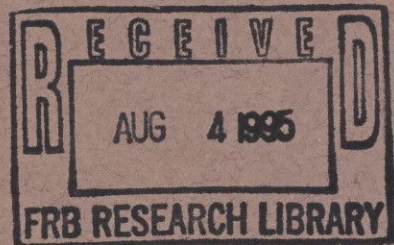


Economic Review

March/April 1995
Volume 80, Number 2

Federal Reserve
Bank of Atlanta



In This Issue:

***Private Sector Responses to the Panic of 1907:
A Comparison of New York and Chicago***

***Using Eurodollar Futures Options:
Gauging the Market's View of
Interest Rate Movements***

***FYI—Examining Small Business Lending in
Bank Antitrust Analysis***

Economic Review

Federal Reserve
Bank of Atlanta

**Economic
Review**

March/April 1995, Volume 80, Number 2

Economic Review

Federal Reserve Bank of Atlanta

President

Robert P. Forrestal

Senior Vice President and Director of Research

Sheila L. Tschinkel

Research Department

B. Frank King, Vice President and Associate Director of Research
William Curt Hunter, Vice President, Basic Research and Financial
Mary Susan Rosenbaum, Vice President, Macropolicy
Thomas J. Cunningham, Research Officer, Regional
Eric M. Leeper, Research Officer, Macropolicy
William Roberds, Research Officer, Macropolicy
Larry D. Wall, Research Officer, Financial

Public Affairs

Bobbie H. McCrackin, Vice President
Joycelyn Trigg Woolfolk, Editor
Lynn H. Foley, Managing Editor
Carole L. Starkey, Graphics
Ellen Arth, Circulation

The *Economic Review* of the Federal Reserve Bank of Atlanta presents analysis of economic and financial topics relevant to Federal Reserve policy. In a format accessible to the nonspecialist, the publication reflects the work of the Research Department. It is edited, designed, produced, and distributed through the Public Affairs Department.

Views expressed in the *Economic Review* are not necessarily those of this Bank or of the Federal Reserve System.

Material may be reprinted or abstracted if the *Review* and author are credited. Please provide the Bank's Public Affairs Department with a copy of any publication containing reprinted material.

Free subscriptions and limited additional copies are available from the Public Affairs Department, Federal Reserve Bank of Atlanta, 104 Marietta Street, N.W., Atlanta, Georgia 30303-2713 (404/521-8020). Change-of-address notices and subscription cancellations should be sent directly to the Public Affairs Department. Please include the current mailing label as well as any new information. ISSN 0732-1813

Contents

Federal Reserve Bank of Atlanta *Economic Review*
March/April 1995, Volume 80, Number 2

1 Private Sector Responses to the Panic of 1907: A Comparison of New York and Chicago

**Ellis W. Tallman and
Jon R. Moen**

The trend toward greater provision of payments services by nonbank providers raises a question for regulators: What if these nonbank institutions suffer unfavorable balances or experience a run? The authors of this article look to the Panic of 1907 as an example of how private market participants, in the absence of government institutions, react to a crisis in their industry. They suggest that New York's and Chicago's contrasting experiences during the panic may provide useful lessons for both regulators and market participants.

The article compares responses to the panic by bank intermediaries in the two cities through clearinghouses. The apparent isolation of trusts from the New York Clearinghouse left the clearinghouse with inadequate knowledge of their condition and hindered prompt action. In Chicago, the clearinghouse had timely information on most intermediaries in the city, including the trusts, and therefore was positioned to react quickly.

The distinct nature of the Panic of 1907 and the differences between private market regulation through clearinghouses and the current framework of public regulation limit recommendations for today's financial world. Nonetheless, the historical experience provides a precedent for the development and growth of payments services offered by nonbank providers, which should not be ignored as key players in the payments system. The key lesson from history is that such ignorance can be expensive.

10 Using Eurodollar Futures Options: Gauging the Market's View of Interest Rate Movements

Peter A. Abken

Investors and analysts frequently use financial market prices in their attempts to divine market expectations—a difficult exercise because of the myriad influences on financial market prices. This article focuses on shifts in market outlook regarding the direction of interest rate movements since 1988 as well as market reaction to specific events influencing interest rate changes in the short run—namely, Federal Reserve monetary policy and its periodic Federal Open Market Committee meetings.

The discussion examines the Eurodollar futures options traded at the Chicago Mercantile Exchange and explains how to infer the implied skewness of interest rates—a measure that gauges the direction and magnitude of their movements—from these options. In particular, this article shows how the skewness of the distribution of a short-term interest rate, LIBOR, can be inferred from market prices.

The basic conclusion of this article is that a marked shift in market outlook on interest rate movements occurred in late 1992. The analysis finds that during 1993 and 1994, skewness was manifest by a premium in the prices of Eurodollar futures puts, which offer protection against rising interest rates, compared with those of Eurodollar futures calls. The findings also indicate, though, that the Eurodollar futures options prices are too “noisy” to detect changes in the markets’ view of future short-term interest rate movements following FOMC meetings.

31 ***FYI—Examining Small Business Lending in Bank Antitrust Analysis***

W. Scott Frame

The U.S. banking industry has entered an unprecedented period of consolidation and reorganization. This bank merger wave has sparked public policy debate about the desirability of such combinations, particularly in regard to evaluating antitrust considerations.

More than thirty years ago, legal precedent established the relevant antitrust product market for banking as the “cluster of banking products and services.” Many are questioning whether a move away from this aggregate approach toward a more traditional product-based antitrust analysis would better reflect today’s market realities, in which the presence of numerous nonbank competitors competing over wider geographic areas often reduces concentration concerns. At the same time, the market for small business loans has particularly interested both bank regulators and the Justice Department because of the lack of nonbank competitors and the local nature of these loans.

The author of this article provides an overview of recent developments in banking antitrust analysis, particularly in the area of small business lending. In discussing the potential costs and benefits to disaggregating the product market for purposes of antitrust analysis, he concludes that while doing so is theoretically appealing, disaggregating the product market for banking (and examining small business lending) suffers from several measurement problems resulting from a lack of reliable data.

Contents

Table of Contents

Introduction	1
Chapter 1: The Federal Reserve System	10
Chapter 2: Monetary Policy	25
Chapter 3: Fiscal Policy	45
Chapter 4: The Business Cycle	65
Chapter 5: Inflation and Deflation	85
Chapter 6: The Labor Market	105
Chapter 7: The Housing Market	125
Chapter 8: The Financial System	145
Chapter 9: International Trade and Finance	165
Chapter 10: The Future of the Economy	185

Appendix A: Glossary	195
Appendix B: Index	215
Appendix C: Bibliography	235
Appendix D: List of Figures	255
Appendix E: List of Tables	275
Appendix F: List of Equations	295
Appendix G: List of Acronyms	315
Appendix H: List of Abbreviations	335
Appendix I: List of Symbols	355
Appendix J: List of Units	375
Appendix K: List of Conversions	395
Appendix L: List of Formulas	415
Appendix M: List of Diagrams	435
Appendix N: List of Charts	455
Appendix O: List of Maps	475
Appendix P: List of Photographs	495
Appendix Q: List of Videos	515
Appendix R: List of Websites	535
Appendix S: List of Journals	555
Appendix T: List of Books	575
Appendix U: List of Articles	595
Appendix V: List of Reports	615
Appendix W: List of Speeches	635
Appendix X: List of Testimonies	655
Appendix Y: List of Hearings	675
Appendix Z: List of Committees	695

Appendix AA: List of Organizations	705
Appendix AB: List of Individuals	725
Appendix AC: List of Events	745
Appendix AD: List of Dates	765
Appendix AE: List of Locations	785
Appendix AF: List of Countries	805
Appendix AG: List of Cities	825
Appendix AH: List of States	845
Appendix AI: List of Counties	865
Appendix AJ: List of Towns	885
Appendix AK: List of Villages	905
Appendix AL: List of Hamlets	925
Appendix AM: List of Parishes	945
Appendix AN: List of Townships	965
Appendix AO: List of Precincts	985
Appendix AP: List of Wards	1005
Appendix AQ: List of Districts	1025
Appendix AR: List of Constituencies	1045
Appendix AS: List of Electorates	1065
Appendix AT: List of Voting Districts	1085
Appendix AU: List of Polling Stations	1105
Appendix AV: List of Ballot Boxes	1125
Appendix AW: List of Voting Machines	1145
Appendix AX: List of Voting Systems	1165
Appendix AY: List of Voting Methods	1185
Appendix AZ: List of Voting Procedures	1205

Private Sector Responses to the Panic of 1907: A Comparison of New York and Chicago

Ellis W. Tallman and Jon R. Moen

The recently proposed (and aborted) merger between software giant Microsoft and Intuit, the producer of the leading personal financial software for personal computers, demonstrated the potential for growth among nonbank providers of payment services. In this case, neither of the parties is in the payments system, of course, but the recent growth in payments services provided through nonbank entities and the tremendous potential for the use of technologies like the Internet for such services points toward greater participation in the payments system by nonbank providers of payment services. For regulators, this trend raises questions: What if nonbank providers of such services suffer unfavorable balances or experience a run? How should they be treated? New York's and Chicago's contrasting experiences during the Panic of 1907 may provide useful lessons concerning this issue for both regulators and market participants.

During the National Banking Era (1863-1914), several episodes of recurrent financial crises plagued the United States well after most other developed banking systems had eliminated them. By this time most European countries had central banks that could provide reserves during a crisis, but in the United States bankers and depositors still had to rely mainly on the private sector to meet unusual demands for cash. Without a central bank to function as a lender of last resort, the U.S. banking system during panics turned to private market organizations known as clearinghouses to protect the system from a total shutdown.¹

The Panic of 1907, the last and most severe of the National Banking Era panics in the United States, provides an example of how private market participants, in the absence of government institutions, react to a crisis in their

Tallman is an economist in the macropolicy section of the Atlanta Fed's research department. Moen is an assistant professor in the department of economics and finance at the University of Mississippi. Moen thanks the University of Mississippi, Office of Research, for a summer research grant supporting this project. The reference department staff of the Joseph Regenstein Library at the University of Chicago provided valuable help in locating information on Chicago trust companies.

industry. In previous research, the authors highlighted how the Panic of 1907 centered on New York City trust companies (Ellis W. Tallman and Jon R. Moen 1990; Moen and Tallman 1992). These trusts, a kind of intermediary not designed as a bank but performing bank services, saw dramatic growth in deposits at the turn of the century mainly as an avenue for circumventing legislative restrictions on national banks.

This article compares private market responses to the Panic of 1907 by bank intermediaries in New York and Chicago through the institution of the clearinghouse. The different responses to the panic center on the relationship between national banks and trust companies and the relationship between the private clearinghouses and trust companies. The fact that New York trust companies were not members of the New York Clearinghouse, whereas the larger Chicago trusts were members of the Chicago Clearinghouse, greatly influenced how the private sector in each city was able to cope with the panic. In Chicago, the clearinghouse had timely information on the condition of most intermediaries in the city, including the trusts, and therefore was able to react quickly to any potential threats to the payments mechanism. The circumstance in New York was notably different. The apparent isolation of trusts from the New York Clearinghouse left the clearinghouse with inadequate knowledge of their condition and hindered prompt action when panic withdrawals first struck those intermediaries.²

The lesson this historical instance offers is that it is unwise to ignore the implications of modern-day financial distress at nonbank intermediaries offering payments services. Although the distinct nature of the Panic of 1907 and the differences between private market regulation of clearinghouses and the current framework of public regulation limit any further inference about recommended responses in today's financial world, there is a clue in examining the historical episode for the questions it raises and for the debate and research it may generate about the potential responses of public authorities to impending changes in the financial system.

Structures and Institutions in New York and Chicago

The Rise of Trusts. The system of unit banking and the stratification of national banks produced several financial centers in the United States, with New York and Chicago being the most important.³ Even

though national banks in both cities had been operating as central reserve banks under the guidelines set down by the National Banking Acts (1863, 1864), and their financial intermediaries operated under similar legal constraints and regulations, the panic unfolded quite differently in each city.⁴ In New York dramatic runs hit the trust companies, forcing several to close. In Chicago suspension of convertibility of deposits into cash was not as extensive as in New York, and the contraction in deposits was much less severe. No trusts were forced to suspend in Chicago. In New York J.P. Morgan was central in directing the actions of the commercial bankers and a rather reluctant clearinghouse association. The Chicago clearinghouse and its member banks appear to have been key in coordinating the response to the panic.

As it does today, New York City obviously played a more central role in the United States financial system than Chicago did. In 1907 the total assets of all New York City national banks were more than five times the size of all Chicago national bank assets—\$1.8 billion versus \$340 million (Moen and Tallman 1992, 612; F. Cyril James 1938, 688). Nevertheless, similarities between the two financial markets justify a comparison. For example, the largest banks and trust companies in Chicago had a volume of assets comparable to that of the largest New York banks and trusts.⁵

Both cities also saw the rapid rise of a relatively unregulated intermediary, the trust company, around the turn of the century (George E. Barnett 1907, 234-35; Moen and Tallman 1992, 612). In Chicago the pace of growth equaled that in New York (James 1938, 690; Moen and Tallman 1994, 20). Notably, between 1896 and 1906 trust company assets and liabilities in both cities grew more quickly than did those at national banks. The result was that by 1907 the trusts in each city controlled a volume of assets comparable to the national banks.

The National Banking Acts of 1863 and 1864, which limited the investment activities of federally chartered banks, had set substantial reserve requirements in response to the perceived instability of banks in the earlier free-banking era. State regulatory agencies, on the other hand, generally placed fewer constraints on trust companies, with laws in New York and Illinois differing little.⁶ Unlike national banks, trusts could invest in real estate, underwrite stock market issues, make loans against stock market collateral, and own stock equity directly in addition to taking in deposits and clearing checks. Trusts in Chicago also provided unsecured lines of commercial credit (James 1938, 702). National banks could make loans against

stock market collateral (call loans), but the National Bank Acts prohibited the other activities, restricting banks to making commercial loans, issuing bank notes, and taking in deposits. The trusts thus offered a way around these restrictions.

Initially trust companies had been established to hold accounts in trust for private estates, and they tended to be small, conservative institutions. Even though they had been given substantial leeway to invest their assets, trusts took advantage of their unregulated status relatively late in the National Banking Era. By 1907, however, trust companies in both New York and Chicago were fully exploiting their investment capabilities.

National banks in these cities sometimes operated trust departments or owned controlling interests in trust companies. Bankers sat on the boards of directors of trust companies, and in Chicago one of the larger trust companies was owned directly by a national bank.⁷ Nevertheless, the largest trust companies in New York and Chicago were generally independent of the national banks. These large trust companies included the Knickerbocker Trust Company and the Trust Company of America in New York and the Merchants Loan and Trust Company and the Illinois Trust and Savings Bank in Chicago.

Clearinghouses. The absence of a central bank made the rise of the private clearinghouse especially dramatic in the United States, and its functions expanded substantially during the National Banking Era (Kevin Dowd 1994; Gary Gorton and Donald Mullineaux 1987; Richard Timberlake 1984). Near the end of the period the clearinghouses had taken on many of the tasks usually associated with a central bank: holding reserves, examining member banks, and issuing emergency currency. Actions by the clearinghouses became central in containing panics.

In both Chicago and New York the clearinghouse could examine the books of member institutions if there was reason to believe a member was facing insolvency. The Chicago Clearinghouse helped formalize the examination powers of clearinghouses when it established an office of independent examiner in 1905, assigning power to examine in detail the books of member institutions at the request of the clearinghouse committee. Many cities followed suit, including New York (James 1938; Fritz Redlich 1968; Gorton 1985). The New York Clearinghouse likewise required members regularly to submit balance sheets made publicly available through the clearinghouse or the state banking regulator.

New York. The most important difference between the trusts in Chicago and New York was their relation-

ship to their respective clearinghouses. In New York in 1907 national banks were members of the clearinghouse. Because trusts were not, they had limited access to the clearinghouse. To avail themselves of clearinghouse services—for example, to clear checks—trust companies had to go through a bank that was a member of the clearinghouse. Not only was access to the clearinghouse indirect but it was uncertain. To secure these services, trusts left significant deposits at banks as clearing balances. These balances, as well as some bankers' balances held at trusts for banks, formed a tight connection between banks and trusts even though trusts were not clearinghouse members.

Unlike in Chicago, national banks in New York viewed trusts as serious competitors. The two became

The Panic of 1907 provides an example of how private market participants, in the absence of government institutions, react to a crisis in their industry.

intense rivals over time, with the banks believing they had a “trust company problem” (C.A.E. Goodhart 1969, 18-19; Redlich 1968, 2, 178). Some have even speculated that the New York banks instigated the panic in 1907 to bring down the trusts, although H.L. Satterlee, J.P. Morgan’s son-in-law, argued that no bank would cause a run on another institution out of fear that it might bring itself down (Tallman and Moen 1990, 7). Evidence to date does not suggest a similar adversarial relationship in Chicago.

Trust companies in New York had not always been isolated from the clearinghouse. Many trusts had been full members of the New York Clearinghouse up to 1903, but New York national banks complained that the trusts’ ability to engage in commercial bank activities without holding the large specie reserves of central reserve city national banks was unfair. In response, the New York Clearinghouse passed a rule requiring member trusts after June 1, 1904, to maintain a cash reserve—between 10 and 15 percent of deposits—with the clearinghouse. Until that time trusts had normally

held only 5 percent cash reserves. In response to the rule trust companies quickly terminated their memberships and withdrew completely from the clearinghouse.⁸ New York trusts on occasion discussed the possibility of forming their own clearinghouse, but the project never got beyond the discussion stage.

Chicago. In sharp contrast, the larger trusts in Chicago were full members of the clearinghouse, and the larger trust companies as well as national banks cleared checks for the smaller banks and trusts.⁹ Unlike their counterparts in New York, trust companies in Chicago were not isolated from the clearinghouse. The Chicago Clearinghouse contemplated imposing on member trusts a reserve requirement similar to that in New York, but such a rule was never adopted (James 1938, 729).

The composition of the Chicago Clearinghouse Committee, six men who served as the executives of the clearinghouse, shows the close link between banks and trusts. In 1907, three of the six were the presidents of large national banks, and the other three were the presidents of the three largest trust companies in Chicago.¹⁰

Banking Panics

Panics—namely, banking panics—are either foreign concepts to those unaware of their existence or a distant memory to those who lived through them.¹¹ A bank panic can be described as a widespread desire on the part of depositors in all banks to convert bank liabilities—their deposits—into currency. A panic entails removal of bank deposits from the depository system, thus threatening the intermediation process. In contrast to bank runs, bank panics are basically systemic problems. Related but distinctive are bank runs, which occur when depositors attempt to liquidate all their deposits at a particular institution. Because the funds may be redeposited at another bank, a bank run does not necessarily imply the removal of funds from the banking system. A number of banks in a region can be affected simultaneously, but the run still does not extend to the entire banking system. Panics can be viewed as systemic bank runs.

