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This Quarterly Review *is published by the Research and Statistics Group of the Federal Reserve Bank of New York. Remarks of* E. GERALD CORRIGAN, *President of the Bank, on strengthening international economic policy coordination begin on page 1. Among the staff members who contributed to articles in this issue are* ANN-MARIE MEULENDYKE *(on a review of Federal Reserve policy targets and operating guides in recent decades, page 6);* LAWRENCE J. RADECKI *and* VINCENT REINHART *(on the globalization of financial markets and the effectiveness of monetary policy instruments, page 18);* BRUCE KASMAN *and* CHARLES PIGOTT *(on interest rate divergences among the major industrial nations, page 28); and* ARTURO ESTRELLA, BEVERLY HIRTLE, *and* JOHN A. BREHM *(on estimating the funding gap of the Pension Benefit Guaranty Corporation, page 45).*

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Strengthening International Economic Policy Coordination

Good evening, ladies and gentlemen. I am delighted and honored to have this opportunity to address you as a part of the ongoing Olin Fellowship Program here at Fairfield University.

The subject I would like to peruse with you is the rapidly changing character of the global economic and financial system. My principal message is that the changes we are seeing in the global economy make it important that we strengthen the process of multilateral economic policy coordination and cooperation.

For the typical citizen here in the United States, symptoms of the changed character of the world economy surround us. When our clock radio—which is probably imported—awakes us, the morning news will usually include a report on overnight stock market developments in Tokyo, the dollar-deutsche mark exchange rate in Frankfurt and the London gold price fixing. Many drive to work in imported cars and even those driving domestic cars probably know that their car is better and cheaper because of the competition of imports. Once in the work place, elements of international trade and finance now have a significant direct or indirect bearing on virtually any type of business enterprise I can imagine—small or large. Indeed, whether it is gyrations in the world price of oil, changes in the dollar exchange rate, or changes in interest rates in a major foreign capital, none of us is insulated from economic and financial developments occurring far beyond our national boundaries.

The extent to which these symptoms of the changed character of the world economic and financial system abound in our daily lives is, in some respects, a more recent phenomenon in the United States than in most other countries of the world. This is so in part because our economy is so large relative to others and in part because we are more economically self-sufficient than are most of the other nations of the world. But, to paraphrase the English poet John Donne, no nation is an island, even a nation as large, as dynamic, and as rich as ours. The energy shocks of the 1970s, the behavior of world equity markets last fall, and our large trade and payment imbalances remind us of that in blunt terms.

Whether it is gyrations in the world price of oil, changes in the dollar exchange rate, or changes in interest rates in a major foreign capital, none of us is insulated from economic and financial developments occurring far beyond our national boundaries.

One consequence of this, of course, is that to a greater extent than was once the case our economic well-being is more closely tied to the economic well-being of others, just as theirs is even more tightly bound up in how we manage our affairs. This, of course, is why each nation of the world, but especially the major nations of which the United States remains the most important, must increasingly view its prospects and its problems in a global context and in a manner that guards against the dangers of myopic

Remarks by E. Gerald Corrigan, President of the Federal Reserve Bank of New York, before the Olin Fellowship Program of the Fairfield University School of Business, October 11, 1988.

approaches to economic policy. Let me cite an example or two of the dangers I have in mind.

- First, we all know that one of the pillars of growth, prosperity, and rising standards of living on a worldwide basis is to be found in free, open, and fair trade between nations. Yet, as we look around the world, it is quite apparent that the maintenance and strengthening of practices and policies that are consistent with the principle of free trade cannot be taken for granted. For example, protectionist sentiments are lurking in the shadows here in the United States; the further economic and financial integration of Europe planned for 1992 is viewed by some as a move toward a "fortress Europe" that will be open internally but closed externally; finally, several nations in the Pacific Basin continue to record very large trade and payment surpluses in a context in which there is at least a question as to how open those economies are to imported goods and services.

  I cite these examples not because I believe any one of them represents a clear and present danger to the world trading system that has flourished in the postwar period. Rather, my point is that each of them reflects concerns and attitudes in one country or group of countries that, at least in part, reflect conditions or perceived attitudes in other countries. Protectionism is at work in the United States partly because of concerns about imports but more so because of perceptions of foreign markets being closed to U.S. goods and services. Similarly, at least part of the motivation for European economic integration seems to be spurred by concerns about protectionism in the United States, the Canadian-United States trade agreement, and the apparent technological gap between the United States and Japan on the one hand and Europe on the other.

  This linkage in attitudes — however loose and imprecise it may be — is potentially of great importance since it implies that if one nation or group of nations begins to slip into a more protectionist mode, retaliatory actions by others could follow swiftly. Should that begin to occur, we would find ourselves confronting not only a clear and present danger to world trade, but also a major threat to growth and prosperity on a worldwide scale.

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- Second, we all know that the United States trade deficit is unsustainable, but what is not always clear is the recognition that there are limits as to how and how quickly that deficit can be eliminated in a context of noninflationary growth in the United States and the world economy. For one thing, we in the United States simply do not have the industrial capacity or the slack in labor markets needed to generate the output of manufactured goods that would be needed to eliminate the trade deficit in the near term. Partly for that reason, but also because of the nature and size of the adjustments required in the surplus nations, the elimination of the trade deficit in the context of growth must be viewed over a time horizon of several years and in a context in which success depends not just on what we do but also on the policies and performance of trading partners. Fortunately, the initial phases of the adjustment process are now well underway, but we still have a very long way to go.

The elimination of the trade deficit in the context of growth must be viewed over a time horizon of several years and in a context in which success depends not just on what we do but also on the policies and performance of trading partners.

- Third, the fact that it will take some time to wind down our trade deficit points to another area in which we must exercise vision and patience, and that relates to the growth of foreign investment in the United States. One does not have to look very long or very hard to find expressions of concern about the speed with which foreigners are accumulating assets — both securities and hard invest-

ments — in the United States. Those concerns are, in some respects, understandable, but the hard fact of the matter is that as long as we have current account deficits, foreign investment in the United States must increase.

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Stated differently, current account deficits — like all deficits — must be financed and, one way or another, the financing of the current account deficit will manifest itself as a net increase in foreign holdings of United States assets. Indeed, it is precisely the cumulative effects of the string of large current account deficits over recent years that — in a proximate sense — account for the substantial change in our net financial position with the rest of the world over that period.

That is, if we go back to 1981, which was the last year in which the United States had a current account surplus, the stock of U.S.-owned foreign assets exceeded the stock of U.S. assets owned by foreigners by about $140 billion. At the end of this year, the stock of U.S. assets — stock, bonds, government securities, factories, farm land, real estate, and so forth — owned by foreigners will exceed the stock of U.S. foreign assets by something close to $500 billion. As a very rough approximation, that swing in balance sheet terms from a net foreign asset position of $140 billion to a net liability position of about $500 billion reflects the cumulative sum of the current account deficits we have incurred since 1981. In addition, because those net foreign obligations must be serviced, we now face a situation in which the current account deficit is larger than the trade deficit.

Looked at somewhat differently, even if we assume a straight-line adjustment to current account balance over the next few years, we are still looking at prospective current account deficits that will almost surely aggregate to at least a couple of hundred billion dollars. But, whatever the precise amount, net holdings of U.S. assets by foreigners will increase by about that amount. The issue, therefore, is not whether we are happy with that outcome — which, by the way, brings with it many beneficial results. The issue is how do we and others manage our affairs so that the prospective deficits are financed in the most painless way possible and that we and others follow through on the policy initiatives needed to better insure that the underlying imbalances in trade and payments will be rectified.

The examples I have just cited, bearing as they do on the persistent and large international trade and payment imbalances in the world economy, are illustrations of why it is so important that policies are aimed at the causes, not the symptoms, of these problems and why it is so very important that we find even more effective ways to cope with these problems in a framework of international cooperation and coordination.

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That, of course, has not been, and will not be, easy because the underlying causes of these imbalances reflect both national and international considerations and because they reflect both macroeconomic and structural or microeconomic forces that have built up in the global economy over a long period of time. In the United States, for example, the heart of the problem lies with the combination of large budget deficits and a very low rate of net private savings. But those macro elements in the United States have been compounded by other factors such as cost and quality deficiencies in at least some sectors of U.S. manufacturing industries. In Europe, sub-par growth in domestic demand, relatively high rates of unemployment, and various structural rigidities have also contributed to these imbalances over time. In Japan and the Pacific Basin, very high savings rates, the historic orientation to export industries, and the visible and invisible barriers to imports have also played a role, as has the debt crisis in much of the developing world. And all of these factors have, to a degree, been amplified by the extreme gyrations and volatility in exchange rates that have

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characterized the last decade or so.

Fortunately, and reflecting in part the efforts of the G-5 and G-7 Ministers of Finance and Central Bank Governors, the last few years have witnessed an intensified effort to attack these problems on both a national and an international scale. And those efforts are clearly bearing fruit. The composition of output in Japan, the United States, and much of Europe has shifted in the right direction even as growth has been maintained; inflation has been reasonably well contained; the U.S. trade deficit in real GNP terms has fallen from a peak of $157 billion in the third quarter of 1986 to $90 billion in the second quarter of 1988; bilateral and multilateral efforts aimed at more open markets abroad are having a measure of success even if the going is tough and slow; productivity and quality gains in U.S. manufacturing are clear and impressive; and the general pattern of behavior in exchange markets in recent months is distinctly more constructive. But, as I said earlier, we still have a long way to go.

To successfully complete the transition to a more balanced world economy surely means that each country must address its own problems. But, in my view, it also means that we must redouble efforts aimed at greater elements of international policy cooperation and coordination, including broad-based financial, political, and moral support for the key multilateral official institutions such as the International Money Fund, the World Bank, and the General Agreement on Tariffs and Trade.

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In urging this, I recognize that there are skeptics who question how much has been, or can be, achieved through the efforts of, say, the G-5 or G-7. The skeptics point out that governments are not prepared to cede sovereignty; that is true. They point out that the process is inevitably confronted with conflicting objectives; that is true. They point out that the tools available for coordination are imperfect at best; that is true. They point out that some aspects of the process—perhaps especially the economic summits of the heads of state—appear to be short on substance and long on ceremony; that may also be true. But what they fail to point out is the alternative.

I, for one, don't really see an alternative other than each country slowly but inexorably drifting in the direction of beggar-thy-neighbor attitudes and policies that can only work to the detriment of all. More importantly, on the positive side of the ledger, I also believe that efforts to date have played a distinctly positive role in getting the necessary adjustment process moving in the right direction. Indeed, even if the process has done nothing more than help each country see its own economic problems and prospects as others see them, the process has value.

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Since I believe the process has done that and more, I believe we should build on our success and seek out ways to further strengthen the spirit, and the substance, of international economic policy coordination. In saying this, I am mindful that we must guard against inflated expectations as to what can be achieved. Similarly, we surely must guard against the illusion that policy coordination can take individual countries—including the United States—off the hook in terms of the things they must do in their own right. Looked at in this light, policy coordination is not, nor can it ever be, a substitute for sound and disciplined policies on the part of individual countries. But, at the very least, international communication, cooperation, and coordination can help to provide a framework that supports the dictates of discipline on the part of individual countries while at the same time reinforcing the mutuality of interests among nations. In addition, the process as a whole breeds familiarity among the participants, a familiarity that can be absolutely invaluable when adversity strikes suddenly, as for example when the debt crisis exploded in the summer of 1982 or when

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worldwide equity markets collapsed last fall.

To put this in a slightly different perspective, let me share with you an excerpt from a letter written by one leading international economic statesman to another. The excerpt reads as follows:

> "I have always taken the position that both you and we had three possible courses in our relations with each other. One was to deal wholly independently with our respective problems, without any relations, and in complete ignorance of what the other was doing, in other words to ignore each other; another might be to pursue a wholly selfish policy, each disregarding completely the interests of the other, and possibly pursuing a policy antagonistic to the other; and the third might be to adopt a policy of complete understanding, and exchange of information and views, and to cooperate where our respective interests made it possible. How can there be any choice between these three, nor any ground of complaint, so long as we are right and not afraid of our critics?"

That letter, ladies and gentlemen, was written by Benjamin Strong, Governor of the Federal Reserve Bank of New York, to Montagu Norman, Governor of the Bank of England, on March 21, 1921. Perhaps there really is nothing new under the sun.

A Review of Federal Reserve Policy Targets and Operating Guides in Recent Decades

In March 1951, the Federal Reserve regained the power to conduct an active monetary policy that it had relinquished during the Second World War. The occasion was the signing of the Treasury-Federal Reserve Accord permitting a move away from the pegged interest rates that had helped to hold down the cost of Treasury financing. The Accord made it possible for the Federal Reserve to make adjustments to its monetary policy stance in pursuit of its ultimate goals of economic expansion and price stability. While those goals have not changed in the ensuing three and a half decades, the intermediate and operational targets of policy have been subject to several significant shifts. This article traces the development of Federal Reserve monetary policy and operating targets since the Accord and discusses the modifications that were made to them.

The Federal Reserve needs intermediate targets and indicators of policy because it does not have the means to achieve the ultimate goals directly. The Federal Open Market Committee (FOMC), which directs monetary policy for the Federal Reserve, developed intermediate targets that were linked, at least indirectly, to the ultimate goals and subject to indirect Federal Reserve control. Because the FOMC lacked the tools to realize even the intermediate objectives over short periods of time, it also developed reserve operating targets that it could achieve promptly, using the policy tools available to it. The Board of Governors of the Federal Reserve System had the authority to affect the banks' demand for reserves through the policies it established with respect to reserve requirements, the discount rate, and the rules of access to the discount window. The FOMC had the means to affect the supply of bank reserves by instructing the Trading Desk at the Federal Reserve Bank of New York to carry out open market purchases or sales of securities. These policy tools could be manipulated to bring about some desired behavior of the operating targets.

This article draws heavily on the annual reports prepared by the Manager of the System Open Market Account for the FOMC and on policy records and directives. Beginning with the 1962 report, large portions of the Manager's reports have been published. The annual report for 1962 appeared in the *Federal Reserve Bulletin* (as did some of the reports for the 1970s). The reports for 1963 through 1969 appeared in the *Annual Report* of the Board of Governors of the Federal Reserve System. Subsequently, the reports appeared in the New York Reserve Bank's *Monthly Review* or *Quarterly Review*.

Additional information was obtained through conversations with John Larkin, Fred Levin, Paul Meek, Robert Roosa, Irwin Sandberg, Peter Sternlight, and Robert Stone, who were at the Desk during many of the years covered. Stephen Axilrod and Donald Kohn of the Board of Governors also provided insights. Other source material is listed in footnotes and in the Appendix.

Overview

In the 1950s and 1960s, the behavior of bank credit generally served as the primary intermediate objective. It was joined by money beginning in the latter part of the 1960s. Various monetary aggregates became the primary intermediate targets in the 1970s. Money received its greatest emphasis in the late 1970s and early 1980s. During the 1980s, as the demand for money seemed to change in a fundamental way, the Committee treated its monetary targets more flexibly and sought to supplement them with other indicators. The immediate operating targets have, in a sense, come full circle since the 1950s: the FOMC initially tar-

geted free reserves and then shifted to federal funds rates, to nonborrowed reserves, and most recently to borrowed reserves, a measure similar in many ways to free reserves.[1]

All of the target variables and indicators that have been used over the years are interrelated. Whenever reserve measures have been the primary operating target, interest rates have played a role in modifying the policy response, and vice versa. But the existence of such relationships does nothing to diminish the importance of the principal target; the selection of this target influences how the Federal Reserve will respond to price behavior and to new developments in the economy.

1953-65: bank credit and free reserves

The Federal Reserve gradually resumed its pursuit of monetary policy goals after the Treasury-Federal Reserve Accord freed it from the obligation to support a pattern of pegged rates on Treasury debt issues. Before the Accord, the Treasury had insisted that the Federal Reserve continue the practice, begun during World War II, of standing ready to buy or sell Treasury securities at posted rates. By 1950, the FOMC was convinced that rates were being held too low, particularly in view of the stimulus to economic growth and to speculative buying associated with the Korean War. The low rates were contributing to excessive provision of reserves and significant inflation. The FOMC believed that a return to an independent monetary policy was essential if inflation were to be contained. It negotiated with the Treasury for a number of months to reach the Accord.[2]

After the Accord, the Federal Reserve gradually withdrew its support of rates.[3] The FOMC created a subcommittee to investigate how the Federal Reserve could best carry out an active monetary policy and encourage the return of an efficiently functioning Government securities market with "depth, breadth, and resiliency." The subcommittee made its recommendations at the end of 1952.[4] It emphasized that the securities markets would function better if policy operations were conducted in ways that showed the public that the Federal Reserve was no longer setting interest rates, and that gave a large number of dealers the oppor-

[1]Mechanically, the behavior of free and borrowed reserves only differ when excess reserves change. The various reserve measures are defined in the Box.

[2]Allan Sproul, who participated in the negotiations as President of the Federal Reserve Bank of New York, offered an interesting commentary on the process in "The 'Accord' — A Landmark in the First Fifty Years of the Federal Reserve System," in Lawrence S. Ritter, ed., *Selected Papers of Allan Sproul*, December 1980; reprinted from the Federal Reserve Bank of New York *Monthly Review*, November 1954.

[3]The Federal Reserve followed a so-called even keel policy during Treasury financing periods through the early 1970s. Until that time, most Treasury coupon securities were sold as fixed-price offerings. Around the financing periods, the Fed avoided changes in policy stance and tried to prevent changes in money market conditions. Major financing operations occurred four times a year, around the middle of each quarter. However, extra unscheduled financing operations occurred when the Treasury found itself short of money. Debt issuance was put on a regular cycle in the 1970s.

[4]"Federal Open Market Committee Report of Ad Hoc Subcommittee on the Government Securities Market," reprinted in *The Federal Reserve System after Fifty Years*, Hearings before the Subcommittee on Domestic Finance of the House Committee on Banking and Currency, 88th Cong., 2d sess. (Washington, D.C.: GPO, 1964), vol. 3, pp. 2005-55.

Box: Reserve Measures

Free reserves are defined as excess reserves less borrowed reserves, or alternatively, as nonborrowed reserves less required reserves. Free reserves are derived from two reserve identities. Total reserves of the banking system equal required reserves plus excess reserves. Total reserves also equal borrowed reserves plus nonborrowed reserves. Total reserves are reserve balances held by depository institutions (DIs) at the Federal Reserve and vault cash that is applied toward meeting requirements. (Before the Depository Institutions Deregulation and Monetary Control Act of 1980, only banks that were members of the Federal Reserve held reserves. Now any DI that accepts transactions accounts can be subject to reserve requirements.) Required reserves are total reserves that DIs must hold to comply with Federal Reserve regulations. They are specified in Federal Reserve Regulation D and are fractions of various maintenance period average deposit levels. Excess reserves are reserve balances that DIs hold that are not needed to meet requirements. Since DIs do not earn interest on excess reserves, they attempt to limit their holdings. However, DIs cannot hit reserve targets precisely, and they can be penalized for failing to meet their requirements on average or for ending the day with their reserve account overdrawn. Hence it is hard to avoid holding some excess reserves. Excess reserves moved in a relatively narrow range for long periods of time, then became more variable in the 1980s, and consequently became harder to estimate. Borrowed reserves are reserve balances acquired from the Federal Reserve's discount window facility. (Extended credit borrowing by banks in difficulty is often treated as akin to nonborrowed reserves.) Nonborrowed reserves are all reserves arising in other ways, primarily through open market operations and through changes in other factors on the Federal Reserve balance sheet.

tunity to make markets with minimal interference from the Fed. To achieve these goals, the subcommittee recommended that open market operations be confined to the short-term Treasury bill market, where the price impact of an operation ought to be the smallest. That would give the securities dealers the opportunity to make active markets in a range of securities and allow the forces of supply and demand to determine the structure of rates. Only if the market for coupon securities were clearly disorderly, and not just adjusting to new information, would the Fed step in to buy or sell coupon securities.

