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Deposit-Institution Failures: A Review of Empirical Literature

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Introduction

The decade of the 1980s has been a particularly turbulent one for the U.S. banking and financial system. Since the establishment of the Federal Deposit Insurance Corporation (FDIC) in 1933, more than 1,500 banks have been declared officially insolvent and were subsequently closed, acquired, or received assistance to prevent closure (see table 1). More than 800 of these closures took place during the 1980s, with 200 institutions being closed in 1988 alone.

De facto failures, which are defined more broadly to include any regulator-induced cessation of autonomous operations, portray an even gloomier picture. This dramatic increase in the bank failure rate has intensified public criticism of deposit-institution regulators, since bank safety and soundness is a major regulatory responsibility.[1] The recent crisis in the savings and loan industry helped the already existing problem to surface, and the public has become more eager to assess and assign blame.

Deposit institutions fail primarily because they take risks, and subsequent events do not always turn out favorably. However, as Kane (1985) notes, when a series of failures occurs, or a major crisis is threatened, the general public blames regulators as much as it blames deposit-institution managers. Regulators are criticized for not being able to detect and curb different forms of unsuccessful risk-taking in time to prevent failures.

Potentially adverse consequences of bank failures include financial losses to bank stockholders and creditors, disruptions of community banking arrangements, contagious losses of confidence in other institutions, and widespread financial distress caused by sharp contractions in the money supply (Benston et al. [1986] and Kaufman [1985]). However, the consequences of an individual bank failure on the local economy are unlikely to be any more severe than those of the failure of any other firm of comparable size (Horvitz [1965], Tussing [1967], Kaufman [1985]). Even the commonly feared financial distress thought to result from multiple bank failures is unlikely to occur. Destruction of the means of payment is an indication that government has not fulfilled its macroeconomic responsibility. Under such circumstances, sensible monetary policy would call for an expansion of the monetary base. It is an established view that bank failures that produce a decline in the

■ 1 For a thorough discussion of safe and sound banking, see Benston et al. (1986).

TABLE 1

U.S. Bank Closures For Various Subperiods, 1934-1988

	Average Number of Closings per Year		Average Deposits in Closed Banks (Millions)	
Years	All Banks	Insured Banks	All Banks	Insured Banks
1934-40	64.2	51.1	68.2	62.3
1941-50	7.3	6.1	10.3	9.9
1951-60	4.3	2.8	11.5	10.5
1961-70	6.3	5.0	34.2	33.5
1971-80	8.3	7.9	537.2	529.1
1981-85	59.8	59.8	6,023.4	6,023.4
1986	138	138	6,471.1	6,471.1
1987	184	184	6,281.5	6,281.5
1988	200	200	37,200	37,200
1989[a]	145	145	21,400	21,400

a. As of August 18, 1989.
SOURCE: 1987 FDIC Annual Report and telephone calls to FDIC.

TABLE 2

Equity, Insolvency, and Failure Definitions

Federally Contributed Equity	= the capitalized value of the deposit-insurance guarantees.
Enterprise-Contributed Equity	= the capital of the institution net of the federally contributed equity.
Book-Value Insolvency	= the book value of assets minus the book value of liabilities (book value of the net worth) is negative.
Market-Value Insolvency Economic Insolvency De Facto Insolvency	= market value of assets minus market value of liabilities net of the value of insurance guarantees (enterprise-contributed equity) is negative.
Official (De Jure) Insolvency Closure De Jure Failure	= capital is judged inadequate by the regulators and the institution is closed or merged out of existence.
De Facto Failure	= any regulator-induced cessation of autonomous operations.

SOURCE: Author.

money supply are the result of errors and misconceptions by central bankers (Thornton [1939], Friedman and Schwartz [1963], Brunner and Meltzer [1964], Cagan [1965]).

The consequences of contagious bank failures are no longer considered serious concerns because of the Federal Reserve System's macroeconomic responsibilities. Yet the failure of individual institutions still remains a serious problem for the general taxpayer. As Kane (1985, 1989) notes, in a crisis, taxpayers are called upon to underwrite the cost to the Treasury of bailing out these institutions. The burden eventually falls on them in the form of higher taxes or higher rates of inflation.[2] The problem for taxpayers is to minimize their own loss exposure.

By developing an accurate model for predicting bank failures, and by understanding the behavior of bank regulators, it will be possible to identify and/or verify the changes necessary to reform the deposit insurance system, thus minimizing the future loss exposure of the U.S. taxpayer.[3]

The purpose of this article is to review empirical literature on deposit-institution failures. Section I introduces and discusses concepts crucial in the analysis. Section II compares and contrasts selected empirical studies. Section III identifies weaknesses in the various approaches to studying the problem and concludes by suggesting future avenues for research.

I. Bank Insolvency, Closure, and Failures: Explaining Regulatory Decision-Making

The purpose of this section is twofold.[4] First, it seeks to define and distinguish between the different insolvency and failure categories listed in table 2. Second, based on the distinction between insolvency and failure, it describes how failure should be modeled within the framework of a regulatory decision-making process.

■ **2** This fact is exemplified by the recent savings and loan bailout.

■ **3** The problems in the present deposit-insurance system and regulator behavior have been identified by Meltzer (1967), Scott and Mayer (1971), Merton (1977, 1978), Kareken and Wallace (1978), Sharpe (1978), Buser, Chen, and Kane (1981), Kane (1981a, 1981b, 1985, 1986, 1988, and 1989), McCulloch (1981, 1987), Kareken (1983), Pyle (1983, 1984), and Benston et al. (1986).

■ **4** The definitions and theoretical analysis presented in this section draw largely on Benston et al. (1986) and Kane (1985, 1989).

Insolvency Versus Failure

Official insolvency occurs when an institution's chartering authority judges its capital to be inadequate. The procedures by which this decision is made are not clear, however.

A firm's capital may be identified as a particular measure of its net worth. Net worth is the difference between the value of the firm's assets and nonownership liabilities. In order to determine the level of capital, itemization of assets and liabilities and adoption of an appropriate valuation rule are necessary (Kane [1989]).

To be able to define capital, various categories of assets and liabilities need to be itemized. A complete definition requires recognition of implicit assets and liabilities as well as explicit ones. Implicit assets and liabilities are defined as all sources of positive and negative future cash flows that are considered "unbookable" by the accounting profession.

Valuation of capital is crucial. Using different valuation rules leads to different asset and liability values. Measuring an institution's capital on the basis of historical cost at which it acquired its various balance-sheet positions is misleading. But historical-cost principles provide the basis for determining the book values of the balance sheet accounts of U.S. banks. Book values are recorded in terms of acquisition costs. As market prices change, these costs tend to depart from market values.

Kane (1989) notes two shortcomings of historical-cost accounting. First, using acquisition cost undervalues an institution's best portfolio decisions and overvalues its worst ones. Second, historical-cost accounting neglects potentially observable changes in the value of a firm's investments by not modifying the acquisition costs to reflect market developments. This method exaggerates the economic relevance of the acquisition costs of an institution's assets and liabilities and fails to appraise its investment successes and failures on an ongoing basis.

To determine a depository institution's level of capital for regulatory purposes, it is helpful to break down its capital into two components: enterprise-contributed equity and federally contributed equity (Kane [1989]). Enterprise-contributed equity is the capital of the institution net of the capitalized value of its deposit insurance guarantees. To the extent that federal guarantees are underpriced, the deposit insurer contributes de facto capital to the institutions. The present deposit insurance system allows aggressive deposit institutions to pass off poorly monitored and unpriced risks onto federal insurance agencies.[5] The federally contributed capital is determined by the amount of risk that insurance agencies stand ready to absorb.

These valuable guarantees are actually equity instruments that make the U.S. government a de facto investor in deposit institutions. Unless an appropriate recapitalization rule is imposed on managers and stockholders, the capitalized value of the guarantees increases as the institution's enterprise-contributed equity decreases or as the riskiness of either its portfolio or environment increases. Clearly, the value of the federally contributed capital should not be counted as a part of the institution's capital for regulatory purposes.

The traditional supervisory approach to regulation also neglects the role of subordinated debt as a potential source of market discipline, and views debt capital as less desirable than equity. However, permitting institutions to count subordinated debt toward capital-adequacy determinations would provide increased protection for the insurance fund in the form of increased market discipline (Benston et al. [1986]).

Holders of subordinated debt are a source of market discipline because, as opposed to depositor debtholders, they cannot withdraw their funds on demand. Also, as opposed to stockholders, they do not share the increased profits that increased risk-taking may bring. Therefore, they prefer safe and conservatively managed institutions. If banks were required to maintain relatively short-term subordinated debt as a certain proportion of equity, thus forcing them into the market on a frequent basis, subordinated debt could protect the insurance agency from losses.

An appropriate insolvency criterion is the market value of enterprise-contributed capital, which can be obtained by subtracting the value of federal guarantees from the institution's market value of equity.[6]

De facto or market-value insolvency exists when an institution can no longer meet its contractual obligations out of its own resources. This occurs whenever the market value of the institution's nonownership liabilities exceeds the market value of its assets; or, in other words,

■ **5** For a thorough review of this issue, see references in footnote 3.

■ **6** An estimate of the capitalized value of the federal guarantees can be obtained using different approaches. For a review of different techniques, see Merton (1977), Marcus and Shaked (1984), Ronn and Verma (1986), Kane and Foster (1986), Benston et al. (1986), Schwartz and Van Order (1988), and Demirgüç-Kunt (1990, forthcoming).

when the market value of its enterprise-contributed equity becomes negative. However, in determining official insolvency, regulators tend to look for book-value insolvency rather than market-value insolvency.

Book-value insolvency exists when the difference between the book values of an institution's assets and liabilities is negative. Even when an institution is book-value solvent, its market-value or economic insolvency may be suggested by refinancing difficulties that surface as an ongoing liquidity shortage. A liquidity shortage occurs whenever an institution's cash, reserve balances, and established lines of credit prove insufficient to accommodate an unanticipated imbalance in the inflow and outflow of customer funds.

If a continuing liquidity shortage is not relieved by outside borrowing or government assistance, assets may have to be sold at "fire-sale prices," that is, for less than their equilibrium value. Such sales erode the institution's capital, and may cause the uninsured customers of the institution to move their funds to safer locations. The resulting run on the institution's resources causes the institution to borrow nondeposit funds or to sell earning assets. Given that these runs are typically motivated by the presence of large unbooked losses in an institution's balance sheet, asset sales push the book value of the institution's assets toward their market value, eventually resulting in the institution's book-value insolvency.

Official (de jure) insolvency, or closure (de jure failure), occurs when the market-value insolvency is officially recognized and the firm is closed or involuntarily merged out of existence. De facto failure can be defined more broadly than closure as any regulator-induced cessation of autonomous operations.

The definitions in this section clarify the difference between economic insolvency and failure of financial institutions. Economic insolvency is a market-determined event. In contrast, de jure or de facto failure results from a conscious decision by regulatory authorities to acknowledge and to repair the weakened financial condition of the institution. Failure is an administrative option that the authorities may or may not choose to exercise even when strong evidence of market-value insolvency exists.

Failure as a Regulatory Decision

Economic theory can explain why deferring meaningful action can be the rational choice for federal officials. The theory of public choice analyzes the working of government by applying and extending economic theory to the realm of political or governmental decision-making.[7] Myers and Majluf (1984), Narayanan (1985), and Campbell and Marino (1988) apply public choice theory to explain the managerial decision-making of an enterprise. Again, based on the public choice theory, Kane (1988 and 1989) develops a model of regulatory decision-making.

The Kane model incorporates the economic, political, and bureaucratic constraints as well as the career-oriented incentives of federal regulators in explaining the regulatory decision-making process. These constraints and incentives foster the difference between market-value insolvency and failure of financial institutions. Due to conflicts of interest between politicians and regulators, and between regulators and taxpayers, timely resolution of market-value insolvencies is often not attractive to deposit-institution regulators.

Kane (1989) argues that this conflict of interest between regulators and politicians complicates the regulatory task of serving the taxpayer. Deposit-institution regulators find it difficult to resist budget constraints imposed by politicians because they are subject to appointment and oversight controls from politicians. As appointed officials, they face political pressures to leave problems unsolved, thus keeping involved constituencies and political action committees willing to pay tribute to politicians.

Regulators also face oversight controls from their regulatory clientele, that is, from the institutions in the industry they regulate (Stigler [1977]). Federal officials have career-oriented incentives to keep their constituencies and clientele happy. Their explicit salaries are lower than what they can make in the private sector. Economists conceive this gap as being bridged by implicit wages. As Kane (1989) notes, these implicit wages consist of certain nonpecuniary benefits of holding a high government office and of future increases in wages that accrue in post-government employment—very often within the regulated industry.

The actions and policy decisions of regulators are closely overseen by their clientele. If regulators can successfully complete their term in government service, they can generally expect higher wages in postgovernment employment. The importance of the perceived quality of their

■ **7** See Buchanan (1960, 1967), Tulloch (1965), Niskanen (1971), Stigler (1977), and Buchanan and Tollison (1984).

performance makes federal officials very sensitive to the opinions of the institutions they regulate, as well as to those of the trade associations connected with these institutions.

These career-oriented incentives introduce political and bureaucratic constraints to regulatory decision-making. Therefore, federal regulators tend to be influenced by their constituencies, avoiding solutions unfavorable to them, or promoting solutions that they find particularly desirable. Lobbying activities exaggerate and make the negative early effects of public policies more visible, further slowing the adoption of substantial changes in financial regulation. For regulators, the economic, political, and bureaucratic constraints increase the career costs of serving the taxpayer well. This conflict of interest between the regulators and the taxpayers leads to the adoption of forbearance policies that allow the continued operation of market-value insolvent institutions.