Bank panics were dangerous especially to the national banking system. During this era, as throughout most of its history, the U.S. banking system has operated on a fractional reserve basis, which is designed so that the cash reserves of banks are only a fraction of their outstanding liabilities. In addition, a high proportion of bank liabilities are demand deposits—that is,

deposits a bank is obligated to pay in cash on demand to depositors. The exchange of deposits for currency at banks may appear initially as equal reductions to both cash holdings and deposits. However, banks keep cash reserves at a reasonable percentage of outstanding liabilities. Thus, when a large amount of deposits is converted to cash, banks may be forced to liquidate some of their interest-bearing assets to increase their cash reserves. Under the National Banking System, without a central bank, the fractional reserve system could not satisfy a large-scale conversion of bank deposits into currency.

Bank panics during the National Banking Era displayed similar characteristics. In general, according to Philip Cagan (1965), bank panics followed business cycle peaks. Often, panics occurred in either spring or fall; this phenomenon can be partly explained by noting that, without a central bank, the seasonal movement of funds between the Midwest and financial centers in the East put strains on bank reserve positions. The failure of a large business or financial institution usually preceded a panic. The length of panics varied; the most intense part of a panic typically took place in the span of a few weeks, and the remnants usually subsided within a few months.

In addition, the stock market would frequently suffer substantial losses in the aggregate, before and during the panic. These could signal to depositors that bank assets might be riskier, especially given the proportion of loans backed by stock market collateral. These loans, known as call loans, were in normal times liquid and demandable loans. During panics, call loans were often viewed as highly risky because the collateral backing them might have fallen to less than the nominal value of the loan. In the Panic of 1907, the precipitous decline in the stock market contributed greatly to the perception that bank assets were questionable.

Panics during the National Banking Era were also characterized by certain mechanisms that private bankers employed to survive the crises. Local clearinghouses provided the medium through which these mechanisms were instituted. James G. Cannon has described this fuller role of clearinghouses: “A Clearinghouse, therefore, may be defined as a device to simplify and facilitate the daily exchanges of items and settlements of balances among the [member] banks and a medium for united action upon all questions affecting their mutual welfare” (1910, 1).

The two primary methods for responding to bank panics during the National Banking Era were (1) clearinghouse loan certificates and (2) the restriction

or suspension of bank deposits' convertibility into currency. Clearinghouse loan certificates, which were loans extended for the purpose of forming reserves, were written for clearinghouse association members and were acceptable for settling clearinghouse accounts. Thus, the clearinghouse and its loan certificates offered the banking system an artificial mechanism to expand the supply of available reserves in order to prevent loan contraction.

When restricting the convertibility of deposits into currency, banks limited the amount of cash available or refused to pay cash in exchange for deposits as they were legally bound to do. This procedure reduced the outflow of bank reserves by slowing the liquidation of deposits. Both mechanisms allowed banks to continue other operations such as making loans and clearing deposits, with restrictions applying only to conversions of deposits into currency. Transactions within the banking system were supported through book entries of debits and credits to member institutions.

Similar Threats, Different Responses

The Panic of 1907 posed similar threats to money markets in both Chicago and New York, and intermediaries' protective responses were in some ways similar. Both cities saw the issuance of clearinghouse certificates and the convertibility of deposits suspended to varying degrees. Chicago banks, like those in New York, imported gold directly from London to maintain reserves (James 1938, 764-65; O.M.W. Sprague 1911, 297). Yet the outcomes were different.

In New York City, the panic hit trust companies hard. Their deposits contracted substantially, whereas at the national banks they increased; the most significant runs occurred at the trusts (Moen and Tallman 1992). A number of New York banks and trusts failed.

In contrast, in Chicago the movements in deposits at the trust companies—and the national banks, for that matter—were much less severe. No obvious difference emerges between depositors' treatment of trusts and national banks in Chicago: demand deposits fell 6 percent at trusts and 7 percent at national banks during the panic (Moen and Tallman 1994). No banks or trusts failed (F. Murray Huston 1926, 360).

Clearinghouse actions are key in explaining these different outcomes. The panic in New York was sparked by F. Augustus Heinze's attempt to corner the stock of United Copper Company.¹² The collapse of the

corner on October 16, 1907, revealed an intricate series of connections linking Heinze to the banking system. Depositors at the banks associated with Heinze and his associates began a series of runs after the collapse, the first being on Mercantile National Bank. The New York Clearinghouse Association examined the bank's assets, found it solvent, and announced that it would support the bank if Heinze would relinquish control of it. Depositors also ran several other Heinze banks, but the clearinghouse promise of support quelled these runs as well. By October 21 the Heinze banks had been reorganized and reopened with new management with the help of the clearinghouse.

On October 21 the panic in New York began in full force, however. The National Bank of Commerce announced that day that it would no longer clear checks for the Knickerbocker Trust Company, alarming the trust's depositors.¹³ In the evening after the news became public, J.P. Morgan, who had been organizing relief efforts during the runs on the Heinze banks, organized a committee of five trust company executives to discuss ways to halt the incipient panic at the trust companies. In the meantime, Benjamin Strong had been attempting to evaluate the financial condition of the Knickerbocker Trust but reported to Morgan that he had been unable to do so before it was to open the next day. With this news Morgan decided not to commit funds to aid the trust; other institutions followed suit. Because the clearinghouse did not regularly monitor New York City trusts, it could not make decisive actions without tedious and protracted examination of trust books first, and the national banks were unable to grant the Knickerbocker Trust aid quickly. On the morning of October 22 a massive run engulfed Knickerbocker, forcing it to close at noon after having paid out over \$6 million in cash. Runs picked up the next day at several other large trust companies.

To combat the panic at the trust companies, the committee of trust company presidents J.P. Morgan had organized attempts to collect funds from other trust companies to stem the panic. When few trusts were willing to cooperate, the committee turned to Morgan. He asked several presidents of the large national banks in New York to assist him. Over the next few days Morgan convinced other financiers to contribute to a "money pool" to aid the trust companies. James (1938, 755-56) described the New York bankers' reluctance to unite to face the threat to the payments system, and he refers to the money pools as attempts at "piecemeal salvage."

The New York Clearinghouse issued clearinghouse certificates to increase liquidity among New York

national banks. Use of certificates instead of cash to settle clearing balances between banks released cash to be paid to depositors. Criticizing the clearinghouse for delaying the use of loan certificates until the panic was well under way, Sprague (1911, 257-58) argued that earlier release of certificates would have calmed financial markets, avoiding the cumbersome, ad hoc money pools and sending aid directly to the troubled banks and trusts.

In reality, however, because the trusts were outside of the New York Clearinghouse, resorting to certificates earlier may have done little to stem the panic at the trusts. Although the use of certificates certainly freed up cash for the national banks to pay out to their depositors, it is not clear how it would have reached

decided to issue loan certificates as well. Partial suspension of currency payments was imposed, with no payments going to correspondent banks in the South or the West. James (1938) criticized this action on the grounds that the use of loan certificates was meant to release cash to pay to depositors, and banks were using the certificates to settle balances among themselves. Sprague (1911) was similarly critical of New York banks. James Forgan, president of the First National Bank of Chicago, decided after a few days that suspension of currency payments combined with the issuance of loan certificates was an ill-formed policy, and the First National Bank began to resume some cash payments to correspondents. Reserves at Chicago national banks fell rapidly to less than 18 percent, well below the legal minimum reserve requirement of 25 percent. Reserves at New York national banks rarely went below 25 percent. Nevertheless, cash payments by Chicago banks did not restore confidence to depositors and correspondents.

The Chicago Clearinghouse eventually authorized issuing some form of emergency currency, an action that went far in relieving Chicago depositors' anxiety. James indicates that the clearinghouse began issuing clearinghouse checks on November 6, partly in response to a petition presented by 500 leading citizens of Chicago.¹⁶ This step apparently calmed the Chicago money market sufficiently, allowing the task of removing restrictions on payments to begin.

Several differences between the Chicago money market and New York's are worth noting. James (1938, 757) argued that the institution of a formal bank examiner had allowed the Chicago Clearinghouse to identify potential weak spots in the banking system and therefore placed it in a sounder position than the clearinghouse in New York in the early stages of the panic in 1907. It was significant that no particular class of intermediary had been excluded from systematic examination in Chicago.

The Chicago Clearinghouse also appears to have been less hesitant to issue clearinghouse loan certificates to member banks and trusts than the New York Clearinghouse had been. In criticism similar to Sprague's of the New York Clearinghouse, James (1938, 761-62) faulted the Chicago Clearinghouse for not issuing clearinghouse loan certificates as emergency currency with the general public soon enough. In comparison with the systematic exclusion of trusts from the clearinghouse in New York, however, the speed with which the two clearinghouses resorted to certificates may not have been as important a factor in resolution of the panic.

There is historical precedent for the development and growth of payments services offered by nonbank providers, which can become key players in the payments system and should not be ignored.

the trust companies. The use of clearinghouse certificates may have signaled to depositors that the clearinghouse was willing to protect banks. For trusts, no such signal could be inferred.¹⁴

In Chicago the private sector response to the panic unfolded differently. Most of it appears to have been contained within the purview of the Chicago Clearinghouse Association, with no particular class of intermediary isolated from the efforts to control the panic. While there were unusually high demands for cash by Chicago depositors during the panic, outright runs like those on the New York trust companies did not occur. In contrast to New York, where a lack of "united action on the part of all New York bankers to meet the situation" helped fuel the panic, bankers in Chicago began shipping cash to correspondents.¹⁵ As the drain on reserves heightened, Chicago bankers began to worry.

Upon learning that the New York Clearinghouse was planning to issue clearinghouse loan certificates, the Chicago Clearinghouse Committee convened and

The Chicago Clearinghouse had learned the value of a united effort to protect the payments system several years earlier (James 1938, 714-19). In December 1905, the Illinois State Auditor threatened closing a chain of banks owned by John Walsh. Many bankers at the time felt that outright failure of the banks would teach a lesson to others about unsound banking. Wanting to avoid harmful effects on the larger banking system, however, James Forgan persuaded reluctant members of the Clearinghouse to stand together and guarantee payment on deposits at the Walsh banks in spite of losses the clearinghouse banks would incur. As a result, no runs ensued. It was this crisis that prompted the Chicago Clearinghouse Association's decision to appoint a special bank examiner.

An earlier experience may have also taught the Chicago Clearinghouse about the importance of clearinghouse access in preventing bank runs (James 1938, 677-78). On Saturday, December 26, 1896, officers of the Atlas National Bank decided that the bank could not reopen the following Monday. The clearinghouse committee met and decided that the bank should be liquidated and that member banks of the clearinghouse should provide the funds (approximately \$600,000) needed to close the bank and pay depositors. This action tended to relieve the general anxiety pervading the Chicago banking system.

The Atlas National, however, had an affiliated savings bank managed by the same board of directors but not included in the clearinghouse plan to liquidate the national bank. Even though the savings bank had been well managed and had a good reputation, the failure of the parent institution and the savings bank's exclusion from the clearinghouse liquidation plan quickly caused a run on the savings bank. It was forced into receivership within a month (James 1938, 679).

Besides the different roles of the clearinghouses in Chicago and New York, the close relationship between the stock market and the banking system in New York may have contributed to the panic's being more severe in that city. Both national banks and trusts in New York were potentially more exposed to fluctuations in the stock market. National banks in New York deposited their bankers' balances—deposits from other banks to meet reserve requirements established by the National Banking Acts—in the short-term call loan market at the stock exchange. Trust companies in New York also held a large volume of call loans. Nevertheless, the greater exposure to the stock market would serve to distinguish both banks and trusts in New York from those in Chicago, not banks from trusts in either city.

Interpreting the Differences

The following interpretation of the differences in deposit and loan behavior in New York and Chicago takes into consideration the structural similarities and differences in the two money markets. Direct access to the liquidity of the clearinghouse prevented panic and runs at Chicago trusts. Being associated with the clearinghouse, the trust companies were perceived as part of the clearinghouse payments system in Chicago and were treated like the national banks by depositors and correspondents.

In New York the trusts had little access to the liquidity the clearinghouse provided and were not viewed as internal to the clearinghouse payments system. The extreme contraction in deposits at trusts reflected depositors' awareness of the isolation of the trusts from the clearinghouse. In both cities there was a net reduction in deposits during the panic, but depositors in Chicago made little distinction between trusts and national banks, and the intermediaries were comparably liquid.¹⁷

The New York trusts, outside of the clearinghouse, were much less restricted than national banks. Their ability to compete in the same markets as banks but at lower costs added instability to the entire payments system, and a run on one class of intermediary could threaten the collapse of the entire interconnected system. Even if other intermediaries were viewed as safe, a run on the trusts threatened to drain reserves from the entire system. This isolation of New York trusts from the clearinghouse seems a key element in propagating the runs on the trusts.

In Chicago, as in New York, the different intermediaries faced different degrees of government regulation. In Chicago, however, the disparity in official regulation between trusts and banks was reduced by allowing trusts reliable access to additional reserves through the clearinghouse. The difference this access made supports Timberlake's argument that clearinghouses could potentially serve the banking industry as the lender of last resort. This history cautions, though, that the simple existence of a clearinghouse is not enough to provide stability to a banking system, particularly if the coverage of the clearinghouse is circumscribed. The broader coverage of the Chicago clearinghouse and its greater knowledge of the condition of intermediaries appear critical elements in the prevention of widespread runs in the city.

Even though the clearinghouses had been evolving into de facto central banks, it is clear that their development was not complete by the Panic of 1907. The

severity of the panic in New York and the absence of a reliable mechanism to cope with financial crises convinced the leading bankers that a centralized and reliable source of liquidity was necessary as the money market grew and became more complex. In particular J.P. Morgan, who had been at the center of the efforts to stop the panic in New York, probably expected that subsequent panics might be even more severe and beyond his or the clearinghouse's ability to control. Rather than continuing to put his assets at risk, Morgan (and other New York bankers) sought a national scheme for dealing with financial crises.

The course of the panic in Chicago suggests that wider coverage by private sector institutions like the clearinghouse could reduce the potential for financial crises. A private sector solution, however, was only temporary. In 1908 the Aldrich-Vreeland Act authorized national banks to issue emergency currency.¹⁸ The long-run impact of the Panic of 1907 and the impacts on the New York money market was that it led

to the establishment of the National Monetary Commission and, eventually, to the creation of the Federal Reserve System, which radically changed the banking industry.

It should be made clear that the point of this article is not to present the discussion and evidence as support for extending the "safety net" to intermediaries not perceived as in the payments system. The Chicago Clearinghouse that monitored trusts as well as extended the benefits of membership was a private coalition of member banks and trusts. The private market structure is clearly different from modern regulator-bank relationships, and to make strong inferences for current circumstances from this instance takes the study beyond its intended goal. Rather, the analysis suggests that there is historical precedent for the development and growth of payments services offered by nonbank providers, which can become key players in the payments system and should not be ignored. The key lesson from history is that such ignorance may be expensive.

Notes

1. The U.S. Treasury attempted on occasion to intervene in financial markets near the end of the National Banking Era—the active Treasury period—but the volume of funds controlled by the Treasury was not adequate to cope with panics.
2. This article complements research in Moen and Tallman (1994). That paper introduces data from Chicago trusts and banks to help uncover the sources of the panic in New York and uncover the differences in the New York and Chicago experiences. The data allow extensive statistical investigation of the panic that the use of New York data alone would not allow. Interested readers are directed to the working paper for further information.
3. St. Louis, the third central reserve city, basically abandoned its role as a central reserve city during the Panic of 1907 (James 1938, 766 fn). This discussion therefore ignores the role of St. Louis banks during the panic.
4. National banks were federally chartered institutions regulated by the Office of the Comptroller of the Currency; the banks were restricted from owning real estate or stock equity directly and had strict requirements on their reserve ratio (reserves/deposits). Trust companies, on the other hand, were examined by state banking regulators and typically had fewer restrictions placed on their investments and their reserve ratios.
5. The Illinois Trust and Savings Bank had assets equal to \$107 million dollars in August of 1907 while the Knickerbocker Trust in New York had \$69 million. The largest trust in New York was the Farmer's Loan and Trust Company, with \$90 million in assets.
6. Indeed, New York's statute was often used as a model by other states drafting regulations covering state-chartered institutions (Magee 1913; Welldon 1910).
7. The First National Bank of Chicago, one of the two largest banks in the nation by 1907, had established its own trust company, the First Trust and Savings Bank. James B. Forgan, president of both the First National Bank and the First Trust and Savings Bank, designed an ownership arrangement that gave the bank and several of its officers complete control over its trust company by acting as trustee for the bank's stockholders (James 1938, 693-95). Forgan was apparently concerned that if the stockholders of the First National Bank were given direct ownership of the trust's stock, over time control of the trust company could slip away from the bank as the bank's stockholders sold their trust shares to outsiders.
8. See Smith (1928, 346-49). Trusts were readmitted to the New York Clearinghouse in May 1911.
9. James (1938, 711-12) provides a list of clearinghouse members and institutions for which they cleared checks.
10. National bank presidents included J.B. Forgan, Ernest A. Hamill, and George M. Reynolds. Trust company presidents included John J. Mitchell, Byran L. Smith, and Orson Smith (Huston 1926, 507-11).
11. The following description summarizes material explained in more detail in Tallman (1988).

12. The following account is based on the more detailed history in Tallman and Moen (1990).
13. Why National Bank of Commerce refused is not clear.
14. In cases of troubled banks approaching illiquidity (as opposed to insolvency), the clearinghouse would guarantee the deposits of the troubled institution in the form of a coinsurance scheme. Timberlake (1984) has pointed out the effectiveness of clearinghouses in preventing the collapse of a fractional reserve system. He emphasizes the ability of the clearinghouse to gather its members into a single force during a crisis, issuing a temporary currency—clearinghouse loan certificates—to meet exceptional demands by depositors for currency.
15. Much of the story below follows from James (1938).
16. Clearinghouse checks were issued directly to depositors, and clearinghouse loan certificates circulated between banks.
17. See Moen and Tallman (1994) for the theoretical implications of the panic in New York and Chicago.
18. Although such currency was issued only once, some scholars have argued that this device was effective for dealing with financial crises and was preferable to the solution eventually chosen (Friedman and Schwartz 1963, 172).