The report also expressed dissatisfaction with the Desk's operating technique. During the interest rate pegging period, the Trading Desk had often used one of a group of 10 dealers as a broker or agent to arrange orders in the market. The dealers that were not part of that group complained that they were unfairly excluded from dealings with the Federal Reserve. The dealers that did act as agents were also dissatisfied because they could not transact business with the Fed for their own portfolios when they were acting as agent. Both groups of dealers felt it was difficult to make two-way markets as long as the Federal Reserve was willing to buy or sell securities at known rates in response to public demand.

The FOMC adopted most key recommendations of the subcommittee. It actively pursued a countercyclical policy using an array of measures to evaluate economic activity and inflationary forces. Between 1953 and 1960, it pursued what came to be known as a "bills only" policy, confining its open market operations to the bill sector except when the coupon market was "disorderly." Throughout the 1950s, there was considerable debate within the System about whether coupon operations should be reintroduced to promote orderly markets or whether coupon markets should be left to function as much as possible without interference from the Fed. On only two occasions during this period were market conditions formally judged to be sufficiently disorderly to justify the Desk's purchase of Treasury coupon issues.

To create a climate where the dealers could make markets on an equal footing, the Trading Desk developed the competitive "go around" technique, still in use today, in which all of the dealers were contacted simultaneously and given the opportunity to make bids or offers. It also increased the number of dealers with which it would trade and specified criteria that dealers had to meet to qualify for a trading relationship.

During these years the FOMC took longer-term guidance from a number of indicators in choosing an appropriate policy stance. It gave special emphasis to the behavior of bank credit (commercial bank loans and investments) as an intermediate policy goal. It sought to speed up bank credit growth in periods when economic activity showed weakness and slow it down in periods of rapid growth. Bank credit statistics were available just after the end of the week for large banks but were only available with a lag of several weeks for small banks. Thus, bank credit was not suitable for day-to-day operating guidance.

The instructions for the Desk's day-to-day operations focused on free reserves — referred to as net borrowed reserves when borrowed reserves are greater than excess reserves — and money market conditions. By money market conditions, the FOMC meant not only short-term interest rates but also indications of the ready availability of funding to the securities dealers.[5] The written directive provided by the FOMC to the Desk was deliberately nonspecific, avoiding even a hint of targeting interest rates. For example, in November 1957, the FOMC directed the Desk to conduct operations "with a view to fostering sustainable growth in the economy without inflation, by moderating pressures on bank reserves." The Manager of the System Open Market Account surmised from the discussion at the FOMC meeting what the Committee wanted.[6]

Free reserves were targeted in order to provide some anchor to the policy guidelines. A relatively high level of free reserves represented an easy policy, with the excess reserves available to the banks expected to facilitate more loans and investments. Net borrowed reserves left the banks without unpledged funds with which to expand lending; they were viewed as fostering a restrictive policy stance. It was assumed that banks would adjust loans and investments when reserve availability changed.

[5]The FOMC took into account that the level of the discount rate would influence interest rates and the banks' perception of reserve availability. However, it did not (and does not) have the authority to change the discount rate and took the rate as a given within the context of short-term policy making.

[6]At that time, there was no provision for the Trading Desk to make modifications to the policy stance between meetings in the event of unexpected developments. The FOMC met very frequently — generally every two weeks through the middle of 1955 and every three weeks subsequently. They often had telephone meetings between regular meetings.

The Committee members were kept informed of what was happening through written reports describing the reserve forecasts, money market conditions, Trading Desk operations, weekly lending patterns of large banks, and background information on other securities markets. Reports were prepared in the open market operations area at the end of each statement period and before each FOMC meeting. An FOMC member also had the opportunity to participate in a daily conference call at which Desk personnel described recent developments affecting reserve demands and supplies and the behavior of the money markets. A wire summarizing the daily conference call was sent to the FOMC members. The written and oral reports have continued through the years, although the topics emphasized have changed as the priorities of policy have changed.

The linkages between free reserves and bank credit were viewed at the time as somewhat complex.[7] High rather than rising free reserve levels were believed to foster rising bank credit since banks would perpetually have more excess reserves than they wanted and would continually expand lending. High net borrowed reserve levels would, in a parallel manner, encourage persistent loan contraction. However, defining the point where free or net borrowed reserves were neutral—that is, fostering neither rising nor falling bank credit levels—was believed to be possible conceptually but not empirically. Other factors complicating the linkage were the distribution of reserves, loan-deposit ratios, the maturities of bank portfolios, the strength of loan demand, and the stage of the business cycle. Still, the Federal Reserve did not consider any of these difficulties to be fatal to the procedure so long as bank credit growth was monitored over time.

Operationally, the Trading Desk worked with a free reserve target that had been implied by the discussion at the most recent FOMC meeting. Research staff members developed and refined techniques during the 1950s and 1960s for forecasting each day what free reserves would be over the reserve maintenance period by forecasting both nonborrowed and required reserves. Maintenance periods were one week long for reserve city banks (member banks with offices located in cities with Federal Reserve banks or branches) and two weeks long for country banks (all other member banks). Computation and maintenance periods were essentially contemporaneous. The reserve factor estimates, which affected nonborrowed reserves, were subject to sizable errors, even though considerable resources were devoted to obtaining timely information about past and likely future behavior of the more volatile factors. Forecasts of required reserves were a problem initially but were improved in the 1960s as data flows were accelerated. Furthermore, reserves were not always well distributed across classes of banks, a condition that sometimes contributed to disparate behavior of free reserves and interest rates. These forecasts guided the Desk in making the appropriate reserve adjustments. It could buy or sell Treasury bills when forecasts suggested that free reserves were below or above the objective. Temporary reserve injections could be made with repurchase agreements (RPs), although the agreements were not used nearly as much as they were later.

[7]See (Peter D. Sternlight), "The Significance and Limitations of Free Reserves," Federal Reserve Bank of New York *Monthly Review*, November 1958, pp. 162-67; and "Free Reserves and Bank Reserve Management," Federal Reserve Bank of Kansas City *Monthly Review*, November 1961, pp. 10-16. A critique of free reserves and a survey of the literature are provided by A. James Meigs in *Free Reserves and the Money Supply* (Chicago: University of Chicago Press, 1962).

Because of the uncertainties in the forecasts of free reserves, and because the FOMC was also interested in money market conditions, the Desk watched "the tone and feel of the markets" each day in deciding whether to respond to the signals being given by the reserve forecasts. Reading the tone of the markets was considered something of an art. Desk officials watched Treasury bill rates and dealer financing costs. They factored in comments from securities dealers about difficulties in financing positions. Desk officials were primarily concerned with the direction in which interest rates were moving, rather than their level, and with the availability of funding. The tone of the markets might suggest whether the free reserve estimates were accurate. If the banks were short of free reserves, they would sell Treasury bills, a secondary reserve, and put upward pressure on bill rates. The banks would also cut back on loans to dealers, thus making dealer financing more difficult.

The federal funds rate played a limited role as an indicator of reserve availability in this period, but it began to receive increased attention during the 1960s. The interbank market was not very broad as the 1960s began, but activity was expanding.[8] During the 1960s, the reports of the Manager of the System Open Market Account increasingly cited the funds rate in the list of factors characterizing money market ease or tightness. Until the mid 1960s, the funds rate never traded above the discount rate. During "tight money periods," when the Desk was fostering significant net borrowed reserve positions, funds generally traded at the discount rate, and the rate was not considered a useful indicator of money market conditions. When free reserves were high, funds often traded below the discount rate and showed noticeable day-to-day variation. At such times, they received greater attention as an indicator of reserve availability.

There was considerable surprise when funds first traded above the discount rate, briefly in October 1964 and more persistently in 1965. Why, it was asked, would any bank pay more for overnight funding than the Federal Reserve charged? In fact, large banks were becoming more active managers of the liability side of their balance sheets. Borrowing from other banks, away from the Federal Reserve, played a role in this management. Though it was not noted at the time, the changes in liability management techniques were making free reserves an increasingly uncertain predictor of bank credit growth. The relationship between bank credit and free reserves depended upon banks

[8]Mark H. Willes, "Federal Funds during Tight Money," Federal Reserve Bank of Philadelphia *Business Review*, November 1967, pp. 3-11; and "Federal Funds and Country Bank Reserve Management," Federal Reserve Bank of Philadelphia *Business Review*, September 1968, pp. 3-8.

responding passively to reserve availability. In 1961, banks developed negotiable Certificates of Deposit (CDs), which they could use to accommodate increased loan demand without having unused free reserves. Interest rate ceilings on CDs under Regulation Q occasionally brought a sudden halt to this kind of expansion. The next logical step was to finance loan demand by purchasing overnight federal funds and renewing the contract each day. Takings in the funds market were not subject to reserve requirements or Regulation Q interest ceilings. (Such ceilings were dropped for most large CDs in 1970.) The discount window could not be used on such a steady basis. The Federal Reserve actively discouraged frequent or prolonged borrowing, thus reinforcing banks' longstanding reluctance to borrow.

In 1961, several developments led the FOMC to abandon its "bills only" restrictions. The new Kennedy Administration was concerned about gold outflows and balance of payments deficits and at the same time wanted to encourage a rapid recovery from the recent recession. Higher rates seemed desirable to limit the gold outflows and help the balance of payments, while lower rates were wanted to speed economic growth.

To deal with these problems simultaneously, the Treasury and the FOMC attempted to encourage lower long-term rates without pushing short-term rates down. The policy was referred to in internal Federal Reserve documents as "operation nudge" and elsewhere as "operation twist." The Treasury engaged in advance refundings and maturity exchanges with Trust accounts. The Federal Reserve attempted to flatten the yield curve by purchasing coupon securities while simultaneously selling Treasury bills. The procedure continued for another year and then ceased to be discussed after short-term rates rose in 1963. The Manager's reports focused mostly on operational difficulties in purchasing coupon issues after a long period of absence from that sector and reached no judgment on the effectiveness of the policy. Academic economists' studies have suggested that the effect on the yield curve was minimal, while practitioners had mixed views of its success.

Second half of the 1960s: transition to new targets and indicators

The formal policy procedures were changed only modestly over the latter half of the 1960s, but the period was marked by questioning and a search for alternative intermediate targets and techniques for achieving them. Inflation, which had been low over the previous decade, was a growing problem, and the annual reports expressed considerable concern about the lack of tax increases (until late 1968) to finance the Vietnam War involvement and the "Great Society" programs. Interest rates rose and became more variable.

Economists, both within and outside the Federal Reserve, questioned the assumed linkages underlying the policy process, including the connections of free reserves and bank credit to the ultimate policy goals of economic expansion and price stability. Quantitative methods were increasingly applied to test the hypothesized relationships among operational, intermediate, and ultimate policy objectives. Some studies suggested that more attention should be paid to money growth and to the behavior of total reserves or the monetary base.

In response to these developments, the FOMC expanded the list of intermediate guides to policy. The directives continued to focus on bank credit but added money growth, business conditions, and the reserve base. Free reserves continued to be the primary gauge for operations. When excess reserve behavior proved difficult to predict, borrowed reserves received increasing weight.

As the federal funds market became more active, the funds rate gained more prominence as an indicator of money market conditions. The annual report for 1967 explicitly cited the funds rate as a goal in itself rather than merely an indicator of the accuracy of free reserve estimates. It said that daily open market operations "focused on preserving particular ranges of rates in the federal funds market and of member bank borrowings from the Reserve Banks."[9] The report expressed concern that reserve forecast errors might lead to unintended money market firmness that market participants could misinterpret.

Although the FOMC met every three to four weeks, it was concerned that developments between meetings might alter appropriate reserve provision. Consequently, in 1966 it introduced a "proviso clause" that set forth conditions under which the Desk might modify the approach adopted at the preceding meeting. The FOMC would have preferred to use bank credit as the trigger to change money market conditions, but data still were available only with a lag. Hence, it used a proxy for bank credit in the proviso clause. After some experimentation, it adopted what it called the bank credit proxy, which consisted of daily average member bank deposits subject to reserve requirements.

[9] "Open Market Operations during 1967," a report prepared for the Federal Open Market Committee by the Open Market Operations and Treasury Issues Function of the Federal Reserve Bank of New York, February 1968, p. 4. The published version of this report, "Review of Open Market Operations in Domestic Securities in 1967," in Board of Governors of the Federal Reserve System, *54th Annual Report, 1967*, (1968), pp. 208-75, had a somewhat different introduction. It omitted the discussion of operational complications that had contained the reference to the funds rate.

Logically the bank credit proxy, which represented most of the liability side of the banks' balance sheets, should have moved in a similar fashion to bank credit, which was most of the asset side of the banks' balance sheets (other than reserves), but they often differed. One source of distortion was the growing use of nonreservable liabilities to finance credit extension. Banks encountered rising interest rates as inflation heated up, and the rate ceilings mandated by Regulation Q often limited the banks' ability to raise rates enough to attract deposits. Furthermore, higher interest rates made reserve requirements more burdensome. Consequently, banks raised money in the Eurodollar market to finance lending. In 1969, the bank credit proxy was expanded to include liabilities to foreign branches, the largest nondeposit liability. Nonetheless, the proxy continued to deviate from bank credit as reserve ratios changed.

If the bank credit proxy moved outside the growth rate range discussed at the FOMC meeting, the Desk would generally adjust the target level of free or net borrowed reserves modestly, on the order of $50 million or so according to rough recollections of officials participating at the time. Sometimes the proviso clause permitted either increases or decreases in the objective for free reserves. Frequently it allowed adjustments only in one direction.

To decide each day on its operations, the Desk looked at the reserve forecasts, short-term interest rates, and availability of financing to the dealers. If the need for reserves was confirmed by a sense of tightness in the markets, the Desk generally responded soon after the 11:00 a.m. conference call. During this period it used a larger share of outright transactions than it currently does, partly because it engaged in less day-to-day fine tuning, but it did make active use of RPs and, after their introduction in 1966, of matched sale-purchase transactions. In 1968, the Board of Governors adopted a system of lagged reserve accounting under which reserve requirements were based on average deposit levels from two weeks earlier, with all member banks settling weekly. The change made it easier to hit free reserve targets — ironically, shortly before free reserve targeting ended.

1970 to 1979: targeting money growth and the federal funds rate

In 1970, money growth formally replaced bank credit as the primary intermediate target of policy, and the federal funds rate replaced free reserves as the primary guide to day-to-day open market operations. The transition was gradual, with the first few years of the decade characterized by frequent experimentation and modification of the procedures. Nonetheless, the framework until October 1979 generally included setting a monetary objective and encouraging the funds rate to move gradually up or down if money were exceeding or falling short of the objective.

Bank credit and its proxy continued for a while in the list of subsidiary intermediate targets, but they received decreasing attention. The Desk also continued to watch the behavior of both free and borrowed reserves, mostly as indicators of how many reserves were needed to keep the federal funds rate at its desired level. The procedures exploited the positive relationship between borrowing and the spread between the funds rate and the discount rate. The relationship was imprecise, but it gave the Desk an idea of how many free or net borrowed reserves were likely to be consistent with the intended funds rate. The Desk used the forecasts of reserve factors to gauge the appropriate direction and magnitude for open market operations.

Initially in 1970, the FOMC selected weekly tracking paths for M1, which were generally the staff projections of likely behavior. It simultaneously continued to specify desired growth of the bank credit proxy and indicated preferred behavior for M2, but those measures received less weight than M1.[10] It instructed the Desk to raise the federal funds rate within a limited band if the monetary aggregates were well above the tracking path or to lower the funds rate within that band if the aggregates were below the tracking path.

In 1972, a number of significant modifications were made. The weekly tracking path for M1 was supplemented (and was later replaced) by two-month growth rate ranges that used the month before the FOMC meeting as a base. The change was designed to reduce the weight given to the rather volatile weekly money numbers and to quantify significant deviations. At the end of that year, the Committee also sharpened the distinction between targeting desired money growth and targeting expected money growth. Initially, the M1 tracking path had been based on Board staff expectations. Setting the desired growth path equal to the projection ran the risk of aiming for money growth that was too high or too low to be consistent with noninflationary growth. By late 1972, the Committee took note of that problem. It developed independent estimates of monetary aggregate growth that were expected to be consistent with moving gradually toward lower inflation. It introduced six-month growth targets designed to achieve these goals. Econometric models, supple-

[10] At the time, M1 consisted of currency and privately held demand deposits. Other checkable deposits were added to the definition in 1980. M2 consisted of M1 plus time and savings deposits other than large CDs at commercial banks. Thrift institution deposits, overnight RPs, Eurodollars, and money market funds were not included until 1980.

mented by the judgments of the staff, were used to develop the six-month and one-year estimates. The models allowed money growth to respond to economic activity and interest rate behavior. The weekly and two-month estimates were derived judgmentally, allowing for a range of technical factors.

The FOMC also introduced a reserve operating mechanism in 1972 that was designed to influence the supply of money. It was to be used simultaneously with the interest rate guideline, which worked through the demand for money. The FOMC made the addition to address a weakness in the existing procedure, namely, the need to rely on staff estimates of the funds rate required to achieve desired money growth. The funds rate worked by affecting the interest rates banks both paid and charged customers and hence the demand for money. But the demand for money was also a function of nominal income and anticipated inflation (which was only partially captured by the behavior of nominal interest rates). The Board staff built models of money demand, as did other Federal Reserve research departments. There was much debate throughout the decade about these models and their accuracy. Some observers felt that the models would have done well enough over periods judged to be of meaningful length (six months to a year) if the FOMC had really allowed interest rates to move as much as the models required. Others felt that it was not practical to control money adequately by working through the demand side, either because the models were not reliable enough or because the interest rate consequences could be too disruptive to markets.

The development of a reserve guideline to aid in achieving monetary targets was based on the reserve-money multiplier model of money control. The model implied that controlling total or required reserves would constrain money growth through the operation of the reserve requirement ratio. The FOMC was concerned, however, that a pure reserve provision strategy would cause undesired short-run volatility of interest rates. The FOMC briefly tried reserve targeting in 1972 but, to limit money market volatility, it put a constraint on the funds rate.

A technical problem complicated the use of a reserve guideline. Controlling total or required reserves was considered the best means of affecting deposits, yet these measures were subject to change for reasons unrelated to the behavior of money. In particular, interbank and federal government deposits were excluded from all the money definitions but were subject to reserve requirements. Government deposits at the time varied far more than they have in recent years. All tax and loan account monies were kept in commercial bank demand deposits subject to reserve requirements until 1977 when a legal change permitted note option accounts that pay interest and are not subject to reserve requirements. To take account of the reserve requirements on deposits not in the money definitions, the Federal Reserve developed a measure that excluded reserves against government and interbank deposits. It was called reserves on private deposits or RPD. While RPD behavior was closer to that of M1 than was total reserve behavior, the linkage was not very close because reserve requirements differed widely according to the size and membership status of the bank. Movements of deposits between large and small banks or member and nonmember banks changed the ratio of RPD to M1. Changes in the ratio of currency to deposits also affected the relationship between RPD and M1.

Using staff estimates of the various ratios, the FOMC set two-month growth target ranges for RPD designed to be consistent with the desired growth in M1, and instructed the Desk to alter its reserve provision in a way that was intended to achieve them. The actions were also supposed to be consistent with achieving a specified federal funds rate each week, which could be moved within a band between meetings. Usually the specified band was 1 to 1¼ percentage points wide over the intermeeting period and somewhat narrower each week. Intermeeting intervals were four to five weeks long. As it turned out, the relatively narrow funds rate constraints often dominated, and the Desk frequently missed the RPD target. RPD targets were declared unachievable, although the funds rate constraint precluded a true test. In 1973, the Committee changed RPD's status from operational target to intermediate target, placing it in the same category as M1 and M2. Since information on the behavior of M1 was about as good as information on RPD, RPD gradually fell into disuse. It was dropped as an indicator in 1976.