In his model, Kane (1988 and 1989) envisions two extreme types of regulators: the unconflicted or faithful agent of the taxpayer, and the conflicted or self-interested agent.

A faithful agent is expected to work toward fulfillment of society's long-term goals. In the Kane model, faithful agents are modeled as maximizing the unobservable market value of the deposit-insurance enterprise. This value is calculated as the net present value of the future cash flows generated by its operations. A faithful agent protects the interests of the taxpayer, resisting politically imposed restraints and career-oriented incentives.

Self-interested agents do not resist economic constraints to avoid the possibility of conflict with politicians. In addition, they are tempted by career-oriented incentives and serve their own narrow interests rather than those of the taxpayer. In the Kane model, conflicted agents maximize their own perceived performance image in an effort to maximize their postgovernment wages. The self-interested agent's decision-making process is subject to economic constraints implicit in the budget procedures, as well as to the political and bureaucratic constraints implicit in career-oriented incentives. The agent, in an effort to serve himself well, gives in to all of these constraints and incentives, and imposes the resulting costs on the unwary taxpayer.

The Kane model is a theoretical model of regulatory decision-making that underlines the factors leading to the distinction between economic insolvency and failure of financial institutions. Clearly, in a realistic analysis, bank failures need to be modeled within the framework of a regulatory decision-making process.

II. Review Of Empirical Literature On Financial-Institution Failures

A summary of selected empirical studies on thrift-institution and commercial-bank failures is given in table 3. The first group of studies (Sinkey [1975], Altman [1977], and Martin [1977]) focuses on developing early warning systems. These systems statistically analyze financial ratios constructed from the balance sheets and income statements that institutions file regularly with federal agencies. The goal is to incorporate this information into monitoring systems and to help regulators by flagging financially troubled institutions as early as possible. To identify these institutions, researchers typically fit cross-sectional models for each year into their sample periods.

The second group of studies (Avery and Hanweck [1984], Barth et al. [1985], Benston [1985], and Gajewski [1988]) attempts to explain statistically de jure failures, labeled in this article as the closure process. Their models seek to identify financial factors that affect the likelihood of an institution's closure. Using cross-sectional data over a given sample period or cross-sectional data pooled from different years, researchers try to pinpoint determinants of closure by analyzing the same types of financial ratios used by the first group of studies.

To clarify the model specifications of earlier researchers, it is helpful to review briefly the regulatory supervision process.

Bank Supervision and Examination

Supervision refers to the oversight of banking organizations and their activities to ensure that they are operated in a safe and sound manner. Examination is a means by which supervisors obtain information on the financial condition of an institution (Benston et al. [1986]). Examination is an important part of the supervisory process. Through periodic examinations and continuous supervision, regulators try to prevent deposit institutions from taking excessive risks that could lead them to economic insolvency.

The supervision and examination of depository institutions are performed by one or more of the following institutions: The Federal Reserve System, state and federal chartering agencies, and federal deposit-insurance agencies. The Office of the Comptroller of Currency (OCC) and the Federal Home Loan Bank Board (FHLBB, now the Office of Thrift Supervision) charter national banks and savings and loan institutions, respectively. State

TABLE 3

A Summary of Selected Empirical Studies on Deposit-Institution Failures

Author	Institutions and Time Period	Estimation Technique	Dependent Variable	Ratio[a]
Sinkey (1975)	110 Problem 110 Nonproblem Commercial Banks (1969-1972)	Discriminant Analysis	Problem/ Nonproblem	Over 100 are tested, 10 are chosen, 6 are significant.
Altman (1977)	56 Serious Problem/49 Temporary Problem/107 No Problem Savings and Loans (1966-1973)	Discriminant Analysis	Serious Problem/ Temporary Problem/ No Problem	32/7
Martin (1977)	58 Closed/ 5,642 Nonclosed Commercial Banks (1970-1976)	Logit	Closed/ Nonclosed	25/4
Avery and Hanweck (1984)	100 Closed/ 1,190 Nonclosed Commercial Banks (12/1978–6/1983)	Logit	Closed/ Nonclosed	9/7[b]
Barth et al. (1985)	318 Closed/ 588 Nonclosed Savings and Loans (12/1981–6/1984)	Logit	Closed/ Nonclosed	12/5
Benston (1985)	178 Closed/ 712 Nonclosed Savings and Loans (1981-1985)	Logit	Closed/ Nonclosed	28/4
Gajewski (1988)	134 Closed/ 2,747 Nonclosed Commercial Banks (1984-1986)	Two-Step Logit	Closed/ Nonclosed	25/10

a. The ratio of the total number of independent variables screened to significant independent variables.
b. Two are significant but have unexpected signs.
NOTE: Significant independent variable definitions are given in table 4.
SOURCE: See text.

banking commissions charter institutions with state charters. The deposit insurance agency for banks is the Federal Deposit Insurance Corporation (FDIC) and for savings and loan institutions it is the Federal Savings and Loan Insurance Corporation (FSLIC), now changed to the Savings Association Insurance Fund by the 1989 Financial Institutions Reform, Recovery, and Enforcement (FIRRE) Act.

The 1989 FIRRE Act restructures the savings and loan industry. Under the new law, what was formerly the Federal Home Loan Bank Board is

divided into three parts: the Office of Thrift Supervision (OTS), the Savings Association Insurance Fund (SAIF), and the Federal Housing Finance Board. The Office of Thrift Supervision is responsible for the examination and supervision of savings and loans, and has the powers formerly vested in the FHLBB. The Savings Association Insurance Fund takes the place of FSLIC.

In addition, a new Bank Insurance Fund is created. Both the Savings Association Insurance Fund and the Bank Insurance Fund are FDIC agencies. The obligations issued by either fund are backed by the full faith and credit of the United States. A five-member Federal Housing Finance Board is established to oversee credit allocation by the 12 district Home Loan Banks to members in the form of advances. The five members are the secretary of the Department of Housing and Urban Development and four others appointed by the president with the advice and consent of the U.S. Senate. In addition, a new agency, the Resolution Trust Corporation (RTC), is created to oversee the liquidation of assets from insolvent thrifts.[8] The FDIC is the day-to-day manager of the RTC. The new law restructures the financial institution industry, dismantles the independent Federal Home Loan Bank System, and gives the FDIC expanded powers.

Besides expanding the FDIC's regulatory turf and power, the new law does not substantially alter commercial bank supervision. National banks may be supervised by the Federal Reserve Board, the OCC, and the FDIC. However, unless the banks require assistance from the FDIC or the Federal Reserve, only the OCC supervises national banks. State-chartered banks are examined and supervised by the Federal Reserve if they are members of the Federal Reserve System, and by the FDIC if they are nonmembers. State-chartered banks can also be examined by their state banking supervisors, with or without the federal examiners.

The Federal Reserve is also responsible for regulating, supervising, and inspecting bank holding companies. Additionally, the states can regulate and supervise holding companies. Federally chartered savings and loan institutions are examined and supervised by the FHLBB (now by the OTS). State-chartered savings and loan institutions are examined and supervised by their state examiners and the FSLIC (now by the SAIF).

Federal examining efforts for banks are coordinated in such a way that an institution is visited by only one examination team from either the Federal Reserve, the OCC, or the FDIC. Federal and state examiners also coordinate their examination schedules and make an effort to conduct joint examinations. If the examinations are conducted separately, federal and state examiners share information by sending each other copies of their examination reports.

Regulators use on-site and off-site methods in order to obtain information about the economic condition of the institutions.

Traditionally, regulators have focused their monitoring efforts on sending teams of field examiners to conduct on-site examinations of each institution. On-site examinations are still heavily relied upon in regulatory monitoring efforts. States require exams every 12 to 18 months for their state-chartered institutions. In theory, sound national banks with assets of $300 million and above are supposed to be examined every 12 months; smaller banks are examined every 18 months. However, in practice, these schedules are often not met, and federal regulators tend to concentrate on large institutions, those showing problems on their call reports, and those with low ratings on past examinations, in deciding how to allocate the limited time of their examiners.

Principles and standards for federal examinations are coordinated by the Federal Financial Institutions Examination Council (FFIEC). This council was established by the Financial Institution and Interest Rate Control Act of 1978. It coordinates the activities of five regulatory agencies: the Federal Reserve, the OCC, the FDIC, the FHLBB (OTS), and the National Credit Union Administration, which charters and regulates national credit unions. Efforts of the FFIEC are directed toward making the field examinations conducted by different agencies similar in scope.

Examiners focus mainly on the adequacy or inadequacy of the firm's capital account for meeting the particular forms of risk exposure. Traditionally, they have devoted their attention to risks from nonperforming and questionable loans and from problems rooted in incompetent management (Kane [1985] and Benston et al. [1986]). The documentation, collateral, and payment records of most large loans and a sample of small loans are examined, and the loans are classified into good, substandard, doubtful, and loss categories. The institution's internal control system and managerial practices are reviewed and evaluated. The examiners discuss their findings with management and may recommend changes in management practices to improve the

■ **8** See Kane (1989) for an analysis of the savings and loan crisis.

institution's performance, and increases in capital to strengthen the institution's balance sheet.

After the on-site examination, federal examiners prepare a formal report pointing out strengths and weaknesses in the firm's operation. This report is further summarized into a five-point CAMEL rating. CAMEL is an acronym for five categories of condition and performance on which the institutions are graded: capital adequacy, asset quality, management, earnings, and liquidity.

Capital adequacy is a measure of an institution's buffer against future unanticipated losses. As explained in section I, in the case of financial institutions, the market value of enterprise-contributed equity is the appropriate indicator of capital adequacy. However, regulators tend to focus on the book value of an institution's equity.

As previously mentioned, in evaluating an institution's asset portfolio, examiners focus on loan quality. Examiners go through loan documentation and check the quality of collateral, if any, backing each loan. Judgments are made as to the quality of each borrower and his ability to repay the loan. In addition, examiners check to see if the institution has a high concentration of loans to a specific industry or to a single borrower.

The determination of an institution's management quality is very subjective. Typically, examiners decide on the competence of management based on the institution's performance in the other four categories.

Examiners rate the earnings of an institution on both recent performance and on the historical stability of its earnings stream. Performance and stability are determined by looking at the institution's profit composition. Examiners try to see if the profits come from a solid operating base or are driven by one-time gains, such as those generated by the sale of assets (Whalen and Thomson [1988]).

Liquidity of the institution is analyzed to determine its exposure to liquidity risk. To determine the institution's ability to meet unanticipated deposit outflows, examiners look at the bank's funding sources as well as the liquidity of its assets.

Since troubled institutions often try to hide their problems from the public and the regulators, it is difficult for examiners to detect problems by looking at the institution's accounts and financial statements. On-site examinations are the most effective way of detecting fraud. As studies by Sinkey (1975, 1979) indicate, quality of management and honesty of employees are the most important factors leading to bank failures. However, examiners were not specifically asked to examine for fraud until 1984. The U.S. House of Representatives Subcommittee on Commerce, Consumer, and Monetary Affairs of the Committee on Government Operations (1984) conducted a study of 105 bank and savings and loan failures between January 1980 and June 1983 and found that "...criminal activity by insiders was a major contributing factor in roughly one-half of the bank failures and one-quarter of the savings and loan failures...." The committee subsequently recommended that federal examiners be trained and advised to specifically examine for fraud.

The component ratings of CAMEL categories are subjectively weighed by the examiner to arrive at an overall rating for the institution. A bank's rating depends on the examining regulatory agency and the examination staff, since subjective judgments are made in obtaining the CAMEL rating (Whalen and Thomson [1988]). The CAMEL system grades an institution on a five-point scale. Institutions with ratings of 4 or 5 are considered "problem institutions." The FDIC publishes a list of problem banks, but the FSLIC does not publicize its parallel list of problem savings and loan institutions. Problem institutions are examined more frequently and monitored more closely.

The CAMEL rating is used by the federal examiners. State examiners conduct similar examinations, but they do not necessarily use the CAMEL system. Federal and state examiners disclose their overall rating to the institution's board of directors.

Regulators also use off-site monitoring to complement on-site examinations. Off-site monitoring focuses mainly on analyzing quarterly income and balance sheet statements obtained from Reports of Income and Condition (that is, call reports) filed with the regulatory agencies.

Statistical early-warning models have been available to supervisory agencies since the mid-1970s. These models were developed to evaluate the financial condition of institutions in order to determine the priority or urgency for on-site examinations. To a limited extent, off-site analysis also looks at market data (such as growth rates, deposit interest rates, and stock prices), public disclosures, and credit ratings assigned by private analysts.