References

- Barnett, George E. *State Banks and Trust Companies since the Passage of the National Bank Act*. National Monetary Commission. Washington, D.C.: Government Printing Office, 1907.
- Cagan, Philip. *Determinants and Effects of Changes in the Stock of Money, 1875-1960*. New York: Columbia University Press/NBER, 1965.
- Cannon, James G. *Clearinghouses*. National Monetary Commission. Washington, D.C.: Government Printing Office, 1910.
- Dowd, Kevin. "Competitive Banking, Bankers' Clubs, and Bank Regulation." *Journal of Money, Credit, and Banking* 26, no. 2 (1994): 289-308.
- Friedman, Milton, and Anna Schwartz. *A Monetary History of the United States, 1867-1960*. Princeton, N.J.: NBER, 1963.
- Goodhart, C.A.E. *The New York Money Market and the Finance of Trade, 1900-1913*. Cambridge, Mass.: Harvard University Press, 1969.
- Gorton, Gary. "Clearinghouses and the Origins of Central Banking in the United States." *Journal of Economic History* 45 (June 1985): 277-84.
- Gorton, Gary, and Donald Mullineaux. "The Joint Production of Confidence: Endogenous Regulation and Nineteenth Century Commercial Bank Clearinghouses." *Journal of Money, Credit, and Banking* 19 (November 1987): 457-68.
- Huston, F. Murray. *Financing and Empire: History of Banking in Illinois*. Chicago: S.J. Clarke, 1926.
- James, F. Cyril. *The Growth of Chicago Banks*. New York: Harper and Brothers, 1938.
- Magee, H.W. *A Treatise on the Law of National and State Banks*. 2d ed. Albany, N.Y.: Bender and Co., 1913.
- Moen, Jon R., and Ellis W. Tallman. "The Bank Panic of 1907: The Role of Trust Companies." *Journal of Economic History* 52 (September 1992): 611-30.
- _____. "Clearinghouse Access and Bank Runs: Trust Companies in New York and Chicago during the Panic of 1907." Federal Reserve Bank of Atlanta, Working Paper 94-12, November 1994.
- Redlich, Fritz. *The Molding of American Banking: Men and Ideas*. New York: Johnson Reprint Co., 1968.
- Smith, James G. *The Development of Trust Companies in the United States*. New York: Holt and Co., 1928.
- Sprague, O.M.W. *History of Crises under the National Banking System*. National Monetary Commission. Washington, D.C.: Government Printing Office, 1911.
- Tallman, Ellis W. "Some Unanswered Questions about Bank Panics." Federal Reserve Bank of Atlanta *Economic Review* 73 (November/December 1988): 2-21.
- Tallman, Ellis W., and Jon R. Moen. "Lessons from the Panic of 1907." Federal Reserve Bank of Atlanta *Economic Review* 75 (May/June 1990): 2-13.
- Timberlake, Richard. "The Central Banking Role of Clearinghouse Associations." *Journal of Money, Credit, and Banking* 41 (February 1984): 1-15.
- Welldon, Samuel. *Digest of State Banking Statutes*. National Monetary Commission. Washington, D.C.: Government Printing Office, 1910.

Using Eurodollar Futures Options: Gauging the Market's View of Interest Rate Movements

Peter A. Abken

Prices formed in competitive financial markets—both debt and equity markets as well as derivative markets—reflect market assessments of future events. One well-known example of a measure of market expectation is the implied volatility of options.¹ A phenomenon known as the volatility smile, a further manifestation of expectations to be discussed shortly, occurs in most options markets. A related but less intensively studied phenomenon that will be investigated here, implied skewness, likewise reflects market expectations. Unlike volatility, which pertains to the expected variability of asset prices, skewness gauges the direction and magnitude of their expected movements—a subject of daily interest in financial markets.

This article focuses on shifts in market outlook on the direction of interest rate movements since 1988 as well as market reaction to specific events influencing interest rate changes in the short run—namely, Federal Reserve monetary policy and its periodic Federal Open Market Committee (FOMC) meetings. The discussion examines the Eurodollar futures options traded at the Chicago Mercantile Exchange, the largest interest rate options market, which offers the best gauge of market interest rate expectations, and explains how to infer the implied skewness of interest rates from these options.

Like simple discount or coupon-bearing bonds, options have definite maturity dates, but unlike bonds their future payoff or cash flow is contingent on the value of an underlying price (used generically to mean the price of a financial asset, exchange rate, or index value). A critical determinant of an

The author is a senior economist in the financial section of the Atlanta Fed's research department.

He thanks Ben Lum of the Chicago Mercantile Exchange and Sailesh Ramamurtie of Georgia State University for very helpful comments.

option's value is the expected variability or volatility of the underlying price, which can be inferred from option prices, because it is this element that in part determines the probability of the option having value at future dates.² Even though volatility itself is not directly observable, options traders typically assess prices in terms of their views of volatility because they can readily intuit volatility and its movements. Standard models make restrictive, simplifying assumptions about volatility. Traders price options by forming judgments about volatility, which are not bound by the limitations of formal models, and then translating those views into prices using a model. That process can be reversed to uncover the market's average expectation of volatility over some horizon (see Linda Canina and Stephen Figlewski 1993). This is the point of departure for this article.

Just as options can be used to infer volatility, they can be used to infer skewness. The accuracy of interest rate option pricing models may be improved if they incorporate information about systematic shifts in interest rate skewness. Better ability to price options is important not only to those who trade options but also to risk managers who use options to hedge interest rate exposures.

The skewness of the underlying interest rate distribution affects the pricing of puts relative to calls and is related to the volatility smile. Eurodollar futures puts protect against rising interest rates and the corresponding calls against falling rates. (See Box 1 on page 26 for further discussion.) Skewness in the distribution of an interest rate implies a greater likelihood that over some future interval a rate will rise rather than fall, or vice versa. Zero skewness—a symmetric distribution—would result in an equal probability of rate increases or decreases. A measurement of skewness does not provide a particular prediction about the direction and magnitude of change in an interest rate but rather is part of the statistical description of how rates fluctuate.³ Intuitively, the more skewed a distribution is in one direction, the farther its mean, the average of all observations, lies from its median, the fiftieth percentile observation, because of the influence of outlying observations in the skewed tail of the distribution.

The method for assessing skewness is elaborated in the sections below. The first part of this investigation examines the behavior of the skewness measure computed daily throughout the sample to check for any regularities in its movements over time. The second part considers changes in skewness coinciding with Federal Reserve policy actions, in particular with changes in the federal funds target.

There is no firm theoretical reason to expect shifts in skewness at the time of individual federal funds target changes.⁴ The very loose hypothesis offered here is that each action the Fed takes signals its intention and resolve to the financial markets. Target changes take place incrementally, with much speculation in financial markets about how many more actions will follow. Many observers believe that the Fed won much credibility with the markets by virtue of its inflation-fighting efforts in the early 1980s and the resulting subdued levels of inflation that have prevailed. The unexpectedly sharp round of tightening actions that started in 1994 were accompanied by much discussion of credibility in the financial press. Current policy moves can also convey information about the prospects for future moves.

The hypothesis under consideration is that once a target change occurs, in particular one that is not fully anticipated, the market reevaluates the likelihood of further changes in the same direction and on the basis of that information may expect a greater probability of future rate moves in one direction rather than the other. Even after four previous tightening moves in 1994, the 50 basis point increase in the federal funds rate on August 16, 1994, could still stimulate a reappraisal of the Fed's intentions, as demonstrated in this example: "The Fed's move triggered the rally in long-term bonds because it signaled the central bank's determination to keep the economy from overheating and keep a lid on inflationary pressures" (Thomas T. Vogel, Jr., 1994, C1, C19). If options traders and other investors perceive a change in the Fed's policy stance—or simply less uncertainty about its goals—their assessment of the underlying interest rate skewness may also be influenced. In this case, a greater chance of further aggressive tightenings could increase skewness.

The basic conclusion of this article is that a marked shift in market outlook on interest rate movements occurred in late 1992, a shift that has not previously been measured or documented. The low short-term interest rates that prevailed at that time coincided with a sharp increase in the implicit skewness of the interest rate distribution. The measured skewness indicates that the likelihood of rising interest rates was much greater than of falling interest rates. The analysis finds that during 1993 and 1994, skewness was manifested by a premium in the prices of Eurodollar futures puts, which offer protection against rising interest rates, compared with those of Eurodollar futures calls. The findings also indicate, though, that the Eurodollar futures options prices are too "noisy" to detect changes in the markets' view of future short-term interest rate movements following FOMC meetings.

Eurodollar Futures and Options

The analysis in this article focuses on Eurodollar futures and options tied to movements in three-month LIBOR, which stands for London Interbank Offered Rate. These contracts, which trade at the Chicago Mercantile Exchange, are the dominant exchange-traded derivatives contracts for hedging short-term interest rate risk. One of the reasons for their popularity is that they are instrumental in hedging risks that arise from taking positions in over-the-counter interest rate derivatives contracts such as interest rate swaps, caps, and floors. Financial intermediaries in the over-the-counter markets, principally commercial and investment banks, turn to the Eurodollar contracts to hedge their interest rate exposures.

Better ability to price options is important not only to those who trade options but also to risk managers who use options to hedge interest rate exposures.

On the last day of the sample for this study (September 9, 1994), the total number of these contracts outstanding (the open interest) was 2,780,000, with the open interest for the Chicago Board of Trades's Treasury bond futures a distant second at 438,000 contracts. The volume of trading in Eurodollar futures on that day was almost 500,000 contracts, a scale of trading activity that dwarfs that in any other futures market. The open interest levels for Eurodollar futures calls and puts were more than one million contracts for each type of option, with daily volumes of 22,000 and 40,000 contracts, respectively. These numbers are huge compared with other options markets, with the one exception of the Treasury bond futures options. For the purposes of this study, these large trading volumes are important because they make it more likely that prices represent a market consensus and consequently that implied volatility or skewness represents expectations rather than market-related factors.⁵ This issue is discussed more fully below.

LIBOR is the rate of interest paid on three-month time deposits in the London interbank market. The interest is paid in the form of an add-on yield, calculated on a 360-day calendar basis, for a \$1 million deposit. (The yield is computed for a deposit of a fixed sum of money. In contrast, Treasury bills and other discount securities accrue interest by price appreciation. Their initial value is less than their face value by an amount sufficient to yield a particular rate of return.) The market for Eurodollar time deposits is a wholesale market in which international banks can borrow and lend funds. To receive the rate of interest stipulated at the time the futures contract was bought, the purchaser of a Eurodollar futures contract in effect is obligated to establish a three-month Eurodollar time deposit of \$1 million upon expiration of the contract. The seller of a Eurodollar futures contract in effect agrees to pay that rate of interest on a \$1 million loan. In practice, the Eurodollar futures contract is cash-settled, which means that a deposit or loan is never made; only the interest payment changes hands. Actual settlement of the \$1 million notional amount of the contract is unnecessary because of the manner in which these futures are used to hedge other positions, as discussed below.

Eurodollar futures contracts mature in a quarterly cycle, with contracts maturing two London business days before the third Wednesday in March, June, September, and December. On any day, Eurodollar futures are traded for these months out to ten years in the future, with substantial open interest for contract months running out approximately three years. The availability of long-dated Eurodollar contracts has increased year by year as the over-the-counter market has grown, driving the need for Eurodollar futures hedges.

The price of the Eurodollar futures contract is actually an index value constructed as 100 minus the add-on yield expressed as a percent. The reason for this arrangement is that a long position (a purchased contract) gains as the index rises, implying that the add-on yield (LIBOR) falls. The index allows the Eurodollar futures contract to behave like traditional commodity futures contracts for which long positions gain as the underlying commodity price rises. Conversely, a short position gains as the index falls and LIBOR rises. The minimum index movement is called the tick size. That amount for the Eurodollar futures contract is 1 basis point (one-hundredth of a percentage point). The add-on yield is computed as a dollar value on a notional \$1 million dollar, three-month deposit. The value of a one-tick change in the index is therefore $.0001 \times 90/360 \times \$1,000,000 = \$25$.

Unlike Treasury bill futures or Treasury bond futures, which are traded on the basis of the prices of these Treasury securities, Eurodollar futures and options are linked directly to an interest rate. The Chicago Mercantile Exchange determines the final settlement price of the Eurodollar contract based on LIBOR prevailing in the cash market by the following procedure. On the last day of trading for an expiring Eurodollar futures contract, the exchange polls sixteen banks active in the London Eurodollar market. These banks are randomly selected from a group of no less than twenty banks. In the final ninety minutes of trading, they are asked for three-month LIBOR quotes at a random time during this period and again at the close of trading. The Chicago Mercantile Exchange specifically asks each bank for "its perception of the rate at which three-month Eurodollar Time Deposit funds are currently offered by the market to prime banks" (Chicago Mercantile Exchange 1994, chap. 39, 3). The four highest and four lowest quotes at both the random and closing-time polls are eliminated and the remaining quotes are averaged together and rounded to the nearest basis point to give the LIBOR value for determination of the final settlement price.

Quarterly Eurodollar futures options that expire simultaneously with their underlying futures contracts are effectively cash-settled. If an option is exercised, a Eurodollar futures call writer (seller) becomes short one Eurodollar futures contract while the call purchaser receives one long Eurodollar futures contract. Eurodollar futures calls gain value as the index rises and LIBOR falls. Thus, calls can protect against falling interest rates. (Conversely, the holder of a Eurodollar futures put gets a short position in a Eurodollar futures contract. Puts can protect against rising interest rates.) At expiration, the Chicago Mercantile Exchange automatically exercises options that are in the money, resulting in an immediate marking to market (that is, closing out) of the futures position. The tick size for the Eurodollar futures options is also 1 basis point, implying a minimum price change of \$25 for an option contract. Another important feature of Eurodollar futures options is that they are American-style options, which means that they can be exercised before their expiration date if early exercise is to the advantage of the optionholder.

The futures and options price data in this study consist of daily closing prices for all three-month Eurodollar futures and options contracts traded at the Chicago Mercantile Exchange. The sample period covered January 1988 through September 1994, which coincides with information on FOMC federal funds rate target changes.

A final point about the data is that there is a close relationship between LIBOR and the federal funds rate. Federal Reserve open market operations have a direct impact in the federal funds market because open market purchases and sales of Treasury securities alter the availability of banking system reserves. Banks in need of reserves can borrow them, usually overnight, in the federal funds market, and banks with surplus reserves can readily lend them. Fed open market operations shift the supply of reserves. (See Marvin Goodfriend and William Whelpley 1986 for a detailed description of the federal funds market.) Because longer-term yields are in part determined as the average of current and future expected short-term interest rates, shifts in the current federal funds rate or anticipated movements in this rate translate into changes in longer-term yields

If investors perceive a change in the Fed's policy stance—or simply less uncertainty about its goals—their assessment of the underlying interest rate skewness may also be influenced.

(see Peter A. Abken 1993). The purchase of fed funds is equivalent to an unsecured loan, and thus the fed funds rate also includes a component for credit risk. Similarly, three-month LIBOR also builds in a credit spread reflecting the average credit risk of participants in the Eurodollar time deposit market. Differences in the terms to maturity of overnight fed funds loans and three-month Eurodollar deposits as well as in their credit spreads result in a less than perfect correlation between the movements in the fed funds rate and three-month LIBOR. Nevertheless, the two are highly correlated, as seen in Chart 1.

Inferring Skewness from Option Prices

Recently there has been a focus on a seeming anomaly in actual market option prices. The standard benchmark for the pricing of equity options is the

Black-Scholes model, which makes a number of strong assumptions about equity prices and interest rates (see Fischer Black and Myron S. Scholes 1973). As discussed by Canina and Figlewski (1993), as well as others, there is a tendency, particularly since the October 1987 stock market crash, for implied volatilities to differ from one strike price to another. This phenomenon is the so-called volatility smile. If the Black-Scholes assumptions were true, then volatility would be constant across all strike prices for an option of a given maturity. The implication of the shifting volatility is that the probability distribution of the stock price differs from the one assumed in the Black-Scholes model.⁶ Using several forms of the Heath-Jarrow-Morton interest rate option pricing model (see David Heath, Robert A. Jarrow, and Andrew J. Morton 1992), Kaushik I. Amin and Morton (1994) have observed a similar phenomenon in Eurodollar futures options.

In two articles, David S. Bates (1988, 1991) proposed a simple measure of skewness for European options and American options on futures contracts.⁷ As Bates and many other researchers have observed, traded options prices can be used to infer the underlying probability distribution, which is pivotal for the pricing of options. Chart 2, panel A, reproduces the simple logic of Bates's skewness measure. The "risk neutral"

probability density function depicts the likelihood that the underlying asset price takes values in certain ranges. The area under the density curve is equal to unity by definition. As noted above, Eurodollar futures and options contracts have a 1 basis point tick size. Any index value would therefore be represented by a thin, 1 basis point sliver under the curve. The theoretical probability of observing that price would be the area of that sliver.