Subsequent modifications to techniques mostly related to the nature of the monetary targets. In 1975, in response to the requirement of a congressional resolution, the Federal Reserve adopted annual monetary target ranges and announced them publicly. A growth cone was drawn from the base period, which was the calendar quarter most recently concluded. Every three months, the target range was moved forward one quarter. The procedure meant that by the time the annual target period was completed, the target had long since been superseded. Frequently, the targets were overshot, and complaints about upward base drift were legion. The Full Employment and Balanced Growth Act of 1978, known as the Humphrey-Hawkins Act, established the current procedure requiring the Federal Reserve to set targets for calendar years and to explain any misses.

In addition to setting the annual targets in February and reviewing them in July as required by the Humphrey-Hawkins Act, the Committee continued to set two-month ranges. In theory, the two-month money growth targets were supposed to be consistent with returning to the annual target range if the money measures were outside the range, and with holding the aggregates within the ranges if they were already there. However, the Committee was often skeptical of staff forecasts. Furthermore, the Committee sometimes felt that the estimated changes in the funds rate needed to get money back on target were unacceptably large. It sometimes approved growth rates that stretched out the period for bringing money back on track, and on occasion it acknowledged that target growth probably would not be achieved within the year.

During most of the 1970s, the FOMC was particularly reluctant to change the funds rate by large amounts at any one time. Part of that reluctance reflected a wish to avoid short-term reversals of the rate. Keeping each rate adjustment small limited the risk of overdoing the rate changes and then having to reverse course. Those priorities restricted the options available to search for the appropriate rate at times when the FOMC was uncertain about the correct rate. The adjustments in the funds rate often lagged behind market forces, allowing trends in money, the economy, and prices to get ahead of policy.

The FOMC usually made only small changes in the funds rate at the meeting; frequently, the rate was not changed and the range surrounded the most recent rate target. The Committee also put relatively narrow limits on the range of potential adjustments that could be made between meetings if money growth went off course. In the early 1970s, the intermeeting funds rate range was generally 5/8 to 1 1/2 percentage points wide. By the latter part of the decade, its width was usually about 1/2 to 3/4 percentage point, and on a couple of occasions only 1/4 percentage point. In addition, the specifications for the aggregates were often set in a way that made it likely that the funds rate would be adjusted in one direction only, effectively cutting the range in half.

In implementing the funds rate targeting procedure, the Desk became increasingly attuned to preventing even minor short-term deviations of the funds rate from target. It felt some constraint not to make reserve adjustments in an overt way unless the funds rate moved off its target. When reserve estimates suggested that a large adjustment was needed but the funds rate did not confirm it early in a statement week, the Desk would worry about delaying its market entry because it might not be feasible to do a very large open market transaction late in the week. To provide needed reserves without an announcement effect, the Desk increasingly used internal transactions with foreign accounts. After the introduction in 1974 of customer-related RPs — agreements on behalf of official foreign accounts — the Desk used the agreements when the funds rate was on target but a reserve need was projected. (Market participants had routinely assumed that outright transactions for customers had no policy significance, and they initially regarded customer-related RPs the same way.)

If the estimated need to add or drain reserves was too large for these techniques, the Desk often pounced on very small funds rate moves off target to justify an operation. For instance, if estimates suggested that additional reserves were needed, the Desk would often enter the market to arrange an RP when the funds rate rose 1/16 percentage point above the preferred level. If, on the other hand, the funds rate fell despite the estimated need to add reserves, the Desk typically would allow a 1/8 percentage point deviation to develop before it would arrange a small market operation to drain reserves. There was an operational limit to how late in the day transactions could be done for same day reserve effect. The cutoff was supposed to be 1:30 p.m., but if the desired funds rate move occurred just after that time, the Desk often responded if it was anxious to do an operation. The end of its operating time was close to 2:00 p.m. by 1979.

The Desk's prompt responses to even small wiggles in the federal funds rate led banks to trade funds in a way that tended to keep the rate on target. Except near day's end on the weekly settlement day, a bank short of funds would not feel the need to pay significantly more than the perceived target rate for funds. Likewise, a bank with excess funds would not accept a lower rate. Rate moves during the week were so limited that they provided little or no information about reserve availability or market forces. Probably few, if any, in the Federal Reserve really believed that brief small moves in the funds rate were harmful to the economy. The tightened control developed bit by bit without an active decision to impose it.

1979 to 1982: monetary aggregates and nonborrowed reserves

In October 1979, the FOMC radically changed the operating techniques it used for targeting the monetary aggregates. It explicitly targeted reserve measures computed to be consistent with desired three-month growth rates of M1. The constraint on the federal funds rate applied only to weekly averages, not to brief periods during the week. Its width was 4 to 5 percentage points, wide enough to allow the adjustments needed to achieve the monetary target. Persistent

overshoots of money targets and severe inflation had changed priorities. Interest rate volatility, so feared when the RPD targets were developed in 1972, seemed more tolerable.

Operationally, the FOMC chose desired growth rates for M1 (and M2) covering a calendar quarter and instructed the staff to estimate consistent levels of total reserves. The process resembled that used to estimate RPDs. The staff estimated deposit and currency mixes to derive average reserve ratios and currency-deposit ratios. The estimation technique employed a mix of judgment and analysis of historical patterns. From the total reserve target, the Desk derived the nonborrowed reserve target by subtracting the initial level of borrowed reserves that had been indicated by the FOMC. The initial borrowing level was intended to be consistent with the desired money growth. If it were inconsistent, money and total reserves would exceed or fall short of path. If the Desk only provided enough reserves to meet the nonborrowed reserve path, borrowing would automatically rise if money growth (and total reserve demands) were excessive, or fall if such growth were deficient. The borrowing move would affect reserve availability and the funds rate and would encourage the banks to take actions that would accomplish the desired slowing or speeding up of money growth. If the pace of adjustment implied by the mechanism did not seem appropriate, instructions were occasionally given to accelerate or delay the borrowing adjustment. The FOMC could make alterations to the basic mechanism at a meeting or direct the Desk to make them under specified conditions between meetings.

To reduce overweighting of weekly movements in money, the total and nonborrowed reserve paths were computed for intermeeting average periods, or two subperiods if the intermeeting period were longer than five weeks. (In 1979 the FOMC met 9 times and in 1980 it met 11 times; in 1981 it moved to the schedule of 8 meetings a year in use today.) A consequence of this averaging technique was that errors in the early part of the period had to be offset by large swings in borrowing in the final week. Informal adjustments were sometimes made to smooth out those temporary spikes or drops in borrowing that were deemed inconsistent with the longer term pattern. While the adjustments were considered necessary to avoid severe swings in reserve availability and interest rates, they gave the appearance of "fiddling" and have led to considerable confusion in the literature. Each week the total reserve path and actual levels were reestimated, using new information on deposit-reserve and deposit-currency ratios.

In implementing the policy, the Desk emphasized that it was targeting reserves and not the funds rate by entering the market at a standard time to perform its temporary operations. It confined outright operations to estimated reserve needs extending several weeks into the future. It arranged them early in the afternoon for delivery next day or two days forward. The federal funds rate was not ignored; it was used as an indicator of the accuracy of reserve estimates, although it was not always that reliable. On the margin, it could accelerate or delay by a day or so the Desk's entry to accomplish a needed reserve adjustment, but its role was much diminished.

Wide swings in the federal funds rate had been anticipated, although there was some surprise at the degree of volatility. Swings in the short-term growth rates of the monetary aggregates also were wider than generally had been expected, although the risk of some overadjustment of money had been recognized from the beginning. Some observers saw it as a necessary antidote to the earlier procedure, which often moved the funds rate too little too late. In part, the sharp movements in both interest rates and money probably reflected the underlying conditions. The effort to end the inflation that had built up over one and a half decades and had come to permeate economic relationships forced major adjustments. Expectations about inflation and economic activity were very fluid during those years; they fluctuated sharply as people evaluated new information and judged whether the anti-inflation policies were likely to succeed.

The control mechanism itself almost assured that money growth would cycle around a trend unless the FOMC intervened in the process. If money rose above its desired level, required reserves would rise by a fraction of the overshoot determined by the reserve ratio. Following the procedures would cause borrowed reserves to rise as well. They would not decline until money growth, and hence total reserve growth, slowed. The higher borrowing would slow money growth, but with a lag. By the time the procedures called for lower borrowing, it would have been high too long, assuring that money growth would fall below the desired level in what appeared to be a "damped cycling process." Borrowing would then fall short too long, setting up the next round of acceleration of money growth.

1983 to the present: monetary and economic objectives with borrowed reserve targets

A breakdown in the relatively close linkage between M1 and economic activity, rather than dissatisfaction with the procedures, led to the next set of changes, although there was also some sentiment that short-term rate volatility had been excessive. By the latter part of 1982, it was becoming apparent that the

demand for money, particularly M1, was strong relative to income, so that growth within the target range would have been more restrictive than seemed desirable under the circumstances. Some of the increase in the demand for money was attributed to the ongoing deregulation of interest rates on various classes of deposits. In particular, NOW accounts were making it more attractive to hold savings in M1. In addition, the maturing of a large volume of special tax-favored "all savers" deposits in October of that year was expected to add substantially to M1 holdings. The FOMC had hoped that M2 would continue to be a reliable indicator, and for a few months at the end of 1982 it attempted to use it as a guide to building total and nonborrowed reserve targets. However, money market deposit accounts (MMDAs), authorized beginning in December 1982, proved very attractive, and the demand for M2 rose sharply.

In the absence of a stable relationship between money and economic activity, the FOMC followed ad hoc procedures for guiding reserve provision, hoping that the distortions to the relationship would prove to be short-lived. The FOMC focused on measures of inflation and economic activity to supplement the aggregates. Instead of computing total and nonborrowed reserve levels linked to some aggregate and deriving a level of borrowing that moved with the deviations of the aggregate from target, it chose the borrowed reserve level directly. It intended to adjust it up or down whenever money seemed to be deviating from path in a meaningful way (after making allowance for distorting factors and taking account of the supplemental indicators).

The monetary aggregates did not quickly resume their prior relationship with economic activity. Declining inflation made holding money more attractive, and interest rate sensitivity increased, since rates on some components of M1 were close to market rates but slow to change. Policy decisions continued to be guided by information on economic activity, inflation, foreign exchange developments, and financial market conditions. In time, money growth was moved from a predominant position in the directive to join the list of factors shaping adjustments to the borrowing level. What apparently started out as a temporary procedure has persisted, with modifications, for six years.

Under current procedures, forecasts of reserve availability are compared to a maintenance period average objective for nonborrowed reserves that is believed to be consistent with achieving the desired amount of borrowing. The decision each day whether to provide or drain reserves is guided to a considerable extent by the estimated difference between the forecast volume of nonborrowed reserves and the objective for the two-week maintenance period. The Desk uses money market conditions, this time specifically the funds rate, to supplement the reserve forecasts, particularly in choosing the days on which operations are conducted and the instruments used to make the reserve adjustments. For instance, if the funds rate is significantly above the range that is expected to correspond to the intended borrowing level (based on the discount rate that is in place), the Desk is more prompt in meeting an estimated reserve need to indicate that the funds rate probably is out of line. But it generally continues to intervene at a standard time and accepts more variation in the funds rate than in the 1970s. Particularly, there are opportunities for market sentiment concerning the likely course of interest rate pressures to exert an influence on those pressures.

Summary

Over the post-World War II period, the FOMC made several significant changes in both the intermediate and operating targets of policy. Concerns about inflation were often a driving force for change. The inflation that accompanied the Korean War led the Federal Reserve to negotiate with the Treasury a means to resume an active monetary policy. The techniques developed after the 1951 Accord reflected the predominant Committee view that bank credit cost and availability played a major role in determining economic activity and that inflation resulted when the economy overheated. Free reserves and money market conditions were adjusted to influence bank credit. Some FOMC members believed that a strong link existed between interest rates and economic activity, but most members, recalling their experience with forced rate pegging in the 1940s, were disinclined to target interest rates directly. The procedure adopted in the early 1950s appeared to work in a generally satisfactory way for a time, and its use persisted for more than one and a half decades.

The change from bank credit to a monetary aggregate as an intermediate target began to evolve in the late 1960s. It was made because observers came to see the relationships between Federal Reserve actions and ultimate outcomes as more complex than previously thought, and because of distress about rising inflation. Some academic research suggested that the behavior of money was a better leading indicator of economic activity and prices than were bank credit or interest rates. Reliance on the federal funds rate rather than free reserves developed as the federal funds market became more active and as the passage of time made associations between funds rate targeting and the rate pegging episode of the 1940s less likely. The changes were formally implemented at the start of the

1970s.

In 1979, the FOMC shifted operating targets dramatically. It did so because the monetary objectives had been overshot repeatedly and inflation had accelerated to unacceptable rates. Use of the funds rate as the operational target was thought to be partly to blame because, as the adjustment tool, rates were changed too cautiously. The monetary aggregates remained the intermediate target, but additional efforts were made to avoid persistent overshooting. Nonborrowed reserves, which were more directly linked to M1, became the operating target.

By contrast, the 1982 adjustments primarily stemmed from problems with M1, and to some extent with the broader money measures, as intermediate targets. By that time, considerable progress had been made in slowing inflation. The modifications were motivated by an apparent breakdown in the traditional relationship between the monetary aggregates, especially M1, and economic activity. Although operating targets had to be modified when the monetary aggregates were deemphasized, the primary operating target, borrowed reserves, was a variant of the previous nonborrowed reserve target.

Since 1982, the Committee has watched what might be called intermediate indicators rather than targets. It has continued to monitor the aggregates and to set targets for M2 and M3. The target setting has been guided by insights that have been gained about how interest rate deregulation and changing expectations of inflation have altered the relationship between the monetary aggregates and the economy and prices. Nonetheless, the relationships are not sufficiently precise to support close short-run targeting of the aggregates at this stage. In the absence of a reliable intermediate target, the Committee has followed developments of the economy and prices directly and has observed a variety of economic statistics, in addition to the monetary aggregates, that point to future moves in the goal variables.

Ann-Marie Meulendyke

Appendix: Selected Readings on Monetary Policy Implementation

Readers interested in knowing more about Federal Reserve policy targets and operating guidelines since the 1950s will find the following sources helpful:

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Appendix: Selected Readings on Monetary Policy Implementation *(continued)*

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The Globalization of Financial Markets and the Effectiveness of Monetary Policy Instruments

Since the early 1970s financial markets around the world have been moving toward fuller integration. At least in principle, this trend could have significant implications for each country's financial markets and the workings of its domestic monetary policy. In the case of the United States, the globalization of financial markets could at times diminish the compatibility of the Federal Reserve's goals for inflation, employment, and external balance. Moreover, the closer integration of domestic and foreign financial markets could conceivably impair the Federal Reserve's ability to implement a change in its monetary policy. This article focuses on this last aspect of globalization and monetary policy. More specifically, we seek to determine whether globalization has loosened the linkage between the instruments of monetary policy—the discount rate and open market operations—and short-term interest rates.

Intuition suggests that closer integration makes the total demand for dollar-denominated money market instruments more interest-rate elastic. The domestic component of this demand would be more elastic because debt instruments issued by foreigners are more readily available to U.S. investors and hence provide closer substitutes for domestic instruments than ever before. The foreign component of this demand would also be more elastic because U.S.-issued instruments appear more often in foreign portfolios. Similarly, the supply side of the market would be more elastic since the issuers of short-term debt instruments have more options. Consequently, a change of a given magnitude in a policy instrument and the corresponding movement of the federal funds rate—other things equal—would have a smaller proximate impact on domestic short-term rates; and a smaller impact on short-term rates implies, according to virtually all descriptions of the monetary transmission mechanism, a diminished effect on the ultimate goals of policy. So, changes in bank reserves would need to be larger than before to alter the three-month interest rate by, say, half a percentage point and thereby tighten policy.

By increasing the participation of foreign investors in U.S. financial markets, globalization may also have made the U.S. money market more sensitive to developments in foreign credit markets and the foreign exchange markets. As a result, the effect of any change in a monetary policy instrument may now be less certain, in the sense that the financial markets' response to discount rate changes or open market operations may not be anticipated as well as before, when the reactions of only the domestic credit markets had to be considered. In these other terms, the effectiveness of monetary policy may also have been diminished because policymakers might turn more cautious when the impact of their actions cannot be gauged in advance.

But the changes brought about by globalization need not be as substantial as such speculation might suggest. It may be argued that globalization has deeply affected the determination of U.S. capital and money market rates and has altered the linkages between money market and capital market rates; nevertheless, its effects may not have significantly reduced the size or the predictability of the proximate impact of policy instrument changes on domestic short-term interest rates. The overnight rate is determined by the supply of nonborrowed bank reserves and this rate is insulated

from any open-economy impacts. If the linkage between the overnight rate and three-month money market rates is essentially unchanged, monetary policy's proximate impact on the money market would be preserved and could be anticipated much as before.

To address these issues, we present a general framework that assumes that assets are not generally perfect substitutes either domestically or internationally. Empirical research has usually rejected the assumption of perfect substitutability of assets. But the framework is also consistent with the view that the substitutability of various types of assets has increased over time. Thus, the trend of the past several years toward globalization has the potential to alter the way the markets set U.S. short-term interest rates. Next, we describe the role of the federal funds market, where policy instrument changes are first felt. Its special function leads us to focus our statistical analysis on the spread between a market-determined short-term interest rate (the three-month Treasury bill rate) and the federal funds rate.

Finally, we specify and estimate an econometric model of that spread in order to gauge the effect of foreign economic conditions on the U.S. money market. On the basis of our regression results, we evaluate the impact of financial market integration on the effectiveness of domestic reserve operations. We find, as anticipated, that foreign economic variables exert a statistically significant influence on U.S. short-term interest rates and that their collective influence has been expanding somewhat relative to domestic economic variables. Such a development would, of course, be consistent with increasing international capital mobility and greater integration of national financial markets. Nevertheless, our results suggest that the expanding significance of foreign economic variables is more directly traceable simply to a relative rise in their volatility compared with the volatility of domestic variables (although the absolute volatility of both has declined). These comparatively greater movements in the foreign variables affecting domestic credit markets have apparently made the outcome of instrument changes (open market operations and discount rate changes) less certain, and consequently, less effective in a qualitative sense.

Surprisingly, however, the growing influence of foreign factors seems to be associated with a *larger* impact on the money market from a given change in the supply of bank reserves. We find limited evidence that domestic reserve operations are actually gaining potency: a somewhat smaller open market operation can be conducted to achieve a given impact on short-term interest rates. This is the opposite of the anticipated effect from globalization. Thus, in this quantitative sense, it can be said that despite globalization, policy actions may not be any less effective.

In summary, our results suggest that while the impact of a given reserve change has possibly become larger in the face of international financial integration, the predictability of the response of domestic short-term interest rates has declined. The latter development has occurred principally because the relative importance of movements in foreign economic variables, which may be essentially unpredictable ex ante, has increased.

The framework for the econometric model

One might reasonably suppose that the globalization of financial markets has had a significant and direct impact on both the U.S. capital and money markets.[1] That is, globalization may well have altered the determination of domestic long-term interest rates and their spreads relative to short-term rates. To be sure, the volume of nonborrowed reserves, as determined by open market operations in conjunction with market factors, retains close influence on the overnight federal funds rate. But notwithstanding this influence, it is logical to ask whether globalization has hampered the Federal Reserve's ability to implement monetary policy changes (as measured by nominal short-term interest rates) using its instruments, the discount rate and open market operations.