Examiners seek to uncover regulatory violations and to identify problem institutions before their condition deteriorates to the extent that the deposit insurance fund is endangered. However, in addition to their inadequate emphasis on fraud

TABLE 4

Definition of Independent Variables Found Significant in Summarized Empirical Studies

Author	Variable	Definition
Sinkey (1975)	*LRTR*	Loan Revenue/Total Revenue
	OETR	Other Expenses/Total Revenue
	OEOI	Operating Expense/Operating Income
	LCR	Loans/(Capital + Reserves)
	SLRTR	Revenue from State and Local Obligations/Total Revenue
	LA	Loans/Assets
Altman (1977)	*NWTA*	Net Worth/Total Assets
	NOIGOI	Net Operating Income/Gross Operating Income
	RETA	Real Estate Owned/Total Assets
	ESTA	Earned Surplus/Total Assets
	TLTS	Total Loans/Total Savings
	HLBANW	FHLB Advances/Net Worth
	SRETA	Real Estate Owned (SI)/ Total Assets
Martin (1977)	*GCARA*	Gross Capital/Adjusted Risk Assets
	NITA	Net Income/(Total Assets-Cash Items in Process)
	CI2LN	(Commercial and Industrial Loans + Loans to REITs and Mortgage Bankers + Construction Loans + Commercial Real Estate Loans)/Total Assets
	GCONI	Gross Charge-offs/(Net Operating Income + Loss Provision)
Avery and Hanweck (1984)	*LNTA*	Natural Logarithm of Total Bank Assets Less Loan Loss Reserves (TA)
	NLTA	Net Loans/Total Assets
	KTA	(Equity Capital + Loan Loss Reserve Allowances)/TA
	CILNNL	Commercial and Industrial Loans/Net Loans
	NITA	Net After-Tax Income/TA
	HERF	Herfindahl Index for Bank's Local Banking Market[a]
	PTD	Semiannual Percentage Change in Total Deposits within Each Bank's Local Banking Market

risk, examiners are typically slow in identifying and evaluating new types of risks as they emerge. The exposure of institutions to interest volatility risk, foreign exchange risk, sovereign risk, and technology risk is still not explicitly priced.[9]

The recent risk-based capital adequacy guidelines established by the Federal Reserve System seek to explicitly price different categories of risk. The guideline is based on a regulatory measure of capital. Capital adequacy is determined by different capital requirement weights attached to assets that fall into broad risk categories. By the end of 1992, institutions are expected to meet a minimum ratio of qualifying total capital to weighted-risk assets of 8 percent.

The risk-based capital ratio focuses on broad categories of credit risk and limited instances of interest-volatility risk. However, it does not incorporate other risk factors mentioned above. Most important, "qualifying capital" is not defined in objective economic terms, that is, as enterprise-contributed capital.

Helping regulators perform the task of uncovering financially troubled institutions is the original motivation of the literature on deposit-institution failures. The next two subsections discuss different approaches taken by earlier empirical researchers.

Choice of Independent Variables

The first group of studies tries to develop early warning systems that are capable of mimicking the regulator's evaluation process. The hypothesis of these empirical studies is that appropriately selected financial ratios designed to measure CAMEL's five categories of information should be able statistically to discriminate between problem and nonproblem institutions. According to the definition of failure featured in this article, these studies do not deserve to be called failure studies because they analyze only the financial condition of the institutions. Moreover, their evaluation of this financial condition is accurate only to the extent that book values reported by an institution approximate market values.

The second group of researchers has a more ambitious goal. Instead of merely analyzing an institution's financial condition, these researchers

■ **9** For definitions of these risk categories and a discussion of how they should be priced, see Benston et al. (1986) and Kane (1985,1989).

TABLE 4 cont.

Definition of Independent Variables Found Significant in Summarized Empirical Studies

Author	Variable	Definition
Barth et al. (1985)	*NWTA*	Total RAP[b] Net Worth/Total Assets
	NITA	Net Income/Total Assets
	ISFTF	Interest Sensitive Funds/ Total Funds
	LATA	Liquid Assets/Total Assets
	LNTA	Natural Logarithm of Total Assets
Benston (1985)	*NWTA*	Net Worth/Total Assets
	RETTA	Net Income/Total Assets
	YLDEAC	Change in Interest and Fee Income/Earning Assets
	COSTFDC	Change in Interest and Depositors' Dividends/Earning Assets
Gajewski (1988)	*PKTAHAT*	Regulator-Recognized Capital/Assets
	NALR	Nonaccrual Loans/Total Assets
	LPDR	Loans Past-Due 90 Days or More, Still Accruing Interest/Total Assets
	NLTA	Net Loans/Total Assets
	SENSDTD	Sensitive Deposits/Total Deposits
	AGTOTTL	Total Agricultural Loans/ Total Loans
	CILTL	Commercial and Industrial Loans/ Total Loans
	NITA	Net Income/Total Assets
	HCN	Corporate Structure[c]
	OGINR82	County-Level Oil and Gas Sector Earnings/Total County Earnings, 1982

a. Herfindahl index is the sum of squares of market shares for banking organizations.
b. RAP stands for regulatory accounting principles. It is a more lenient set of accounting principles than the generally accepted accounting principles (GAAP). Under RAP, institutions have a higher book net-worth than under GAAP.
c. Corporate structure variable equals zero if the bank is independent or a one-bank holding company; it equals the number of banks in the multibank holding company if a subsidiary.
SOURCE: See text.

set out to explain why it fails. However, although they acknowledge the conceptual distinction between economic insolvency and failure (Avery and Hanweck [1984], Barth et al. [1985], Benston [1985], implicitly; and Gajewski [1988], explicitly), their models contain the same financial ratios used in the first group of studies.

Independent variables used in both groups of studies are intended to proxy different dimensions of the CAMEL rating system. Authors typically start out with either a large number of financial ratios that cover all the CAMEL categories, or selected financial ratios that were found to be significant in earlier studies. Independent variables found to be significant in the reviewed studies are summarized in table 4.

Interpretations of some financial ratios vary across different studies. When the same ratios are interpreted differently and classified under separate categories by different authors, this is noted and discussed. Authors' classifications of significant independent variables into CAMEL categories are given in table 5.

Choice of Statistical Methods

Statistical techniques used in these studies also differ. Earlier research used multiple discriminant analysis (MDA), while more recent researchers prefer qualitative response models (QRM).[10]

Although discriminant analysis (DA) and qualitative response (QR) models can be used interchangeably, the motivations behind the two models are quite different. What distinguishes a DA model from the ordinary QR model is that a DA model specifies a joint distribution of dependent (y_i) and independent (x_i) variables, not just the conditional distribution of y_i given x_i. In econometric QR models, the determination of x_i (bank characteristics) clearly precedes that of y_i (failure); therefore, it is important to specify $P(y = 1 \mid X)$, while the specification of the distribution of X may be ignored. On the contrary, in the DA model, the statement $y = 1$ (for example, being a problem bank) logically precedes the determination of X (problem-bank characteristics); therefore, it is more natural to specify the joint distribution of X and y (Amemiya [1981]).

In simple terms, DA is merely a classification technique, while QR models analyze a causal relationship. Because problem and nonproblem banks do not come from different groups, but the banks become problem banks through time, QR models are intuitively more appealing in our case. In other words, it is more natural to think of problem banks being assigned to the problem list because of their characteristics than vice versa.

In addition, QR estimators have desirable statistical properties. The discriminant analysis

■ **10** See Amemiya (1981) for a discussion of these two techniques. Judge et al. (1985), Chapter 18 contains a thorough discussion of qualitative response models.

TABLE 5

Significant Independent Variables Classified into CAMEL Categories

Variables	Sinkey (1975)	Altman (1977)	Martin (1977)	Avery and Hanweck (1984)	Barth et al. (1985)	Benston (1985)	Gajewski (1988)
Capital Adequacy	*LCR*	*NWTA* *HLBANW* *ESTA*	*GCARA*	*KTA* *LNTA*	*NWTA*	*NWTA*	*PKTAHAT*
Asset Quality	*LRTR* *LA*	*RETA* *SRETA* *TLTS*	*GCONI* *CI2LN*	*NLTA* *CILNNL*			*NALR* *LPDR*
Management Competence	*OEOI* *OETR*						*NLTA* *SENSDTD* *AGTOTTL* *CILTL*
Earnings	*SLRTR*	*NOIGOI*	*NITA*	*NITA* *HERF* *PTD*	*NITA* *ISFTF*	*RETTA* *YLDEAC* *COSTFDC*	*NITA* *OGINR82*
Liquidity					*LATA* *LNTA*		
Fraud							*HCN*

SOURCE: See text.

estimator is the *ML* estimator when X is multivariate normal. However, DA is not consistent when this assumption is violated. Still, studies analyzing robustness of discriminant analysis to non-normality report good performance by DA. QR models are not affected by the distribution of X. Properties of the two estimators are further discussed in Amemiya (1981).

Keeping in mind the underlying difference between the two models, DA might be useful if a dichotomous classification is the goal. On the other hand, QR models should be preferred when the model, the estimation of the coefficients of the independent variables, and thus the determination of the probability of the occurrence of the event, is important.

Review of Prior Empirical Literature

Sinkey's (1975) problem-bank study is one of the earliest on this topic. He uses linear multiple discriminant analysis (MDA) to evaluate data on 220 problem and nonproblem commercial banks for the period 1969-1972. Half of his sample consists of commercial banks that were listed as problem banks by the FDIC in 1972 and early 1973. Each problem bank is matched with a nonproblem bank based on the following characteristics: (1) geographic market area, (2) total deposits, (3) number of banking offices, and (4) Federal Reserve membership status. The sample contains mostly small banks (total deposits less than $100 million).

After testing more than 100 ratios designed to cover all CAMEL categories, 10 financial variables are chosen. Among these, six significantly increase the overall discriminatory power of the model in a stepwise analysis. In table 4, these variables are ranked in decreasing contribution to discriminatory power. The loan revenue variable (*LRTR*), which is an indicator of asset quality, proves to be the best discriminator.

Sinkey interprets most of the variables in his study as proxies for management quality and honesty, including two operating efficiency variables (*OEOI, OETR*). The loan-to-capital ratio (*LCR*) is taken as a measure of adequate bank capital. Sinkey concludes that although the differences in the means of these variables are statistically significant, the classification accuracy of

the model is low due to group overlap among the problem and nonproblem banks.

Altman (1977) also uses multiple discriminant analysis to analyze three groups of troubled savings and loan institutions. Improving on Sinkey's (1975) study, he tests and rejects the equality of group dispersion-matrices, and therefore uses a quadratic structure. He examines data on 212 savings and loan associations during the period 1966-1973. Of these institutions, 56 are classified as having serious problems, 49 as having temporary problems, and 107 as having no problems. His definition of "serious problem" closely matches the definition of failure in this paper. He defines "temporary problem" institutions as those with problems similar to the ones in the serious problem group, but that have avoided regulatory interference.

Finally, the "no problem" group serves as the control group. It consists of institutions that did not show any indication of financial problems on the failure date of the serious-problem group, or thereafter. The range of asset size in all three samples is from $1 million to $100 million.

Altman tests 32 financial ratios that cover all CAMEL categories. His best predictor model includes only seven variables, listed in table 4. Altman concludes that operating income (*NOIGOI*) and its trend are the most important discriminators. He also finds net worth (*NWTA*) and real estate owned (*RETA*) variables to be important. He interprets these variables as reflecting an institution's profitability, capital adequacy, and asset quality.

Martin (1977) is the first author to use a logit probability model to evaluate commercial-bank failures. He analyzes data covering all commercial banks that were members of the Federal Reserve System between 1970 and 1976. In addition to closures, his failure definition includes banks whose net worth "...declined drastically over a year or less." Therefore, his analysis focuses on certain kinds of insolvency and not just on failure.

Martin's work represents the transition between the first and second group of studies. He analyzes an institution's probability of becoming insolvent in a book-value sense before analyzing the group characteristics. The second group of studies takes this analysis one step further to explain the closure process rather than merely to approximate an early-warning system.

Martin obtains his best results using 1974 data on 23 failed and 5,575 nonfailed commercial banks. He analyzes 25 ratios chosen for their usefulness in previous studies. The preferred model includes only four variables. These variables measure earnings (*NITA*), loan quality (*CI2LN, GCONI*), and capital (*GCARA*).

Avery and Hanweck (1984) study commercial bank closures using semiannual data for 100 closed and 1,190 nonclosed commercial banks during the period December 1978 to June 1983. Their sample includes only institutions with assets of $250 million or less. Although closure is acknowledged to be a regulatory decision, it is analyzed using only nine financial ratios, chosen because previous authors found them significant. They assume that the probability of closure depends on a distributed lag of the financial condition of the institution and estimate a logit probability model. Five financial-ratio coefficients prove significant and receive signs expected a priori. These ratios incorporate elements of earnings (*NITA*), asset quality (*NLTA, CILNNL*) and capital adequacy (*KTA, LNTA*).

Avery and Hanweck interpret bank size (*LNTA*) as an indicator of ability to raise new capital. Observing the reluctance of regulators to fail large banks, they state that larger institutions may raise capital more easily since it may be assumed that they are managed better and able to turn around faltering situations quickly. Local banking market variables (*HERF, PTD*) are also significant, but receive unexpected signs. Their most puzzling result is a counterintuitive sign for lagged financial-condition variables. They conclude that lagged financial ratios are not important in explaining bank closures.

Barth et al. (1985) study thrift institution closures using a logit probability model. They use semiannual data for 318 closed and 588 nonclosed savings and loan associations covering the period December 1981 to June 1984. They also mention that closure is a decision made by the regulators. Again, however, only 12 financial ratios similar to the ones used in earlier studies are analyzed. Five of these variables receive their expected signs and prove statistically significant. These measure capital adequacy (*NWTA*), asset quality (*ISFTF*), earnings (*NITA*), and liquidity (*LNTA, LATA*). They interpret size (*LNTA*) as an indicator of greater liquidity, since they believe larger institutions have a greater ability to borrow in order to alleviate unexpected liquidity problems. A possible alternative interpretation is that this variable captures the reluctance of regulators to liquidate large institutions (Conover [1984], Seidman [1986]).