Both European and American options have payoffs that depend on the underlying index value settling above the option strike for calls or below the strike for puts. A standard equation of the value of an option (Bates 1991; Jarrow and Andrew Rudd 1983) shows the relationship between strike price, index value, and the probability density. The value of a European call option is

$$c_t = e^{-r\tau} E^*[F_{t+\tau} - K_c / F_{t+\tau} > K_c] \times \text{Prob}^*(F_{t+\tau} > K_c).$$

The value of the index τ periods in the future is denoted by $F_{t+\tau}$. The strike level of the call option is K_c . This equation simply says that the value of a call equals the expected value of the payoff $E^*[F_{t+\tau} - K_c / F_{t+\tau} > K_c]$, if the call finishes in the money, times the probability that the call ends up in the money at expiration. (The asterisk

Chart 1
Federal Funds Rate versus Implied Eurodollar Futures Rate

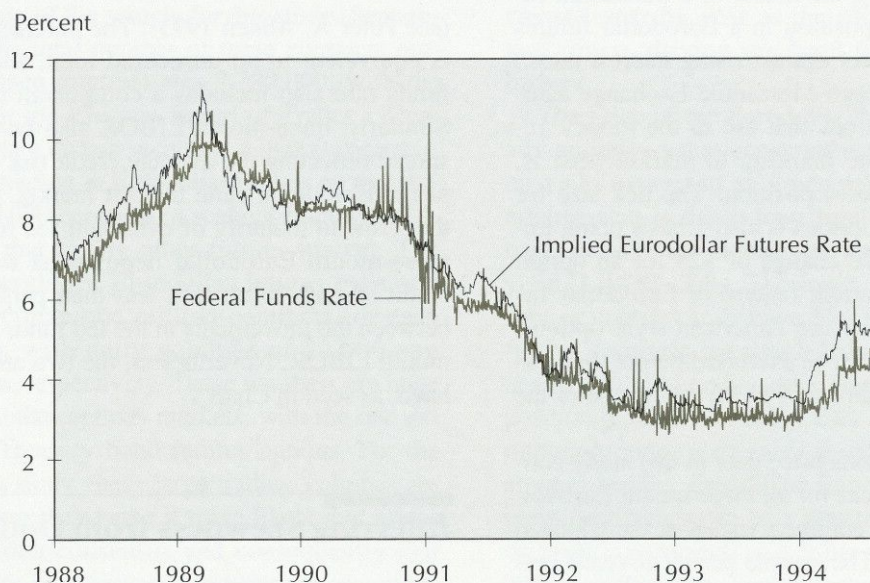
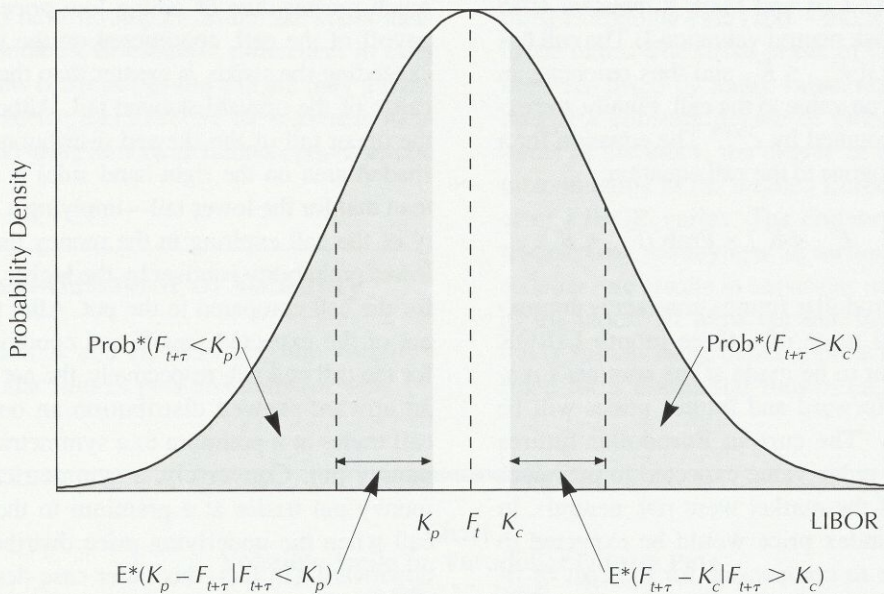


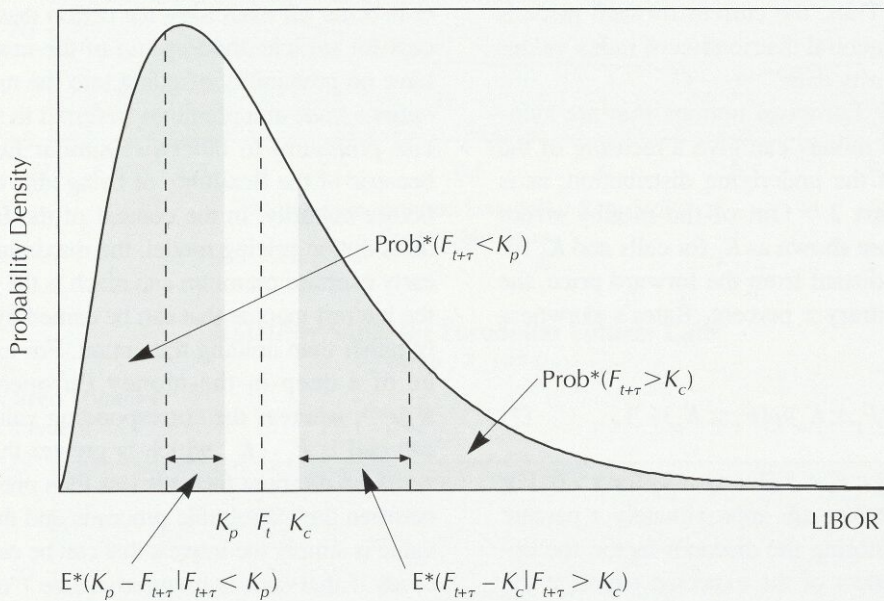
Chart 2
Example of a Symmetric Distribution

A



Example of an Asymmetric Distribution

B



next to the mathematical expectation operator, E , and the conditional probability, Prob , indicates that the relevant probability density is the risk neutral one, not the actual or “true” probability density. [See Jarrow and Rudd 1983 or John C. Cox and Mark Rubinstein 1985 for the rationale for risk neutral valuation.] The call has no value at maturity if $F_{t+\tau} \leq K_c$, and thus outcomes in this range contribute no value to the call. Finally, the expected payoff is discounted by $e^{-r\tau}$.⁸ The equation for a European put is analogous to the call equation:

$$p_t = e^{-r\tau} E^*[K_p - F_{t+\tau} / F_{t+\tau} < K_p] \times \text{Prob}^*(F_{t+\tau} < K_p).$$

The price of a Eurodollar futures contract is approximately the forward price of a three-month LIBOR add-on yield payment to be made at the contract’s maturity.⁹ Henceforth, forward and futures prices will be used synonymously. The current Eurodollar futures price is equal to the index value expected to prevail at the maturity date (if the market were risk neutral). In contrast, an equity index price would be expected to appreciate over time to compensate for the cost of financing a position in the stocks to deliver against a forward position in an equity index contract. A futures position, to a first approximation at least, involves no “cost of carry” because it costs nothing to initiate and margin can be posted in the form of interest-bearing Treasury securities. Thus, the current forward price is the mean of the risk neutral distribution of index values to prevail at the maturity date.

Bates shows how European options that are symmetrically out of the money can give a measure of the implicit skewness of the underlying distribution, as is readily seen in Chart 2.¹⁰ Out-of-the-money strike prices for the index are shown as K_c for calls and K_p for puts, which are equidistant from the forward price, the mean, F_t , by an arbitrary x percent. Bates’s skewness measure is simply

$$SK(x) = c(F_t, \tau; K_c) / p(F_t, \tau; K_p) - 1, \quad (*)$$

where $K_p = F_t / (1 + x) < F_t < F_t(1 + x) = K_c$ for $x > 0$. For x , the call and put strikes are approximately x percent out of the money. Ignoring the discount factor, the option value is the product of the expected payoff if the option is in the money and the “tail” probability. For the symmetric distribution depicted in Chart 2, panel A, the skewness measure is zero. In this case both tails, the shaded regions to the left of K_p and to the right of K_c , have equal area, and therefore the probability of observing prices below the put’s strike is the same as that of observing prices above the call’s strike. The expected

option payoffs are also equal. Thus, the symmetrically out-of-the-money call and put prices are the same.

Panel B shows a positively skewed distribution, that is, one for which the chance of observing high prices is much greater than of seeing low prices. The expected payoff of the call, conditional on the underlying price exceeding the strike, is greater than that for the put because of the upward-skewed tail. Although the area of the upper tail of the skewed distribution (shown as the shaded area on the right-hand side) is actually smaller than that for the lower tail—implying a lower probability of the call expiring in the money than the put—this lower probability is offset by the higher expected payoff for the call compared to the put. After taking the product of the expected payoff and conditional probability for the call and put, respectively, the net effect is that for an upward-skewed distribution an out-of-the-money call trades at a premium to a symmetrically out-of-the-money put. Conversely, a symmetrically out-of-the-money put trades at a premium to the corresponding call when the underlying price distribution is skewed downward. (In fact, this latter case describes the pricing relationship for Eurodollar calls and puts. LIBOR itself has an upward-skewed distribution.)

As shown by Robert E. Whaley (1986), both American futures puts and calls may be rationally exercised early. If an option is sufficiently in the money, the holder is better off exercising the option than keeping it. Except for sufficiently deep-out-of-the-money options that have no probability of going into the money, American options trade at a premium (referred to as an early exercise premium) to otherwise similar European options because of the flexibility of being able to exercise them before maturity. In the context of the Black (1976) futures option pricing model, the maximum value that the early exercise premium can reach is the present value of the interest income that can be earned by exercising early rather than holding the option. For example, the value of a deep-in-the-money European call is $(F_t - K_c)e^{-r\tau}$, whereas the corresponding value of an American call is $F_t - K_c$, which is greater than $(F_t - K_c)e^{-r\tau}$ since the discount factor is less than one. The difference between the exercisable proceeds and the European call value is simply the interest that can be earned on the proceeds if that sum is invested at rate r over the remaining life τ of the option. An analogous argument applies to puts, except that the exercisable proceeds are $K_p - F_t$.

In general, the possibility of early exercise and the premium associated with it obscure inferences about the underlying distribution because the early exercise decision is sensitive to the cash flows of the underlying asset. However, futures contracts are assumed to have a

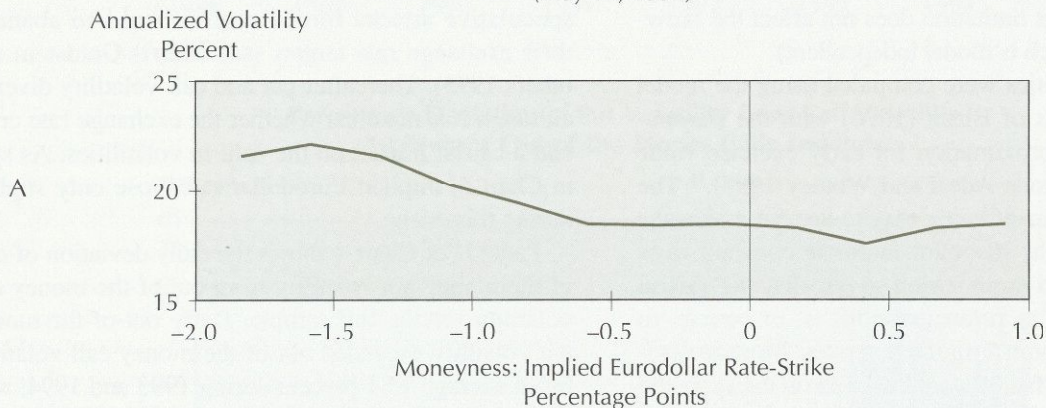
zero cost of carry and hence no cash flows so that the decision to exercise early depends only on the distribution of the asset price. For a symmetric distribution, the early exercise premiums for puts and calls would be equal and would have no impact on the skewness measure. For an asymmetric distribution, differences in early exercise premiums between put and call are only a function of the asymmetry, and therefore the skewness measure remains valid using American futures options prices.

1994. This smile is typical of those in the sample. Option volatility is plotted against its "moneyness," to which it is clearly sensitive. The degree of moneyness for the calculations was determined relative to the implied Eurodollar rate (100 - index) rather than relative to the index. The strike prices of Eurodollar futures options are listed by index value, not implied Eurodollar rate. If a constant degree of moneyness is defined in terms of the index, the degree of moneyness will fluctuate in terms of the implied Eurodollar rate as the level of LIBOR varies. The converse is of course also true; fixing moneyness in terms of the implied Eurodollar rate results in variations in moneyness in terms of the index. (It turns out that the results are qualitatively similar using either approach.) Moneyness is defined for a Eurodollar futures call (which is a put on

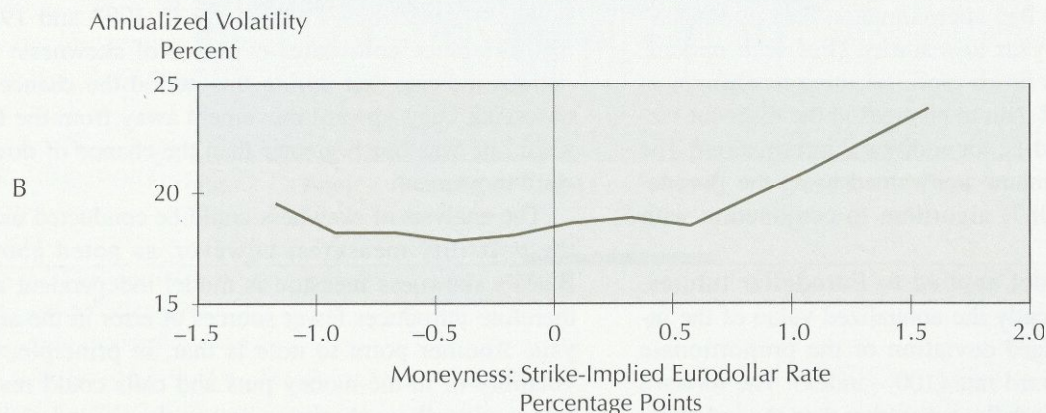
The Historical Behavior of Volatility

Chart 3, panels A and B, illustrates the volatility smile in Eurodollar futures puts and calls for May 17,

Chart 3
Volatility Smile for Eurodollar Futures Puts
(May 17, 1994)



Volatility Smile for Eurodollar Futures Calls
(May 17, 1994)



the Eurodollar rate) by the difference between the option's strike (expressed as a Eurodollar rate rather than as an index) and the current implied Eurodollar rate and for a Eurodollar futures put (a call on the rate) by the difference between the implied Eurodollar rate and the option's strike.

Volatility is also known to be sensitive to an option's maturity. The options plotted had maturities that ranged from 90 to 270 days. Once the 90-day bound was reached, puts and calls were rolled forward to the longest available maturity under 270 days. This somewhat arbitrary choice was governed by two considerations related to the need to form daily time series of volatility and skewness with few missing observations. First, fewer out-of-the-money options tend to be available for shorter maturities. These out-of-the-money positions tend to be infrequently traded. Second, longer-term options are generally less liquid, particularly in the earlier years in the sample, when in fact many long-dated maturities were not even traded. The option valuation model for extracting implied volatilities, described next, also made it desirable to avoid longer-term options (although this limitation does not affect the skewness measure, which is model independent).

Implied volatilities were computed using the model for futures options of Black (1976) with the Barone-Adesi/Whaley approximation for early exercise value (see Giovanni Barone-Adesi and Whaley 1987).¹¹ The model has the virtue of being easy to use but makes the assumption that the discount factor is constant over time, an awkward supposition given that the *raison d'être* of Eurodollar futures options is, of course, to hedge uncertain short-term interest rates. More realistically, the discount factor would depend on the expected path of the overnight rate over the life of the option. In other words, the discount factor would be stochastic, not deterministic. In practice, many users of Eurodollar futures options employ Black's model, and one can argue that it is not a bad approximation for options having less than one year to maturity. (For such options, the option price is much more sensitive to changes in its expected payoff than to changes in the discount factor. See notes 9 and 12 for additional information.) The early exercise premium was valued using the Barone-Adesi/Whaley (1987) algorithm in conjunction with Black's model.

In Black's model applied to Eurodollar futures, volatility is technically the annualized value of the instantaneous standard deviation of the proportionate change in the forward rate (100 – index). The forward rate or implied Eurodollar rate rather than the index enters Black's formula when computing an option price.

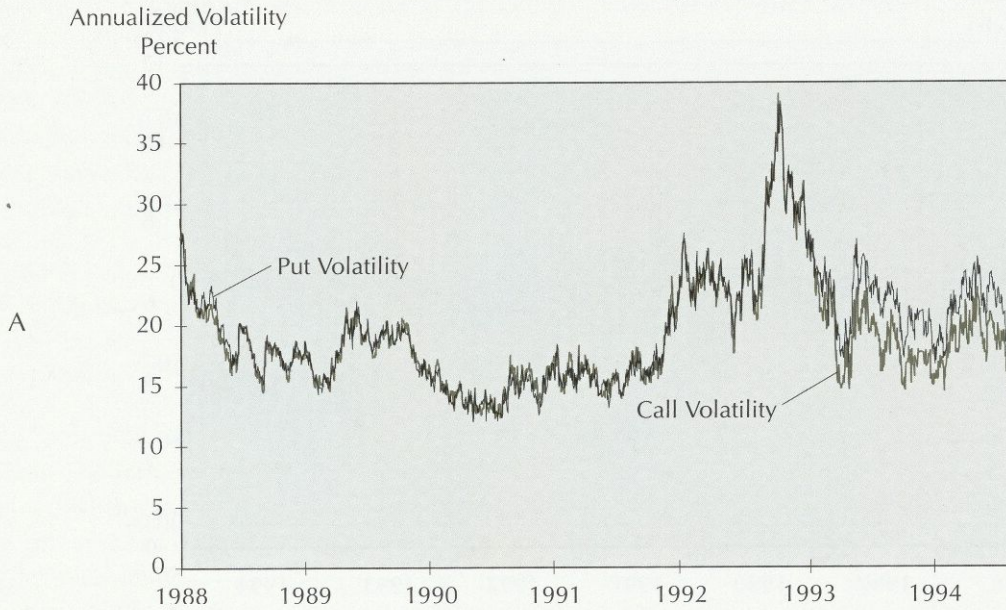
The key application of this model is in translating option prices into volatilities. Different option pricing models will generate qualitatively similar plots of the time series of volatility.¹²

The time-series behavior of historical volatility clearly implies that skewness in the distribution of LIBOR is important. Chart 4, panel A, depicts the full-sample history of volatility for out-of-the-money Eurodollar calls and puts. The options were out of the money by 10 percent of forward LIBOR, the implied Eurodollar futures rate. Since strikes are not quoted at exactly 10 percent out of the money except by pure coincidence, an interpolation technique, cubic splining, was used to estimate the call and put option prices that were exactly 10 percent out of the money.¹³ Implied volatilities were computed from the interpolated prices. Call and put volatility appear to be very close until early 1993, when put volatility rose above call volatility. The spike in both call and put volatility in September 1992 corresponds to the breakdown of the European Exchange Rate Mechanism, which had held major European currencies in close alignment until massive speculative attacks forced central banks to abandon their exchange rate targets (see Morris Goldstein and others 1993). Thereafter put and call volatility diverge, although it is not clear whether the exchange rate crisis had a causal impact on the split in volatilities. As seen in Chart 5, implied Eurodollar rates rose only slightly during this crisis.

Panel B of Chart 4 shows the daily deviation of out-of-the-money put volatility from out-of-the-money call volatility for the full sample. Daily out-of-the-money put volatility exceeded out-of-the-money call volatility by an average 15.1 percent during 1993 and 1994, with a standard deviation of 7.1 percent. In the earlier part of the sample, the deviation was a mere 0.33 percent, statistically insignificantly different from zero. There is obviously considerable variation in the computed volatility deviations. Particularly in 1993 and 1994, this difference constitutes evidence of skewness: the options indicate that during this period the chance of observing large upward movement away from the forward rate was much greater than the chance of downward movement.

The analysis of skewness could be conducted using the volatility measures; however, as noted above, Bates's skewness measure is model independent and therefore introduces fewer sources of error in the analysis. Another point to note is that, in principle, the volatility of in-the-money puts and calls could reveal information about skewness, but in-the-money options tend to be too thinly traded to be used in the analysis.