To look into this matter, we will construct and estimate a single-equation econometric model. This model fits within a general framework for credit markets with cross-country linkages. It relates the spread between the overnight federal funds rate and the three-month Treasury bill rate to domestic and foreign economic factors. The empirical results obtained from this model may provide some insight into the potentially declining efficiency of monetary policy instruments.

A general model of the financial sector

In the most general case, the demand for a particular U.S. financial asset depends on: (a) its own rate of return relative to those of all other domestic assets; (b) the return in dollars on foreign assets, equal to their own rates of return, plus the expected change in the exchange rate; (c) the level of financial wealth and the flow of saving, both here and abroad; and (d) other relevant macroeconomic variables that affect perceptions of risks and the future value of the various assets.[2] These relevant variables include foreign-

[1] See Bruce Kasman and Charles Pigott, "Interest Rate Divergences among the Major Industrial Nations," in this issue of the *Quarterly Review*.

[2] This follows from James Tobin, "A General Equilibrium Approach to Monetary Theory," *Journal of Money, Credit, and Banking*, February 1969, pp. 15-29.

sector indicators such as the volatility of the exchange rate and the current account position.

Each financial asset substitutes to some extent for every other financial asset. Some pairs of assets are nearly perfect substitutes for each other, such as commercial bank negotiable certificates of deposit and bank holding company commercial paper (provided that they have similar maturities and are issued by similarly rated institutions). Other assets are weak substitutes: for example, low-grade corporate bonds and overnight Eurodollar deposits. The extent to which domestic and foreign assets are substitutes for one another is a function of their similarity in terms of liquidity, maturity, default risk, and other characteristics, as well as the importance the market attaches to distinctions of nationality and currency denomination.[3] Generally, domestic and foreign assets will tend to be more closely substitutable the more open the national financial markets and the lower the barriers to international flows.

The influence of foreign economic factors on U.S. interest rates could be growing through any of several routes, each related to the globalization of financial markets and the increasing openness of the U.S. economy. First, and most important, the reduction of barriers to international capital flows, a key element of the globalization of financial markets, by itself tends to make domestic and foreign assets closer substitutes by allowing investors greater freedom to choose among alternatives. Consequently, movements in foreign demand and supply, other things equal, should exert through either interest rates or exchange rates greater influence on domestic financial conditions, and vice versa. Second, the real sector of the U.S. economy is more open than before, with the result that the scale of certain variables, such as the volumes of exports and imports and the associated financial transactions, has increased relative to the economy as a whole, and the impact of the exchange rate on the real economy has increased. Third, there may be more variation in important international economic variables (for example, the U.S. exchange rate), such that they are the source—relative to domestic economic factors—of more of the shifts in the demand for financial assets. Greater variability of international economic factors would be likely to increase the number and size of unpredictable shifts in domestic credit demand or supply.

Much of the empirical research on interest rate determination is not particularly helpful in addressing whether and how foreign factors are becoming more important. This research has tended to concentrate mostly on testing the expectations theory of the yield curve and theories of international interest rate parity. Econometric models of domestic interest rate determination have tended to be constructed on the joint assumptions that all assets (or all assets within a particular class) are perfect substitutes and that expectations of future interest rates are formed "rationally";[4] the models of international rate determination have most often been based on the assumption of perfect capital mobility. Under these assumptions, the demands for domestic financial assets are infinitely sensitive to differentials in expected rates of return, and hence, we should never observe persistent differentials over the same holding period because the marketplace would quickly arbitrage them away. Nor should we observe persistent differentials in yields between similar foreign and domestic assets after adjustment for expected currency changes; the marketplace should arbitrage away differentials across currencies.

Empirical research usually rejects the expectations theory of the yield curve.[5] Instead, systematic deviations between the actual three-month Treasury bill rate and that predicted by the yield curve are observed. Similarly, perfect substitutability among assets that differ only with respect to currency denomination has been tested and generally rejected; significant differentials in ex ante (uncovered) yields have been found.[6] Unfortunately, researchers have had little success in identifying the factors causing these differentials. Thus, we do not have much to build on when we address how the trend toward globalization may have changed the connection between policy instruments and money market rates.

The independence of the federal funds rate

Before describing the econometric model used in this paper and discussing our regression results, it is useful to clarify the special role of the federal funds rate in the money market. The overnight market for federal funds is largely independent of, but not disconnected

[3]See Kasman and Pigott, "Interest Rate Divergences."

[4]That is, investors base their expectations on all information economically available about the future behavior of interest rates.

[5]For a summary of this line of research, see Robert J. Shiller, John Y. Campbell, and Kermit L. Schoenholtz, "Forward Rates and Future Policy: Interpreting the Term Structure of Interest Rates," *Brookings Papers on Economic Activity*, 1:1983, pp. 173-217; and N. Gregory Mankiw, "The Term Structure of Interest Rates Revisited," *Brookings Papers on Economic Activity*, 1:1986, pp. 61-96. For a collection of papers on the domestic and international determinants of interest rates, see *Nominal and Real Interest Rates: Determinants and Influences*, Bank for International Settlements (Basle, Switzerland, 1985).

[6]Paul Boothe and others, *International Asset Substitutability: Theory and Evidence for Canada*, Bank of Canada, 1985; and M.A. Akhtar and Kenneth Weiller, "Developments in International Capital Mobility: A Perspective on the Underlying Forces and the Empirical Literature," Federal Reserve Bank of New York, Research Paper no. 8711, in *International Integration of Financial Markets and U.S. Monetary Policy*, December 1987.

from, the rest of the money market. As a practical matter, if we look at the average funds rate calculated over intervals longer than a month, we find that it is set within a range by the demand for and supply of bank reserves independently of other short-term rates, and thus it is subject to the influence of open market operations. Changes in other interest rates do feed back onto the fed funds rate, but only to a limited extent. In the opposite direction, the federal funds rate is connected to the rest of the money market, such that domestic operations set off a chain reaction affecting other money market rates. Thus, in the classification scheme for economic models, the financial sector is not a fully simultaneous system. Instead, it is block recursive, the funds market constituting the first block and the rest of the financial markets the second and main block.[7]

The demand for bank reserves is created by (a) reserve requirements and (b) each bank's need to post a positive reserve balance in its account at the Federal Reserve every night. The supply of bank reserves is essentially determined by (a) the actions of the Manager for Domestic Operations and (b) the administration of the discount window. "Market factors" such as float and Treasury fiscal operations cause unintended fluctuations in supply to the extent that the open market Desk does not perfectly foresee and allow for them. The funds market thus redistributes reserves among banks so that they can meet reserve requirements and avoid overnight overdrafts.

The specialized nature of the federal funds market is manifested in rate movements that take place late in the trading day. When a significant shortage or surplus of reserves appears on a settlement day, the fed funds rate will soar or plunge far outside of its recent trading range. These movements, typically occurring after 4:00 p.m., do not correspond to changes in the closely related markets for overnight repurchase agreements (RPs) and overnight Eurodollars, because by that time these markets are effectively closed for the day. Movements in the fed funds rate can also occur if the Fedwire is down or if some large bank is having computer problems.[8]

As noted, however, the funds rate is not totally disconnected from the rest of the money market in the short run—its independence can be overstated. The federal funds rate trades within a range even when no policy moves are being made. Developments in the RP market or very short-term Eurodollar market can spill over and affect the overnight funds rate, particularly within a single two-week reserve maintenance period. Expectations of an imminent policy move will also cause overnight funds to trade high or low relative to other money market rates.

In sum, by virtue of the conservation of reserves in the domestic banking system, there is no reason to presume that globalization has directly had any measurable effect on the determination of the overnight federal funds rate—except perhaps within the reserve averaging period. Within such periods, the possibility exists that the increasing integration of world financial markets may have had some minor effects on the behavior of the overnight funds rate. For example, globalization may have increased the size and depth of the overnight Eurodollar market and made overnight Euros a better substitute for overnight fed funds. In addition, by increasing the volume or variance of clearings of money-center banks, globalization may have raised the demand for excess reserves.[9]

The connection to other interest rates

Immediately available funds are lent to the banking sector by private firms and municipalities through RPs, and by thrift institutions and credit unions through federal funds purchases. (Transactions in "immediately available funds" are those in which the transfer of money is made during the same business day and not at the end of the day or on the next day.) Moreover, immediately available funds are channeled downstream from small banks to large banks through the federal funds market. To some extent, these participants can shift to or from other instruments (term fed funds, term RPs, very short maturity Eurodollar deposits, "short" Treasury bills) if the overnight fed funds rate is out of line with slightly longer-term rates. The possibility of substitution creates a connection between the overnight funds rate and other money market rates. (In a generalized model of the financial sector, the federal funds rate would appear in the demand equations of other short-term instruments.) Thus, open market operations can influence money market rates directly by affecting the federal funds rate and indirectly by changing the markets' expectations of the future values of this rate.

All this implies that the spreads between the federal funds rate and other money market rates can be quite variable from one month to the next. The Treasury yield curve may be upward sloping, and yet the overnight federal funds rate may be well above the one- or three-month bill rate because monetary policy is plac-

[7] In such a system, the endogenous variables are determined in sequence, either individually or in groups.

[8] There are also quarter-end and year-end effects.

[9] No increase in the clearing banks' demand for excess reserves has been detected, however, during the past several years as the volume of transactions handled by CHIPS (Clearing House Interbank Payments System) has grown rapidly.

ing considerable pressure on banks' reserve positions; or the funds rate may be below the Treasury bill rates if modest reserve pressure is being imposed.

Moreover, because federal funds and Treasury bills are imperfect substitutes, there is some scope for the internationalization of financial markets to have an effect. The rate spread between them is not determined exclusively by the expected future path of domestic short-term interest rates; other factors matter. So, since the overnight fed funds rate is influenced by changes in the supply of nonborrowed reserves, movements in the spread between the fed funds and Treasury bill rates reflect changes in the stance of monetary policy—as well as developments in domestic and foreign credit markets.[10] Whether movements in the rate spread now reflect changes in Federal Reserve instruments to a lesser degree because of globalization is the focus of the remaining sections of this article.

Estimation and analysis of the model

To investigate the effect of the globalization of financial markets on the linkage between open market operations and domestic short-term interest rates, we estimated a single-equation econometric model based on the generalized framework of the preceding section. This model explains the movements in the spread between the overnight federal funds rate and the three-month U.S. Treasury bill rate.

The spread is most obviously and directly affected by changes in the instruments of monetary policy. The overnight federal funds rate is expected to rise relative to the three-month Treasury bill rate as the supply of bank reserves is tightened; the funds rate is expected to fall relative to the bill rate when reserve supply is easing. Thus, on average the spread widens as reserve supply tightens, and narrows (and may even turn negative) when supply eases. Of course, the spread can narrow or widen without any policy-related change in the supply of reserves; many other factors influence the spread between these two interest rates. In any case, the best choice among possible measures of the influence of policy actions on the funds rate is clearly borrowed reserves (or the related measure, free reserves).[11]

Another important factor affecting the federal funds-Treasury bill rate spread is the U.S. bond rate (the long end of the domestic yield curve). Changes in the bond rate, through arbitrage up and down the yield curve, should be positively correlated with changes in the bill rate. The bond rate, though labeled a domestic-economy variable, may be an important channel through which foreign financial shocks or impulses are transmitted to the domestic credit markets. In the past few years, the foreign demand at some auctions of U.S. Treasury bonds has been estimated by primary dealers to be on the order of 40 to 50 percent. It would seem then that the influence of economic developments outside the country can be introduced by variables that are nominally labeled domestic; and it is probably futile to categorize variables as purely domestic or purely foreign.

In addition to these two "domestic economy" variables, any number of explicitly foreign economic factors could also affect the federal funds-Treasury bill spread:

- First, movements in foreign interest rates would be expected to be correlated with movements in domestic interest rates, especially as foreign assets become increasingly substitutable for domestic assets; more than one connection between foreign and domestic rates could be imagined. Thus, weighted averages of foreign short- or long-term interest rates were included in the regressions as explanatory variables.
- Second, the exchange rate would be expected to influence the spread directly or indirectly. The anticipated change in the exchange rate is a component of the anticipated total return from assets denominated in a foreign currency. Moreover, with a much longer lag, a significant change in the exchange rate affects the competitiveness of an economy's products in world markets and thus adds or subtracts from its aggregate demand. Such shifts would in turn affect the demand and supply of credit. Through these channels domestic financial markets could be affected by actual or anticipated exchange rate movements. To capture these

[10] That the slope of the Treasury yield curve, measured from three or six months to 10, 20, or 30 years, is an indicator of the stance of monetary policy is a view held by many participants in the credit markets, including economists working in the area. For example, see Drexel Burnham Lambert Government Securities Inc., "Treasury Market Comment: October 1987." A variation is Laurent's use of the spread between the long-term bond rate and the federal funds rate as an indicator of policy. See Robert D. Laurent, "An Interest Rate-Based Indicator of Monetary Policy," Federal Reserve Bank of Chicago *Economic Perspectives*, January-February 1988, pp. 3-14. The spread used in this paper is still another variation. As the next section will show, this spread is affected by many factors, only some of which are identifiable by statistical analysis, and thus is far from an unambiguous indicator of policy changes. First, the long-term bond rate and foreign factors affect the spread; second, short-term shifts in the demand for Treasury bills—as in a "flight to quality" by investors—distort it.

[11] Because policy changes can be accomplished through changes in the discount rate instead of, or in conjunction with, open market operations, one would expect the discount rate to be one of the factors appearing in the regression equation. The discount rate, however, is omitted for several reasons: a discount rate change is often widely anticipated before it is announced, a surcharge was imposed during 1981, and additional multicollinearity would be introduced.

effects, we tried two proxies as explanatory variables: changes in the exchange rate and its forward premium. The actual change in the exchange rate, besides altering competitiveness, represents the realized currency gain or loss; since expectations are not measured well, the actual change may have to substitute for the anticipated change in the exchange rate.

- Third, the amount of currency risk incurred by investing in foreign assets—the risk that an investor takes by later having to convert the return from a foreign-currency-denominated asset into dollars—should be relevant. The greater the risk, the less attractive the foreign assets. Thus, the variance of the exchange rate was used as a measure of volatility in the foreign exchange market.
- Fourth, the closer integration of U.S. financial markets with those in the rest of the world may affect the spread by enhancing international capital mobility as well as asset substitutability. Increased capital mobility and the process of financial market integration may be reflected in the growing volume of international financial and nonfinancial transactions. We tried two proxies to capture this trend toward greater internationalization: the sum of all private financial inflows and outflows and direct investments, and the sum of U.S. merchandise exports and imports (both scaled by nominal GNP).

Regression results

In each of the regressions in the first set, we added one of a number of foreign factors to an equation that otherwise contained only domestic-economy variables. Thus, the spread between the federal funds rate and the Treasury bill rate was initially explained by (a) discount window borrowing, (b) the domestic bond rate, and (c) one of the foreign variables. In these regressions, with all variables appearing in first-difference form, statistically significant coefficient estimates were found for discount window borrowing, for the domestic bond rate, and among the foreign variables, for foreign short-term interest rates; but none of the other foreign variables proved significant. Thus, insignificant estimates were found for foreign long-term rates, for foreign trade (the ratio of U.S. exports and imports to GNP), for foreign financial transactions (the ratio of financial inflows and outflows to GNP), and for the exchange rate, its forward premium, and its volatility. The coefficient for the foreign trade variable came closest to achieving the usual significance levels and hence it was included in later regressions.

The regression results for the equation that included foreign *short-term* rates *but* not foreign trade are reported in column 1 of Table 1. The estimated long-run impacts of borrowed reserves, the bond rate, and foreign short-term rates on the spread are in the expected direction and seem reasonable in magnitude:

- If borrowed reserves rise $100 million while the domestic bond rate and foreign money market rates are constant, the spread between federal funds and Treasury bills immediately grows 4 basis points and eventually widens by a total of 11 basis points.[12] Intuition suggests that the bill rate should rise more and the spread should widen less than the model indicates. But it must be remembered that the bond rate is held constant so that pressure is being placed on the bill rate only from shorter maturities. On average, a tightening of policy would also cause the domestic bond rate to rise; pressure would then be applied to the bill rate from the long end of the market as well (and if foreign short-term rates rise, from the international money market too).
- If the bond rate falls by 100 basis points with monetary policy unchanged and foreign short-term rates constant, then the spread of the federal funds rate over the Treasury bill rate widens by 50 basis points in the same month, but later narrows, ending with a net increase of 23 basis points.[13] Essentially, the bill rate moves down less than the bond rate, and the Treasury yield curve flattens; with the funds rate nearly constant and a lower bill rate, the spread between the overnight and three-month rates widens.
- When foreign short-term interest rates fall while domestic long-term rates and discount window borrowing are constant, the spread between the federal funds rate and the bill rate initially widens, as would be expected. According to the equation, given a 100 basis point fall in foreign short-term rates, the bill rate falls by 36 basis points. In the longer run, though, the spread is relatively unaffected. The coefficient estimates imply that the spread will eventually be a little narrower than it was initially but the effect may be too small to be significant.[14] In any event, it is difficult to interpret the coefficient on foreign short-term rates in a conventional fashion. Changes in foreign rates may

[12]The short-run effect is the sum of the two borrowed reserves coefficients (−4.78 + 26.66) divided by a scaling factor ($58.7 billion, total reserves as of December 1987); the long-run effect is the sum of the simple change in the bond rate plus 2.5 times the change in the bond rate from its average over the four previous months (−4.78 + (2.5)(26.66)) divided by a scaling factor.

[13]These effects are calculated in the same way as those for the borrowed reserves variable.

[14]The effects are again calculated in the same way as for the borrowed reserves.

well be a response to U.S. rates or may reflect, at least to some extent, industrial countries' efforts to coordinate monetary and exchange rate policies.

Having found that foreign short-term rates contributed significant explanatory power to the equation, we then reestimated the regression equation by adding the other foreign variables one at a time. In this second set of regressions, none of the additional foreign variables was significant. The variable coming closest to significance was foreign trade (t-statistic of 1.72). The results of this regression are reported in column 2 of Table 1. A rise in foreign trade is correlated with an increase in the spread between federal funds and Treasury bills.

In sum, foreign variables do seem to be playing a role in determining the federal funds-Treasury bill spread. Foreign short-term rates clearly contribute; foreign trade, as a proxy for international activity generally, may also. To be sure, the inclusion of foreign short-term rates, with or without a foreign trade variable, only modestly improves the equation's fit (R^2). The degree of improvement in the overall fit, however, is likely to be a deceptive indicator of the role of foreign factors and may be a poor way to measure the effect of globalization. In the presence of a high degree of multicollinearity, as is the case here, the marginal increase in the regression's explanatory power should not be interpreted as meaning that only a negligible share of the movements in the spread can be attributed to foreign sources. The marginal increase is biased toward understating the contribution of the foreign factors.

Table 1

Regression Results for the Model

Sample Period: November 1979 to December 1987

Independent Variables:	Coefficient Estimates (t-statistics in parentheses) Version 1	Version 2
Constant	0.019 (0.5)	0.019 (0.5)
BR_t-BR_{t-1}	−4.78 (−0.7)	−6.54 (−1.0)
BR_t-$BR4_{t-1}$	26.66 (4.6)	28.35 (4.8)
$BOND_t$-$BOND_{t-1}$	−0.68 (−3.7)	−0.56 (−2.9)
$BOND_t$-$BOND4_{t-1}$	0.18 (1.3)	0.10 (0.8)
FST_t-FST_{t-1}	−0.70 (−2.2)	−0.79 (−2.5)
FST_t-$FST4_{t-1}$	0.34 (2.0)	0.35 (2.0)
$FRTRD_t$-$FRTRD4_{t-1}$	–	148.0 (1.7)
	Summary Statistics	
R^2	0.42	0.44
Durbin-Watson	2.51	2.51
Standard error	0.54	0.53

Note: All variables entered the regression in first-difference form.