Benston (1985) conducts a logit analysis of 178 closed and 712 nonclosed savings and loans for the period 1981-1985. Among the 28 financial ratios he includes, only four prove statistically significant. These are measures of capital adequacy (*NWTA*) and earnings (*RETTA, YLDEAC,* and *COSTFDC*).

Gajewski (1988) studies commercial-bank closures by analyzing a 1986 cross-sectional data set of 134 closed and 2,747 nonclosed banks. Emphasizing the need to differentiate between insolvency and failure, Gajewski is the first author to incorporate this distinction into his modeling. His model has two equations. The first mimics the regulatory screening process, in the spirit of an early-warning model. The second studies the closure process. Although Gajewski recognizes the importance of the regulatory decision-making process in explaining bank closures, his two equations differ only in their endogenous variables—book-value insolvency and closure. He analyzes both insolvency and closure using only financial ratios and county characteristics.

Characteristics of the bank's local economy are represented by the percentage of county-level oil and agricultural earnings to total county earnings. A total of 25 financial ratios covering CAMEL categories are chosen to study the financial condition and closure of the institutions.

The final specification of the logit probability model develops 10 significant variables, listed in table 4. These include measures of capital adequacy (*PKTAHAT*) obtained from the first equation, asset quality (*NALR, LPDR*), management competence (*NLTA, SENSDTD, CILTL, AGTOTTL*), earnings (*NITA, OGINR*82), and fraud (*HCN*). What Gajewski interprets as management-competence variables are interpreted as asset-quality variables by earlier authors.

Relative Importance of Different CAMEL Categories

Although cited studies analyze the relative discriminatory power of different CAMEL categories, it is difficult to compare the findings of one study against another, due to differences in data sets, proxies, and interpretations. Nevertheless, all authors find capital adequacy (*C*), generally proxied by the book value of net worth, to be significant. In addition, earnings (*E*), usually a measure of net income, are a significant indicator of financial condition.

After capital adequacy and earnings, asset quality (*A*), as proxied by various loan ratios, is found to be a significant indicator of financial trouble by most authors. Fraud and management competence (*M*) prove to be difficult categories to proxy. Instead of explicitly representing them by financial ratios, most authors prefer to consider the set of included variables as incorporating implicitly the effects of management and fraud. With the exception of the study by Barth et al., liquidity (*L*) is not found to be a significantly important category.

III. Possibilities for Improving the Empirical Analyis of Deposit-Institution Failures

The literature on deposit-institution failures still leaves much room for improvement. The first group of studies seeks to discriminate between problem/nonproblem and closed/nonclosed institutions using only financial ratios. The choice of candidate regressors in the accounting-ratio models lacks a compelling theoretical foundation. Financial ratios are simply utilized in various statistical procedures until they "work." The second group of studies seeks to explain failure using only instrumental variables borrowed from accounting-ratio models. These studies fail to distinguish successfully between insolvency and failure in their modeling and have little theoretical underpinning.

In studying the failure of financial institutions, it is crucial to make a distinction between economic insolvency and failure. As discussed in section I, economic insolvency is a market-determined event. In contrast, the decision to fail an institution requires that a state commission or federal agency realize, often under the urging of the deposit-insurance agency involved, that a natural propensity to forbear is no longer in its bureaucratic interest (Kane [1985]).

Failure is a regulatory decision, influenced by conflicts of interest that exist between regulators, politicians, and taxpayers. These conflicts of interest allow political, bureaucratic, and economic pressures, and career-oriented incentives of the regulators, to shape failure decisions. Therefore, economic insolvency and failure of financial institutions should be distinguished but studied simultaneously.

Furthermore, failure should be modeled formally as the outcome of a regulatory decision-making process, explicitly taking into consideration regulators' constraints and conflicts of interest.

In studying economic insolvency of financial institutions, the appropriate measure is the market value of enterprise-contributed capital. Assuming an efficient stock market, the market value of enterprise-contributed capital summarizes the institution's financial condition, freeing the researcher of the dilemma of picking and choosing the "right" financial ratios among many possibilities. Also, if one uses financial ratios calculated from balance sheets and income state-

ments, the implicit assumption is that book values adequately proxy market values.

Adopting the market value of enterprise-contributed equity as the measure of economic solvency and analyzing failure within a theoretical model of regulatory decision-making brings a much-needed structure to the choice of independent variables, establishing a theoretical basis for the empirical research on deposit-institution failures.

Most studies of problem and failed banks concentrate on small-bank failures. They include few, if any, large banks in their samples. However, recent increases in large-bank insolvencies indicate the importance of developing a model of large-bank failures.

Developing a large-bank failure model has the further advantage of allowing us to use stock-market data. In addition, as Kaufman (1985) states, consequences of insolvency and failure of large banks are blown out of proportion by the regulators. Regulators publicly show a fear of large-bank failures, ostensibly because of the possible repercussions on the banking system and on economic policy. At the time of the Continental Illinois National Bank crisis, Comptroller of the Currency C. T. Conover (1984), in defense of his rescue of the bank, argued:

> In our collective judgement (directors of the FDIC, the chairman of the Federal Reserve Board, and the Secretary of the Treasury), had Continental failed and been treated in a way in which depositors and creditors were not made whole, we could very well have seen a national, if not an international, financial crisis the dimensions of which were difficult to imagine. None of us wanted to find out.

What leads to forbearance policies and inefficient insolvency resolution methods, however, is not necessarily these vague and poorly documented consequences, but the hidden fears of what particularly visible large-bank failures can do to the perceptions of the quality of regulators' performance in office (Kane [1989]).[11] Thus, one would expect the political and bureaucratic constraints of the regulators to be especially binding when their decision to fail concerns a large bank.

Demirgüç-Kunt (1990, forthcoming) addresses the above issues.[12] It is a study of large commercial-bank failures for the period 1973-1989. Annual panel data are used in estimation. The failure model developed distinguishes between economic insolvency and failure, studying them simultaneously. An estimate of the market value of enterprise-contributed equity is taken as the measure of economic insolvency. Failure determination is based on a theoretical model of failure decision-making in the spirit of the Kane model. The theoretical model identifies and explicitly incorporates important regulator constraints and incentives. In the empirical model, the FDIC's number of examiners and size of the insurance fund are proxies for economic constraints, whereas failure rate (for banks and businesses), number of problem banks, variance of interest rates, and bank size are included to proxy political and bureaucratic constraints implicit in the career-oriented incentives of regulators.

As expected, results indicate that regulator constraint and incentives play a significant role in failure determination. The empirical model of bank failures developed in Demirgüç-Kunt (forthcoming) is more complete because it takes into consideration a previously ignored determinant of the decision-making process and brings theoretical structure to the empirical deposit-institution failure literature.

One possibility for future research in this area of deposit-institution failures is to investigate changes in regulatory decision-making through the years. Periodic restructuring of the financial system (most recently by the 1989 FIRRE Act) leads to shifts of power among different regulatory bodies and may affect failure decisions. It is also important to take into consideration differences among various insolvency resolution methods, that is, different categories of de facto failure (Maddala [1986]).[13] Development of a failure model that distinguishes between different methods of insolvency resolution is the next challenging task facing economists.

■ **11** A discussion of these policies can be found in Kane (1985, 1989), Benston et al. (1986), and Caliguire and Thomson (1987).

■ **12** See Demirgüç-Kunt (1989) for a preliminary version of the study and empirical results. The theoretical model is fully developed in Demirgüç-Kunt (1990, forthcoming).

■ **13** For a discussion, see references in footnote 11.

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Settlement Delays and Stock Prices

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Introduction

The typical stockbroker requires only about two minutes to execute and confirm a market order. During that time, the order is routed electronically either to the specialist or to the Intermarket Trading System, which connects eight regional markets including the New York Stock Exchange and the National Association of Securities Dealers. These agents then pair the order with another buy or sell order.[1] Thanks to modern technology, the process of executing a trade and producing a confirmed order is quick and efficient.

Although this confirmed order represents a binding contract between the buyer and seller, neither the security nor payment for the security changes hands at the time the trade is confirmed. Instead, payment for the stock occurs five business days later, when the buyer delivers a bank check to the seller and the seller delivers the promised securities.[2] Until final payment is made, the stock trade remains conditional, and official title remains with the seller, who cannot use the proceeds of the sale.

The equity markets have no provision to compensate the seller for the opportunity cost he bears while waiting for the trade to clear. In contrast, bond-market procedures call for explicit adjustment of the cost of the bond for interest accrued since the most recent coupon date. Interest is calculated using the number of days from the last coupon payment until the date of delivery, not the date of the trade. If the terms of the trade call for delivery tomorrow instead of today, the buyer must pay an extra day's worth of interest. Another important market, residential real estate, while not explicitly adjusting the purchase price for the date of closing, does prorate taxes and rents for the date of occupancy.

Although the stock markets make no explicit adjustment for the opportunity cost of settlement delays, rational investors do not ignore the fact that they lose several days' worth of interest. Indeed, much empirical work has assumed that investors consider delivery procedures in pricing assets, although few studies have tested this theory.

This paper studies whether investors do, in fact, consider settlement delays in determining stock prices. We construct two models of stock

■ **1** For a further discussion of trading details, see Jakus and Chandy (1989).

■ **2** In practice, these transactions usually are executed by brokers acting as agents.

returns. The first expresses returns as a function of changes in the settlement delay. The second models returns as a function of changes in the length of the delay and in the federal funds rates during the delay. The first model controls for variation in the length of the delay, while the second controls for both the opportunity cost and the length of the delay. We then conduct regression tests of the significance of these variables. Both models show that in the full sample and all subperiods, investors apparently do consider the settlement delay; the variables controlling for it are statistically significant and correctly signed.

Section I reviews previous research regarding payment delays, and section II develops our model of the return-generating process. In section III we describe the data, conduct preliminary tests, and report the results. A summary concludes the paper.

I. Previous Research and the Impact of Delivery Procedures

Lakonishok and Levi (1982) speculate that settlement and check-clearing delays might explain the "weekend effect" in stock prices. The weekend effect refers to the well-documented tendency of stock prices to decline on Monday.[3] Lakonishok and Levi note that, in addition to the settlement delay, the check presented at settlement requires another business day to clear. They claim this makes the total payment delay six business days. For their empirical work, they add and subtract interest based on the prime rate, but, more important for our purposes, they conduct no tests to determine if buyers actually do compensate sellers in the manner they suggest.

DeGennaro (1990, forthcoming) tests the conjecture that the combined settlement and check-clearing delays explain the weekend effect. He concludes that, while the combined delay fails to explain the weekly return pattern, it does appear to influence measured stock returns. However, he also reports that the estimated rate of compensation for the combined delay varies substantially, suggesting that further work is necessary.

■ **3** The weekend effect was first identified by Cross (1973). An important paper by French (1980) reexamined this apparent anomaly, demonstrating that returns on Monday are so persistently negative that rational investors must expect to suffer losses on Mondays. Lakonishok and Smidt (1988) extend the evidence of negative Monday returns to a 90-year sample. Gibbons and Hess (1981) show that Treasury bills also earn below-average returns on Mondays, although returns are not negative for bills.

Another example is Choi and Strong (1983), who study "when-issued" common stock. Firms announce stock issues well in advance of the time the new securities are issued; investors trade these securities on a "when-issued" basis. Choi and Strong attempt to determine why this when-issued stock commands a premium over the corresponding stock that is currently outstanding. They speculate that when-issued stock represents the existing share plus a zero-interest loan. They find that adjusting prices for the interest savings is insufficient to explain the discrepancy, but again, they do not test to see if investors price the zero-interest loan.

More recently, Flannery and Protopapadakis (1988) assume that settlement and clearing delays are priced in their test of the generality of the weekend effect. They study three stock indexes and seven Treasury bond maturities to learn if intraweek seasonality is the same across these assets. Following the suggestion of Lakonishok and Levi, they adjust the returns on the 10 assets to control for the financing costs incurred during the payment delays. They find that the returns on these assets do not vary in a similar manner during the week, but again, the authors do not test if the delay is actually priced.

DeGennaro (1988) shows such payment delays can have important implications for interest rates. If delays exist in the Treasury bill market, but are not explicitly incorporated into pricing equations, certain common estimators of term premiums are biased in favor of finding positive premiums. He shows that this bias is sufficiently large to explain the results of McCulloch (1975). However, he does not test if investors do, indeed, consider these delays.

The results of the present paper are important for several reasons. First, if the delays have no impact on observed prices, then the aforementioned studies must be flawed: theoretical work begins with inappropriate assumptions, and empirical studies are misspecified. Second, if investors do consider settlement delays in determining equity prices, then observed prices diverge from true prices. This has implications for the event-study methodology commonly used in empirical tests (see, for example, Hite and Owers [1983]). To conduct an event study, the researcher first estimates the parameters of a model using time-series data prior to the event in question. He then calculates abnormal returns, defined as realized returns less the returns predicted by the model. Significance tests can be conducted using the cumulative sum of these residuals.

To date, all event studies known to the author have ignored the possibility that payment delays

may influence the measured stock price and return. If these delays do affect stock prices, events that may seem to be economically significant may in fact be negligible once proper accounting for the delays is made. Conversely, events judged to be insignificant may be important.

Consider, for example, an event that the researcher expects to generate positive returns, but which in fact does not. The total compensation for the settlement delay, capitalized in the observed price, may be higher than usual on the event date (due to a holiday that lengthens the delay, or perhaps simply to an increase in interest rates). This would make the observed price higher than usual, biasing the significance of test statistics. The reverse might also be true. The economic effect of an event may be positive and significant, but if the number of calendar days in the delay is lower than usual, or if the opportunity cost on a daily basis is less, then the impact of a true economic event might be negated and appear insignificant.