Chart 4
Eurodollar Futures Call and Put Volatility
10 Percent Out-of-the-Money Calls and Puts



Percentage Deviation of Put Volatility from Call Volatility
10 Percent Out-of-the-Money Calls and Puts

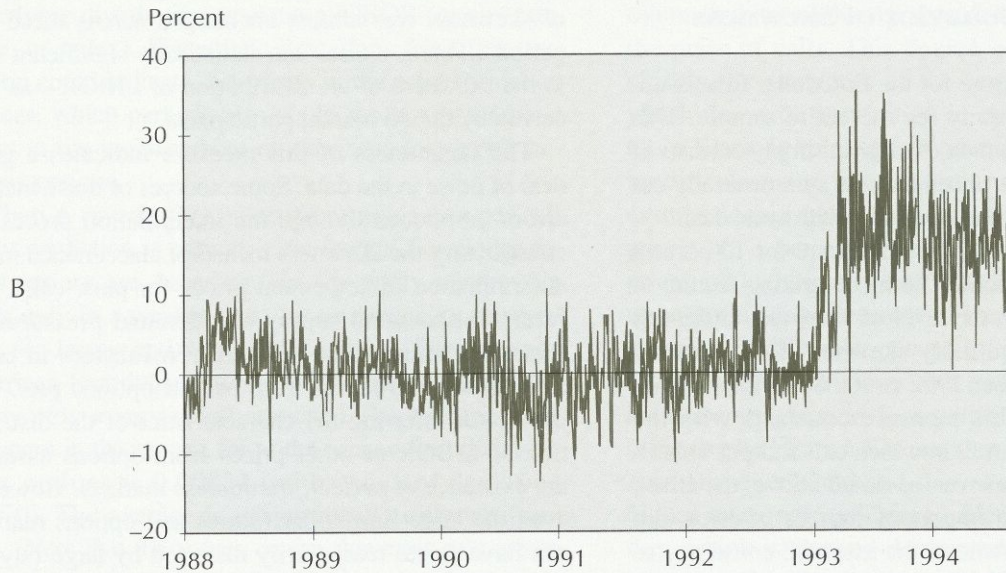
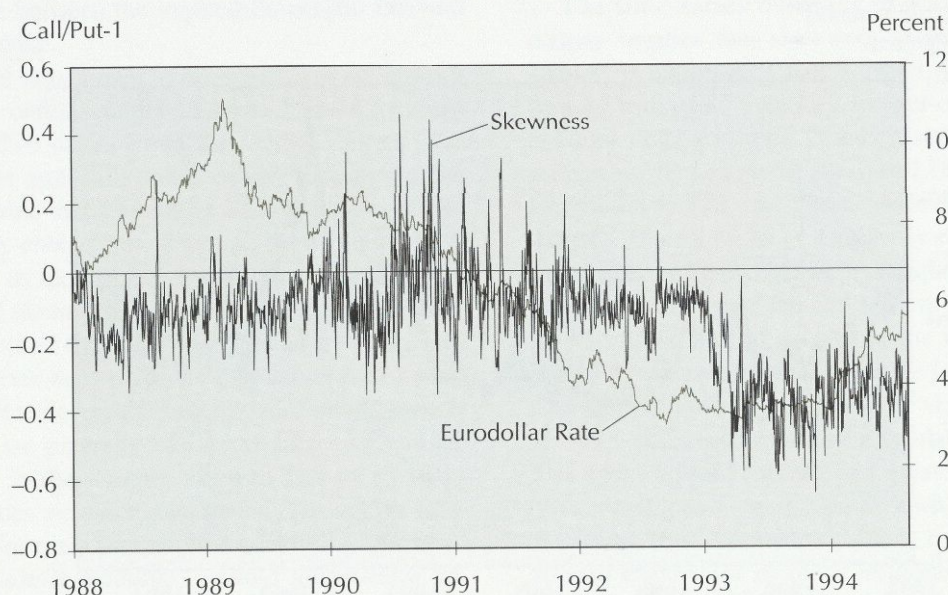


Chart 5
Implied Skewness of Eurodollar Futures Options
10 Percent Out-of-the-Money Calls and Puts



The Historical Behavior of Skewness

The skewness measure for the Eurodollar futures options was computed daily for the entire sample. This measure, given by equation (*) above, simply consists of the ratio of call to put prices that are symmetrically out of the money. Both options mature on the same date.

Chart 5 shows the skewness measure for 10 percent out-of-the-money options. The most striking feature of this plot is the shift in the level of skewness at the end of 1992. The average daily skewness from January 1988 through December 1992 is -0.089 (with standard deviation 0.103). This measure contrasts with the volatility plots of Chart 3, in which call and put volatility are very close. However, as noted above, the Black model introduces two important sources of error into the assessment of skewness: the assumed constancy of the discount factor and the approximation of the early exercise premium.

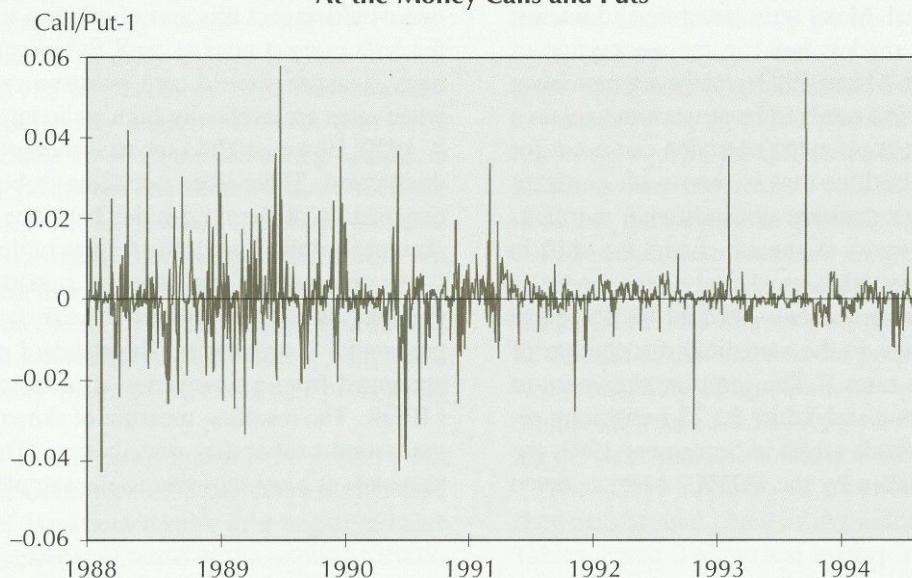
From January 1993 to September 1994, the daily average skewness increased markedly. The average for this period was -0.344 (with standard deviation 0.110). Note that a greater negative value corresponds to greater skewness. This change reflects an increase in the price of puts (protection against upward moves in

LIBOR) relative to calls. It is striking that the volatility of skewness was almost unchanged across these two periods. This is a clear-cut, statistically significant shift in the skewness of the distribution of LIBOR—as perceived by option market participants.

The jaggedness of this measure indicates a great deal of noise in the data. Some sources of noise include errors introduced through the interpolation process in constructing the skewness measure, inaccuracies in the determination of settlement prices for puts, calls, and futures prices, and supply and demand pressures on prices stemming from short-term imbalances in order flow in the Eurodollar futures and options pits. The theory for inferring the characteristics of the distribution of LIBOR or other prices from options assumes the existence of perfect, frictionless markets. However, even the large Eurodollar futures and options markets can have prices temporarily distorted by large buy orders (which drive prices up) or sell orders (driving prices down) as other market participants take the other side of the trades.

It is instructive to repeat the calculations for Chart 5 for at-the-money puts and calls. For European options, a standard option pricing relationship known as put-call parity can be used to show that futures put and call options with strike prices equal to the forward rate

Chart 6
Implied Skewness of Eurodollar Futures Options
At-the-Money Calls and Puts



have equal value. This result does not depend on the underlying distribution governing LIBOR (or any rate, price, or index). Systematic deviations from this prediction could indicate distortions in the price formation process, which perhaps also could result in systematic errors in the measurement of skewness for out-of-the-money options.

Chart 6 reveals that, apart from noise, the put-call parity prediction is correct, even though Eurodollar futures options are American and the parity relationship holds only in a weaker form (as an inequality relationship; see Jarrow and Rudd 1983). (In fact, European and American Eurodollar futures options prices usually differ by only a very small amount.) The average daily skewness in the sample for at-the-money Eurodollar futures options is 0.00024 (with standard deviation 0.0070). The average is insignificantly different from zero. (Note that the values on the skewness axis are an order of magnitude smaller for this chart than for the previous one for out-of-the-money options). As Bates found in his work on equity options, the skewness measure is roughly linearly related to the degree of moneyness. Thus, 5 percent out-of-the-money options have a time series plot (not shown here) that has about the same shape as that for 10 percent out-of-the-money options, but the skewness values are half the size in absolute value.

The average -0.09 skewness corresponds to a premium on puts, a price 10 percent higher compared with the price of calls. This degree of skewness matches closely the skewness of the lognormal distribution, which has wide application in option pricing. The famous Black-Scholes option pricing model as well as its modification for futures options (the Black model) assume lognormally distributed prices. Bates (1988) proves an “ x percent” rule for options on assets whose prices are lognormally distributed. For these prices, options that are x percent out-of-the-money will exhibit a premium of calls over puts of x percent. For Eurodollar futures options, it is puts that trade at a premium, and the skewness measure is negative. The reason is that it is the implied Eurodollar rate that is assumed to be lognormally distributed and thus skewed upward toward higher rates, not its Chicago Mercantile Exchange index, which is skewed downward. In 1993 and 1994, however, the distribution of LIBOR implicit in the options became considerably more skewed, well in excess of the degree of skewness for a lognormal distribution.

The increase in skewness corresponds, roughly, to the low level of LIBOR and other short-term interest rates that prevailed in 1993 and 1994. The implied Eurodollar rate is shown superimposed on the skewness

graph in Chart 5. It would seem intuitive that the greater likelihood of upward movements in rates would coincide with historically low short-term rates. The market might expect that rates would “revert” to a higher long-run level. Many term structure and interest rate option pricing models build in the assumption of mean reversion (see Abken 1993). However, more than simple mean reversion needs to be at work to explain a shift in skewness because mean reversion can occur for a stationary distribution, that is, one with constant skewness (and other constant unconditional moments like mean and variance). A regime change—a shift in Federal Reserve policy that is external or exogenous to current interest rate movements—would be needed to account for a change in the statistical distribution of short-term interest rates.¹⁴ The jump in skewness in 1992 followed immediately after the 25 basis point reduction in the fed funds target in September 1992, the last easing action taken by the FOMC. Also, as noted

in the previous section, it followed the breakdown of the European Exchange Rate Mechanism.

However, even if there are distinct regime shifts that result in a so-called nonstationarity distribution, one would expect this sort of relation to be symmetric for high interest rates as well as low rates. The skewness measure should turn positive or less negative when rates are cyclically high, as in late 1988 and early 1989. However, the skewness measure is flat during this period. There does not seem to be a satisfactory explanation of the time-series behavior of the implied skewness of the Eurodollar futures options.

As noted above, the standard statistical measure of skewness will differ between the risk neutral and actual probability distributions. The standard measure can be computed from a time series of historical three-month LIBOR. The resulting measure of skewness pertains to the actual probability distribution. This measure of skewness is very sensitive to the sample period select-

Table 1
Federal Reserve Policy Easings of the Federal Funds Rate Target

Date of Change	Prediction Date	Prediction	Actual	Surprise	Target Change
06/06/89	06/02/89	9.70	9.50	-0.20	-0.25
07/07/89	06/30/89	9.50	9.25	-0.25	-0.25
07/27/89	07/21/89	9.25	9.00	-0.25	-0.25
10/16/89	10/13/89	8.87	8.75	-0.12	-0.25
11/06/89	11/03/89	8.87	8.50	-0.37	-0.25
12/20/89	12/15/89	8.38	8.25	-0.13	-0.25
07/13/90	07/13/90	8.00	8.00	0.00	-0.25
10/29/90	10/26/90	7.88	7.75	-0.13	-0.25
11/14/90	11/09/90	7.75	7.50	-0.25	-0.25
12/07/90	12/07/90	7.25	7.25	0.00	-0.25
12/19/90	12/14/90	7.25	7.00	-0.25	-0.25
01/09/91	01/04/91	7.00	6.75	-0.25	-0.25
02/01/91	02/01/91	6.25	6.25	0.00	-0.50
03/08/91	03/08/91	6.25	6.00	-0.25	-0.25
04/30/91	04/26/91	6.00	5.75	-0.25	-0.25
08/06/91	08/02/91	5.75	5.50	-0.25	-0.25
09/13/91	09/13/91	5.25	5.25	0.00	-0.25
10/31/91	10/25/91	5.25	5.00	-0.25	-0.25
11/06/91	11/01/91	5.00	4.75	-0.25	-0.25
12/06/91	12/06/91	4.50	4.50	0.00	-0.25
12/20/91	12/20/91	4.00	4.00	0.00	-0.50
04/09/92	04/03/92	4.00	3.75	-0.25	-0.25
07/02/92	06/26/92	3.75	3.25	-0.50	-0.50
09/04/92	09/04/92	3.00	3.00	0.00	-0.25

Source: Federal Reserve Board of Governors. Rates are expressed in percent. Predictions are from the Money Market Services survey of economists.

ed and to the computed mean of LIBOR during that period because skewness is measured in terms of deviations of observations from the sample mean. (See note 10 for the formula for skewness.) To avoid the second of these problems, the daily change in LIBOR can be used because the mean daily change is close to zero. From January 1988 to December 1992 the computed skewness is significantly negative at better than the 1 percent significance level. In the remaining sample, it is significantly positive. (The same results obtain for computations done in the levels.) Therefore, concerning a shift in skewness, there is agreement between Bates's skewness measure, which is a forward-looking, options-based measure of the risk neutral distribution, and the standard calculation of skewness, which is a backward-looking measure of the actual probability distribution.

However, it is surprising that for the period from January 1988 to December 1992 the standard statistical computation of skewness results in a negative value while Bates's measure, in terms of the implied LIBOR, finds a positive value. These are very different mea-

asures, but one would expect that they agree in sign. Amin and Morton (1994) argue that Eurodollar futures puts were overvalued and that, in fact, this overvaluation could have been exploited to generate trading profits, even after accounting for transactions costs. They conducted trading-rule tests to demonstrate this possibility. Their sample of prices ran from January 1, 1987, to November 10, 1992. It is possible that this overvaluation could explain the difference between the skewness measures. Nevertheless, it would stretch credulity to believe that the increase in implied skewness in 1993 and 1994 resulted from increased mispricing of the puts in one of the most active, liquid financial markets in the world. (Amin and Morton's article was also in the public domain at this time, so the purported overvaluation was presumably common knowledge.) In any case, the sample skewness of LIBOR reversed in this period, taking the same sign as implied skewness.

The following analysis examines the behavior of skewness around changes in the federal funds targets. Tables 1 and 2 show the history of Federal Reserve target changes to the fed funds rate from March 1988

Table 2
Federal Reserve Policy Tightenings of the Federal Funds Rate Target

Date of Change	Prediction Date	Prediction	Actual	Surprise	Target Change
03/01/88	02/26/88	6.63	6.50	-0.13	0.13
03/30/88	03/25/88	6.63	6.75	0.12	0.25
05/09/88	05/06/88	6.87	7.00	0.13	0.25
05/25/88	05/20/88	7.13	7.25	0.12	0.25
06/22/88	06/17/88	7.38	7.50	0.12	0.25
07/19/88	07/15/88	7.63	7.69	0.06	0.19
08/09/88	08/05/88	7.85	8.13	0.28	0.44
10/20/88	10/14/88	8.13	8.25	0.12	0.12
11/17/88	11/11/88	8.31	8.32	0.01	0.07
11/22/88	11/18/88	8.31	8.38	0.07	0.06
12/15/88	12/09/88	8.55	8.69	0.14	0.31
12/29/88	12/23/88	8.88	8.75	-0.13	0.06
01/05/89	12/30/88	8.88	9.00	0.12	0.25
02/09/89	02/03/89	9.14	9.06	-0.08	0.06
02/14/89	02/10/89	9.25	9.31	0.06	0.25
02/23/89	02/17/89	9.37	9.75	0.38	0.44
02/04/94	02/04/94	3.25	3.25	0.00	0.25
03/22/94	03/18/94	3.50	3.50	0.00	0.25
04/18/94	04/15/94	3.50	3.75	0.25	0.25
05/17/94	05/13/94	4.00	4.25	0.25	0.50
08/16/94	08/12/94	4.50	4.75	0.25	0.50

Source: Federal Reserve Board of Governors. Rates are expressed in percent. Predictions are from the Money Market Services survey of economists.

Table 3
Wilcoxon Signed-Rank Test of Shift in Skewness
All Sample FOMC Dates

Policy Easings		
	Before Policy Move	After Policy Move
Number of observations	48	48
Mean skewness	-0.090	-0.052
Standard deviation	0.017	0.020
Number of Pairs		24
Signed-Rank Test		112
Critical Value		92*
Policy Tightenings		
	Before Policy Move	After Policy Move
Number of observations	42	42
Mean skewness	-0.160	-0.146
Standard deviation	0.021	0.020
Number of Pairs		21
Signed-Rank Test		106
Critical Value		68*

Note: An (*) denotes 10 percent significance level. The event window spans two days before the policy move and two days after it. The day of the move is excluded. The number of observations is the total number of days included in all event windows; the number of before and after pairs is the total number of policy moves considered. The Wilcoxon signed-rank test critical value is the value at or below which a shift in location is significant at the indicated level.

through August 1994. There were a total of forty-five policy moves: twenty-four easings and twenty-one tightenings. Most of these occurred in 25 basis point increments, with a few 50 basis point changes and some of 12.5 basis points (1/8 point) or smaller. In addition, the table shows the results of a Money Market Services survey of economists taken a couple of days before the policy moves. Most of the easing moves had an element of surprise, as the economists on average underpredicted the magnitude of the changes. The results reported below are stratified into "All FOMC Sample Dates" and "Dates of Policy 'Surprises' Only." If the Money Market Services survey reflects general market expectations, Eurodollar futures prices would be more likely to jump in reaction to a surprise, in the

direction of the target change. Skewness may also be more likely to change if a policy action is unanticipated because market participants may reassess their views about the distribution of LIBOR.

The behavior of skewness is examined around the time of FOMC policy actions using a standard "event study" approach. The Wilcoxon signed-rank test, explained in Box 2 (page 27), is used to test for a shift in skewness before and after the date on which the FOMC changes its federal funds rate target.¹⁵ Many factors besides FOMC actions influence measured skewness; they are unspecified and simply viewed as "noise" in the data. To reduce some of the noise in the sample skewness values, an average is taken of daily values over a window of a fixed number of days before and after the target-change date. In the tests reported below, that window is two days before and two days after a target-change date. The results turn out not to be extremely sensitive to the number of days in the window; however, increasing the number of days in the average tends to reduce the difference between the before-and-after period. The wider the window, the more likely other events and news besides FOMC actions are to affect skewness. (Another consideration is that increasing the number of days makes it more likely that a rollover into a new contract will occur in the window, which affects skewness and volatility because both of these moments vary with time to maturity.)

Tables 3 and 4 give the analysis of the skewness measure's movements at the times of federal funds target changes. In light of the volatility of the skewness measure in Chart 5, it is not altogether surprising that it is not possible to detect a statistically significant shift in skewness before and after target changes.¹⁶ The point estimate for skewness in the two-day window before a target change and that in a two-day window after the change decrease for easings on all FOMC dates (from -0.09 to -0.05), but the difference is statistically insignificant. Furthermore, those dates categorized as surprises to the market show virtually no change in point estimates, and the standard deviations of the estimates are even higher than for all dates. The results for policy tightening dates are likewise insignificant.