Dependent variable	= Federal funds rate less the three-month Treasury bill rate.
BR	= Borrowed reserves (in hundreds of millions of dollars), divided by total reserves (in billions).
BR4	= The average of borrowed reserves (divided by total reserves) over the previous four months.
BOND	= The 10-year Treasury bond rate.
BOND4	= The average of the bond rate over the previous four months.
FST	= An average of foreign short-term interest rates.
FST4	= The average of foreign short-term rates over the four previous months.
FRTRD	= The sum of nominal exports and imports, divided by GNP (all in billions of dollars).
FRTRD4	= The average of FRTRD over the previous four months.

A complete description of the variables is provided in the Appendix.

Gauging the impact of globalization

The next step was to apportion the explained variability in the spread between the domestic and foreign factors and to make an inference regarding the importance of globalization. But before taking this step, we calculated the actual and predicted variability of the spread, measured by the standard deviation, within 12-month intervals, moving through the sample one month at a time from January 1980 to December 1987. The predicted variability is the degree of variability expected given the movements in the factors incorporated in the model; it is derived using the coefficient estimates of the regression model (version 2, which includes the foreign trade variable). Chart 1 compares predicted variability with actual variability. (The predicted variability is shown by the dashed line, the actual variability by the solid line.)

The period from late 1979 to mid-1982, when the Domestic Trading Desk used a nonborrowed reserves operating target, clearly coincides with a high degree of volatility in the spread. Moreover, the larger movements in borrowed reserves, the bond rate, and the foreign variables in that period are the sources of much, but by no means all, of this higher variability; some of the variability cannot be attributed to factors identified in the model. This increase in residual variance could be the by-product of the monetary policy

tactics of the period, or the effect of atypically large real or financial shocks to the economy, such as the credit control program. Thus, besides greater variability of the right-hand side variables in the regression, there is a larger element of unexplained variation—variation that cannot be attributed to factors explicitly included in the regression model.

We next calculated the relative contributions of domestic and foreign factors to the variability of the spread, as predicted by the equations, and plotted the results in Chart 2. This statistical procedure does not allow precise attribution, but it does seem that (a) foreign factors introduce less variability than domestic factors into the spread, but (b) the share introduced by foreign forces is gradually increasing over time, although with a highly irregular trend. In the early 1980s, foreign factors were responsible for about 25 percent of the spread's variability; most recently, about 40 percent on average. This increase is one indication that, relatively speaking, foreign economic factors are having a greater effect than before on the determination of U.S. short-term interest rates.

If one channel of influence for monetary policy is its impact on short-term interest rates, and if this impact, in turn, operates in part through the effect of open market operations on the market for reserves and the funds rate, then any nonpolicy factor that may influence the spread between the funds rate and the bill rate can be an impediment to policy if its influence is not easily forecastable. Thus, a growing influence of foreign factors on this rate spread may represent a problem for policy if these foreign influences are hard to predict and hence hard to allow for. Foreign influence on the spread may be difficult to estimate for several reasons: despite improved communications, developments in foreign economies are not as well understood as those in the domestic economy; the actions of foreign central banks are not known in advance; and foreign investors respond somewhat differently from domestic investors to changes in the economic outlook. Under these circumstances it can be argued that the effectiveness of policy has declined as the role of foreign factors has increased.

The procedure used in our regression analysis to this point does not permit us to say whether the increased variability in the rate spread attributable to foreign factors reflects the direct impact of the increased globalization of financial markets. Indeed, the use of a constant coefficient model automatically rules out the possibility of any such inference. One way to test for an increased impact of rising international financial integration would be to see if the estimated

Chart 1

The Actual and Predicted Standard Deviation of the Change in the Rate Spread

Overnight Federal Funds Rate versus the Three-Month U.S. Treasury Bill Rate

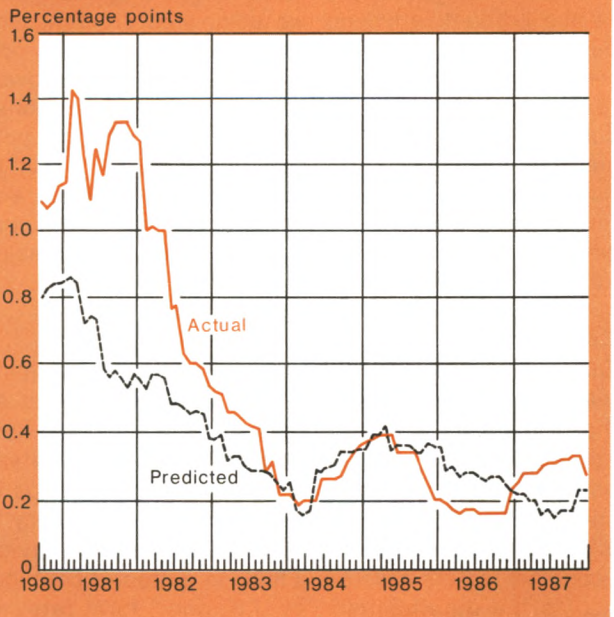
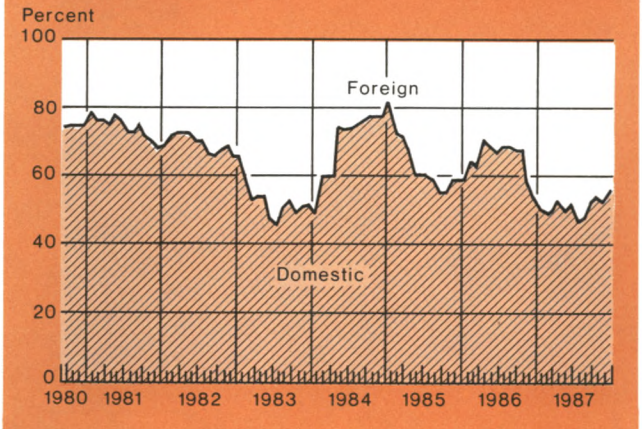


Chart 2

The Contributions of Domestic and Foreign Variables to the Standard Deviation of the Change in the Rate Spread

Overnight Federal Funds Rate versus the Three-Month U.S. Treasury Bill Rate



coefficient on the foreign factors rises over time. In another set of regressions, one coefficient in each equation was allowed to rise or fall steadily through the sample period.[15] These time-varying regression results do *not* indicate increasing foreign-variable impacts on the spread. The hypothesis that the coefficient for foreign short-term interest rates has remained essentially constant is not rejected on the basis of conventional statistical tests. This may simply mean that globalization of the money markets was substantial by the early 1980s and progressed more slowly thereafter, while still occurring apace in the capital markets. For the foreign trade variable, however, a constant coefficient can be rejected, but surprisingly, the coefficient is declining, not rising as anticipated. (See column 4 of Table 2.)

On the domestic side, a constant coefficient for the bond rate can not be rejected. Because globalization of capital markets has supposedly been progressing rapidly this decade, it might have been expected that this coefficient would have increased over time. In the case of the borrowed reserves variable, a constant coefficient can be rejected, but the regressions indicate that the coefficient *falls* during the sample period. For the change in borrowed reserves from the previous month (but not for the change from the average over the previous four months), a constant coefficient can be rejected at the 95 percent level. The results appear in the first three columns of Table 2.

If the finding of a declining coefficient is correct, the implication is that a given increase—in, say, the level of borrowings induced by open market operations—may produce approximately the same upward pressure on the funds rate as in earlier years but may now have a larger effect on the other short-term rates presumed to affect the economy at large. That is, the rise in the funds rate is now more nearly matched by a rise in the bill rate, so that the impact on the spread is smaller than in earlier years. Even if this finding is true, however, its practical significance is doubtful since it simply means that a smaller volume of open market operations is needed, other things equal, to produce a given impact on bill rates and other short-term rates.

In any case, the power of the test used is unknown; it may have the tendency to indicate incorrectly a changing coefficient value more often than the test's significance level suggests. Moreover, this finding could also be the product of mixing two somewhat different time periods, 1979-82 and 1983-87. The earlier period corresponds to the time when the path for nonborrowed reserves was directly tied to the growth of the money supply. Finally, greater coordination of monetary policies may invalidate the "other things equal" assumption underlying this analysis. That is, domestic and foreign monetary policies may now be changed in concert, causing the location of the shift in the regression equation to be misidentified.

[15] Allowing all coefficients to vary through time in a single regression consumes too many degrees of freedom and introduces too much collinearity.

Table 2

Testing for Changing Coefficient Values

Sample Period: November 1979 to December 1987

Independent Variables:	Coefficient Estimates (t-statistics in parentheses) Equation 1	Equation 2	Equation 3	Equation 4
Constant	0.018 (0.5)	0.011 (0.1)	0.017 (0.1)	0.020 (0.1)
BR_t-BR_{t-1}	45.08 (2.1)	−4.45 (−0.7)	43.96 (2.0)	−6.17 (−0.9)
(BR_t-BR_{t-1}) *Time	−0.44 (−2.4)	– –	−0.45 (−2.5)	– –
BR_t-$BR4_{t-1}$	26.71 (4.7)	57.26 (3.1)	28.44 (5.0)	26.75 (4.6)
(BR_t-$BR4_{t-1}$) *Time	– –	−0.29 (−1.7)	– –	– –
$BOND_t$-$BOND_{t-1}$	−0.69 (−3.9)	−0.64 (−3.5)	−0.56 (−3.0)	−0.56 (−2.9)
$BOND_t$-$BOND4_{t-1}$	0.15 (1.2)	0.17 (1.3)	0.078 (0.6)	0.15 (1.1)
FST_t-FST_{t-1}	−0.85 (−2.7)	−0.81 (−2.5)	−0.94 (−3.0)	−0.81 (−2.6)
FST_t-$FST4_{t-1}$	0.43 (2.5)	0.37 (2.2)	0.44 (2.6)	0.27 (1.5)
$FRTRD_t$-$FRTRD4_{t-1}$	– –	– –	151.8 (1.8)	854.6 (2.2)
($FRTRD_t$ -$FRTRD4_{t-1}$)*TIME	– –	– –	– –	−5.38 (−1.9)
Summary Statistics				
R^2	0.46	0.44	0.46	0.46
Durbin-Watson	2.52	2.51	2.53	2.50
Standard error	0.52	0.53	0.52	0.52

Conclusion

Our study provides some empirical evidence indicating that an increased impact of foreign developments on the U.S. money markets may have loosened the linkage between changes in the supply of bank reserves and U.S. money market interest rates, and perhaps to some extent complicated the use of monetary policy to influence these rates. According to our results, foreign economic factors have been making a greater contribution to the determination of U.S. short-term rates in recent years. A greater role played by foreign factors in

the domestic credit markets makes for more uncertainty in anticipating the proximate impact of a policy instrument change. Whether the greater contribution by foreign economic factors indicated by the regression model has been precipitated by globalization is debatable; but a case can be made that the greater volatility in the financial and real sectors of the world economy is attributable to tighter connections among financial markets worldwide.

One indication that globalization has loosened the linkage would be regression estimates showing an increasing effect of foreign economic factors on the spread between the federal funds rate and the Treasury bill rate, or a decreasing effect of domestic factors on that spread. Such changes in the effects were not observed, however. Instead, we found some statistical evidence suggesting that the potency of monetary policy instruments may be greater, in the limited sense that a given change in borrowed reserves may have a larger impact on money market rates than in the past.

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Appendix: Description of the Variables Used in the Regression Equations

Variables appearing in reported results

The dependent variable, SPREAD, equals the overnight federal funds rate (monthly average of effective daily rates) less the three-month Treasury bill rate (monthly average of daily rates in the secondary market, bank discount basis). Source: Board of Governors of the Federal Reserve System.

BR equals the sum of adjustment and seasonal borrowing from the discount window, in millions of dollars. Source: Board of Governors of the Federal Reserve System.

BOND equals the 10-year Treasury bond rate (monthly average of daily rate in the secondary market). Source: Board of Governors of the Federal Reserve System.

FST equals the weighted average of the short-term interest rates in 10 countries (Switzerland and the G-10 countries excluding the United States); the weights are the same as those used for the exchange rate. Source: INTMAC database of the Board of Governors' staff.

EXP is the merchandise exports of the United States, seasonally adjusted. Source: Department of Commerce.

Variables appearing in unreported results

Imports are the merchandise imports of the United States, seasonally adjusted. Source: Department of Commerce.

Foreign long-term interest rates equal the weighted average of the long-term interest rates in 10 countries; the weights are the same as those used for the exchange rate.

U.S. exchange rate is the index of the weighted average exchange value of the U.S. dollar against currencies of other G-10 countries plus Switzerland. March 1973 = 100 (weights based on the 1972-76 global trade of each of the 10 countries). Source: Board of Governors of the Federal Reserve System.

Volatility of the exchange rate equals the standard deviation of the change from the previous day in the logarithm of the U.S. exchange rate, calculated monthly. Source: INTMAC database of the Board of Governors' staff.

The forward premium of the exchange rate equals the difference between the yen-dollar or mark-dollar spot rate and the three-month forward rate. Source: Bank for International Settlements.

The dollar volume of U.S. government securities (Treasury and agency) bought by foreign private investors was obtained from the Treasury Department.

Interest Rate Divergences among the Major Industrial Nations

The international integration of financial markets has increased dramatically during the last decade. Government-imposed barriers to international capital flows were gradually relaxed throughout the 1970s and by now have been substantially eliminated in the major industrial countries. More recently, the development and growth of currency and interest rate swaps, options, and other new financial instruments have further stimulated international financial integration by giving investors and borrowers a wider range of choices than that traditionally available from purely domestic channels. Distinctions between domestic and foreign financial markets are fading rapidly as major corporations can gain access to New York, London, and other international financial centers nearly as readily as their home markets.

It is widely presumed that financial integration reduces interest rate divergences among similar credit instruments and increases the degree to which yields in different markets move together over time. Historical experience with integration of domestic financial markets would seem to support this presumption. For example, the development of national money and capital markets in the United States during the latter part of the 19th century reduced regional disparities among interest rates and made the rates increasingly responsive to national, as opposed to purely local, conditions. This experience suggests that growing international financial integration should reduce interest differentials across countries and possibly limit the autonomy of national monetary authorities in controlling domestic financial yields. The actual record of the last two decades, however, raises doubts about these propositions. In particular, international interest divergences during much of the 1980s have been as great or greater than those observed during most of the 1960s and 1970s.

This article examines interest rate divergences among the United States and other major industrial countries from the 1960s through the present. As the next section shows, interest rate disparities among nations can arise from differences in currency denomination and national jurisdiction as well as from factors that cause yields to diverge domestically. Expected exchange rate changes and their associated risks, together with institutional barriers to financial flows across national borders, are potentially important sources of international interest disparities. The analysis also shows that increased financial integration unambiguously reduces one source of international interest rate divergences, that arising from institutional barriers. Whether integration actually leads to interest rate convergence, however, depends critically on the nature of other economic changes occurring at the same time and their effect upon currency expectations and risks.

These points are underscored by our empirical analysis of interest divergences. Neither nominal nor real interest rates have shown any systematic tendency toward convergence during the past 25 years. However, the factors underlying interest rate disparities apparently have changed significantly. Currency expectations and associated risks are now the primary sources of divergence, while the importance of overt barriers to capital mobility has declined markedly. These changes can be attributed to the historical association of increased financial integration with the shift from fixed to flexible exchange rates that has resulted in increased volatility in currency values.

Causes of interest divergences

In general, disparities among yields on alternative assets reflect differences in their underlying characteristics. Within a given nation, liquidity, credit risk, tax treatment, and other related attributes determine the relative yields on various instruments. Differences in these characteristics also contribute to interest variations across countries—indeed, the international diversity in these attributes is often greater than the diversity within any single nation. In a world composed of many countries, however, interest rates may also diverge because of currency distinctions and jurisdictional differences, the latter reflected largely in capital controls and other institutional barriers to financial flows across borders.

The existence of different national currencies is a fundamental source of international interest rate divergences. To compare yields on assets denominated in different currencies, an investor requires an estimate of their exchange rate at maturity. For example, the *dollar* return on an instrument denominated in German marks (DM) depends upon how much the DM is expected to appreciate (or depreciate) over the holding period. This means that yield differentials among assets denominated in different currencies implicitly reflect market forecasts of future exchange rate changes. In addition, investing in one currency as against another involves potential risks because exchange rates cannot be predicted exactly. This currency risk, resulting from uncertainty about future exchange rates, is also a potential source of interest divergences across countries.[1]

International interest divergences also reflect nationality distinctions arising from a variety of government policies and institutional imperfections that effectively impede financial flows across national jurisdictions. Until fairly recently, most industrial countries explicitly restricted or otherwise regulated international capital flows; these restrictions have been substantially removed in the United States, Canada, Japan, the United Kingdom, and Germany, but remain important in many other nations.[2] Interest divergences based on nationality can also arise from differences in tax systems or other policies not explicitly aimed at capital flows, as well as from private market imperfections such as incomplete information or monopolistic restrictions on market access and pricing.

The effects of these various factors on interest divergences across countries can be summarized in the following identity:

$$\text{(i)}\quad i - i^* = \%s + DOM + CRISK + BAR,$$

where i and i* are, respectively, the interest rates on U.S. assets and foreign-currency-denominated assets of a given maturity while %s is the expected (annualized) rate of dollar depreciation to maturity. The remaining terms represent the effects of "domestic" distinctions among the assets (DOM), currency risk factors (CRISK), and official and private barriers to capital flows (BAR).[3]

The difference in asset returns expressed in a common currency, that is, adjusted for expected exchange rate changes, is a reflection of these last three elements:[4]

$$\text{(ii)}\quad i - i^* - \%s = DOM + CRISK + BAR.$$

Furthermore, an investor can in some cases avoid the risk associated with uncertainty about future exchange rates by "hedging" (selling) the proceeds of a foreign currency investment in the appropriate forward market. The return differential on this hedged (or "covered") basis is simply the interest differential ($i - i^*$) less the forward premium on the dollar (fp), defined as the annualized difference between its forward and spot values:

$$\text{(iii)}\quad i - i^* - fp = DOM + BAR.$$

The covered return differential is not (directly) affected by currency distinctions since it is adjusted for both the expected level and uncertainty of future exchange rates.[5] Thus, for assets that are comparable in terms of their domestic characteristics (DOM = 0), the covered differential is essentially a reflection of barriers to capital flows (BAR).

[1]Currency risk thus arises from the variances of the perceived distribution of exchange rates rather than their means. From a market perspective this risk reflects the potential loss to an investor in a currency from an unanticipated change in that currency's value.

[2]Deregulation of capital flows generally has proceeded furthest in shorter-term markets. See M. A. Akhtar and Kenneth Weiller, "Developments in International Capital Mobility: A Perspective on the Underlying Forces and the Empirical Literature," Federal Reserve Bank of New York, Research Paper no. 8711, in *International Integration of Financial Markets and U.S. Monetary Policy*, December 1987. Note that even the prospect of the imposition of capital controls can affect interest rates. Risks arising from the possible *inability* to repatriate funds are generally referred to as "sovereign" and "political" risks.

[3]The substitutability of different countries' assets is essentially a function of the importance of the factors summarized by BAR and CRISK. In reality, the factors underlying these terms are often closely related, even if distinct in theory.

[4]The common currency differential as we have defined it is also known as the "uncovered" differential, denoting that the relative return is not hedged in the forward market.

[5]However, currency distinctions may be implicit in the covered differential when, for example, official regulations treat foreign currency investments differently from investments in domestic currencies (the effect would be captured in BAR). Generally, formal forward markets exist only for certain short-term assets, although recently developed currency swap facilities provide comparable arrangements for some longer-term assets.