Other important results might also be affected. For example, French and Roll (1986) document a large decrease in volatility when markets are closed. The variance of stock returns from Friday's close to Monday's close is only about 10 or 15 percent higher than during a one-day holding period. If the opportunity cost of the settlement delay varies systematically—for example, if interest rates or the delay varies according to the day of the week—French and Roll's variance ratio measures both the true volatility and the variance in the opportunity cost. While this is unlikely to be sufficient to overturn their results, divergences from true prices are especially important in studies of variance, which is a particularly sensitive measure due to the squaring of deviations from the mean.

Perhaps the most important reason for studying whether delivery procedures are important and whether settlement delays are priced is their implication for market efficiency. If the settlement delay does not affect prices, then researchers must not only reinterpret research that presumes it does, but they must also explain why rational investors ignore the fact that the present value of the purchase price is reduced because of these delays.

The choice of delivery procedures may become an increasingly important policy issue for the securities industry. For example, the present five-day delivery terms trace to the inability of technology to handle heavy trading volume during the late 1960s. Prior to February 9, 1968, the settlement period was only four business days; extending it to five ensures that brokers have a weekend between the trade date and the delivery date to complete the necessary paperwork. Conceivably, further increases in volume could force another extension, while technological advances might permit a reduction.

A reduction in the time between the trade date and the delivery date may be important in preventing defaults on trades. For example, although the buyer and seller commit to trade at the confirmation of their order, large price changes create incentives for one side of the transaction to renege. For example, equity purchasers during the week of October 12, 1987, expected to receive stock worth a given amount; instead, they received stock worth about 20 percent less. Although the safeguards against such defaults proved adequate in this case, the increasing volatility of financial markets observed in recent years means larger losses can be sustained between the time of the trade and the date that the trade becomes final, increasing the likelihood that the buyer will default.

II. The Model

If investors consider delivery procedures in pricing stocks, then observed prices contain the true value of the underlying asset plus an adjustment for the settlement delay. Observed prices misstate true values. Since empirical work must use observed prices, we must devise a model that removes any adjustment the market incorporates for the delay. To do this, we first define the true stock price, P^*, as the price observed in the absence of delays. The expected true price at time t as a function of the true price at the beginning of the holding period (time $t-1$) is

$$(1) \quad E_{t-1}(P_t^*) = P_{t-1}^* \exp\,[E(R^*) - E_{t-1}(d_t)],$$

where E_{t-1} is the expectations operator conditioned on information available at time $t-1$, P_t^* is the unobservable true price at time t, $E(R^*)$ is the unobservable (constant) expected continuously compounded daily rate of return on the stock in the absence of delays, d_t is the dividend yield, and *exp* is the base for natural logarithms. Equation (1) states that if no dividends are expected to be paid, the expected price at t is the price at $t-1$ adjusted for the expected continuously compounded rate of price appreciation. If dividends are expected to be paid, the expected price is adjusted downward accordingly.

To incorporate the settlement delay, the observed price P is written as

$$(2) \quad P_t = P^*_t exp\left(\sum_{j=1}^{s_t} c_{jt}\right),$$

where s_t is the number of days in the settlement delay and c_{jt} is the continuously compounded rate of compensation on day j for trades made at t. If investors ignore delivery procedures, c equals zero and the true price equals the observed price. If sellers demand and receive compensation for the settlement delay, c is positive. In equation (2), $\sum_{j=1}^{s_t} c_{jt}$ represents the total compensation to the seller for financing the position until he receives the proceeds of the sale at settlement.

Equation (2) is also true at $t-1$, so

$$(3) \quad P_{t-1} = P^*_{t-1} exp\left(\sum_{j=1}^{s_{t-1}} c_{j(t-1)}\right).$$

Solving equations (2) and (3) for P^*, substituting into equation (1), and assuming that the P and c are uncorrelated, we can rearrange equation (1) to obtain

$$(4) \quad \log[E_{t-1}(P_t)/P_{t-1}] + E_{t-1}(d_t) = E(R^*) + \sum_{j=1}^{s_t} c_{jt} - \sum_{j=1}^{s_{t-1}} c_{j(t-1)}.$$

Letting c be constant and defining Δs_t as the change in s at time t, we obtain

$$(5) \quad E_{t-1}(R_t) = E(R^*) + c \times \Delta s_t,$$

where the total expected return on the stock—capital gains plus dividends—is written as R_t. Intuitively, equation (5) says the observed expected return equals the expected return in the absence of delays plus changes in the impact of delays.

To proxy for the dependent variable R_t, we use the return on the value-weighted portfolio, including dividends, provided by the Center for Research in Security Prices (CRSP). Although we have derived our model in terms of an individual stock, if the settlement delay affects any stock, it must affect all stocks. Further, this effect is not diversifiable: any settlement effects must appear in the observed return on a portfolio.

Substituting ex post values, we obtain our test equation:

$$(6) \quad R_t = b_0 + b_1 \Delta s_t + e_t.$$

In this model, b_0 estimates the unobservable expected continuously compounded daily rate of return on the stock in the absence of delays, and b_1 estimates c, the rate sellers receive as compensation for the settlement delay. Theory suggests that both coefficients should be positive. This is because risk-averse investors require a premium to compensate for the nondiversifiable risk contained in stocks, and increases in the financing costs during the settlement delay require buyers to raise their bids to compensate the sellers. Therefore, one-tailed tests are appropriate.

One potential problem with this specification is that Δs varies relatively little. To circumvent this, we also estimate a second specification. Rather than letting the settlement cost per day (c) be constant in equation (4), we use the federal funds rate as a proxy for c. The federal funds rate is both readily available and responsive to changes in the economic environment. Formally, we write

$$(7) \quad \gamma f_{jt} = c_{jt},$$

where f_{jt} is the federal funds rate on day j of the settlement delay for trades at t, and γ is a constant. For notational convenience, we define $\sum S_t$ as $\sum_{j=1}^{s_t} f_{jt}$, so that $\gamma \times \sum S_t = \sum_{j=1}^{s_t} c_{jt}$. Substituting $\sum S$ into equation (4) and combining terms yields

$$(8) \quad E_{t-1}(R_t) = E(R^*) + \gamma \times \Delta\Sigma S_t,$$

where $\Delta\Sigma S_t$ is the change in ΣS at t, and the total expected return on the stock is again written as R_t. Substituting ex post values, we obtain

$$(9) \quad R_t = b'_0 + b'_1 \Delta\Sigma S_t + e'_t.$$

As in equation (6), b'_0 estimates the unobservable expected continuously compounded daily rate of return on the stock in the absence of delays, but in this model, b'_1 estimates γ, the proportion of the federal funds rate sellers receive as compensation for the settlement delay. One-tailed tests are again appropriate.

Equation (9) offers both advantages and disadvantages relative to equation (6). In equation (9), the independent variable is a function of the federal funds rate, and therefore may be simultaneously determined with the stock return. However, it controls for both the length of the settlement delay and the opportunity cost during that delay rather than for simply the number of

TABLE 1

Regression Results

Equation (10), Full Sample

Estimates obtained by regressing the rate of return on the CRSP value-weighted index, including dividends (R_t), on the change in the settlement delay (Δs_t), corrected for heteroscedasticity:

$$(10) \quad R_t = b_0 + b_1 \Delta s_t + u_t,$$

$$u_t = e_t - \theta e_{t-1}.$$

Full sample period: January 1, 1970-December 31, 1986 (4,296 observations)

Variable	Parameter estimate (t-statistic)
b_0	4.68×10^{-4} (3.03)[a]
b_1	7.27×10^{-4} (4.07)[a]
θ	0.23 (15.5)[a]

a. Significant at the 1 percent level.
NOTE: Significance levels are for one-tailed tests on b_0 and b_1.
SOURCE: Author's computations.

days in the delay. It is also much more variable than Δs in equation (6).

Which economic or institutional forces could cause the slope coefficients in equations (6) and (9) to be not significantly different from zero? First, s_t is the *promised* settlement delay. Although the exchanges alter s_t only rarely, brokerage firms may not credit and debit accounts as accurately as the exchanges. For example, they may err and credit a customer's account later than promised. Such mistakes may not always be discovered. Even if the customer does detect the error, he must take the time to complain. Investors may, therefore, base compensation on the expected value of the delay rather than on the promised delay. If so, the independent variables in equations (6) and (9) are incorrect proxies for the true values, and the estimated coefficients could be insignificant.

In addition, some investors face different values of s_t because of the procedures of their agents. For example, some brokers debit accounts for purchases on the trade date, but credit accounts for purchases only on delivery. This asymmetric treatment permits the brokerage firm to use the funds between the two dates. The firm generates revenue by imposing an added cost of trading on its customers. If these investors are the marginal traders, neither Δs_t nor $\Delta \Sigma S_t$ measures the true cost of the delays these investors face. Again, the estimated slope coefficients could be insignificant.

III. Data and Results

Data

The stock-return measure is the return on the CRSP value-weighted index, with dividends. We use 4,296 observations from January 1, 1970, through December 31, 1986. Federal funds rates used to compute the opportunity cost of the settlement delay are from the Federal Reserve Board. We estimate equation (6) in the full sample and in three subperiods partitioned at October 6, 1979 and October 9, 1982, the dates of important changes in the Federal Reserve's operating procedures. On the former date, the central bank began focusing on the level of nonborrowed reserves rather than on the level of the federal funds rate. On the latter date, it began attempting to stabilize interest rates.

Preliminary Tests

The ordinary least squares residuals from equation (6) exhibit positive first-order serial correlation, while higher-order autocorrelations are small. This is consistent with the use of an index as the dependent variable and with the results of Scholes and Williams (1977). To see this intuitively, note that some securities composing the index do not trade at the closing bell. The most recent prices for these securities are "stale." If the market moves up or down since the last trade, these stale prices tend to move in the same direction when the securities subsequently do trade, inducing serial correlation at lag one. Therefore, we fit a first-order moving average to equation (6) and estimate

$$(10) \quad R_t = b_0 + b_1 \Delta s_t + u_t,$$

$$u_t = e_t - \theta e_{t-1}.$$

To formally investigate the possibility that the parameters in equation (10) may not be stable across subperiods, we conduct the test according to Chow (1960) for each subperiod partition. These tests show that both break points are

TABLE 2

Regression Results

Equation (10), Subperiods

Estimates obtained by regressing the rate of return on the CRSP value-weighted index, including dividends (R_t), on the change in the settlement delay (Δs_t), corrected for heteroscedasticity:

$$(10) \quad R_t = b_0 + b_1 \Delta s_t + u_t,$$

$$u_t = e_t - \theta e_{t-1}.$$

First sample period: January 1, 1970 - October 6, 1979 (2,467 observations)

Variable	Parameter estimate (t-statistic)
b_0	3.10×10^{-4} (1.47)[a]
b_1	7.20×10^{-4} (3.43)[b]
θ	0.31 (16.3)[b]

Second sample period: October 7, 1979 - October 8, 1982 (760 observations)

Variable	Parameter estimate (t-statistic)
b_0	5.60×10^{-4} (1.41)[a]
b_1	8.73×10^{-4} (1.76)[c]
θ	0.17 (4.86)[b]

Third sample period: October 9, 1982 - December 31, 1986 (1,069 observations)

Variable	Parameter estimate (t-statistic)
b_0	7.61×10^{-4} (2.92)[b]
b_1	5.98×10^{-4} (1.60)[a]
θ	0.10 (3.42)[b]

a. Significant at the 10 percent level.
b. Significant at the 1 percent level.
c. Significant at the 5 percent level.
NOTE: Significance levels are for one-tailed tests on b_0 and b_1.
SOURCE: Author's computations.

necessary. For the first partition, the F-value is 7.64, which exceeds the 1 percent critical value of 3.78. For the second, the F-value is 5.59, which again is significant at the 1 percent level. In addition, the test rejects the conjecture that the first and third subsamples can be combined.

Because of weekends and holidays, holding periods range from one to four days. Given the results of French and Roll (1986), we would expect heteroscedasticity to be present, depending on the holding period for the observations. This proves to be the case. In the full sample, for example, the F-ratio using the variance of the three-day holding period and the one-day holding period is 1.31, which exceeds the critical 1 percent value of 1.15. Similar results are found for both subperiods. Therefore, we weight observations by the inverse standard deviation of the residuals for the holding period in all reported results.

Results Using the Change in the Length of the Delay

Table 1 contains the results obtained by estimating equation (10) using the full sample. Given the results of the Chow tests reported above, these estimates must be interpreted with caution, but we report them for completeness. All parameters have their expected signs and are statistically significant. The intercept, which estimates the expected daily stock return in the absence of delays, implies an annual rate of about 11.80 percent. This is quite close to the actual realized value of 10.97 percent. The parameter b_1 estimates c, the rate of compensation for the settlement delay. This parameter is also significant, with a t-statistic of 4.07.

Table 2 contains the results from the subperiods, which are broadly consistent with the full sample. For the first subperiod, the intercept is positive and significant at the 10 percent level, and is almost exactly the correct magnitude. The estimated value of .000310 implies an annual rate of about 7.81 percent; the actual value was 7.13 percent. The estimate of b_1 is reliably different from zero, with a t-ratio of 3.43.