Another piece of evidence that the market reactions to individual FOMC action is very moderate comes from examination of the level of the Eurodollar futures price. The average reaction of these prices to FOMC moves indicates that policy moves raising or lowering the federal funds target have only a slight impact on forward Eurodollar rates. The market may reassess the likelihood of future policy moves in the

same direction, but the change in expectation is small. Using the same event window as in the measurement of volatility, an average reaction of the Eurodollar futures rate to target changes was computed. On average, the shortest maturity contract rate dropped about 0.5 percent following easings and jumped about 0.2 percent following tightenings. This shift is slight and amounts to only about a 1 to 2 basis point change for a Eurodollar rate of 4 percent. Note that in this study the shortest-maturity contract had at least ninety days to maturity, implying that the reaction is to the likelihood of future policy moves.

Conclusion

Investors and analysts frequently attempt to use financial market prices to divine market expectations. This kind of exercise is difficult because of the myriad influences on financial market prices. This article has shown how the skewness of the distribution of a short-term interest rate, LIBOR, can be inferred from market prices. The study discussed Bates's (1988) skewness measure for American futures options and reported a daily time series of these measures computed from prices for Eurodollar futures options. Because it is not clear what factors influence skewness, the recent behavior of the implied skewness is hard to interpret. Individual Federal Reserve policy actions do not have a discernible impact on measured skewness. However, the markedly increased degree of skewness in three-month LIBOR, and perhaps in other short-term interest rates, since 1992 is striking and potentially important for the pricing of options and other interest rate contingent claims.

Future research should investigate the cause of the shift in skewness and also examine skewness in other interest rate markets. Another task needing attention is to determine the economic significance of this variation in skewness. Would an option pricing model, such as that of Steven L. Heston (1993), in which the degree of skewness is estimated from data rather than imposed by assumption, outperform standard models? Would

Table 4
Wilcoxon Signed-Rank Test of Shift in Skewness
Dates of Policy "Surprises" Only

Policy Easings		
	Before Policy Move	After Policy Move
Number of observations	34	34
Mean skewness	-0.073	-0.071
Standard deviation	0.021	0.022
Number of Pairs		17
Signed-Rank Test		73
Critical Value		41*
Policy Tightenings		
	Before Policy Move	After Policy Move
Number of observations	32	32
Mean skewness	-0.150	-0.146
Standard deviation	0.024	0.021
Number of Pairs		16
Signed-Rank Test		64
Critical Value		24*

Note: An (*) denotes 10 percent significance level. The event window spans two days before the policy move and two days after it. The day of the move is excluded. The number of observations is the total number of days included in all event windows; the number of before and after pairs is the total number of policy moves considered. The Wilcoxon signed-rank test critical value is the value at or below which a shift in location is significant at the indicated level.

traders using such a model profit from their use of a "better" model at the expense of competitors using models with a poorer match to the actual distribution? How important are these considerations for risk management and hedging operations? These questions are fertile ground for continuing work on the topic of the skewness of interest rate distributions.

Box 1

Hedging with Eurodollar Futures and Futures Options

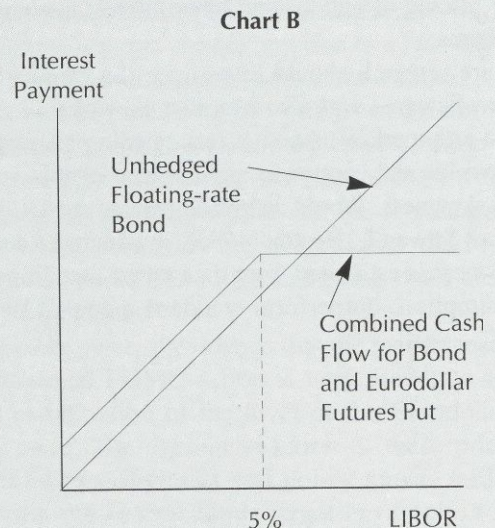
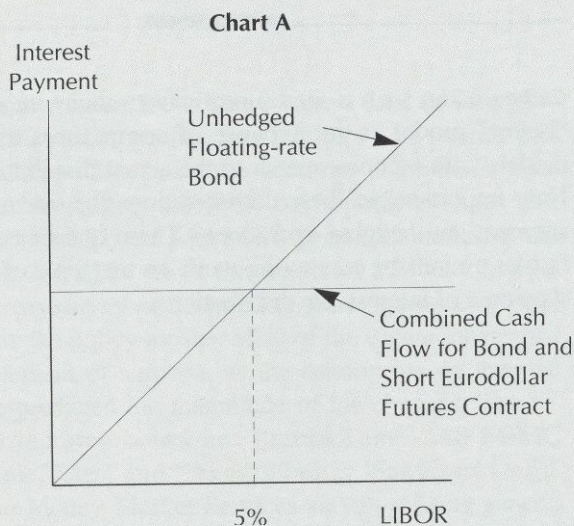
Two simple examples illustrate the use of Eurodollar futures and options on those futures for hedging an underlying exposure. First consider the case of a corporate treasurer who wants to hedge a floating-rate bond against a rise in LIBOR, the rate to which the bond is indexed. To hedge against a rise in three-month LIBOR, a portfolio manager would go short an appropriate number of Eurodollar futures contracts. The basic hedging mechanism is that as LIBOR rises, the short futures position gains, offsetting increased interest payments on the floating-rate bond.

Chart A shows the relation between cash flows on the unhedged floating-rate bond and the hedged short futures and bond position. One futures contract with contract size of \$1 million would be sold short for each \$1 million in face value of the debt.¹ The 45-degree upward-sloping line from the origin represents the interest payout for one floating-rate payment on the bond at a particular date. Assume a futures contract expires on that same date (if not, a "basis risk" will exist because of the mismatch in the dates for cash flows on the futures and the bond). The unhedged bond requires an increase in the interest paid that moves one-for-one with increases in LIBOR and conversely for decreases in LIBOR. Selling a futures contract short effectively obligates the treasurer to pay the difference between the prevailing LIBOR at expiration of the futures and the implied LIBOR (that is, $100 - \text{index}$) at the time the futures contract was sold.² For example, a contract sold at 95.00 implies LIBOR of 5 percent. The short futures sale effectively locks in the implied LIBOR. For each basis point that LIBOR falls below 5 percent,

the futures contract generates a loss of a basis point, or \$25, while the interest payment on the bond with \$1 million face value also drops by \$25, an interest saving that is exactly offset by the future's loss. Conversely, as LIBOR rises above 5 percent, the futures contract gains a basis point and the bond's payment increases by the same, offsetting amount. In other words, the futures contract is a liability when LIBOR is below 5 percent and an asset when LIBOR is above 5 percent. Chart A depicts the interest payment for the unhedged and floating-rate bond positions. (The interest payment is expressed in percentage points.) Chart A could also illustrate the use of a long Eurodollar futures position in conjunction with a floating-rate bond held as an asset. The combination locks in a fixed interest payment to the bondholder.

The treasurer could use Eurodollar futures puts as an alternative hedge of the floating-rate bond. These puts hedge against increases in LIBOR while retaining the possibility of realizing lower interest costs if LIBOR falls. Strike prices on the options are available in a range of prices in 25 basis point increments around the implied LIBOR of the futures contract expiring at the same time as the option. Assume that the selected strike is a price of 95.00 or 5 percent. Chart B shows how the borrowing cost varies with LIBOR on the date an interest payment is due. As before, the unhedged case has a 45-degree line.

The option price is quoted in basis points, each valued at \$25. Thus, if the option costs 8 basis points, the dollar cost is \$200 for a \$1 million face value of bonds being hedged. Below the strike level of 5 percent, adding the option increases the total borrowing cost by 8 basis points.



This cost is properly viewed as that of insuring against a future level of LIBOR above the strike. For LIBOR at 5 percent and higher, the total borrowing cost levels out at 5.08 percent. Analogous reasoning applies to the case of a Eurodollar futures call that hedges a floating-rate asset.

Notes

1. In actual practice, a hedge is "tailed," that is, the number of contracts held long or short is reduced to adjust for the effect of daily resettlement and interest on futures margin

accounts (see Duffie 1989, 239-41). Futures require daily marking-to-market, which effectively settles and reestablishes the futures position each day. Tailing a futures position achieves a better hedge between the futures position on which daily gains and losses are realized immediately and the underlying position on which those gains and losses are deferred until a future date.

2. The description in the text is a simplification that treats a futures contract as a forward contract. As observed in the previous note, futures contracts are marked to market daily.

Box 2

Testing for a Shift in Skewness

The Wilcoxon signed-rank test is a nonparametric test; it does not rely on any assumptions about the distribution of the sample statistic. Specifically, no assumption is made about how skewness is distributed. The sample under consideration consists of twenty-four easings and twenty-one tightenings, which are examined separately. These constitute small samples, and consequently the measurement of average skewness is subject to a nontrivial sampling error that is accounted for in evaluating the statistical significance of the before and after average skewness.

To use the signed-rank test, the differences in the measured skewness before and after the policy-change date are computed for each of the twenty-four easing and twenty-one tightening dates, which as just noted are tested separately. If there is no shift in skewness, both the sign and magnitude of the differences in skewness will vary purely because of sampling variation—that is, because of random errors in the measurement of skewness. The signed-rank test is based on the intuition that if the null hypothesis of equal before-and-after distributions is true, half of the skewness differences will be positive and half negative in large samples. Furthermore, positive and negative differences of the same absolute value in magnitude should be equally likely to be observed.

The computation of the Wilcoxon signed-rank test statistic is straightforward. The skewness differences from each of the dates of Fed funds target changes are ranked by absolute value of the difference from smallest to largest. (They are ranked 1, 2, 3, . . . , with ties getting an averaged rank.) Then the sum of the rankings for negative differences and that for positive differences are computed. The null hypothesis is that the positive and negative rank sums are equal. To be conservative, no a priori view of how skewness changes before and after target-change dates is made, and consequently a so-called two-sided test of the signed-rank statistic is used. The smaller of the positive and negative rank sums is compared with tabulated critical value for the Wilcoxon signed-rank test. (See William Mendenhall, Richard L. Scheaffer, and Dennis D. Wackerly 1981 for further details about this test and for a table of the critical values.) If the computed rank sum is less than or equal to the critical value, the null hypothesis is rejected and a difference in the mean of the before-and-after distributions is detected (subject to the usual caveat about statistical type I errors).

Notes

- Two other familiar examples of the anticipatory nature of prices are the dividend discount model of stock prices and the expectations theory of the term structure for bond prices (or, equivalently, interest rates). The dividend discount model collapses a future expected, infinite stream of dividend payments into a present value, the stock price, by discounting each of the expected cash flows by a discount factor (see Bodie, Kane, and Marcus 1989). Changes in either the discount factor—the time value of money and an adjustment for risk—or the expected dividend affect the current stock price. Similarly, the expectations theory links longer-term bond prices with shorter-term bond prices through expected future bond prices that equate holding period returns (see Abken 1993). Both of these examples are of a market's evaluation of the mean or average prices of cash flows that will occur.
- Option-implied volatility has been extensively analyzed. Feinstein (1988) and Canina and Figlewski (1993) discuss the accuracy of implied volatility in equity index options as forecasts of volatility.
- Skewness is technically the normalized third central moment of a distribution. See note 10 for the formal definition. The first moment is the mean and the second central moment is the variance. Some distributions are uniquely characterized by a small set of moments. For example, the normal distribution, which has zero skewness, is completely characterized by its mean and variance.
- One study in a similar vein to this article but conducted using a much different methodology is Das (1995). He estimated a model of short-term interest rate movements that allows for gradual (that is, continuous) rate changes and jumps (discontinuities in the path of rates.) He found that there is a statistically significant increase in the "jump" probability immediately following FOMC meetings. He concluded that during the 1980s markets tended more to react to FOMC actions than to anticipate them. He also found evidence of skewness, although his focus is on kurtosis. Kurtosis is related to the fourth moment of a distribution (whereas skewness is related to the third) and refers to the thickness of the tails of the distribution. The occurrence of jumps in interest rates increases the thickness of the tails—there is a greater probability of observing "outliers" for such a distribution compared with one for which jumps do not occur.
- Alternative contracts to three-month Eurodollar futures are one-month LIBOR and 30-day federal funds futures contracts. These have shorter maturities and might be more sensitive to Federal Reserve policy actions. However, they are too thinly traded (volumes of only a few thousand contracts) and, most important, do not have options associated with them.
- A number of researchers have independently formulated a new approach to option valuation that attempts to "back out" the implied probability distribution of equity index prices from quoted option prices on the index. Rubinstein (1994), Shimko (1993), Derman and Kani (1994), and Dupire (1994)

all extract the implied probability distribution from traded, liquid options in order to price other, less liquid options consistently across instruments. Their objective is to price exotic options like barrier and lookback options. Rather than assuming a particular distribution that governs the movements of the underlying price, they infer the distribution from quoted prices and recognize that this distribution can vary over time.

- The following discussion derives from Bates (1991).
- The exposition makes the simplifying assumption that the expected payoff can be discounted at a fixed instantaneous rate, r . Making this assumption is justified in the context of Eurodollar futures options later in the text.
- Forward prices are equal to futures prices only if interest rates are deterministic (see Cox, Ingersoll, and Ross 1981). For a short Eurodollar futures position, rising interest rates will result in positive marked-to-market cash flows that are not realized by a short forward position. For both types of contracts to be held in equilibrium, futures prices have to be higher than forward prices. Flesaker (1993) points out that in practice the difference is negligible for contract maturities less than one year.
- Bates's measure of skewness in options prices is distinct from the standard statistical measure of skewness based on the central third moment of a data sample of N observations:

$$m_3 = \frac{1}{N} \sum_{i=1}^N (X_i - \bar{X})^3$$

$$s = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (X_i - \bar{X})^2}$$

$$\text{Skewness} = \frac{N^2}{(N-1)(N-2)} \frac{m_3}{s^3}$$

(from Doan 1994, p. 14-238). Furthermore, the skewness measured using option prices is that of the risk neutral distribution, whereas skewness computed from actual data, in this case a time series of LIBOR, is that of the actual probability distribution.

- See also Tompkins (1989) for an application to Eurodollar futures options. However, Tompkins incorrectly ignores the early exercise feature of these options in discussing valuation.
- The plotted implied volatility of the HJM model with proportional volatility in Figure 1 of Amin and Morton (1994) is very close to that in Chart 4 below. Both plots show the history of a proportional volatility of the "spot" rate, although in the HJM model the spot rate is stochastic and the early exercise premium is evaluated by backward recursion through a nonrecombining binomial tree. However, Amin and Morton find that the average implied volatility of puts is greater than that for calls during January 1987 to November 1992.
- Cubic splines were fit to the call and put option prices on any given day. The method of natural cubic splines de-

scribed in Press and others (1988) was used. The value of 10 percent out of the money was used because, by trial and error, it was determined that this is the maximum degree of out-of-the-moneyness that could be used to plot a time series of volatilities with relatively few missing daily observations. A greater degree of out-of-the-moneyness resulted in an increasing lack of availability of puts or calls to make the computations. Also, as Bates (1988) points out, in-the-money options can also be used to assess skewness. However, these tend to be less liquid and the skewness measures derived from them tend to differ substantially from those derived from the out-of-the-money options.

14. Federal Reserve monetary policy could be viewed as being endogenous to the business cycle. Skewness may be conditional on the stage of the business cycle as perhaps gauged by the level of short-term interest rates. Unconditional skew-

ness could be constant in the long run. In that case an endogenous shift in conditional skewness may have occurred in late 1992. Unfortunately, the sample contains only one observation on this kind of shift. On the basis of the Eurodollar futures evidence, there is no way to tell whether the shift in skewness (and Fed policy) is exogenous or endogenous.

15. During the period of this study, Federal Reserve interventions in the federal funds market occurred between 10:30 A.M. and 10:45 A.M. Chicago time, although on occasion open market operations took place outside of these times (see Smith and Webb 1993).

16. A similar test was done for changes in volatility for both puts and calls. The results also indicated statistically insignificant changes in volatility.

References

- Abken, Peter A. "Innovations in Modeling the Term Structure of Interest Rates." In *Financial Derivatives: New Instruments and Their Uses*. Atlanta: Federal Reserve Bank of Atlanta, 1993.
- Amin, Kaushik I., and Andrew J. Morton. "Implied Volatility Functions in Arbitrage-Free Term Structure Models." *Journal of Financial Economics* 35 (1994): 141-80.
- Barone-Adesi, Giovanni, and Robert E. Whaley. "Efficient Analytic Approximation of American Option Values." *Journal of Finance* 42 (June 1987): 301-20.
- Bates, David S. "The Crash Premium: Option Pricing under Asymmetric Processes, with Applications to Options on Deutschemark Futures." Rodney L. White Center for Financial Research, Working Paper 36-88, October 1988.
- _____. "The Crash of '87: Was It Expected? The Evidence from Options Markets." *Journal of Finance* 46 (July 1991): 1009-44.
- Black, Fischer. "The Pricing of Commodity Contracts." *Journal of Financial Economics* 3 (1976): 167-79.
- Black, Fischer, and Myron S. Scholes. "The Pricing of Options and Corporate Liabilities." *Journal of Political Economy* 81 (May/June 1973): 637-54.
- Bodie, Zvi, Alex Kane, and Alan J. Marcus. *Investments*. Homewood, Ill.: Irwin, 1989.
- Canina, Linda, and Stephen Figlewski. "The Informational Content of Implied Volatility." *Review of Financial Studies* 6 (1993): 659-81.
- Chicago Mercantile Exchange. *Rules of the CME*. November 1994.
- Cox, John C., Jonathan E. Ingersoll, and Stephen A. Ross. "The Relation between Forward Prices and Futures Prices." *Journal of Financial Economics* 9 (1981): 321-46.
- Cox, John C., and Mark Rubinstein. *Options Markets*. Englewood Cliffs, N.J.: Prentice-Hall, 1985.
- Das, Sanjiv R. "Jump-Diffusion Processes and the Bond Markets." Harvard Business School, Division of Research, Working Paper 95-034, 1995.
- Derman, Emanuel, and Iraj Kani. "Riding on a Smile." *Risk* 7 (February 1994): 32-39.
- Doan, Thomas A. *RATS User's Manual, Version 4*. Evanston, Ill.: Estima, 1992.
- Duffie, Darrell. *Futures Markets*. Englewood Cliffs, N.J.: Prentice Hall, 1989.
- Dupire, Bruno. "Pricing with a Smile." *Risk* 7 (January 1994): 18-20.
- Feinstein, Steven P. "A Source of Unbiased Implied Volatility Forecasts." Federal Reserve Bank of Atlanta, Working Paper 88-9, December 1988.
- Flesaker, Bjorn. "Arbitrage Free Pricing of Interest Rate Futures and Forward Contracts." *Journal of Futures Markets* 13 (1993): 77-91.
- Goldstein, Morris, David Folkerts-Landau, Peter Garber, Liliana Rojas-Suárez, and Michael Spencer. *International Capital Markets, Part I: Exchange Rate Management and International Capital Flows*. World Economic and Financial Surveys. Washington, D.C.: International Monetary Fund, April 1993.
- Goodfriend, Marvin, and William Whelpley. "Federal Funds." In *Instruments of the Money Market*, edited by Timothy Q. Cook and Timothy D. Rowe. Richmond: Federal Reserve Bank of Richmond, 1986.
- Heath, David, Robert A. Jarrow, and Andrew J. Morton. "Bond Pricing and the Term Structure of Interest Rates: A New Methodology." *Econometrica* 60 (January 1992): 77-105.
- Heston, Steven L. "Yield Curves and Volatility." Yale School of Organization and Management, unpublished manuscript, July 1993.
- Jarrow, Robert A., and Andrew Rudd. *Option Pricing*. Homewood, Ill.: Irwin, 1983.
- Mendenhall, William, Richard L. Scheaffer, and Dennis D. Wackerly. *Mathematical Statistics with Applications*. 2d ed. Boston, Mass.: Duxbury Press, 1981.
- Press, William H., Brian P. Flannery, Saul A. Teukolsky, and William T. Vetterling. *Numerical Recipes in C: The Art of*

- Scientific Computing*. New York: Cambridge University Press, 1988.
- Rubinstein, Mark. "Implied Binomial Trees." *Journal of Finance* 49 (July 1994): 771-818.
- Shimko, David. "Bounds of Probability." *Risk* 6 (April 1993): 33-37.
- Smith, David G., and Robert I. Webb. "The Volatility of Eurodollar Futures Prices around Fed Time." *The Journal of Fixed Income* 2 (March 1993): 58-73.
- Tompkins, Robert. "The A-Z of Caps." *Risk* 2 (March 1989): 21-23, 41.
- Vogel, Thomas T., Jr. "Fed Rate Boost Spurs Rally in Bond Markets." *Wall Street Journal*, August 17, 1994, C1, C19.
- Whaley, Robert E. "Valuation of American Futures Options: Theory and Empirical Tests." *Journal of Finance* 41 (March 1986): 127-50.