It is also useful to express the yield differential in terms of the traditional expected inflation (%p) and real interest (r) components of nominal interest rates:

$$\text{(iv)}\quad i - i^* = (\%p - \%p^*) + (r - r^*).$$

Nominal interest divergences among countries also can be expressed as the sum of differences in expected inflation rates and in their real interest rates (where the real interest rate measures an asset's return in goods rather than money). Furthermore, the real interest differential is itself partly a reflection of expectations about the future *real* exchange rate (x), defined as the nominal rate deflated by the ratio of home to foreign prices (p and p^*):

$$x \equiv s \div (p/p^*).$$

The real exchange rate effectively measures the value of a country's goods in terms of its foreign counterparts.[6] Using the last two expressions, we can write the real interest differential in terms analogous to relation (i) for the nominal difference,

$$\text{(v)}\quad r - r^* = \%x + \text{CRISK} + \text{BAR} + \text{DOM}.$$

To summarize, observed nominal interest divergences across countries can be accounted for by four sets of factors: expected changes in nominal exchange rates (which in turn reflect differences in anticipated inflation and expected changes in real exchange rates); currency risk; the effects of barriers to capital mobility; and domestic characteristics summarized in DOM. These factors are the proximate determinants of international interest differentials and will provide a useful framework for our later analysis of the actual behavior of interest rate divergences among the United States and other countries.

Fundamental determinants

These proximate sources are not, however, the most basic causes of international interest divergences, but rather the reflection of more fundamental exogenous economic conditions. In thinking about these fundamental causes, we can make a distinction between factors directly affecting particular financial markets and those determining the transmission of their effects among countries.

In principle, virtually any disturbance that affects one country's financial markets more than another's may lead to international interest rate differentials. Of particular importance historically have been divergent national inflation rates, which normally have been associated with disparate monetary policies. A country that has a higher inflation rate than abroad must generally maintain nominal interest rates above those of its trading partners in order to compensate for the decline in the value of its currency that typically results from the inflation.[7] Divergences in real as well as nominal interest rates have also resulted from shorter-term fluctuations in monetary policy that affect domestic liquidity, from disparities in fiscal policies, and even from commodity supply shocks such as the oil price increases of the 1970s.[8]

All of these conditions can create pressures for interest rates to diverge across countries. Nonetheless, the extent to which such divergences actually occur, as well as the way in which they are reflected in currency expectations and other proximate components, depends upon the nature and strength of the transmission of such disturbances from one country to another. Particularly critical to this transmission mechanism are the mobility of capital and the exchange rate regime.

In its broadest sense, capital mobility refers to the degree to which international financial flows tend to respond to changes in asset yields.[9] Key aspects of international capital mobility are the extent and severity of explicit official and private barriers to capital flows and the degree to which assets that are similar (DOM = 0) but issued in different countries or currencies are viewed as close substitutes by investors. Generally, the greater the mobility of capital, the larger the combined effect of a change in a country's interest rates on foreign interest rates and exchange rates. An increase

[6] The real exchange rate is essentially an extension of the "terms of trade" to include nontraded goods as well. Changes in the nominal exchange rate can be expressed as the sum of the change in the corresponding real exchange rate plus the inflation differential. The traditional theory known as "purchasing power parity" essentially asserts that real exchange rates are constant in the long run.

[7] To the extent that a rise in the inflation rate simply leads to a compensating increase in domestic interest rates and depreciation in the nominal exchange rate (leaving the real exchange rate unaltered), it need not lead to any further divergence in real interest rates or yields expressed in a common currency. Typically, however, inflation has indirect effects on real interest and exchange rates and may affect the BAR and CRISK components as well.

[8] For example, the mid-1970s oil price rise led to the following consequences in most importing countries: an acceleration of inflation, sharp increases in nominal and real interest rates, and a subsequent downturn in real economic activity. Because the magnitude and timing of these effects varied greatly across countries, depending on their reliance on oil imports and other factors, international interest divergences increased markedly during this episode.

[9] This is the traditional broad definition of capital mobility. Under a narrower definition, capital mobility refers only to the severity of explicit barriers and other market imperfections that impede international financial flows. Thus currency risk is a determinant of the degree of capital mobility under the broad definition but not necessarily under the narrower one.

in capital mobility can be thought of as a reduction in the average size and variability of the BAR and CRISK terms defined earlier. It follows that a given disturbance is apt to produce smaller divergences in asset yields expressed in a common currency when capital mobility is high than when it is low.

Equally important to the international transmission of interest rate changes, however, is the flexibility of exchange rates. Unlike a fixed rate regime where exchange rates (at least in principle) are not free to vary, a floating rate system allows changes in interest rates to affect present and future currency values. Consequently, for a given amount of capital mobility, a change in one country's interest rates will have more impact on actual and expected exchange rates (and possibly CRISK), and less on foreign interest rates, when exchange rates are flexible than when they are fixed. In this sense, the current flexible exchange rate regimes may allow greater scope for international interest rate divergences.

Implications of reduced barriers to capital mobility

International financial integration has risen considerably over the last two decades, in large part because of a dramatic reduction in overt barriers to capital flows among the major industrial nations. The discussion in the preceding section shows that this development, of itself, should reduce international interest rate divergences, whether expressed in national currencies, a common currency, or in real terms. Historically, however, changes in international financial integration have not occurred in isolation but have been accompanied by other complex economic changes, some with potential effects on interest rate determination. For this reason, the implications of increased financial integration are apt to be less clear-cut in an international context than within a single nation.

In a national market, the use of a single currency precludes variations in nominal exchange rates as well as any persistent disparities in inflation rates across regions. The domestic sources of interest divergences are therefore significantly fewer than the international sources; consequently, there is a fairly strong presumption that increased financial mobility and integration will lead to closer alignment of interest rates across markets.

In an international economy comprising many nations and currencies, however, whether increased capital mobility leads to convergence of interest rates depends upon the nature of the changes in exchange rate behavior and government policies that are occurring at the same time. During the postwar era, increased financial integration has been accompanied by a transition from fixed to highly variable exchange rates and, as documented in the next section, greater disparities in national inflation rates. In effect, as the importance of factors reflected in BAR has declined, the potential importance of currency expectations and risk factors may well have increased. Accordingly, interest rates have been subject to conflicting pressures: easing of restrictions on capital flows has tended to push the rates toward convergence, while greater exchange rate volatility and inflation disparities have increased pressures for the rates to diverge. As we show in the empirical analysis that follows, this configuration of economic changes over the last three decades has led to a fairly complex and variable pattern of interest rate divergences among the major industrial nations.

Evidence on interest rate divergences

We now examine the historical pattern of interest rate divergences and their proximate determinants for five major industrial countries—the United States, Germany, Japan, the United Kingdom, and Canada. Divergences among both short-term money market rates and longer-term government bond yields are considered.[10] We first show that these nations' nominal interest rates exhibit no consistent trend toward convergence over the last two decades, although the impact of barriers to capital mobility (BAR) has declined markedly. This implies that currency factors are now the main source of observed international interest rate divergences. We then go on to consider the extent to which expected exchange rate changes can account for interest differentials across countries, asking whether asset yields expressed in a common currency have converged over time. Finally, we examine the nature of the currency expectations themselves, in particular the degree to which they appear to be a reflection of anticipated inflation differentials or of fluctuations in real exchange rates.

Nominal interest rate divergence

Interest rate dispersion can, in principle, be measured in several ways. In most of the analysis below, we focus on an indicator of the aggregate level of interest rate divergence for the group as a whole—the average absolute deviation of individual rates from the group mean. This indicator measures the collective impact of the proximate sources of interest differentials identified earlier: expected exchange rate changes, currency risk,

[10]The short-term rates used in this study are: three-month certificate of deposit (CD) rate for the United States; three-month interbank rate for Germany; two- to three-month interbank (call) rate for Japan; the one-month financial paper rate for Canada; and the three-month interbank loan rate for the United Kingdom. The long term rates are government bond yields of greater than five-year maturities. These are generally the most comparable rates available for the entire period.

and barriers to capital mobility, as well as any domestic comparability distinctions among assets. For assets that are reasonably comparable, this measure indicates the degree to which international interest rates diverge in a given period and their tendency towards convergence over time.

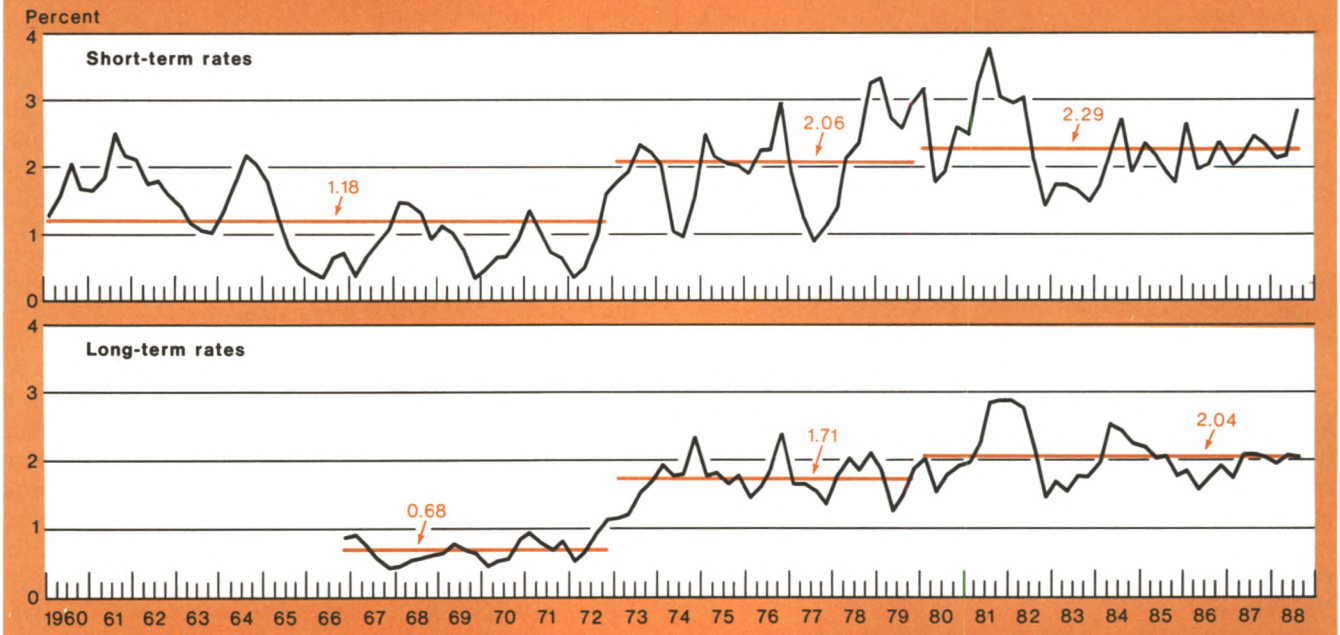
Of course, the assets considered here are not perfectly comparable, and thus interest rate divergences need not disappear across countries even as currency and jurisdictional differences subside. Our analysis will suggest that domestic comparability distinctions are generally insignificant among short-term instruments. More important differences in average maturity and other characteristics are, however, reflected in long-term rates. Nonetheless, these distinctions have remained relatively stable and hence are unlikely to have had a substantial impact on changes in the pattern of interest rate dispersion over time. For this reason, a comparison of average levels of interest rate divergence across relevant periods should provide a reasonable indication of trends in their proximate determinants.

Further insight into the nature of international interest rate divergences is provided by examining bilateral interest rate relations. We present evidence concerning one important component of our aggregate dispersion measure, U.S.-foreign bilateral interest rate differentials. In addition, the tendency for U.S. and foreign interest rates to move together is analyzed in the accompanying Box. While not directly measuring the size of divergences, this analysis provides some indication of the strength of linkages between domestic and foreign asset markets during different historical periods.

Chart 1 presents our measure of the degree of dispersion of nominal interest rates from the 1960s onward. The chart shows clearly that nominal interest rates often have diverged widely. The average absolute deviation of short-term interest rates from the group mean has frequently exceeded 200 basis points and has only rarely fallen below 150 basis points during this decade. Long-term rates, although typically less widely dispersed than the short rates, have generally diverged by more than 150 basis points.

Chart 1

Nominal Interest Rate Dispersion*



Sources: Interest rates are taken from the countries' central bank publications.

Note: Figures with arrows indicate period averages for 1961-72, 1973-79, and 1980-88:III.

*The mean absolute deviation of quarterly average interest rates from the simple average of the group. The group includes the United States, Canada, the United Kingdom, Germany, and Japan. Short-term interest rates are three-month money market rates. Long-term interest rates are yields on government bonds with maturities of five years or more.

It is also apparent that the degree of nominal interest rate divergence has tended to increase over time. Interest rates were most closely aligned during the years 1966-71: both short- and long-term rates generally fell within 100 basis points of the group mean during this period. Since 1973, however, divergences among the rates have become increasingly pronounced. Average rate deviations over 1973-79 exceeded 200 basis points on short-term and 170 basis points on long-term rates, roughly double the levels of the 1960s and early 1970s. The dispersion of nominal interest rates reached its peak in 1981. Nonetheless, for the 1980s as a whole, interest rate divergence has exceeded that of the two preceding decades.

This trend towards greater nominal interest rate dispersion among industrial countries can also be observed in U.S.-foreign bilateral interest rate relations. The average absolute interest differential between U.S. rates and those abroad has risen steadily during the past two decades, increasing roughly by 100 basis points for both short- and long-term rates (Table 1). Underlying this trend have been particularly sharp increases in the size of U.S. interest differentials with Germany and Japan. U.S. rates, uniformly the lowest among industrial nations during the 1960s, began to rise relative to those in Germany and Japan during the 1970s; by the 1980s both short- and long-term U.S. interest rates had increased on average to more than 300 basis points above their German and Japanese counterparts. In contrast, the gap between U.S. interest rates and their typically higher Canadian and U.K. counterparts exhibits no systematic tendency to increase over time. In nearly all cases, however, the volatility of the U.S.-foreign interest differentials has been substantially higher since 1973 than earlier.

The impression that interest rates have not converged is further supported by evidence on the correlation of U.S. and foreign yields (see the accompanying Box). Specifically, the response of foreign interest rates to a given change in U.S. rates was generally *smaller* during the 1980s than the average response over the 1970s and 1960s.

These results are particularly striking in view of the clear evidence that the component of interest divergences attributable to explicit barriers to international capital flows (BAR) has declined markedly over time. These barriers were fairly stringent in Japan and Europe for much of the postwar period and effectively helped insulate domestic interest rates from changes in financial conditions abroad.[11] Beginning in the mid-1970s these impediments were largely removed in the major industrial countries as part of a larger move toward financial deregulation.

An indication of the effect of these changes can be seen from the fall in the dispersion of *covered* short-term interest rates shown in Chart 2.[12] The identity (iii) discussed in the previous section shows that, for com-

[11]The United States also imposed barriers to capital flows during parts of the 1960s and 1970s, although they were usually less restrictive than those imposed by other major industrial countries. An example is the interest equalization tax of the late 1960s.

[12]Because of limitations on forward rates and other required data, our analysis is largely confined to short-term interest rates over the 1970s and 1980s. To reduce comparability differences, we have used the Japanese Gensaki (bond repurchase) rate for this section and the appendix rather than the two- to three-month call rate referred to elsewhere in the article (and in all other charts and tables). The Gensaki rate is most comparable to the short rates for the other countries but was only available on a regular basis from the early 1970s on.

Table 1

U.S.-Foreign Bilateral Nominal Interest Differentials

(Period Average of Quarterly Observations in Percentage Points)

Period	Average Absolute Deviation†		Germany		Japan‡		Canada		United Kingdom‖	
	Short	Long	Short	Long	Short	Long	Short	Long	Short	Long
1960-72	1.78	1.19	0.60	−1.82	−2.86	−0.85	−0.66	−0.72	−1.95	−1.88
			(1.54)	(0.82)	(2.53)	(0.75)	(0.75)	(0.37)	(1.18)	(0.52)
1973-79	2.57	2.16	1.32	−0.01	0.31	−0.04	−1.15	−0.62	−3.31	−4.93
			(2.81)	(2.01)	(3.38)	(1.51)	(1.53)	(0.44)	(2.26)	(1.49)
1980-88§	2.81	2.17	3.23	3.03	3.68	3.77	−1.49	−0.71	−1.76	−0.72
			(1.25)	(1.02)	(2.64)	(1.34)	(1.09)	(0.71)	(2.56)	(1.33)

Note: Figures in parentheses are standard deviations.
†Simple average of the four absolute bilateral interest differentials.
‡Japan's long-term interest rates begin in 1967.
‖United Kingdom's long-term interest rates begin in 1961.
§1988 data through third quarter.

Box: Foreign Responses to U.S. Interest Rate Changes

The analysis of interest rate dispersion presented in the text focuses on cumulative levels of interest rate divergence across countries. Our aggregate indicator—the average absolute deviation of rates from the group mean—provides a good summary measure of the overall size of interest rate divergences that arise from currency and jurisdictional differences. It is also useful, however, to examine whether the tendency for national interest rate movements to be associated with each other has been affected by financial integration. Accordingly, in this section we present evidence concerning the average response of foreign interest rates to movements in U.S. and German rates.

The correlation and average response measures in Table A identify the strength and magnitude of interest rate linkages between national asset markets, thus providing some indication of the nature of the transmission of disturbances from one country to another.† No clear relationship exists, however, between these measures of responsiveness and the degree of interest rate dispersion. An increase in the response of foreign to U.S. interest rate changes, for example, does not necessarily imply a narrowing of interest differentials or consequently our measure of rate divergence. The extent to which rates will diverge also depends upon the size of the original disturbance and its persistence over time.

An examination of Table A suggests that only Canadian interest rates respond in a consistent and strong manner to movements in U.S. rates. Responses of other foreign

†Like the dispersion indicator, these measures provide a purely statistical indication of the degree of association—in this case between changes in U.S. and foreign rates. They provide no direct measure of causal relations or the strength of interest rate transmission in any fundamental sense.

Table A
Transmission of Interest Rate Movements†

	Nominal						Real		
	Short-Term			Long-Term			Short-Term		
1960s	ρ	B_1	B_2	ρ	B_1	B_2	ρ	B_1	B_2
United States	—	—	0.10	—	—	0.27	—	—	0.00
Germany	0.25	0.64	—	0.35	0.45	—	0.20	0.01	—
Japan‡	0.01	0.02	0.08	NA	NA	NA	−0.07	−0.25	−0.06
Canada	0.60	0.88	0.13	0.63	0.91	0.26	0.15	0.17	0.11
United Kingdom§	0.25	0.47	0.86	−0.02	0.57	0.16	0.34	0.83	−0.26
1970s									
United States	—	—	0.45	—	—	0.34	—	—	0.31
Germany	0.50	0.56	—	0.41	0.52	—	0.34	0.38	—
Japan	0.28	0.21	0.16	0.15	0.16	0.47	−0.22	−0.26	−0.16
Canada	0.78	0.69	0.34	0.72	1.10	0.42	0.43	0.37	−0.11
United Kingdom	0.28	0.38	0.29	0.22	0.58	0.82	0.41	0.98	1.06
1980 to 1988-II									
United States	—	—	0.66	—	—	1.05	—	—	0.45
Germany	0.33	0.17	—	0.61	0.36	—	0.29	0.19	—
Japan	−0.36	−0.20	−0.10	0.42	0.21	0.40	−0.18	−0.13	−0.22
Canada	0.77	0.80	1.31	0.89	1.05	1.21	0.69	0.81	0.86
United Kingdom	0.14	0.12	0.01	0.47	0.41	0.65	0.13	0.17	0.09

†The column headings: ρ = correlation of U.S. with foreign interest rate.
B_1, B_2 = average response, in percentage points, of foreign interest rates associated with a one percent change in U.S. (B_1) and German (B_2) rates.
‡Japan's long-term interest rates begin in 1967.
§United Kingdom's long-term interest rates begin in 1961.

