FHA
Government securities
Corporate debt

Regulation/Supervision

State Superintendents of Banking

Other Important Characteristics

Most located on east coast of U.S. - represent important deposit institutions in these states

COOPERATIVE FARM CREDIT SYSTEM: Federal Land Banks, Federal Intermediate Credit Banks, Production Credit Associations

Regulation/Supervision

Farm Credit Administration

Other Important Characteristics

Exempt from state usury laws
Tax advantages - important consideration in competition with commercial banks

Table A1. (continued)

Federal land banks: Cooperative system owned by people who use services to provide dependable low cost long-term credit to rural customers

Principal Sources of Funds

Sale of consolidated Federal Land Bank bonds
Income from lending operations and investments--each borrower required to purchase stock equal to not less than 5% or greater than 10% of loan
Capitalized by stock held by Federal Land Bank Associations

Principal Uses of Funds

First mortgage loan on real estate

Other Important Characteristics

Link with customers primarily through Federal Land Bank Associations
Interest rate held to lowest possible level consistent with sound business practices

Federal Intermediate Credit Banks: Owned by PCAs who use

Principal Sources of Funds

Sale of bonds in national financial market

Principal Uses of Funds

Provide funds to owner Production Credit Association

Production Credit Associations: Cooperative ownership through purchase of stock by borrowers provide dependable source of short-term credit to farmers and ranchers

Principal Sources of Funds

From Federal Intermediate Credit Banks--pledge notes of member borrowers

Table A1. (continued)

Principal Uses of Funds

Loans for--operating expenses, livestock purchases, livestock production, equipment purchase, living expenses, real estate
Operating loans usually for one year; loans for capital purchase up to 7 years

Other Important Characteristics

Other services include AGRIFAX--an electronic record keeping system
Credit life insurance
Crop hail insurance

Farmers Home Administration: Agency of the Department of Agriculture

Principal Uses of Funds

Direct short- or long-term loans to farmers unable to get credit through conventional lenders.

Regulation/Supervision

Department of Agriculture

Other Important Characteristics

Initial obligations to farmers generates $1.23 in loans from other lenders for every $1.00 of FHA loans (1976)

LIFE INSURANCE COMPANIES: Provide death benefits to customers

Principal Sources of Funds

Policy premiums

Principal Uses of Funds

Corporate bonds
Commercial, residential, farm mortgages
Securities

Table A1. (continued)

Regulation/Supervision
Subject to state and federal laws
Other important Characteristics
Generally suffers from disadvantageous tax status in competition with other lenders

APPENDIX B. COMPARISON OF MAJOR FINANCIAL INSTITUTIONS REFORM PACKAGES 1971-1976

Table B1. Comparison of reform packages (29, 30, 165, 166, 167, 68)

Recommendations: Sources of Funds	Hunt Commission 1971	President's Recommendations 1973	Financial Institutions Act 1975	FINE Study 1976
Phase out interest rate ceilings on savings and time deposits	X	X	X	X
Allow savings and loans (SL) and mutual savings banks (MSB) to offer demand deposits and	X	X		X
third-party payment services	X			X
Allow commercial banks (CB), SL, MSB to offer full service corporate and individuals, negotiable order of withdrawal (NOW) accounts		X	X	
Allow national CB to offer corporate savings accounts		X	X	
Remove limits on CB creation of acceptances	X			
Phase out prohibition of interest rate payment on demand deposits				X
Allow credit unions (CU) to offer variable share certificates similar time and savings accounts			X	
Allow community CU in low-income areas to issue demand deposits and other third party arrangements				X
Recommendations: Uses of Funds				
Abolish CB restrictions on real estate loans	X			
Expand CB real estate loan powers		X	X	

Table Bl. (continued)

	1971	1973	1975	1976
Recommendations: Uses of Funds (cont.)				
Allow CB "leeway" in investment in any asset (some size limits and limits on equity investments)	X			
Allow CB, SL, MSB equity investment in community rehabilitation and development projects intended to improve low and middle income groups employment and housing	X			
Allow CB, SL, MSB community rehabilitation loans (within limits)		X	X	
Allow SL, MSB limited consumer loan powers' consumer loans limited to 10% of assets;	X		X	
powers to include credit card payments and revolving lines offered and to extend powers to CU				X
Allow SL, MSB real estate loan powers under same conditions as CB	X	X	X	
Allow SL, MSB commercial loan powers to extent loans are related to housing		X		
Allow expanded SL, MSB: investment in equities (size, % of issue and quality limits; no investment in CB, stock SL or their holding companies);	X			
investment in all U.S. government, state and municipal debt instruments of all maturities	X			
limited acquisition of high-grade private debt securities;		X		
acquisition of commercial paper, banker's acceptances and high grade corporate debt (10% of assets);				X
invest in commercial paper, corporate debt and bankers' acceptances--extend powers to CU				X
Allow SL, MSB to make loans anywhere in U.S. or territories	X			
Allow SL: to make interim construction loans not tied to permanent financing;			X	X
ownership in real estate and non-interest yielding loan agreements;	X			
unrestricted loan powers for mobile homes;	X			

Table B1. (continued)