FYI

Examining Small Business Lending in Bank Antitrust Analysis

W. Scott Frame

Fueled by the repeal of many depression-era interstate banking and intrastate branching laws, the U.S. banking industry has entered an unprecedented period of consolidation and reorganization. In fact, between 1990 and 1994 there were more than 1,500 bank mergers and acquisitions (Ed Dillon 1995). This bank merger wave has sparked public policy debate about the desirability of such combinations, particularly in the context of antitrust evaluation. The U.S. Department of Justice and bank regulators, such as the Federal Reserve, are responsible for preserving and protecting competition in the midst of industry consolidation.¹

Although all corporate merger applications are evaluated uniformly (as outlined in U.S. Department of Justice 1992), legal precedent has established unique parameters for analyzing bank mergers.² Given the large technological and regulatory changes the financial services industry has experienced in recent years, many have questioned whether a move toward a more traditional product-based antitrust analysis would better reflect today's market realities, in which many retail and large-firm lending markets have numerous nonbank competitors (competing over wider geographic areas) whose presence reduces concentration concerns in these markets. At the same time, the market for small business loans has been of particular interest to both bank

The author is an economic analyst in the financial section of the Atlanta Fed's research department and a Ph.D. candidate in the economics department of the University of Georgia. He thanks Christopher Holder, Frank King, Larry Wall, and especially Aruna Srinivasan for helpful comments.

regulators and the Justice Department because of the lack of nonbank competitors and the local limitations of customers.

The increased attention to small business lending in bank merger applications has effectively moved antitrust authorities away from an aggregate approach to product market definition.³ Macroeconomic concerns as well as changes in the banking industry have driven this shift in focus. The importance of small businesses within the U.S. economy was highlighted during the most recent economic recession (1990-92) as the credit crunch stifled innovation and employment in many small firms.

Recent academic literature on banking antitrust analysis has found the market for unsecured small business loans to be unique because of the "local" nature of these loans and the lack of nonbank competition. Although theoretically appealing, disaggregating the product market for banking (and examining small business lending) suffers from several measurement problems resulting from a lack of reliable data.

This article intends to provide an overview of recent developments in banking antitrust analysis, particularly in the area of small business lending. The article begins by outlining the traditional approach to antitrust analysis. The next section provides a historical perspective on legal precedents in banking antitrust analysis and discusses how changes in the financial services marketplace may influence such analysis in the future. In particular, through a summary of the academic literature, the article examines the importance of small business lending as a unique product market. Finally, the article discusses the potential costs and benefits to disaggregating the product market for purposes of antitrust analysis and highlights some policy considerations.

Antitrust Analysis

Defining the relevant product and geographic markets is critical to conducting a complete competitive analysis of any corporate merger. All firms that influence (or could potentially influence) market prices of the goods or services in question should be included in the analysis.⁴ In general, a market includes buyers and sellers in a geographic area that can significantly influence the price, the quality, or the quantity of the specific commodities or services traded. A market can also be delineated as a geographic area in which the prices of all similar (substitute) goods are dependent on each

other but are unaffected by prices for such goods outside of this area.

The Product Market. Dennis Carlton and Jeffery Perloff (1994) note that a proper definition of the product dimension of a market should include all products that are close demand or supply substitutes. For example, Product B is a *demand substitute* for Product A if an increase in the price of A causes consumers to use more B instead. Product B is a *supply substitute* for Product A if, in response to an increase in the price of A, firms producing B switch some of their production facilities to the production of A. In both cases, the presence of Product B significantly constrains the pricing of Product A, provided that an increase in the price of A would result in either a significant decline in the quantity of A consumed as consumers switch from A to B or a significant increase in the supply of A as firms switch production from B to A.

Two Supreme Court decisions, both involving non-financial institutions, stand out as providing guidance in establishing relevant markets in antitrust matters: *United States v. E.I. DuPont de Nemours & Co.* (1956) and *Brown Shoe Co. v. United States* (1962).⁵ In the DuPont ruling, the court recognized that all products have substitutes and that a major task of antitrust analysis is the identification and evaluation of these substitute products. The court stated that product markets are to be determined by the cross-elasticity of demand between the product claimed to be monopolized and other products. (Cross-elasticity of demand refers to the relationship between the quantity demanded of one product and a change in the price of another. The more responsive the quantity of a product demanded is to a price change in another good, the higher the cross-elasticity and the more the products are viewed as substitutes for each other.) Depending on the degree of cross-elasticity, products may be categorized as either perfect substitutes, close substitutes, or nonsubstitutes. In the *Brown Shoe Company* case, the court affirmed its position regarding cross-elasticities of demand and provided the following seven criteria to be used in defining antitrust markets and/or submarkets: (1) industry or public recognition, (2) a product's peculiar characteristics and uses, (3) unique production facilities, (4) distinct customers, (5) distinct prices, (6) sensitivity to price changes, and (7) specialized vendors.

On the supply side, the Justice Department's 1992 *Horizontal Merger Guidelines* specify that the relevant antitrust market includes firms that are currently producing and selling the relevant product as well as "uncommitted entrants," or firms that likely would readily enter the market without significant sunk costs in re-

sponse to a “small but significant nontransitory increase” in the market price.⁶ Because additional market entrants help deter the original firm from exercising its market power (its ability to profitably maintain a price above the opportunity costs of its resources), their presence enhances competition. In theory, a measurement of cross-elasticity of supply would be relevant in determining the level of potential competition in a market. In practice, however, cross-elasticities cannot be used to precisely determine markets because estimation is difficult and current theory does not define specific numerical levels at which one product is viewed as an adequate substitute for another. Also, substituting products may not be feasible in the short term because it could involve changing production processes. As a result, the courts’ definition of the relevant market includes only those producers that might have a direct and immediate effect on competition.

Geographic Markets. Once the relevant products have been identified, geographic markets are determined for each product. The geographic limit of a market is determined by simply answering the question of whether an increase in price in one location substantially affects price in another. If so, then both locations are in the same market.⁷

Market Concentration and Structure. After both the product and geographic markets have been determined, the level of competition must be assessed. In assessing market power, economists are concerned with the level of the sellers’ concentration in a market. This level is a function of both the number of firms and their respective market shares, or the percentage of the market supplied (or controlled) by a particular firm during a specified time period.⁸ The most popular measure of market concentration is a concentration ratio, which shows the level of market shares accounted for by the largest firms in a particular market.⁹ Some analysts, however, consider the Herfindahl-Hirschman Index (HHI) to be analytically superior to a simple concentration ratio because it takes into account both the number and size distribution of the sellers in the market.¹⁰

Competitive analysis of corporate mergers (including those in banking) relies heavily on theories developed in the subfield of economics known as industrial organization. Specifically, the structure-conduct-performance (SCP) paradigm serves as the cornerstone of antitrust analysis because the structure of a market (that is, its degree of concentration) is viewed as revealing information about the level of competition within it.¹¹ In the SCP paradigm, an industry’s competitive performance depends on the conduct of buyers and sellers, which depends on the structure of the market. The structure,

in turn, is based on conditions such as technology and demand for a product.

The relationship between market structure (level of concentration) and performance (profits or prices) implied by the structure-conduct-performance theory has been studied extensively. Alton Gilbert (1984) reviewed the earliest structure-performance studies of the banking industry, noting that they provided limited support for the SCP paradigm and suffered from various methodological flaws. Of particular concern was that many of these early studies treated market structure as exogenous (that is, determined outside of the marketplace), implying that competition between firms has no effect on structure.¹² As a result, these studies were unable to distinguish between market power and production efficiency as the source of concentration and profitability. Sherill Shaffer (1994) pointed out that economic theory implies that an efficient firm (one delivering either a superior product or operating at a lower cost) can drive its rivals out of a competitive market unless the rivals are able to emulate the successful firm. It follows that such superiority would result in both high profitability and a large market share for the successful firm, resulting in a more concentrated market (despite the vigor of competitors).

Other recent articles, such as Michael Smirlock’s (1985) and Allen Berger’s (1991), have addressed the need to account for cost differences between institutions. Both Smirlock and Berger find that the link between concentration and profitability largely disappears after accounting for relative production efficiency. However, Douglas Evanoff and Diana Fortier (1988) found that some of the profit-concentration linkage may persist, even after considering efficiency, in markets with substantial barriers to entry. In addition, Shaffer (1994) noted that studies of the relationship between prices and concentration have generally found evidence that high market concentration is correlated with prices unfavorable to the consumer.¹³ Inherent in all of these results is the notion that commercial banking is a distinct line of commerce, that banks compete in local market areas, and that nonbank competition is negligible.

Competition in the Banking Industry

The evaluation of competition within banking markets begins with a discussion of the relevant product market. Legal precedent has established commercial banking as a distinct line of commerce—effectively

bundling together the various products and services offered by these institutions. This definition does not recognize nonbank financial institutions as significant competitors in several of the individual banking products.¹⁴ Yet, in fact, competition from nonbanks serves to lessen banks' market power, and, if formally recognized, such competition lowers the level of concentration within these product markets.

The Cluster Approach. In a 1963 case involving Philadelphia National Bank the Supreme Court clarified the means by which regulators should measure competition in the banking industry.¹⁵ Christopher L. Holder (1993a) noted that this ruling established three major legal precedents still used by the Federal Reserve. First, the court confirmed that the Sherman and Clayton Antitrust Acts apply to banking and used market structure as an indicator of competition within the market. Second, the ruling determined that "the cluster of products (various kinds of credit) and services (such as checking accounts and trust administration) denoted by the term 'commercial banking' . . . composes a distinct line of commerce" for Clayton Act purposes. Third, the decision indicated that the sections of the country affected by an acquisition (the geographic market) must be taken into account.¹⁶ In sum, the Philadelphia National case established commercial banking as a distinct line of commerce, defined the relevant product market as including only those institutions offering the full cluster of bank products and services (including demand deposits and commercial loans), and determined the relevant geographic market to be local. This ruling runs counter to the typical product market analysis employed in other industries.

The Philadelphia National judgment establishing the so-called cluster approach was reaffirmed by rulings in cases involving Phillipsburg National Bank (1970) and, more recently, Central State Bank (1985).¹⁷ In the Central State Bank case, the Department of Justice proposed that the relevant product market be strictly composed of transactions accounts and small business loans, the products in which banks generally have the fewest competitors.¹⁸ The court dismissed these arguments and stated that, while there may be identifiable submarkets within the commercial banking market, "submarkets are not a basis for the disregard of a broader line of commerce that has economic significance. In selecting between two product markets, the court must select the one which will reflect the full brunt of any and all anticompetitive effects of the challenged acquisition or merger" (1291). Therefore, in the Central State Bank case the Supreme Court determined that the cluster of products and services termed "commercial banking" has

economic significance well beyond the various products and services involved.

The individual bank products discussed in the Philadelphia National case represented varying degrees of geographic market delineation. The "cluster of banking products and services" not only aggregated products but it also defined (in essence) a local market that represented some sort of "average" of the actual geographic markets of the individual products. In measuring the "cluster," the court used deposits as a proxy for a bank's capacity to provide cluster products and services and then estimated market shares in an attempt to uncover any existing market power. This approach to product market analysis serves to reduce costs to both potential bank acquirers and regulators performing the analysis by reducing uncertainty about the appropriate product market definition. However, as the financial services industry has evolved and the levels of competition in various products have changed in response to technology and nonbank entry, legal precedent has lagged because the courts have not yet recognized sub-product markets in banking.

The Impact of Nonbank Competitors. Examining the relevant antitrust product market for banking is challenging because the distinctions among different types of financial institutions have blurred in the last two decades. Deregulation, market innovation, and advances in electronic technology in recent years have widened the range of institutions and the distance over which households and firms select financial services. The authorization of interest-bearing checking accounts, the spread of automated teller machines, and the growth of nationwide issuers of credit cards have been instrumental changes for financial institutions. Regulatory changes have allowed thrifts and other nonbank financial institutions to offer a greater number of services and have permitted producers of specialized financial services (such as mortgage and finance companies) to offer services in any market.

In a 1974 case involving Connecticut National Bank the Supreme Court upheld its Philadelphia National ruling but noted that thrifts and other nonbank institutions had made competitive inroads in some services.¹⁹ However, the court concluded that thrifts should not, at that time, be a factor in assessing the competitive effects of bank mergers because thrifts were not competitive in the area of commercial lending. With the passage of the Depository Institutions Deregulation and Monetary Control Act of 1980 (DIDMCA) and the Garn-St Germain Act of 1982, thrifts were authorized to compete with banks in providing the cluster of products previously unique to banking.²⁰ Nevertheless, al-

though many thrifts have become competitive retail lenders, most have not been aggressive commercial lenders. For this reason, the Federal Reserve, in assessing the competitive effects of a merger using the “cluster” approach, accords thrift deposits 50 percent weight to reflect both actual and potential competition by these firms.²¹ In addition, the Fed’s assessment makes allowances in the threshold levels of changes in the Herfindahl-Hirschman Index (HHI) for bank mergers to reflect nonbank competition.²² In short, nonbank firms have significantly enhanced retail banking competition, resulting in the modification of bank merger analysis. However, the market for unsecured small business loans has experienced little competition from nonbanking firms.

The Role of Small Business Lending

Although the “cluster” of banking services remains the appropriate product market definition as defined by legal precedent, the Department of Justice has recently begun examining subproducts, particularly loans to small businesses, in its merger analysis.²³ Recent academic literature has indicated that special attention to small business lending may be warranted because of the “local” nature of these loans and the relative absence of nonbank competitors in the provision of unsecured business credit.²⁴ Such a disaggregated analysis, while in the mainstream of antitrust, stretches legal precedent for banking. This approach has been somewhat controversial in that it has increased uncertainty for merging parties and has not yet been tested in the courts, principally because banks are reluctant to incur the costs associated with prolonged litigation.²⁵

Whether sanctioned or not by legal precedent, there may be an economic basis for treating small business loans as a unique product. Two recent studies have examined the behavior of small firms and their banking relationships. Gregory Elliehausen and John Wolken (1990) found that small firms are more likely than large firms to depend on their primary institution for credit and to use fewer financial institutions in general. Their research claims that the costs financial institutions incur for credit evaluation, monitoring, and bankruptcy tend to be higher, relative to the size of the transaction, for small firms than for large firms. This cost difference is enhanced when the financial institution is a distant one. As a result, distant suppliers (or lenders) are less likely to accept credit applications from small firms, particularly distant ones, than from

large firms, especially when the desired credit would be unsecured.

Mitchell Peterson and Raghuram Rajan (1994) discuss the ways in which the relationship between a firm and its creditors affects the availability and cost of funds to firms.²⁶ Using a sample of small business loans, Peterson and Rajan find that the availability of funds increases and the cost of funds decreases, although relatively less so, as a result of a continuing relationship. The authors discuss two important dimensions of credit relationships—duration and the interaction over a number of products. Duration is important: the longer a business has been servicing its loans, the more likely the business is to be viable and the owner trustworthy. Therefore, the lender expects the loans to be less risky, reducing the expected cost of lending and increasing the willingness to provide funds. A firm’s use of multiple products can also affect future borrowing by either increasing the precision of the lender’s information or by spreading the fixed costs of information gathering over multiple products.

Peterson and Rajan also point out that information asymmetries between small firms and potential public investors are substantial because these firms are unlikely to be monitored by rating agencies or the financial press. This asymmetric information, by increasing the uncertainty of lenders, implies that lenders will charge borrowers higher interest rates to compensate for higher risk. In fact, Joseph Stiglitz and Andrew Weiss (1981) show that the interest rate charged determines not only the demand for capital but also the riskiness of borrowers. If this observation is true, lenders may optimally choose to ration the quantity of loans they grant rather than raising the rate to clear the market. This second effect may imply that the problems of adverse selection and moral hazard may have a sizable effect for small firms.²⁷ As a result, small firms generally must rely on their primary local institution for unsecured credit because their close relationship will reduce these information asymmetries.²⁸

Competition in business lending from nonbanks, such as commercial finance companies and factoring companies, is primarily concentrated in collateralized (secured) lending. In contrast to collateralized lending, monitored (unsecured) lending requires the lender to watch the borrower’s financial condition closely. Banks are considered to have a comparative advantage in monitored lending because they are better able to obtain information about the financial condition of borrowers.²⁹ Specifically, banks can monitor loans through their access to borrowers’ transaction accounts. Leonard Nakamura (1992/1993) notes that a small firm’s checking

account sheds light on its revenues and expenses because the firm's cash flows are typically documented completely within that one account. Nakamura proposes this "checking account hypothesis" as an explanation of the resolution of information asymmetries that arise in some small-business lending situations.

Nonbanks provide only a very limited amount of unsecured small business credits. The issue of small business loan securitization has been explored recently in search of ways to improve small businesses' access to credit. George Benston (1992) and Christopher Beshouri and Peter Nigro (1994) concluded that the characteristics of small firm finance (especially informational asymmetries and ongoing monitoring) impose significant costs that may offset any funding advantages to securitization. Thrift institutions, while having both the authority to underwrite business loans and access to transactions accounts, have not become a significant competitor in this area. The financial troubles faced by thrifts in the last ten years have, in fact, resulted in substantial cutbacks in their commercial and industrial loan portfolios. Timothy Hannan and J. Nellie Liang (1995) assessed the competitive influence of thrift institutions on the pricing of commercial loans made by commercial banks. The study's empirical tests suggest that thrifts should not be given consideration in antitrust evaluations of business lending for bank mergers.