Box: Foreign Responses to U.S. Interest Rate Changes *(continued)*

rates to U.S. yields have been much more variable and generally very modest. In addition, movements in German interest rates seem to elicit only a weak response from all countries.

Overall, these response measures support the conclusions in the text that financial integration has not been associated with a closer alignment of interest rates across countries. At the least, there appears to be no systematic tendency for foreign rates to become more responsive to U.S. yields over time; this result also applies generally to the responses of foreign rates to German yields. Indeed, a one percent change in U.S. nominal interest rates was generally associated with a smaller response in corresponding European and Japanese rates during the 1980s than during the 1970s or 1960s.‡ Similarly, associations among short-term real interest rates were generally weaker for the 1980s as a whole than for the prior decade. Thus, statistical linkages among national interest rates do not seem to have become stronger over time—a pattern clearly consistent with the evidence cited earlier.

‡Correlations among long-term interest rates were somewhat greater during the 1980s than the 1970s. This finding is largely a reflection of the higher variability of interest rates in the latter period. Correlations, however, do not directly measure the quantitative change in one interest rate associated with a change in another.

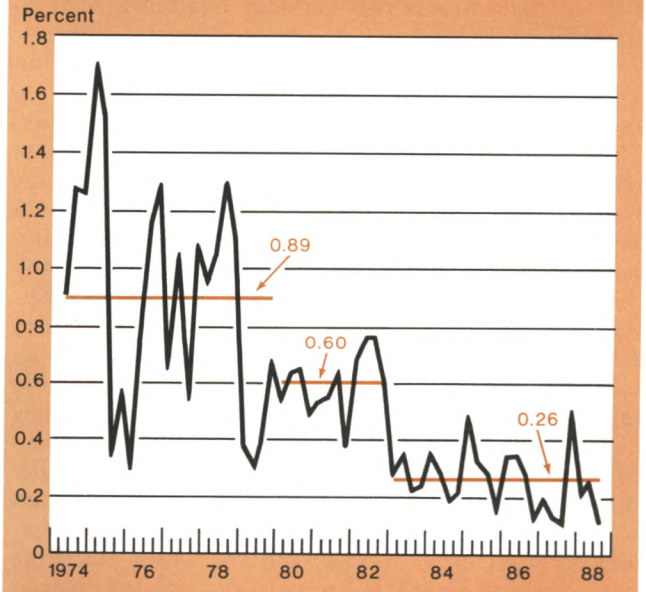
parable assets (DOM = 0), the level of the covered U.S.-foreign yield differential—with asset proceeds hedged in the forward markets to compensate for expected exchange rate changes and currency risk factors—provides a direct measure of the contribution of nationality distinctions (BAR).

Divergences in covered yields clearly have become both substantially smaller and less variable over the past decade. Most notably, since 1982 the average (absolute) deviation of short-term covered interest rates from the group mean has fallen to roughly 25 basis points, a level representing only about 10 percent of the dispersion of short-term nominal interest rates. This reflects a sharp decline when compared to the 90 basis point dispersion in covered yields over the 1974-79 period, which represents more than 40 percent of the total dispersion of unadjusted rates during this period.

Further insight into this apparent decline in barriers to capital mobility is presented in the Appendix, where we consider the determinants of U.S.-foreign bilateral covered interest differentials. The analysis suggests that the closer alignment of covered yields during the 1980s is the result of a general dismantling of official barriers to capital flows—both abroad and in the United States—as well as other developments promoting the integration of short-term financial markets across industrial nations.[13]

Chart 2

Covered Interest Rate Dispersion*



Sources: Interest rates are taken from the countries' central bank publications.

Note: Figures with arrows indicate period averages for 1974-79, 1980-82, and 1983-88:III.

* The mean absolute deviation of quarterly average short-term asset yields (converted to dollar terms by the forward exchange rate premia) from the simple average of the five countries. Short-term interest rates are three-month money market rates.

[13]The extent of integration among longer-term markets (or its change over time) is much more difficult to gauge, in part because forward or other explicit mechanisms for hedging longer-maturity investments have not been available until the last several years. A recent analysis by Helen Popper ("Long-Term Covered Interest Parity: Two Tests Using Currency Swaps," unpublished paper, Department of Economics, University of California at Berkeley, August 1987) does suggest fairly close alignment of covered yields as calculated from

Differentials expressed in common currency

The fact that interest rates have not converged even as barriers to capital mobility have fallen has one reasonably unambiguous implication: currency-related factors, as reflected in forward exchange premia, are now the primary source of international yield divergences. What then is the nature of these currency factors and, more specifically, how do we assess the relative importance of exchange rate expectations and currency risk?

One common view is that eliminating barriers to financial flows across countries necessarily means the near equalization of asset yields expressed in a common currency, that is, adjusted for expected exchange rate changes. This would imply that anticipated exchange rate movements are now the primary source of observed interest differentials across countries on comparable assets and that currency risks have a fairly limited role, at least at the margin. This view is implicit in several recent analyses that link the rise in U.S. interest rates above those abroad over 1981-85 to the concurrent "overvaluation" of the dollar relative to its (presumed) long-run equilibrium. Given the high and increasing exchange rate volatility over the last 15 years, however, it is far from obvious that currency risk factors are so unimportant. Indeed, it is at least conceivable that currency risk premia have increased enough to offset the tendency toward convergence in interest rate levels arising from the reductions in barriers to capital flows.

The main problem in resolving these questions is that neither exchange rate expectations nor currency risk premia are directly observable. Indeed, exchange rate expectations have been notoriously difficult to measure because of the high volatility of currency values. Any concrete analysis must be based upon proxies (preferably several) for expectations. One possibility is to use actual exchange rate changes over a given period as an approximation of the anticipated change during the same period in order to gauge the common currency yield differential. Conceptually, this indicator, which can be thought of as the ex post yield differential, is equal to the actual ex ante differential (reflecting currency risk as well as any remaining DOM and BAR) plus the market's forecast error in predicting the future exchange rate. *If* market forecasts are not systematically biased and forecast errors are roughly comparable among periods, this proxy will indicate the broad trends in actual common currency interest differentials.

Chart 3 shows the dispersion of the short-term interest rates expressed in dollars using the ex post measure. Divergences in ex post dollar yields have risen dramatically over time. The average divergence has exceeded 1000 basis points over the last decade, more than twice that recorded before 1973. Furthermore, the divergences have been somewhat greater during the 1980s than over 1973-79.

It is doubtful that these trends reflect increasing currency risk premia alone. In particular, the magnitude of the dispersion of ex post differentials seems implausibly large to represent risk premia. (Note that typical gaps between yields on very high risk junk bonds and AAA rated bonds are smaller than the differentials shown in Chart 3.) The fact that the dispersion of the ex post yields is nearly five times that of the unadjusted interest rates also suggests that forecast errors are largely responsible for the observed pattern in ex post yield dispersion. Thus, the increasing divergences shown in the chart are most likely the reflection of increasing currency volatility and unpredictability; they provide no conclusive evidence whether ex ante common currency interest differentials have converged.

Possibly more informative are various surveys of the exchange rate expectations of market observers and participants that have only become available during the 1980s.[14] Estimates of dollar depreciation based on a survey reported in the *Economist Financial Review* are presented in Table 2 along with the corresponding forward discount on the dollar quoted at the time of the survey. Recall that the forward discount on the dollar is equal conceptually to its expected depreciation plus the currency risk premium (CRISK). Thus the difference between the forward discount and the market survey expectations figure can be taken as a proxy for the currency risk.

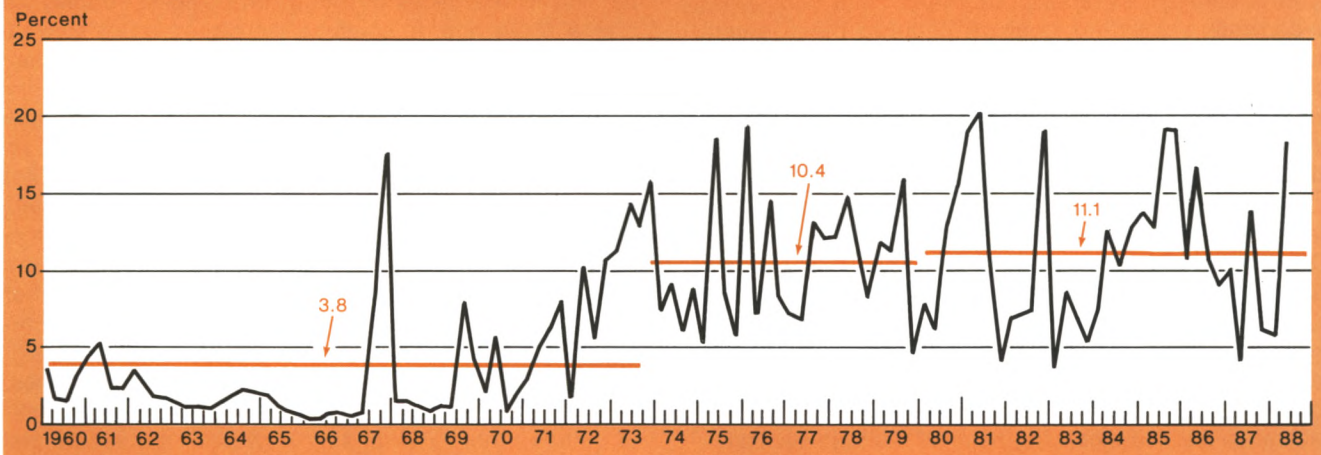
As the table shows, survey estimates of dollar depreciation typically exceeded the forward discount for most of the 1980s, suggesting that investors viewed dollar assets as generally less risky than similar assets denominated in foreign currencies. The average size of these risk premia proxies is quite large, exceeding 500 basis points in many cases. Nonetheless, the survey measures and forward exchange premia do tend to vary together. As the table shows, both 3-month and 12-month forward discounts on the dollar are largest for those currencies against which the dollar is expected to depreciate most. Moreover, the expected depreciation and forward discount rates show a positive and statis-

Footnote 13 continued
currency swap quotes (essentially futures prices) for high-quality bonds issued in the Euromarkets.

[14]See the work of Jeffrey Frankel and Kenneth Froot: "Using Survey Data to Test Standard Propositions Regarding Exchange Rate Expectations," *American Economic Review*, vol. 77, no. 1, pp. 133-53; and "Interpreting Tests of Forward Discount Unbiasedness Using Survey Data on Exchange Rate Expectations," NBER Working Paper no. 1963, July 1986. See also Kathyrn Dominiquez, "Are Foreign Exchange Forecasts Rational?: New Evidence from Survey Data," Board of Governors of the Federal Reserve System, International Finance Discussion Papers, no. 241, May 1986. Here we use the *Economist Financial Review* survey data provided by Ken Froot.

Chart 3

Ex Post Dollar Asset Yield Dispersion*



Sources: Interest rates are taken from the countries' central bank publications. Exchange rates are taken from International Financial Markets.

Note: Figures with arrows indicate period averages for 1960:I-1973:III, 1973:IV-1979:IV, and 1980:I-1988:II.

* The mean absolute deviation of ex post dollar asset yields from the simple average of the five countries. Asset yields are adjusted by actual exchange rate movements to determine ex post dollar returns. Asset yields are three-month money market rates.

Table 2

Survey Data and Foreign Exchange Rate Premia: June 1981-May 1987

(Period Average in Percent)

	German Mark		Japanese Yen		British Pound	
	3-Month Horizon	12-Month Horizon	3-Month Horizon	12-Month Horizon	3-Month Horizon	12-Month Horizon
Forward exchange premia on the dollar (+ = discount)	3.86	3.78	3.95	3.97	−0.94	−0.47
Survey-based estimates of dollar depreciation†	11.47	9.00	11.70	9.14	2.88	2.38
Estimated currency risk premia (+ = discount)	−7.61	−5.22	−7.75	−5.17	−3.82	−2.86
Memo: correlation of survey-based estimates of dollar depreciation and forward exchange premia	0.50	0.72	0.53	0.53	0.41	0.63

Source: Data provided by Ken Froot from data base used in Frankel and Froot, "Using Survey Data to Test Standard Propositions Regarding Exchange Rate Expectations," *American Economic Review*, March 1987.

†Survey-based data are from the *Economist Financial Report*.

tically significant association over time.[15]

As a whole, the survey evidence suggests that both expected exchange rate changes and currency risk premia are important components of forward premia and interest differentials across countries. This conclusion is consistent with the findings of most other recent studies of these questions.[16] But the data are too limited to draw more specific conclusions concerning the relative importance of currency expectations and risk premia or to assess the extent to which ex ante common currency yield differentials have changed over time.

Nature of expectations

Finally, to clarify the nature and importance of the exchange rate expectations, we ask whether they reflect differences in anticipated inflation rates, expected changes in real exchange rates, or both. Our earlier conceptual analysis implies that this question essentially concerns the behavior of real interest rates and their relation to the corresponding nominal rates. In particular, a comparison of relations (i) and (v) shows that real interest differentials reflect expectations of real exchange rate changes (as well as DOM, CRISK, and BAR) and, unlike their nominal counterparts, are not directly affected by anticipated currency movements arising from inflation differentials. Thus, comparing the dispersions of real and nominal interest rates should help to clarify the relative importance of expectations about inflation and about real exchange rate movements. Admittedly, real interest rates and the expected inflation rates underlying them are not directly observable; they can, however, be approximated using past inflation as a proxy for anticipated future rates.[17]

Chart 4 presents the dispersion of short-term and long-term real interest rates calculated in this manner. As a comparison of Charts 1 and 4 reveals, the dispersion of real interest rates remained relatively close to that of nominal yields during the 1960s and early 1970s and rose above that of nominal rates by well over 100 basis points during 1973-75.[18] After 1975, however, the dispersion in real rates declined, dropping to roughly its pre-1973 average. In contrast, the dispersion of nominal yields continued to increase and during the 1980s has averaged nearly twice its pre-1973 level.

The clear implication that can be drawn from this evidence is that expectations concerning inflation (that is, differences in the rate anticipated for various countries) have been a significant source of interest differentials across countries during the era of floating exchange rates and indeed were the primary cause of the increased divergence in nominal rates observed after 1975. Consequently, it appears that currency expectations arising from inflation differences have been a significant contributor to international interest divergences, at least over the past 10 to 15 years. This result is not, of course, entirely surprising in view of the substantial increase in the variability and disparity of national inflation rates that occurred during the 1970s.

More striking, however, is that the average dispersion of real interest rates has been both substantial (generally above 100 basis points) and roughly constant over time. This relative stability in the average level of real interest rate dispersion is remarkable in light of the clear evidence that financial integration has virtually eliminated one of its most significant sources. The earlier analysis strongly suggests that barriers to capital mobility probably were the main contributor to real (as well as nominal) interest dispersion prior to 1973 and an important contributor during the latter 1970s. The role of capital controls, however, became minor during the 1980s. Thus, currency factors—currency risk premia and expectations about *real* exchange rates—have increased in size and now appear to be the main source of real interest divergences among the countries.

Furthermore, there is reason to believe that expectations about real exchange rate movements have been a significant contributor to real interest rate divergences, particularly in recent years. The evidence for this conclusion stems from the conceptual nature of real exchange rates and their actual behavior in the 1970s and 1980s. This same evidence also suggests, although only tentatively, that interest rate divergences adjusted for expected movements in real exchange rates were in fact smaller on average during the 1980s than in the

[15] In "Using Survey Data to Test Standard Propositions," Frankel and Froot also compare the forecast errors (prediction less actual change) implied by the survey data and corresponding forward premia. These errors are closely related, suggesting that expectations, at least as measured by the surveys, are an important element of the forward premia and corresponding interest differentials. The errors are also large, both absolutely and relative to the risk premia implied by the survey data. This result is consistent with our contention that forecast errors are largely responsible for the pattern of ex post nominal interest divergences.

[16] Most evidence suggests that currency risk premia exist, but considerable controversy remains over their empirical importance. The strongest evidence that currency risk premia play a major role in interest differentials across countries has been provided by Eugene Fama, "Forward and Spot Exchange Rates," *Journal of Monetary Economics*, November 1984, pp. 319-38; his results suggest that currency risk premia are more variable than exchange rate expectations and show a strong negative correlation with them.

[17] Here we use the past year's inflation (in the GNP deflator) to measure short-term real interest rates and the past two years' inflation for the long-term yields.

[18] In Japan and the United Kingdom during the mid-1970s, government controls sharply restricted the flexibility of nominal interest rates in adjusting to the severe fluctuations in inflation occurring at the time. This led to dramatic swings in real interest rates and largely explains the exceptionally large dispersion in these rates among the countries in the mid-1970s.

1970s.

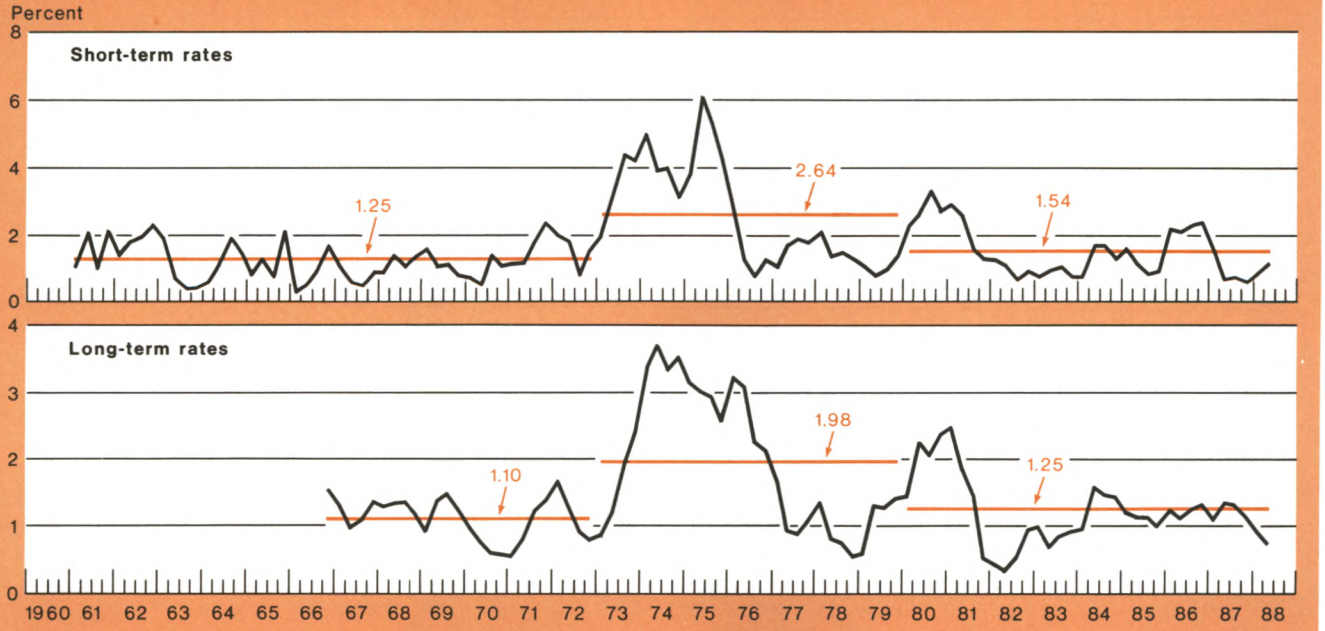
As indicated earlier, the real exchange rate for a given country measures the average level of its product prices relative to those of its trading partners; hence real exchange rates are a key determinant of the nation's international competitiveness. It is therefore reasonable to suppose that at any time there is a long-run equilibrium real exchange rate level (consistent with a sustainable external payments position) toward which the actual exchange rate tends to move over time. This notion is the basis for the traditional and widely accepted notion of "purchasing power parity" (PPP), which in its strictest form implies that the equilibrium real exchange rate is constant in the long run. More realistic interpretations of PPP allow for some evolution in the long-run equilibrium arising from differences in productivity, demand, and other relevant trends across countries. Either interpretation implies, however, that short-term variations in real exchange rates represent, at least in part, departures from long-run values that tend to be reversed over time.[19]

Before the 1971 Smithsonian agreement to devalue the dollar, real exchange rates of the dollar and other major currencies were fairly stable, at least relative to their long-term trends. Fluctuations in the real value of the dollar became more considerable during the 1970s and, as Chart 5 reveals, became highly pronounced in the 1980s. The chart also shows that deviations of the real dollar from its past trend and period average, which can be viewed as very rough proxies for the long-run equilibrium, have also been quite large during the present decade, both in absolute terms and relative to

[19]Several recent studies of exchange rate behavior during the 1970s and 1980s imply that the long-run equilibrium real exchange rate changes fairly continuously. Some in fact suggest that actual real exchange rate changes largely reflect fluctuations in their long-run equilibrium and that there is virtually no tendency for current real exchange rate movements to be reversed in the future. See, for example, John Campbell and Richard Clarida, "The Dollar and Real Interest Rates," paper presented at the 1986 Carnegie-Rochester Conference on Public Policy, November 21-22, 1986.