After the first change in Federal Reserve operating policy, the results are somewhat different. The intercept is still marginally significant and again about the correct size (it implies a daily rate of 14.10 percent versus the actual 12.08 percent). Despite being larger in magnitude, however, the significance of the slope coefficient is smaller. The t-ratio is 1.76. The larger standard error is consistent with the smaller sample size and with the increased volatility during this

TABLE 3

Regression Results

Equation (11), Full Sample

Estimates obtained by regressing the rate of return on the CRSP value-weighted index, including dividends (R_t), on the change in total return from an investment in federal funds during the settlement delay ($\Delta\Sigma S_t$), corrected for heteroscedasticity:

$$(11)\quad R_t = b_0' + b_1'\Delta\Sigma S_t + u_t',$$

$$u_t' = e_t' - \theta' e_{t-1}'.$$

Full sample period: January 1, 1970-December 31, 1986 (4,296 observations)

Variable	Parameter estimate (t-statistic)
b_0'	4.69×10^{-4} (3.03)[a]
b_1'	2.73 (4.02)[a]
θ'	0.23 (15.6)[a]

a. Significant at the 1 percent level.
NOTE: Significance levels are for one-tailed tests on b_0' and b_1'.
SOURCE: Author's computations.

period, when the Federal Reserve did not attempt to stabilize interest rates.

The third sample begins on October 9, 1982. The results of this subsample are similar to those of the second subsample. The estimate of b_0 implies a stock return of 19.17 percent; the actual value was 19.07 percent. The t-value of 2.92 is significant at the 1 percent level. The estimated slope coefficient is 0.000598, which differs from zero at the 10 percent level.

Results Using the Change in the Opportunity Cost During the Delay

The preliminary tests using equation (9) yield results similar to those of equation (6). Chow tests confirm that the subperiods are best estimated separately. Heteroscedasticity is again present, and a first-order moving average is required. We estimate

$$(11)\quad R_t = b_0' + b_1'\Delta\Sigma S_t + u_t',$$

$$u_t' = e_t' - \theta' e_{t-1}'.$$

For completeness, table 3 contains the results obtained by estimating equation (11) using the full sample. Again, all parameters have their expected signs and are statistically significant. The intercept, which estimates the expected daily stock return in the absence of delays, is very close to the value in table 1. The parameter b_1' estimates γ, the proportion of the federal funds rate that buyers receive as compensation for the settlement delay. This parameter is also significant, with a t-statistic of 4.02. The coefficient of 2.73 is also reliably different from unity. A t-ratio testing the hypothesis that the estimated value equals one is 2.55, which rejects the null hypothesis at the 1 percent level. Thus, we reject the conjecture that the rate of compensation is the federal funds rate. The federal funds rate is too low or too stable to serve as the rate of compensation.

Table 4 contains the estimates from the subperiods, which are again similar to those from equation (10). For the first subperiod, the intercept is the same size and is equally significant as in table 2. The estimate of the slope coefficient, b_1', is 3.80. As is the case for the full sample, this is reliably different both from zero and from unity. The t-ratios are 3.64 and 2.69, respectively.

After the first change in Federal Reserve operating policy, the intercept is still significant and again about the correct size, but the slope coefficient is much smaller. The estimated value is 1.84. This differs from zero at the 10 percent level, but unlike the case in the first subsample, it does not differ from unity. The t-statistic is only 0.71. We cannot reject the hypothesis that the rate of compensation for settlement delays equals the average realized federal funds rate during the sample.

The third sample begins on October 9, 1982. The results are similar to the second subsample and comparable to equation (10). The estimate of b_0' is significant and implies a stock return of 19.18 percent, compared to the actual value of 19.07 percent. The estimated slope coefficient, b_1', is 2.59, which differs from zero at the 5 percent level, but does not differ from unity. The t-statistic is only 1.03.

The results suggest that during the first sample, the Federal Reserve's intervention in the federal funds market prevented the federal funds rate from tracking market conditions as well as it did during periods when the Federal Reserve concentrated on other policy vehicles. When the federal

TABLE 4

Regression Results

Equation (11), Subperiods

Estimates obtained by regressing the rate of return on the CRSP value-weighted index, including dividends (R_t), on the change in total return from an investment in federal funds during the settlement delay ($\Delta\Sigma S_t$), corrected for heteroscedasticity:

$$(11)\quad R_t = b'_0 + b'_1\Delta\Sigma S_t + u'_t,$$

$$u'_t = e'_t - \theta' e'_{t-1}.$$

First sample period: January 1, 1970 - October 6, 1979 (2,467 observations)

Variable	Parameter estimate (t-statistic)
b'_0	3.10×10^{-4} (1.46)[a]
b'_1	3.80 (3.64)[b]
θ'	0.31 (16.2)[b]

Second sample period: October 7, 1979 - October 8, 1982 (760 observations)

Variable	Parameter estimate (t-statistic)
b'_0	5.62×10^{-4} (1.41)[a]
b'_1	1.84 (1.55)[a]
θ'	0.17 (4.85)[b]

Third sample period: October 9, 1982 - December 31, 1986 (1,069 observations)

Variable	Parameter estimate (t-statistic)
b'_0	7.61×10^{-4} (2.92)[b]
b'_1	2.59 (1.68)[c]
θ'	0.10 (3.44)[b]

a. Significant at the 10 percent level.
b. Significant at the 1 percent level.
c. Significant at the 5 percent level.
NOTE: Significance levels are for one-tailed tests on b'_0 and b'_1.
SOURCE: Author's computations.

funds rate is permitted to float freely, we cannot reject the notion that stock purchasers compensate sellers for the settlement delay at the federal funds rate. However, when the central bank intervenes, the federal funds rate appears to be too stable to serve as the rate of compensation.

Since the estimates of b'_1 exceed unity, they are higher than predicted by Lakonishok and Levi (1982), who argue that delays should be compensated at the riskless rate. To the extent that the overnight federal funds rate is riskless, the coefficient should be one if Lakonishok and Levi are correct. The results in table 4 are, however, consistent with their empirical results. Lakonishok and Levi assume that settlement and check-clearing delays are priced at the prime rate and test to see if the prime rate is large enough to explain the weekend effect. Although a strict interpretation of their story requires that sellers be compensated at the riskless rate, they report that the prime rate is too low to eliminate these effects completely. This suggests that if the settlement and check-clearing delays were in fact the sole reason for the weekly pattern, rates of compensation during these delays must be larger than the riskless rate. Since our results apply only to the settlement delay and not to the check-clearing delay, they do not directly relate to those of Lakonishok and Levi. However, they do suggest the possibility that rates of compensation are larger than the riskless rate.

Conceivably, though, the rate of compensation should *not* be the riskless rate: errors in posting to brokerage or bank accounts do occur. While restitution is always made if the error is caught, the seller may not notice it. Even if he does, complaining is time-consuming. The seller may therefore require a premium over the riskless rate. In addition, the buyer may very well be willing to pay this premium. If he monitors his account, it cannot be debited early, but through bank or brokerage error, it may be debited late. Since the buyer can only win, he is willing to pay extra for this possibility.

Using the brokers' call money rate as the interest rate proxy would probably produce smaller values of b'_1. This rate tends to be higher than the federal funds rate, so smaller proportions of the call money rate imply the same levels of compensation. If the call money rate is as variable as the federal funds rate, t-tests would be less likely to reject the notion that the rate of compensation is the call money rate.

IV. Conclusion

This paper shows that investors consider delivery procedures in pricing stocks. We model stock returns in two ways. The first uses a function of the length of the settlement delay, while the second uses a function of both the length of the delay and interest rates during the delay. We find that the coefficient on this variable is always correctly signed and statistically significant. This means that observed prices diverge from the prices that would be observed in the absence of this trading mechanism. This, in turn, means that measured returns diverge from true returns.

While this result is comforting to researchers who have assumed that settlement delays are priced, it does have implications for empirical studies using daily stock-return data. Since the observed price equals the true price plus a premium to compensate for financing costs, measured returns diverge from true returns if the premium changes during the holding period. This could, for example, affect event studies either by masking the impact of a true economic event or by lending statistical significance to "events" which result only from changes in the premium and not from any underlying economic force.

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The Effect of Bank Structure and Profitability on Firm Openings

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Introduction

The banking industry has undergone significant changes in recent years. Much attention has been given to the effect of financial deregulation and interstate banking on the structure of the banking industry. Attention has also been directed at the systematic effects of financial structure on the national economy.

However, bank structure can also affect local economic development.[1] The availability and the cost of financing potentially varies across regions due to differences in bank structure and in the health of the local banking sector. Since bank credit is an important source of financing for new firms, differences in bank structure can affect regional growth.

This paper examines the effects of bank structure and profitability on the birth of new firms, an important component of economic development. Specifically, we enter measures of profitability, concentration, size, and entry of a region's banking sector (as well as an overall measure of lending activity) into a standard model of firm location. This enables us to test for independent effects of bank structure and profitability on regional growth, as measured by business openings.

Our results suggest that bank structure and profitability have significant effects on firm openings. A profitable and competitive banking market is associated with a higher rate of firm births. In particular, firm births are found to be associated with higher bank profits, higher numbers of bank employees, lower levels of concentration, higher proportions of small banks, and freer entry of new banks into the region. These results support the position that bank structure and profitability influence economic development.

Section I briefly reviews previous work relating banking and economic activity and discusses the implications of bank structure for regional growth. Section II presents a standard model of firm location and extends it to include measures of bank structure and profitability. Section III describes the data, and section IV provides results on the impact of banking on firm location. Finally, section V presents conclusions.

■ 1 We use the term "bank structure" to refer to both the organization of banks themselves (number of branches, employees per bank, etc.) and the market structure of the banking sector (concentration, ease of entry, etc.).

I. Bank Structure and Regional Growth

With the advent of deregulation and interstate banking, the banking industry has changed significantly in recent years. Much attention has been given to the effects of these developments on the structure of the banking industry itself.[2] Attention has also been directed at the systematic effects of bank failures and financial structure on aggregate economic activity.[3] The effect of changes in bank structure on regional economies, however, remains an open question.[4]

For example, Eisenbeis (1985), in a recent article on interstate banking, comments that:

> The most controversial issues surrounding consideration of modifying interstate banking laws deal with the implications of proposed changes for competition and concentration of resources. There is little doubt that restrictions on geographic expansion have, in the past, insulated many local markets from competition and have restricted economic growth. While casual inspection of the data suggest that states with more liberalized policies toward intrastate banking have generally had higher economic growth rates than unit banking states, empirical studies show no convincing relationship between banking structure and economic development. More detailed study would have to be done to determine whether this is just a matter of correlation or causation. (p. 231-32)

We approach this issue by studying the effect of bank structure on business openings. If bank structure and the health of the local banking sector affect the cost and availability of credit for new firms, changes in bank structure will potentially affect regional growth.

Financial institutions, especially banks, are the primary supplier of external funds to new businesses, which are typically small, independent enterprises. Unlike medium-sized (100 to 500 employees) or large corporations, small businesses have limited access to organized open markets for stocks, bonds, and commercial paper. Approximately three of every four existing small businesses have borrowed from banks.[5]

The availability of credit at affordable rates for the start-up and the continued operation of new firms is not necessarily a given.[6] For small start-up firms (typically "mom and pop" operations), financing comes mostly from private sources, such as personal savings, home equity loans, and loans from friends or relatives. For larger small businesses, capital for start-ups comes from financial institutions and organized venture capital firms, as well as from friends, relatives, and informal investors. Even after being established, firms may require financing when cash inflow lags behind cash outflow due to a rise in receivables or an inventory buildup.

When external financing is used, it is received primarily from commercial banks. The rates charged for small start-up firms are typically 2 to 3 percentage points above that charged for larger firms. This is due in part to the high-risk nature of new small businesses, which lack collateral and a credit history and suffer high rates of failure.

Some researchers and many policymakers argue that banks do not meet the needs of various types of businesses, particularly small businesses. They contend that due to high monitoring costs and a lack of adequate information about risk, a market failure exists—popularly referred to as the "credit gap." It has been argued that the price of credit, especially working capital, provided to small and middle-sized firms is too high after controlling for appropriate risk factors. The

■ **2** For example, Lee and Schweitzer (1989) use event-study analysis to determine the effect on stock prices of decisions by bank holding companies (BHCs) to establish subsidiaries within Delaware and find no evidence of long-term stock price changes during the postannouncement period. Trifts and Scanlon (1987) use a sample of interstate mergers to provide early evidence of the effects of interstate bank mergers on shareholder wealth. Born, Eisenbeis, and Harris (1988) provide evidence on the market evaluation of financial firms entering into interstate banking when restrictions are relaxed and find no significant effect of an announced geographic interstate expansion on shareholder values.

■ **3** Gertler (1988) provides an overall review. Bernanke (1983) argues that extensive bank runs and defaults in the 1930-1933 financial crisis reduced the efficiency of the financial sector in performing its intermediation function, causing adverse effects on real output, other than through monetary channels. Samolyk (1988) conducts a similar test on British data, using corporate and noncorporate insolvencies as proxies for the health of the financial sector, and also finds that credit factors matter empirically on output. Gilbert and Kochin (1990, forthcoming) provide additional tests of the hypothesis that bank failures have adverse effects on economic activity using rural county-level data and find that closing banks has adverse effects on local sales and nonagricultural employment.

■ **4** As discussed in Gertler (1988), the literature on financial structure and economic development has principally focused on variations across countries. Gurley and Shaw (1955) emphasize the role of intermediaries in the credit supply process. They note that in developed countries there typically exists a highly organized system of financial intermediation facilitating the flow of funds between savers and investors. They argue that the role intermediaries play in improving the efficiency of intertemporal trade is an important factor governing general economic activity. The correlation between economic development and financial sophistication across time and across countries has often been noted. See Goldsmith (1969) and Cameron (1972) for examples of such studies.