Contrasting the Cluster and Disaggregated Approaches to Antitrust Analysis

The Justice Department's manner of defining the relevant product market(s) for banking—individual products and services (particularly loans to small businesses)—parallels analysis conducted in other industries and is consistent with both theoretical and empirical evidence. However, legal precedent still maintains that "the cluster of commercial banking products and services" is the relevant product market. To examine the policy implications of changing the approach to bank merger analysis, an accounting of the various costs and benefits must be made.

In evaluating the cluster approach, the potential cost to be considered is that of market power arising from an approved merger, which results in a consumer welfare loss.³⁰ This loss would typically result from borrowers paying higher rates on loans and depositors receiving lower interest on savings. Because many retail and large-firm lending markets appear to have access to a wide range of nonbank competitors, market

power does not seem, in general, to be the important consideration it is in other product markets. However, there is evidence that unsecured loans to small businesses (working capital loans) do tend to be local and are not often provided by nonbank lenders. As a result, any market power realized as a result of a combination would likely be in the area of loans to small businesses. In fact, Hannan (1991) provides evidence that small commercial loans are local in nature and that the level of concentration in a market significantly affects the pricing of these loans. Hannan's findings suggest that a closer examination of the market for small business loans is warranted when regulators are evaluating the competitive effects of a merger.

The cluster approach to bank merger analysis does have an advantage in that institutions, when considering a merger, can overcome most of the uncertainty surrounding antitrust evaluations. Specifically, banks can analyze the necessary data themselves prior to performing due diligence analysis or engaging consultants, resulting in substantial cost savings.³¹ Institutions can thus tender offers more confidently, having addressed antitrust concerns in advance. In addition, regulators save valuable public resources by conducting fewer detailed investigations in antitrust cases involving merging parties that have not examined these competitive issues prior to filing an application. Such cases generally result in the withdrawal of the application—after the parties involved and their respective regulators have expended significant resources.

Another possible approach would be to break up the cluster (and analyze individual product markets), but doing so would present a significant cost in that uncertainty would be increased for actual (and potential) applicants. This uncertainty would concern which particular subproduct(s) markets would be examined (and how these markets would be defined geographically) as well as the lack of accurate data for analysis.³² For example, in assessing competition for small business loans, if a bank operates in several geographic markets, regulators may be unable to surmise the level of business lending within a particular market area. As a result, estimates must be constructed for each institution based on its total deposits, total small business loans, and market deposits. (See the box on page 38 for a discussion of the determination of market shares for small business lending.)

These estimations raise questions as to the accuracy of competitive evaluations of small business lending for several reasons. First, conditions within individual markets may differ, and the commercial loan-to-deposit ratio for the whole institution may bear little resem-

blance to its ratio in a specific market. In fact, this problem may become even greater after interstate branching takes effect in 1997, as banks consolidate their individual subsidiaries into branches. Second, evaluations are made by examining total small business loan amounts outstanding rather than using the number of loan originations. Institutions with very few (but relatively large) loans or those that have recently been inactive business lenders may be given disproportionate weight. Third, it is not disclosed in the Call Report submitted by banks (see the box) whether the loans are secured. Fourth, the Call Report defines loans to small businesses as "small loans," or loans with original amounts of less than \$1 million. Information on the size of the businesses receiving these loans is not available.

Efforts to overcome the aforementioned problems have centered on calling each of the individual institutions in the relevant geographic market. In theory, more accurate data could be obtained directly from bank branches; however, this approach only poses a new set of problems. First, these efforts can be quite costly (in terms of labor hours) to the institutions not involved in the proposed merger. As a result, they have little incentive to comply with the regulatory request for data. Second, most institutions do not separate the relevant data by branch. In other words, the Call Report is generated for the institution, and its own records are kept in the same format. Third, even if branch-level data are available, some institutions may confuse (or combine) commercial and industrial and commercial real estate loans.

Overall, the cluster (as a reasonable product market proxy) seems to significantly reduce information costs between banking institutions, their regulators, and federal antitrust enforcement agencies. However, compelling theoretical and empirical evidence suggests that the market for small business loans deserves additional scrutiny in antitrust evaluations. Although a disaggregated approach to product market definition is more in line with analysis performed in other industries, a number of measurement problems cloud any conclusion that an exclusive subproduct market approach would provide substantial benefits in excess of the aforementioned information costs.³³

Conclusion

More than thirty years ago, legal precedent established the relevant antitrust product market for banking as the "cluster of banking products and services." This aggregate approach to product market definition is unique to banking and contrasts with traditional antitrust analysis. Technological advancements have consistently raised the level of competition in most banking products as more banks and nonbank competitors find it feasible to compete in distant geographic markets. However, while nonbank competition has been significant in many retail banking markets, unsecured lending to small businesses remains primarily a "bank" product. Both theoretical and empirical evidence has confirmed that, because of problems caused by information asymmetries, unsecured working capital loans are provided almost exclusively by local banks. As a result, geographic markets for these loans are generally defined more narrowly than those for the cluster of banking products and services, resulting in greater market concentration. It is this concentration (and its resulting effects on economic performance) that is of interest to antitrust authorities when evaluating bank mergers.

Whether or not the competitive analysis of bank mergers can benefit from examining small business lending markets depends on a number of factors, including (1) the reliability of concentration estimates, (2) the effects of this concentration on consumers, (3) supply reactions to concentration, (4) the development of supply substitutes (such as securitization), and (5) the adequacy and cost of information on small business lending in each local geographic market. Even if a disaggregated approach were adopted, it might be reasonable to continue the cluster analysis as a low-cost initial screen for bank merger applications. In sum, as a policy of examining small business loans is clearly articulated and data become more reliable, the benefits to consumers from examining particular subproducts (such as small business loans) in banking antitrust evaluations will become clearer.

Market Share Calculation for Small Business Lending

In order to determine the market shares of each institution competing in a particular market, data from the Consolidated Reports of Condition and Income (Call Reports) on small loans to businesses are compiled.¹ Because Call Reports give aggregate measurements (for each institution as a whole), the level of lending within an individual market will often have to be estimated. These estimates are constructed by first determining the relative presence of each bank in the market by dividing its in-market deposits by its total (institution-wide) deposits.² This ratio is then multiplied by the bank's loans to small businesses outstanding (from the Call Report) to determine an estimate of in-market small business lending. Once these es-

timations are completed for all market participants, individual market shares may be computed. See Table A for an example of how market shares are calculated for small business loans.

Notes

1. The Consolidated Reports of Condition and Income collect basic financial data of commercial banks, including balance sheet, income statement, and supporting schedules. Each bank submits these reports quarterly to its primary regulator.
2. As mentioned previously, deposit data by branch are available, but loan data are not.

Table A
Athens, Georgia, Banking Market
Small Business Loans (SBLs)
(Data as of June 30, 1994)

Holding Company/Institution	Total SBLs	Total Deposits	In-Market Deposits	Estimated In-Market SBLs	SBL Market Share
Synovus Financial Corporation/Athens First Bank and Trust Company	19,217	372,847	296,519	15,283	15.00
Suntrust Banks, Inc./Trust Company Bank of NE Georgia	22,035	241,156	204,479	18,684	18.34
NationsBank Corporation/NationsBank of Georgia	868,004	8,645,894	200,395	20,119	19.75
First Commerce Bancorp/First National Bank of Commerce	6,333	104,779	87,761	5,304	5.21
Oconee State Bank	9,901	73,524	73,524	9,901	9.72
Bank South Corporation/Bank South NA	252,811	4,403,626	72,904	4,185	4.11
First American Bancorp/First American Bank and Trust Company	2,505	68,309	68,309	2,505	2.46
First National Bankcorp*/First National Bank of Jackson County	9,070	55,273	55,273	9,070	8.90
Georgia National Bancorp/Georgia National Bank	6,958	53,713	53,713	6,958	6.83
Community Bankshares/Community Bank and Trust Company-Jackson	3,850	42,745	42,745	3,850	3.78
Bank of Danielsville	665	42,023	42,023	665	0.65
TCB Bancshares/Commercial Bank	808	35,825	35,825	808	0.79
Bank of Georgia	1,505	34,852	34,852	1,505	1.48
Merchants and Farmers Bank	255	32,903	32,903	255	0.25
Main Street Banks/Southern Heritage Savings Bank	1,101	22,641	22,641	1,101	1.08
Southtrust Corporation/Southtrust Bank of Georgia	88,084	2,067,791	12,234	521	0.51
Peoples Holding Company/Peoples Bank	7,027	95,102	11,247	831	0.82
First Security Bankshares/Braselton Banking Company	347	5,637	5,637	347	0.34
Total Market	1,300,476	16,398,640	1,352,984	101,892	100.00

*Also includes deposits of a branch of Bank of Banks County.

Notes

1. The Federal Reserve has jurisdiction over mergers of state member banks and mergers or acquisitions by bank holding companies. The Comptroller of the Currency has primary responsibility for mergers of national banks. The Federal Deposit Insurance Corporation oversees insured state non-member banks.
2. Specifically, *United States v. Philadelphia National Bank*, 374 U.S. 321 (1963), found commercial banking to be the relevant product market (or a distinct line of commerce) and the geographic market to be local for Clayton Act purposes. (The Clayton Act of 1914, along with the Sherman Act [1980] and the Federal Trade Commission Act [1914], is one of three major statutes governing antitrust policy. The Clayton Act is directed primarily against four specific practices: price discrimination that lessens competition, tie-ins and exclusive dealing that lessen competition, mergers that reduce competition, and interlocking directorates among competing firms.)
3. It should be noted that the Board of Governors of the Federal Reserve has not made a public statement about its willingness to examine small business lending in analyzing merger applications.
4. In practice, approximations are made in specifying both product and geographic markets. In fact, the definition of the relevant market(s) is often contested in antitrust cases.
5. See *United States v. E.I. DuPont de Nemours & Co.*, 351 U.S. 377 (1956), and *Brown Shoe Co. v. United States*, 370 U.S. 294 (1962). These cases are discussed in Carlton and Perloff (1994).
6. Ordinarily, this price increase is assumed to be 5 percent.
7. The Justice Department's 5 percent test is applicable to geographic market definitions as well as those for product markets.
8. Market shares are based on the percentage of total deposits controlled by each firm within a specific market.
9. The most often cited concentration ratios are the three-firm (CR3) and four-firm (CR4) ratios.
10. The HHI measures the sum of squared market shares of each firm in the market. Thus, the HHI ranges from zero in a perfectly competitive market with an infinite number of firms to 10,000 in a purely monopolistic market with one firm. In the 1992 *Horizontal Merger Guidelines*, a market in which the HHI is less than 1,000 is considered unconcentrated; between 1,000 and 1,800, moderately concentrated; and exceeding 1,800, highly concentrated.
11. See Carlton and Perloff (1994) for an overview of the structure-conduct-performance paradigm.
12. Structure-performance studies have been conducted for numerous industries. In addition, the methodological critique presented by Gilbert (1984) is not unique to studies of the banking industry. See Carlton and Perloff (1994) for a discussion of both of these issues.
13. See Berger and Hannan (1989), Calem and Carlino (1991), and Hannan (1991).
14. For example, secured commercial lending is dominated by commercial finance companies, factoring companies, and the use of trade credit. In addition, mortgage companies, thrifts, credit unions, and finance companies all originate mortgage loans.
15. See *United States v. Philadelphia National Bank*, 374 U.S. 321 (1963).
16. The court opined that "in banking, as in most service industries, convenience of location is essential to effective competition. Individuals and corporations typically confer the bulk of their patronage on banks in their local community; they find it impractical to conduct their banking business at a distance" (358).
17. See *United States v. Phillipsburg National*, 399 U.S. 350 (1970), and *United States v. Central State Bank*, 621 F.Supp 1276 (1985).
18. Transactions accounts and small business loans are offered by few nonbank providers. In addition, customers for these products are considered to be "locally limited," resulting in a more narrowly defined geographic market. These points are discussed below.
19. See *United States v. Connecticut National Bank*, 418 U.S. 656 (1974).
20. DIDMCA allowed savings and loan associations to make consumer loans and offer consumer checking (NOW) accounts and phased out interest rate ceilings on time and savings deposits. The Garn-St Germain Act, in turn, allowed federally chartered thrifts to hold up to 10 percent of their assets in commercial loans and to enhance their consumer lending activities and allowed both banks and thrifts to offer money market accounts.
21. The Justice Department, on the other hand, recognizes thrift deposits at only 20 percent of their total.
22. In the 1992 *Horizontal Merger Guidelines*, mergers in highly concentrated markets (those with an HHI exceeding 1,800) must not produce a change in the HHI of more than 50 points. For bank mergers, a change of 200 points is allowed in recognition of nonbank competition. In practice, these threshold levels represent only a reference point in examining mergers that exceed them. See Holder (1993b) for a discussion of "mitigating factors," or additional considerations examined by antitrust authorities in these merger applications.
23. The Department of Justice considers firms with up to \$10 million in annual revenues as small businesses. Some merger cases of interest include First Hawaiian/First Interstate of Hawaii (1990), Fleet-Norstar/Bank of New England (1991), Society/Ameritrust (1992), and Bank of America/Security Pacific (1992).
24. Commercial banks and small businesses have a unique relationship. Small businesses rely almost exclusively on local commercial banks for working capital loans. In turn, many smaller banks rely on these businesses for the bulk of their commercial lending, as many middle-market and large firms have taken their business to only the largest banks or to public capital markets.
25. In such a case an individual bank would bear the entire social cost of resolving this issue while accruing only the private benefit.

26. Such a credit relationship can be described as a close and continuous interaction between borrower and lender that generates useful information about the borrower's financial state.
27. Adverse selection implies that as higher interest rates are charged, riskier borrowers may solicit loans, while moral hazard implies that (creditworthy) borrowers may take on riskier investments.
28. The issues presented above are not applicable for secured credit. The differences between secured and unsecured credit are discussed below.
29. If the borrower's financial condition deteriorates, the bank must either refuse future loans or call the loan if the firm violates any covenants.
30. In such a case, structural numbers (as measured by the HHI) for the cluster of banking products and services (for which deposits are proxies) would not exceed Justice Department guidelines, while numbers for an individual product (such as small business loans) might exceed threshold levels. The opposite scenario, of course, would be a situation in which the merger passed an antitrust screening using a subproduct market approach, while it would have failed the cluster test. This second scenario, however, is believed to be much less likely because geographic markets for small business loans are generally defined more narrowly.
31. Summaries of deposit data, which are used as a proxy for the cluster of bank products and services, are readily available from the Federal Deposit Insurance Corporation and from a number of commercial vendors. Also, most Federal Reserve Banks have predefined geographic market definitions that are available upon request.
32. For example, when analyzing competition within small business lending, the geographic market may be defined more narrowly than that for the traditional (cluster) analysis.
33. It should be mentioned that these measurement problems would exist in analysis of almost any industry. In fact, as a regulated industry, banking data are unusually uniform and complete.

References

- Benston, George. "The Future of Asset Securitization: The Benefits and Costs of Breaking up the Bank." *Journal of Applied Corporate Finance* 5 (Spring 1992): 71-82.
- Berger, Allen. "The Profit-Concentration Relationship in Banking." Board of Governors of the Federal Reserve System, Finance and Economic Discussion Series, No. 176, November 1991.
- Berger, Allen, and Timothy Hannan. "The Price-Concentration Relationship in Banking." *Review of Economics and Statistics* 71 (May 1989): 291-99.
- Beshouri, Christopher, and Peter Nigro. "Securitization and Small Business Loans." Office of the Comptroller of the Currency. Economic and Policy Analysis Paper Series, No. 94-8, December 1994.
- Calem, Paul, and Gerald Carlino. "The Concentration/Conduct Relationship in Bank Deposit Markets." *Review of Economics and Statistics* 73 (May 1991): 268-76.
- Carlton, Dennis, and Jeffery Perloff. *Modern Industrial Organization*. New York: Harper-Collins, 1994.
- Dillon, Ed. SNL Securities. Telephone conversation with author, April 20, 1995.
- Elliehausen, Gregory, and John Wolken. "Banking Markets and the Use of Financial Services by Small and Medium-Sized Businesses." *Federal Reserve Bulletin* 76 (October 1990): 801-17.
- Evanoff, Douglas, and Diana Fortier. "Reevaluation of the Structure-Conduct-Performance Paradigm in Banking." *Journal of Financial Services Research* 1 (June 1988): 277-94.
- Gilbert, Alton. "Bank Market Structure and Competition: A Survey." *Journal of Money, Credit, and Banking* 16 (November 1984): 617-45.
- Hannan, Timothy. "Bank Commercial Loan Markets and the Role of Market Structure: Evidence from Surveys of Commercial Lending." *Journal of Banking and Finance* 15 (February 1991): 133-49.
- Hannan, Timothy, and J. Nellie Liang. "The Influence of Thrift Competition on Bank Business Loan Rates." *Journal of Financial Services Research* 9 (June 1995): 107-22.
- Holder, Christopher L. "Competitive Considerations in Bank Mergers and Acquisitions: Economic Theory, Legal Foundations, and the Fed." Federal Reserve Bank of Atlanta *Economic Review* 78 (January/February 1993a): 23-36.
- _____. "The Use of Mitigating Factors in Bank Mergers and Acquisitions: A Decade of Antitrust at the Fed." Federal Reserve Bank of Atlanta *Economic Review* 78 (March/April 1993b): 32-44.
- Nakamura, Leonard. "Monitoring Loan Quality via Checking Account Analysis." *Journal of Retail Banking* 14 (Winter 1992/1993): 16-33.
- Peterson, Mitchell, and Raghuram Rajan. "The Benefits of Lending Relationships: Evidence from Small Business Data." *Journal of Finance* 49 (March 1994): 3-37.
- Shaffer, Sherill. "Bank Competition in Concentrated Markets." Federal Reserve Bank of Philadelphia *Business Review* (March/April 1994): 3-16.
- Smirlock, Michael. "Evidence on the (Non) Relationship between Concentration and Profitability in Banking." *Journal of Money, Credit, and Banking* 17 (February 1985): 69-83.
- Stiglitz, Joseph, and Andrew Weiss. "Credit Rationing in Markets with Imperfect Information." *American Economic Review* 71, no. 3 (1981): 393-410.
- U.S. Department of Justice. *Horizontal Merger Guidelines*. Washington, D.C.: U.S. Department of Justice, April 2, 1992.

FEDERAL
RESERVE
BANK OF
ATLANTA

Public Affairs Department
104 Marietta Street, N.W.
Atlanta, Georgia 30303-2713
(4 0 4) 5 2 1 - 8 0 2 0

Bulk Rate
U.S. Postage
PAID
Atlanta, GA
Permit 292