	1971	1973	1975	1976
Recommendations: Uses of Funds (cont.)				
Minor liberalization of CU lending powers		X		
All CU to offer credit lines in accordance with credit worthiness of member			X	
Allow CU to offer 30 year mortgages to members			X	
Allow CU to offer longer maturity consumer loans			X	
Recommendations: Taxation				
Uniform tax system for all deposit institutions	X			X
No change in tax exempt status for CU		X	X	
CU tax responsibility in accord with expanded powers	X			
CB, SL, MSB tax credit for investment in residential mortgages		X		
Individual and corporation tax credit on residential mortgage investment			X	
Mortgage tax credit for properties destined for low or middle income owners or renters				X
For SL, MSB tax credit could replace special treatment of bad debt reserves			X	
Recommendations: Chartering, Conversion, Branching				
Allow dual charter (federal, state) for SL, MSB	X	X		
Allow federal charter for mutual commercial banks	X			
Allow Federal Home Loan Bank Board charter of federal stock SL or MSB	X			
Allow or encourage state-wide branching for CB, SL, MSB				X
Allow interstate branching for federally insured depository institutions (unless in conflict with state law)				X
If state law conflict exists, allow federally insured out-of-state institutions and federally charter in-state institutions to branch in SMSA with population in excess of two million				X

Table B1. (continued)

	1971	1973	1975	1976
Recommendations: Chartering, Conversion, Branching (cont.)				
Allow foreign bank branching in accord with domestic bank restrictions				X
Allow freedom of conversion	X	X		
SL, MSB state to federal, federal to state, mutual to stock, stock to mutual				
Federal chartered SL to national bank (FDIC supervision)				
Mutual SL to federal charter, national bank or SL				
Recommendations: Supervision and Regulation				
Establish Administrator of State Banks to supervise state-chartered insured CB, MSB and SL (with third-party payments in excess of 10% of liabilities)	X			
Rename comptroller of the Currency to Office of the National Bank Administrator and give authority over national CB, federally chartered MSB, mutual CB, federally chartered SL (with third-party payments orders in excess of 10% of liabilities)	X			
Remove Federal Reserve authority over state member	X			
Remove Federal Deposit Insurance corporation authority over state chartered, insured CB	X			
Establish Federal Deposit Guarantee Administration to coordinate insurance function of Federal Deposit Insurance Corporation, Federal Savings and Loan Insurance, Corportion and National Credit Union Administration	X			
All federally insured depository institutions and their holding companies would be supervised and regulated by new Federal Depository Institutions Commission				X

Table Bl. (continued)

	1971	1973	1975	1976
Recommendations: Housing and Mortgage Markets				
Eliminate interest rate ceilings on VA-guaranteed and FHA-insured mortgages	X	X		
and prohibit such market distortions as charging points			X	
Adoption of variable rate mortgages	X			
Encourage states to eliminate ceilings on residential mortgages	X			
Encourage states to eliminate "doing business" taxes on out of state institutions	X			
Allow Federal Home Loan Bank Board to lend directly to depository institution providing mortgage loans for low and moderate income housing				X
Allow Federal Reserve Board to provide reserve credits to all depository institutions on new and outstanding low and moderate income housing and construction loans				X
Recommendations: Reserve Requirements				
Require mandatory Federal Reserve membership for CB and SL, MSB with third-party accounts	X			
Require reserves on demand deposits and NOW accounts of federally chartered institutions which are members of Federal Reserve of Federal Home Loan Bank		X		
Federal Reserve sets reserve requirements: demand deposits are NOW accounts (1-22%), savings accounts (1-5%), time accounts (1-10%)		X		
Require all federally insured depository institutions to meet Reserve requirements. Reserves to be held at Federal Reserve				X
Phase in equal treatment for all institutions of a given size	X			X
Eliminate reserve requirements on time, savings, share accounts and certificates of deposit	X			
Federal Reserve sets reserve requirements between 7 and 22%	X			

Table B1. (continued)

	1971	1973	1975	1976
Recommendations: Reserve Requirements (cont.)				
Allows full and equitable access to all Federal Reserve facilities for all institutions required to maintain reserves				X
Allow limited Federal Reserve facilities for foreign banks				X
Recommendations: Other				
Allow CB, SL, MSB to engage in same financed fiduciary or insurance activities as approved for bank holding companies (SL, MSB only for individual and non-business customers)	X			
Allow CB authority to underwrite municipal revenue bonds secured by revenues from essential public services	X			
Allow CB, SL, MSB authority to sell and manage mutual funds, including commingled agency accounts	X			
Grant Federal Reserve more flexible authority to define assets eligible for discounts		X		
Allow CB to underwrite state and municipal securities including revenue bonds				X
Allow SL, MSB, CU power to engage in same trust activities as CB under supervision at new Federal Depository Institutions Commission				X
Allow CU opportunity to obtain liquidity advances from a Central Discount Fund	X	X	X	
Allow CU to sell travelers checks, registered checks, cashier's checks and mortgage life insurance	X			
Allow CU to market bookkeeping and data processing services	X			
Eliminate CB restrictions on discount eligibility of certain assets	X			
Expanded regulatory supervision of trust activities and pension funds	X			
Encourage states to change laws so as to allow flexible loan rates in life insurance policy in order to reflect current market rates	X			
Encourage more equitable tax treatment for insurance companies relative to other financial intermediaries	X			
Continue study of Electronic funds transfer systems				X