■ **5** Small Business Administration (1985), p. 206.

■ **6** Current information is not available on the sources of internal financing to small firms. For historical data, see Small Business Administration (1984).

credit gap is aggravated in times of tight credit, during which banks ration funds, with larger firms receiving a disproportionately large share.

This perception of market failure is reflected in how public-sector development agencies lower the cost of credit by providing access to sheltered pools of money (such as public pension funds), by passing on the favorable tax treatment of funds (through tax abatement and public bonds), or by accepting risks greater than private institutions are willing to bear (such as the loan guarantee program of the Small Business Administration).[7]

While there are no direct measures of the price and availability of credit for small businesses across regions, they are likely to vary with bank structure.[8] Concentrated banking markets with large banks and high barriers to entry may be unresponsive to the credit needs of small businesses and new firms. Lending to new firms entails higher risks than lending to established firms, since a large proportion of new firms fail in the first few years.

Heggestad (1979), Rhoades and Rutz (1982), Clark (1986), and Liang (1987) argue that banks in highly concentrated markets trade potential monopoly profits for lower risk. Alternatively, a highly competitive bank market, characterized by large numbers of smaller banks and easy entry, may result in a greater availability of credit at lower prices for small businesses. Finally, a profitable banking sector is expected to result in less credit rationing and a greater supply of credit for small firms. Even if most start-ups do not rely directly upon commercial banks for their initial financing, the expectation of ample credit for future expansion at low cost potentially affects the decisions of entrepreneurs to start a firm.[9]

An understanding of the impact of bank structure on firm location and regional growth is important because of the significant changes occurring due to deregulation and interstate banking. By the end of 1988, all but three states permitted some form of interstate acquisition of their banks, 14,600 offices of banking organizations existed outside the organizations' home state, and more than half of these were permitted to offer all banking services.[10] To the extent that this results in freer entry and increased competition among banks, the availability of capital for small businesses and new firms could increase. In the Southeast and New England, however, these developments have increased the number of extremely large banks, called "superregionals," at the expense of regional banks. Increased concentration could reduce the supply of credit for small businesses.

A recent survey of state bank regulators by Hill and Thompson (1988) found that advancing economic development is an important goal of state bank regulators.[11] If changes in bank structure do indeed affect regional growth, however, policymakers may be misjudging the costs and benefits of deregulation and interstate banking. We now turn to an empirical analysis of this issue.

II. A Model of Firm Location

To study the effect of bank structure and profitability on local economic activity, we concentrate on firm openings because they are driven by current and expected economic conditions, as opposed to expansions, contractions, and deaths, which will be greatly affected by the large fixed costs associated with changing locations. The model estimated here was originally developed by Carlton (1979), though we more closely follow Eberts and Stone (1987).[12]

The number of new establishments in a city is assumed to depend on the number of potential entrepreneurs in the city and on the probability that a given entrepreneur will start a new firm. The higher the level of economic activity in a city, the greater the number of potential entrepreneurs. Also, the higher the expected profitability of new firms, the larger the probability that they will actually emerge.

■ **7** See Hill and Shelley (1990, forthcoming).

■ **8** This would not be true if banks were perfectly contestable; the actual number and size distribution of competitors would not affect the price or the availability of credit. Whalen (1988) found that there is evidence that bank performance is systematically related to proxies designed to measure the intensity of actual and potential competition in rural banking markets in Ohio and concludes that these non-SMSA banking markets are contestable, since potential competition matters, but are not perfectly contestable. Our results suggest this may be true for SMSAs as well.

■ **9** Unfortunately, we do not have measures of sources of funds from nonbank entities, which potentially compete with commercial banks.

■ **10** These figures come from a recent comprehensive review of interstate banking by King et al. (1989). Earlier surveys include Whitehead (1983a, 1983b, and 1985), and Amel and Keane (1986).

■ **11** It ranked third, just behind ensuring the safety and soundness of depositors' funds and providing banking (depository) services throughout their states.

■ **12** For reviews of the firm-location literature, see Bartik (1985, 1988), Wasylenko (1988), and Wolkoff (1989).

Carlton (1979) modeled this birth process as a Poisson probabilistic model, since the birth of new establishments is a discrete event. Let p_i be the probability that a potential entrepreneur will start an establishment in a given city; then let

$$(1) \quad \ln p_i = x_i b + e_i, \quad i = 1,..., M,$$

where x_i is a vector of independent variables affecting firm profitability, b is a vector of fixed coefficients, e_i is an error term composed of the variance of the Poisson process and a random error, and M is the number of cities in the sample. Consistent estimates of the mean and variance of p_i are given by

$$(2) \quad E(p_i) = (N_i / BP_i),$$

$$(3) \quad Var(p_i) = (N_i / BP_i^2),$$

where N_i is the observed number of births and BP_i is the birth potential as proxied by employment in the standard metropolitan statistical area (SMSA).[13] Carlton shows that a consistent and asymptotically efficient estimate of b can be obtained by weighted least squares, with weights equal to the standard error of the Poisson process.

The independent variables typically used to measure expected profitability include wage rates, tax rates, unionization rates, and energy prices. We extend this list by including measures of bank structure and profitability. As discussed in the previous section, these measures determine, at least in part, the price and availability of credit and thus expected profitability and firm openings. Measures of bank structure and profitability are employed because direct measures of the price and the availability of credit are unavailable. To control for the effects of bank structure and the availability of credit on firm births, we include measures of the number and size distribution of banks as well as a measure of the financial health of banks.

III. Data

Data from 259 SMSAs across the country are employed to estimate the model. The dependent variable (*BIRTHRATE*) is the natural log of the ratio of new firm births (as reported for the years 1980 to 1982 in the USELM data) to existing employment in the SMSA.[14] A birth is defined as an establishment that did not exist in 1980 but did exist in 1982. Births within this two-year period are treated as comparable.

We divide the independent variables into two types. The first are measures of local economic conditions, and the second are measures of bank structure and profitability. All data are measured at the SMSA level unless otherwise noted.

The measures of local economic activity are the natural logs of the wage rate (*WAGE*), the number of establishments (*FIRMS*), the gross state product (*GSP*), the personal income (*PINC*), and the population (*POP*). Also included is the effective state corporate tax rate (*TAX*).[15] We control for population by entering it directly into our equation rather than using per capita variables that would impose additional structure.

Bank data are obtained from the Federal Financial Institutions Examination Council's Reports on Condition and Income, known as call reports, for 1980. (We assume that the lagged 1980 variables on banking are exogenous to firm births occurring between 1980 and 1982.) Measures of bank structure and profitability are created by aggregating data from individual banks up to the SMSA level. The total amount of loans and leases (*LOANS*) is a measure of the level of bank intermediation. The average rate of return (*RETURN*), net income divided by assets, measures the amount of resources available for future lending and the health of the banking sector.[16] This variable may also be measuring the effects of bank structure and the general economic health of the region. The empirical analysis will thus explicitly control for these effects.

We employ standard measures of market structure such as the total number of banks (*HQS*) and branches (*BRANCH*), the number of bank employees per bank (*BANKEMP*), and a Herfindahl index of the concentration of deposits (*HERF*).[17] We also include a measure of bank

■ **13** Although policymakers concerned with economic development value the employment resulting from new firms, the firm location literature explicitly models the birth of the firm itself. Using job creation (instead of firm births) as the dependent variable, however, yielded similar results.

■ **14** USELM stands for the U.S. Establishment and Longitudinal Microdata file constructed for the Small Business Administration by Dun and Bradstreet.

■ **15** *WAGE* and *TAX* are 1977 variables from the Census of Manufactures. *GSP, PINC,* and *POP* are 1980 variables from the Census Bureau and the Department of Commerce. The number of establishments is a 1980 variable from the USELM data.

■ **16** Specifications using income divided by equity capital yield similar results.

■ **17** The Herfindahl index is defined as the sum of the square of each bank's share of deposits for a given SMSA. While we are interested in the effect of concentration in the lending market, we assume that deposits are subject to less geographic dispersion than loans, and thus provide a more accurate indicator of concentration in the local banking sector.

TABLE 1

Descriptive Statistics

Variable	Mean	Standard Deviation
BIRTHRATE (firm birth/employment)	0.008	0.003
WAGE (manufacturing)	5.986	1.183
TAX (effective tax rate)	0.403	0.039
FIRMS (number of establishments)	13,150	24,713
POP (population, thousands)	635.4	1,060.2
LOANS (total loans and leases, millions)	2,656.4	9,411.5
RETURN (net income/assets)	0.009	0.003
HQS (number of banks)	23	39
BRANCHES (number of branches)	132	252
BANKEMP (employees/bank)	196.8	324.6
HERF (Herfindahl concentration index)	2,499	1,849
SIZE 1 (percent of banks with $0-$25 million assets)	0.456	0.224
SIZE 2 (percent of banks with $25-$50 million assets)	0.180	0.129
SIZE 3 (percent of banks with $50-$75 million assets)	0.084	0.092
SIZE 4 (percent of banks with $75-$100 million assets)	0.058	0.100
SIZE 5 (percent of banks with $100-$250 million assets)	0.042	0.073
SIZE 6 (percent of banks with $250-$400 million assets)	0.028	0.081
ENTRY (percentage change in the number of banks)	-0.014	0.156
PINC (personal income, millions)	6,740.4	12,413.0
GSP (gross state product, millions)	100,680	84,277

NOTE: Changes are measured as log differences.
SOURCE: Authors' calculations.

entry (*ENTRY*), the percentage net change in the number of banks from 1978 to 1980.[18]

Our last measures of bank structure are a set of variables (*SIZE* 1–*SIZE* 6) that control for the size of banks. *SIZE* 1 is the proportion of banks in an SMSA with assets less than $25 million, *SIZE* 2 is the proportion of banks with assets between $25 and $50 million, *SIZE* 3 is the proportion of banks with assets between $50 and $75 million, *SIZE* 4 is the proportion of banks with assets between $75 and $100 million, *SIZE* 5 is the proportion of banks with assets between $100 and $250 million, and *SIZE* 6 is the proportion of banks with assets of $250 to $400 million. The proportion of banks with assets greater than $400 million is the omitted category in our estimations.[19] Summary statistics for these variables are presented in table 1.

A pervasive problem with this data set for the purpose of looking at how banking activity affects the regional economy is that regions for which data are collected (SMSAs and states) and economic regions do not necessarily match. In addition, for some variables, such as *LOANS*, though the total dollar value of loans is known, it is not possible to determine where the loans were made. For example, loans made by an Ohio bank to firms in Florida and Ohio are counted in the same way.

With the banking data, there is an additional measurement problem in that a call report for a consolidated banking unit may include data for branches not located in the SMSA. In states that allow branch banking, activity at the branches may be reported solely in the SMSA headquarters. Thus, our measures of competition and concentration are potentially subject to errors. The sensitivity of our full sample results to this potential errors-in-variables problem is tested by running the model without SMSAs in states that have statewide branching, and then again without SMSAs in states that have limited branching (that is, only SMSAs in unit banking states).

IV. Estimation and Results

Full Sample Results

Estimates of variations of the above model for the full sample are presented in table 2. Equa-

■ **18** Note that this measure treats entry and exit symmetrically.

■ **19** Alternative measures of size were also tested. In general, only the measures of the smaller banks were statistically significant.

TABLE 2

Estimation Results

Coefficient	(1)	(2)	(3)
WAGE	-0.6823[a]	-0.4426[a]	-0.5076[a]
	(0.1131)	(0.1023)	(0.1140)
TAX	-1.8368[a]	-1.7032[a]	-1.5193[a]
	(0.5694)	(0.5442)	(0.5490)
FIRMS	0.2825[a]	0.3453[a]	0.3046[a]
	(0.0940)	(0.0939)	(0.1090)
POP	-0.2412[a]	-0.1694[b]	-0.3532[a]
	(0.1015)	(0.1002)	(0.1692)
LOANS	—	-0.0393	-0.0602
		(0.0870)	(0.0872)
RETURN	—	31.7890[a]	31.2940[a]
		(6.8238)	(6.8055)
HQS	—	-0.0693	-0.0451
		(0.1294)	(0.1293)
BRANCHES	—	-0.2271[a]	-0.1945[a]
		(0.0555)	(0.0574)
BANKEMP	—	0.3192[a]	0.3191[a]
		(0.0942)	(0.0938)
HERF	—	-0.1987[a]	-0.1911[a]
		(0.0687)	(0.0684)
SIZE 1	—	0.8650[a]	0.8550[a]
		(0.2463)	(0.2450)
SIZE 2	—	0.3396	0.3168
		(0.2537)	(0.2525)
SIZE 3	—	0.4889[b]	0.4486
		(0.2746)	(0.2742)
SIZE 4	—	0.4387	0.4101
		(0.2688)	(0.2677)
SIZE 5	—	-0.0085	-0.0432
		(0.3159)	(0.3146)
SIZE 6	—	-0.0803	-0.0816
		(0.2784)	(0.2770)
ENTRY	—	0.4314[a]	0.4239[a]
		(0.1319)	(0.1312)
PINC	—	—	0.1838
			(0.1785)
GSP	—	—	0.0427[b]
			(0.0239)
CONSTANT	-4.0502[a]	-4.6572[a]	-6.3725[a]
	(0.4267)	(0.7856)	(1.5336)
Log likelihood function	-95.4467	-46.6358	-44.1093
R-square	0.2109	0.4579	0.4683
Mean of the dependent variable	-4.9267	-4.9267	-4.9267
No. of obs.	259	259	259

a. Significant at the 95 percent confidence level.
b. Significant at the 90 percent confidence level.
NOTE: Standard errors of the coefficients appear in parentheses.
SOURCE: Authors' calculations.

tion (1) is a basic, static model of firm location, where the probability that a birth will occur depends on the wages, taxes, number of establishments, and population. This set of variables differs somewhat from that employed by Carlton (1979), who also used the unionization rate and energy prices in his estimates for selected industries. Eberts and Stone (1987) found that energy prices do not matter when the model is estimated with aggregate manufacturing data, and it is even less likely that energy prices would matter since we are looking at all industries.

Because we are not concerned about differences across industries and are interested only in whether there are statistically significant effects on aggregate regional economic activity as a result of bank structure and profitability, energy prices can safely be omitted. The unionization rate was omitted due to lack of available data. We assume that unionization is not systematically related to the banking variables.

All the coefficients in equation (1) are statistically significant at the 95 percent confidence level. As expected, we find that higher wages and higher effective corporate tax rates reduce the probability of firm births in an SMSA. Also, the probability of firm births increases with a greater number of establishments (*FIRMS*) and a lower population. Though the coefficient on population is somewhat unexpected, this result suggests that given the similar magnitude and opposite signs of these two coefficients, perhaps the number of firms per capita is the appropriate regressor. We continue entering population as a separate regressor because this is the most general way of including population in the model.[20]

Equation (2) estimates the same model, only now the measures of bank structure and profitability are included. The results strongly support the view that bank structure and profitability have a statistically significant effect on firm births. The addition of the bank structure variables did not affect the estimates of the basic firm location variables. The basic firm location coefficients have roughly the same magnitude and remain statistically significant at the 90 percent confidence level or higher.

The measure of the total amount of financial intermediation (*LOANS*) is negative but not statistically significant. The *RETURN* variable has a positive and statistically significant coefficient,

■ **20** More restrictive specifications using per capita variables yielded similar results.

TABLE 3

Unit and Limited Branching States

Coefficient	(1)	(2)	(3)
WAGE	-0.7558[a]	-0.4559[a]	-0.4610[a]
	(0.1137)	(0.1075)	(0.1340)
TAX	-3.0484[a]	-1.5043[a]	-0.7901
	(0.6175)	(0.6943)	(0.8031)
FIRMS	0.4437[a]	0.4013[a]	0.4063[a]
	(0.1132)	(0.1392)	(0.1654)
POP	-0.4337[a]	-0.3001[a]	-0.3458[b]
	(0.1224)	(0.1367)	(0.2088)
LOANS	—	-0.1162	-0.1612
	—	(0.1352)	(0.1371)
RETURN	—	44.3430[a]	43.4040[a]
		(9.9812)	(9.9638)
HQS	—	0.1324	0.2018
	—	(0.2000)	(0.2031)
BRANCHES	—	-0.2778[a]	-0.2647[a]
	—	(0.0735)	(0.0736)
BANKEMP	—	0.5493[a]	0.5817[a]
	—	(0.1412)	(0.1419)
HERF	—	-0.2163[a]	-0.2104[a]
	—	(0.0863)	(0.0861)
SIZE 1	—	1.2428[a]	1.2287[a]
	—	(0.3579)	(0.3569)
SIZE 2	—	0.7064[a]	0.6672[b]
	—	(0.3454)	(0.3449)
SIZE 3	—	0.8670[a]	0.8677[a]
	—	(0.3380)	(0.3370)
SIZE 4	—	0.9456[a]	0.9459[a]
	—	(0.3281)	(0.3270)
SIZE 5	—	0.7980[b]	0.7962[b]
	—	(0.4074)	(0.4068)
SIZE 6	—	0.0360	0.1004
	—	(0.4510)	(0.4527)
ENTRY	—	0.1757	0.1948
	—	(0.2295)	(0.2311)
PINC	—	—	0.0108
	—	—	(0.2472)
GSP	—	—	0.0661[b]
	—	—	(0.0372)
CONSTANT	-3.7568[a]	-5.1642[a]	-5.9276[a]
	(0.4690)	(1.0234)	(1.9894)
Log likelihood function	-53.0456	-19.2143	-17.4198
R-square	0.3675	0.5569	0.5652
Mean of the dependent variable	-4.9699	-4.9699	-4.9699
No. of obs.	190	190	190

a. Significant at the 95 percent confidence level.
b. Significant at the 90 percent confidence level.
NOTE: Standard errors of the coefficients appear in parentheses.
SOURCE: Authors' calculations.

suggesting that (controlling for structure) a profitable banking sector is associated with a higher probability of firm births. Profitable banks could have more opportunities for providing intermediation services and engage in less credit rationing, suggesting a positive relationship with firm births. Alternatively, high profits in the banking sector could merely be indicating profitable market conditions for other industries as well. (We will therefore control for regional economic activity in equation [3].)

The number of banks (*HQS*) is not statistically significant, but *BRANCHES, BANKEMP,* and *HERF* are, suggesting that the greater the number of branches and the more concentrated the banking market (at least as measured by *HERF*), the lower the probability of firm births. More branches could reflect more of a retail orientation of the banks. Also, the more employees per bank, the higher the probability of firm births.

The statistical significance and the magnitude of *SIZE* 1 suggest that smaller banks (those with less than $5 million in assets) are more involved in firm births than larger banks: the higher the proportion of small banks, the higher the probability of firm births. Finally, the coefficient on *ENTRY* is positive and statistically significant, implying that the more contestable the banking market (as indicated by a larger value for entry), the higher the probability of firm births.

In equation (3), two more measures of regional activity (*PINC* and *GSP*) are added to the model to see whether the bank structure and profitability effects are merely reflecting regional economic conditions. Of the added regressors, only *GSP* is statistically significant and only at the 90 percent confidence level. The bank-related coefficient estimates do not change appreciably with the addition of these regressors. In particular, *RETURN* retains its positive and statistically significant value even when we control as much as possible for local economic conditions, suggesting that this variable is doing more than just reflecting a robust local economy.[21]

Partial Sample Results

As previously discussed, the banking data are potentially subject to significant measurement

■ **21** Specifications that included the complete set of economic variables but entered the various bank structure variables separately (instead of the full set) yielded similar results. An exception was our measure of concentration, *HERF*, which was statistically significant only when the *SIZE* variables were included as well.

TABLE 4

Unit Banking States

Coefficient	(1)	(2)	(3)
WAGE	-0.8847[a]	-0.5494[a]	-0.3466[a]
	(0.1994)	(0.1951)	(0.2724)
TAX	-1.6874	-0.2816	-0.9859
	(1.0677)	(0.9922)	(1.7693)
FIRMS	0.5193[a]	0.3525	0.5890[b]
	(0.1778)	(0.2747)	(0.3543)
POP	0.5029[a]	0.0184	0.2364
	(0.1885)	(0.2915)	(0.3563)
LOANS	—	0.2934	0.1598
	—	(0.3359)	(0.3606)
RETURN	—	36.6800[b]	43.8810[b]
		(22.1410)	(23.4160)
HQS	—	-0.4136	-0.1035
	—	(0.6288)	(0.6956)
BRANCHES	—	-0.3807[b]	-0.4427[b]
	—	(0.2136)	(0.2367)
BANKEMP	—	0.0810[b]	0.1937
	—	(0.4796)	(0.5147)
HERF	—	-0.1543	-0.0565
	—	(0.2107)	(0.2396)
SIZE 1	—	2.7195[a]	2.5134[b]
	—	(1.3662)	(1.4066)
SIZE 2	—	1.9879	1.7754
	—	(1.2694)	(1.3086)
SIZE 3	—	2.3452[a]	2.2601[a]
	—	(0.9367)	(0.9560)
SIZE 4	—	0.7998	0.7543
	—	(1.1518)	(1.1646)
SIZE 5	—	2.0300[b]	1.7276
	—	(1.0934)	(1.1633)
SIZE 6	—	1.1386	1.1365
	—	(1.0377)	(1.0511)
ENTRY	—	1.5843[a]	1.3682[a]
	—	(0.6238)	(0.6601)
PINC	—	—	-0.4996
	—	—	(0.4562)
GSP	—	—	-0.0231
	—	—	(0.0741)
CONSTANT	-4.2875[a]	-10.0850[a]	-5.8005
	(0.6673)	(2.8175)	(4.9151)
Log likelihood function	-13.6582	12.8326	13.7363
R-Square	0.4021	0.7603	0.7677
Mean of the dependent variable	-4.7987	-4.7994	-4.7993
No. of obs.	58	58	58

a. Significant at the 95 percent confidence level.
b. Significant at the 90 percent confidence level.
NOTE: Standard errors of the coefficients appear in parentheses.
SOURCE: Authors' calculations.

error. In states that permit statewide branching, a call report for a consolidated banking unit may include data for branches not located in the SMSA. While the standard errors-in-variables problem in econometrics results in a bias toward zero in the estimated coefficients, we wanted to test whether our results were due to measurement error. We therefore estimate the model without SMSAs in states that have statewide branch banking, and then again without SMSAs in states that allow statewide or limited branching. These results are reported in tables 3 and 4.

In table 3, we reestimate the model omitting SMSAs in states with statewide branching.[22] Although the magnitude of the coefficients tends to be larger, there is no qualitative change in the results in equation (1). In equation (2), the results are again quite similar to those in table 1, except that more of the size variables are statistically significant, but ENTRY is no longer statistically significant. These differences carry over to the results for equation (3). Thus, omitting the SMSAs in the statewide branching states has little effect on our results.

Though we remove most of the measurement problems in the banking variables by omitting the SMSAs in the statewide branching states, the same problems hold to a much lesser degree for the SMSAs in the states with limited branching, which generally allow branches to operate only in contiguous counties.

In table 4, the model is reestimated with only the SMSAs in the unit banking states.[23] These statistical results are not as strong, but our sample has fallen from 259 in table 2, to 190 in table 3, to only 58 in table 4. Of the bank structure and profitability variables (reported in equation [2]), *RETURN, BRANCHES, SIZE* 1, *SIZE* 3, and *SIZE* 5 all remain statistically significant. *BANKEMP* and *HERF* lose their statistical significance, but *ENTRY* once again becomes statistically significant. When we add *PINC* and *GSP* in equation (3), *WAGE* is no longer statistically significant, but the number of establishments (*FIRMS*) is. Of the banking variables, *RETURNS, BRANCHES,*

■ **22** Thus, we omit SMSAs in the following states: Alaska, Arizona, California, Connecticut, Delaware, Florida, Hawaii, Idaho, Maine, Maryland, Nevada, New Hampshire, New Jersey, New York, North Carolina, Oregon, Rhode Island, South Carolina, South Dakota, Utah, Vermont, Virginia, and Washington.

■ **23** Thus, only SMSAs in the following states are included in this sample: Colorado, Illinois, Kansas, Missouri, Montana, Nebraska, North Dakota, Oklahoma, Texas, West Virginia, and Wyoming.

SIZE 1, *SIZE* 3, and *ENTRY* all remain statistically significant. In the basic firm-location model (equation [1]), the coefficients retain the same signs and magnitudes, though the state corporate tax rate (*TAX*) is no longer statistically significant. When we add the bank variables, only *WAGE* retains its statistical significance.

Clearly, the model does not perform as well with this sample. Even the coefficients in the basic firm location model lose their statistical significance (except for *FIRMS*). Whether this is due to the small sample size or to possibly peculiar characteristics of the included SMSAs is unclear.[24] Yet even with this sample, bank structure (as measured by *RETURN, BRANCHES, SIZE* 1, *SIZE* 3, and *ENTRY*) retains a statistically significant effect on firm births.

In summary, the error-in-variables problem discussed in the previous section does not appear to severely bias our results. Estimates of the model using the full sample are very similar to the estimates obtained using only SMSAs in states with unit or limited branching. When the model is estimated with just the SMSAs in unit branch banking states, the estimates change much more, but the profitability of the banking sector, the number of branches, the proportion of small banks, and entry all have a statistically significant effect on the probability of firm births. Our measure of concentration (*HERF*) retains the same sign and magnitude but is not statistically significant. Banking structure and the availability of credit appear to have measurable effects on firm births.

V. Conclusion

This study presents evidence on the effects of bank structure and profitability on the births of new firms. The attraction of new firms is an important goal of local economic development policies, which often provide public-sector financial incentives. Private-sector financial structure, however, potentially influences firm location through the price and availability of credit from commercial banks.

The empirical analysis examines the relationship between banking activity and regional development from 1980 through 1982. Using bank-level data, we construct measures of lending, profitability, concentration, size, and entry in the banking sectors of 259 SMSAs. Measures of bank structure are included in a standard model of firm location in order to test for independent effects of banking on regional growth as measured by firm births.

As with other firm location studies, we find firm births to be positively associated with low wages, low taxes, and a large number of existing firms. Our analysis, however, also shows that the private banking sector appears to be systematically related to the probability of firm births. Higher rates of firm openings are associated with a healthy and competitive banking sector. Specifically, firm births are associated with higher rates of bank profits, higher numbers of bank employees, lower levels of concentration, higher proportions of small banks, and higher rates of entry of new banks into the SMSA. These results are robust across several specifications and samples and support the position that bank structure and profitability are significant factors in facilitating economic development.

■ **24** The remaining SMSAs in the sample tend to be in states with large energy and agricultural sectors.

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