Chart 4

Real Interest Rate Dispersion*



Sources: Interest rates are taken from the countries' central bank publications.

Note: Figures with arrows indicate period averages for 1961-72, 1973-79, and 1980-88:II.

* The mean absolute deviation of quarterly average real interest rates from the simple average of the group. The group includes the United States, Canada, the United Kingdom, Germany, and Japan. Real short-term interest rates are three-month money market rates, less the inflation in the GNP/GDP deflator over the past year. Real long-term rates are yields on government bonds with maturities of five years or more, less the inflation in the GNP/GDP deflator over the past two years.

the 1970s.

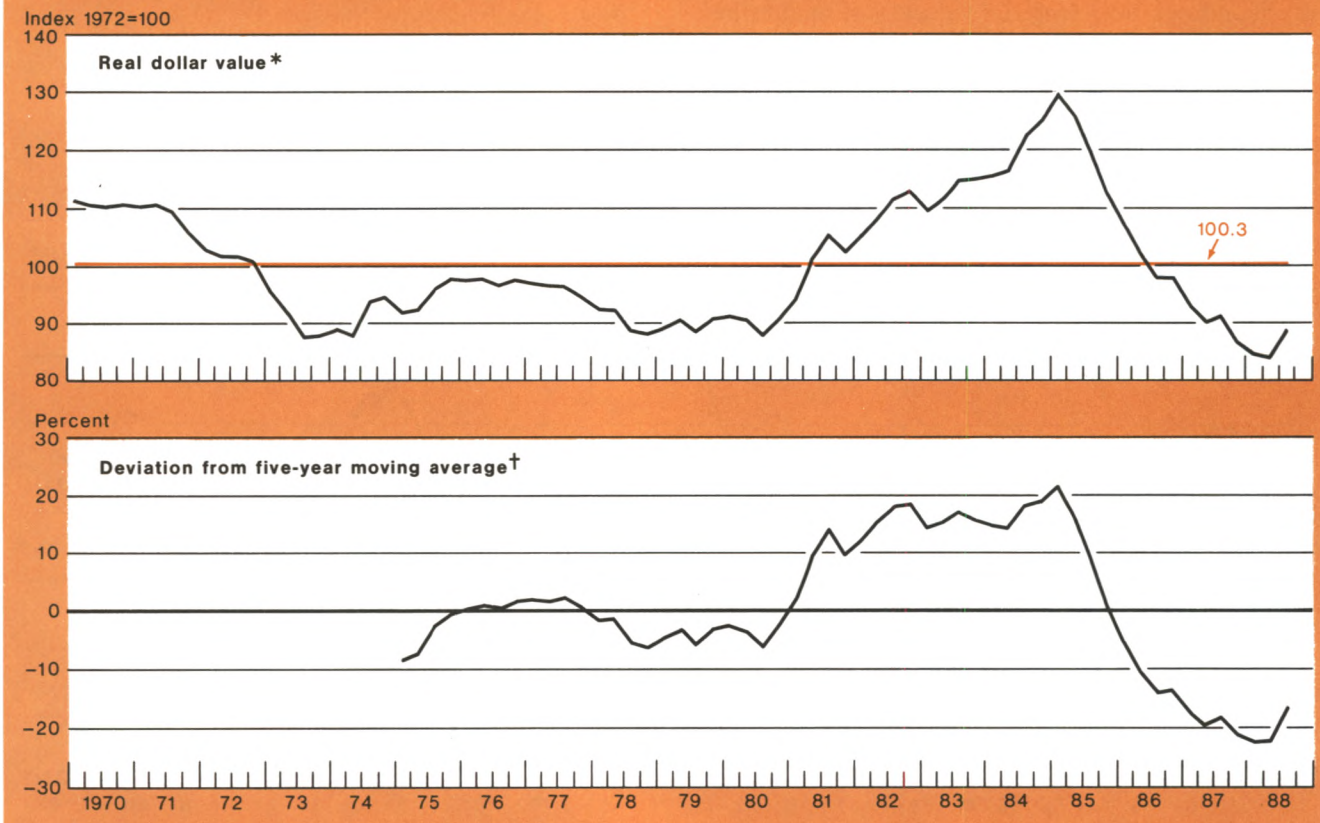
PPP theory strongly suggests that this behavior indicates a substantial "overvaluation" of the dollar relative to its long-term equilibrium during the first half of the 1980s. Similarly, the theory would attribute the sharp decline in the dollar after 1985 to a "correction" of this overvaluation. From this interpretation of the dollar's movements—which is supported by the unprecedented rise in the U.S. trade deficit after 1982—we can infer that anticipated changes in the real value of the dollar (at least over the medium term) have been sizeable and have contributed significantly to the divergences in real interest rates observed during the decade. The evidence from Chart 6 provides some support for this supposition: the real long-term interest differential between the United States and the four major foreign countries rose with the appreciating real dollar over most of 1980-84; the real interest differential and the dollar also fell together after 1985.[20]

On balance these arguments suggest that expected movements in real exchange rates have been a significant source of real interest divergences during the

[20]There is, of course, no rigid linkage between real interest rates and exchange rates, either in theory or practice. As Chart 6 also shows, the dollar continued to rise over 1984-85 even when U.S. real interest rates fell relative to abroad. Nonetheless, the pattern evident before and after that period does support the hypothesis that expectations about future dollar movements were an important proximate source of real interest differentials observed at the time.

Chart 5

Real Value of the Dollar



Source: Morgan Guaranty Trust Company, World Financial Markets.

Note: Figure with arrow indicates period average.

*Real trade-weighted value of the dollar against 15 industrial countries computed using dollar exchange rates deflated by the ratio of foreign to U.S. manufacturing wholesale prices.

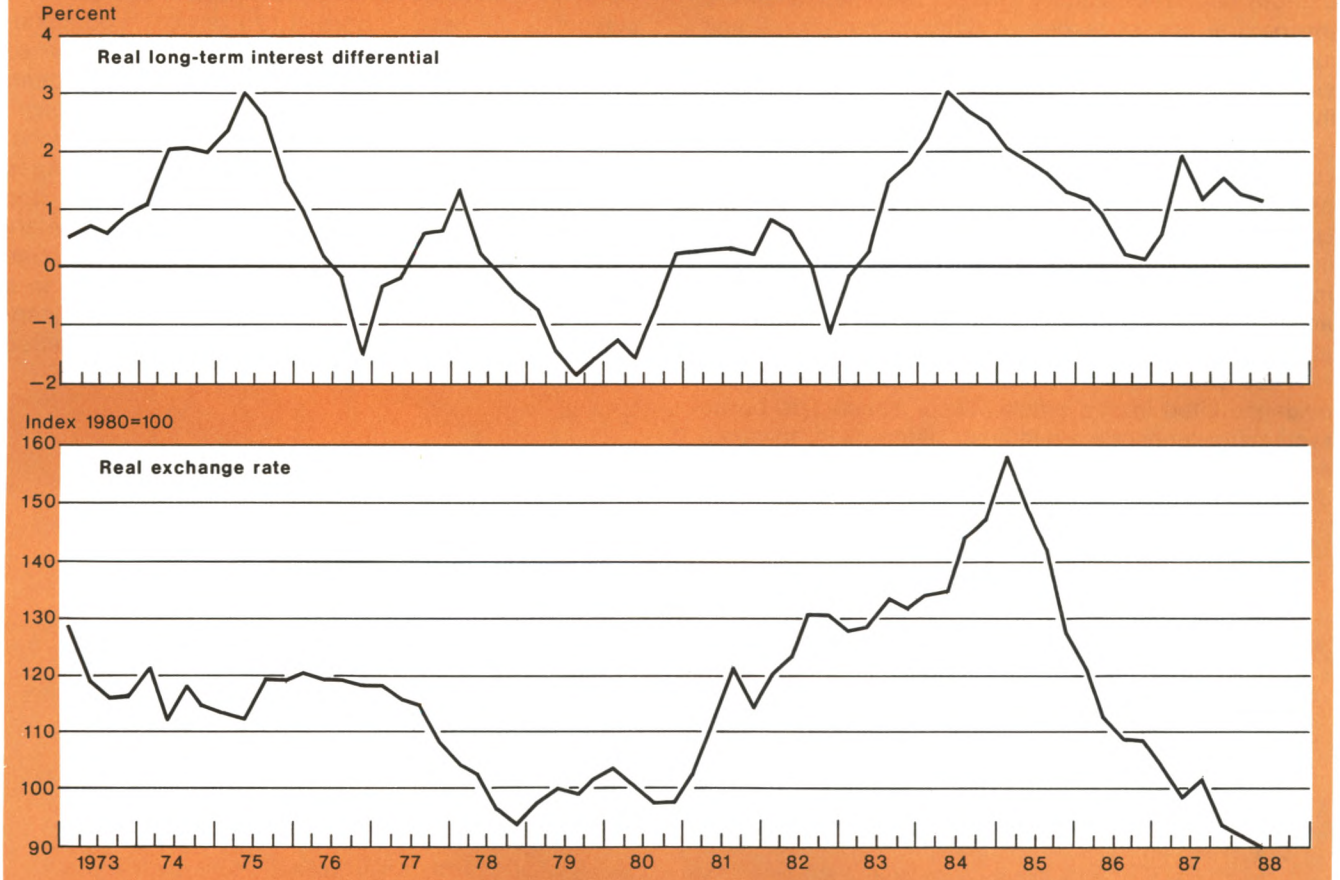
†Deviation of the real trade-weighted exchange rate from its five-year moving average.

1980s; the role of real exchange rate expectations during the 1970s is less clear, but very likely less important than after 1980. More generally, this behavior provides further evidence of the major role that currency expectations, apparently reflecting perceptions about both the real and inflation components of exchange rates, have played in interest differentials across countries in recent years.

More speculatively, the apparent increase in importance of real exchange rate expectations may also mean that interest rates expressed, ex ante, in a common currency were more closely aligned in the 1980s, when international financial integration was greater than earlier. By definition, the real interest differential is equal to the expected change in the real exchange rate plus the common currency differential (see relations ii and v). Hence, the fact that the dispersion in real interest rates did not rise in the 1980s over the latter 1970s, while the magnitude of expected real exchange rate changes apparently did, suggests a possible decline in the dispersion of common currency differentials. Of course, the very rough and preliminary nature of our analysis makes

Chart 6

U.S.-Foreign Real Interest Differential and Real Exchange Rate*



Sources: Interest rates are taken from the countries' central bank publications. The GNP/GDP deflators are taken from publications of the countries' central statistics offices. Exchange rates are taken from International Financial Statistics.

*Weighted average of bilateral U.S.-foreign real long-term interest differentials and of real dollar exchange rates against Canada, the United Kingdom, Germany, and Japan. Real long-term interest rates are yields on government bonds with maturities of five years or more, less the inflation in the GNP/GDP deflator over the past two years. Real exchange rates are calculated using nominal dollar exchange rates deflated by the ratio of foreign to U.S. GNP/GDP deflators. Weights are calculated using OECD estimates of GNP adjusted for purchasing power parity.

this conclusion especially tentative.

Conclusion

It seems reasonably clear that international financial integration has increased considerably over the last decade. However, the effect of integration on the relationship of interest rates across countries has been somewhat different from that suggested by prior experience with the integration of domestic financial markets. Interest rates in the major U.S., European, and Japanese money markets now move very closely with their counterparts in the corresponding "offshore" Eurocurrency markets. Yet divergences among national interest rates, even for instruments with very similar characteristics, have often been very large in recent years.

As our analysis has shown, these patterns are not paradoxical; cross-country interest rate disparities are the natural consequences of differing currencies and jurisdictions that, while irrelevant or negligible within a single country, are potentially very important in an international context. In particular, in an environment of flexible exchange rates and divergent national economic conditions, interest differentials across countries can be expected to arise even when capital mobility and financial integration are "perfect." Of themselves, reductions in barriers to financial flows may be expected to reduce international interest rate divergences, but not if accompanied by increased exchange rate fluctuations and greater disparities in national economic policies.

These observations are reasonably consistent with the evidence cited in this article. There appears to be no systematic tendency for interest differentials to abate across countries over time; indeed nominal interest divergences during the 1980s have been greater on average than those observed during the previous two decades. Nonetheless, this analysis provides clear evidence that the sources of international interest differentials have changed. During the 1960s, interest rate divergences were sustainable under a fixed exchange rate regime in large part because of fairly stringent limitations on financial flows across national jurisdictions. With the substantial reduction in such barriers over the last 15 years, interest differentials across countries have become primarily associated with expected exchange rate changes—apparently reflecting both increased divergences in national inflation rates and greater real exchange rate fluctuations—and currency risk premia.

More fundamentally, this analysis has implications for the conduct of monetary policy in a financially integrated world economy. Our results suggest that the ability of monetary authorities to influence domestic interest rates independently of rates abroad has not declined significantly over time. In this narrow sense, the independence of national monetary policies may not have been appreciably reduced by international financial integration. Nonetheless, the reduction in barriers to international capital flows has strengthened the overall linkages among domestic interest rates, exchange rates, and foreign interest rates. As a result, domestic monetary policy actions influence and are influenced by foreign economic conditions more now than in the past. In a broader sense, therefore, increased international financial integration has led to greater *interdependence* among national monetary policies.

Bruce Kasman
Charles Pigott

Appendix: The Determinants of U.S.-Foreign Covered Interest Differentials

The closer alignment of covered interest rates across countries that has been documented in the text may reflect changes in several factors related to national jurisdiction. In addition to explicit restrictions on capital flows, perceived differences in U.S. and foreign assets arising from domestic tax systems, default risk, transaction costs, or political and sovereign risk are embedded in covered interest differentials. In this section we attempt to identify more clearly the role that factors specific to U.S. and foreign markets have played in the decline of covered interest differentials. To this end, we decompose each U.S.- foreign covered interest differential into the sum of the onshore-offshore differential for each country's assets and the offshore differential on U.S. and foreign assets:†

$$\text{Covered differential} = \text{USDE} + \text{FORDE} + \text{USFORE}$$

The first term, USDE, measures the interest differential between comparable dollar assets in domestic markets and Euromarkets. Since the United States has had vir-

†In more precise terms, any covered differential $[(1+i) - (1+i^*)f]$ can be seen to equal $(i-iE) + (iE^*-i^*)f + [(1+iE) - (1+iE^*f)]$, where i, i^*, iE and IE^* are U.S. onshore, foreign onshore, U.S. Euromarket, and foreign Euromarket rates, respectively, and f is the forward exchange rate premium.

Appendix: The Determinants of U.S.-Foreign Covered Interest Differentials *(continued)*

tually no capital controls from the early 1970s onward (with the exception of several months in 1980), this term captures the role of domestic U.S. regulations in generating covered interest differentials. The second term, FORDE, is a similar measure for foreign assets and again reflects the importance of foreign regulations, including the influence of any foreign capital controls.

The third term in this decomposition, USFORE, captures the covered differential in Euromarkets between dollar assets and assets denominated in foreign currencies. Since controls in these markets are insignificant and identical across the assets compared, this differential provides a measure of the impact of political risk considerations. Most studies have found these differentials to be rather small—indeed not significantly different from zero on average.‡

‡For a recent examination of covered interest differentials in Euromarkets, see Vincent Reinhart and Kenneth Weiller, "What Does Covered Interest Parity Reveal about Capital Mobility?" Federal Reserve Bank of New York, Research Paper no. 8713, in *International Integration of Financial Markets and U.S. Monetary Policy*, December 1987.

In the table, this decomposition of U.S.-foreign covered interest differentials is presented for a number of periods during the past 15 years. Focusing first on our bilateral covered differentials with Japan and the United Kingdom, we see that capital controls, reflected in the large size and variability of FORDE, were a major determinant of interest rate variations before 1980. After 1979, however, sharp declines emerge in the size and variability of the FORDE component for Japan and the United Kingdom, a finding consistent with other evidence indicating that these countries dismantled their controls at roughly that time. For Germany and Canada, two countries that loosened capital controls earlier, this component of the covered differential has been relatively small throughout our sample.§

The small size (generally below 20 basis points) and variability of these differentials for all the foreign countries since 1982 support the conclusion that foreign barriers

§There is substantial evidence, however, that at least until the mid-1970s capital controls in Germany were a significant component of covered interest differentials.

Decomposition of U.S.-Foreign Covered Interest Differentials
(In Percentage Points)

	Total Covered Differential†	USDE	FORDE	USFORE
Germany				
Jan. 74 - Aug. 77	−0.78 (0.50)	−0.61 (0.40)	−0.35 (0.30)	0.19 (0.20)
Sep. 77 - Nov. 79	−1.06 (0.43)	−0.60 (0.25)	−0.40 (0.27)	−0.06 (0.19)
Dec. 79 - Dec. 82	−1.65 (0.40)	−0.89 (0.29)	−0.48 (0.30)	−0.29 (0.20)
Jan. 83 - Sep. 88	−0.43 (0.40)	−0.25 (0.22)	−0.20 (0.17)	−0.01 (0.16)
Japan				
Jan. 74 - Aug. 77	−0.30 (5.17)	−0.61 (0.40)	NA NA	NA NA
Sep. 77 - Nov. 79	−2.20 (1.72)	−0.60 (0.25)	−1.83 (1.76)	0.22 (0.92)
Dec. 79 - Dec. 82	−0.82 (1.67)	−0.89 (0.29)	0.32 (0.72)	−0.26 (1.57)
Jan. 83 - Sep. 88	−0.50 (1.15)	−0.25 (0.22)	0.13 (0.25)	−0.41 (1.16)
Canada				
Jan. 74 - Aug. 77	−0.32 (0.72)	−0.61 (0.40)	NA NA	NA NA
Sep. 77 - Nov. 79	−0.69 (0.74)	−0.60 (0.25)	−0.09 (0.16)	0.00 (0.68)
Dec. 79 - Dec. 82	−0.87 (0.92)	−0.89 (0.29)	−0.18 (0.35)	0.19 (0.89)
Jan. 83 - Sep. 88	−0.15 (0.68)	−0.25 (0.22)	−0.13 (0.13)	0.20 (0.64)
United Kingdom				
Jan. 74 - Aug. 77	1.92 (1.77)	−0.61 (0.40)	1.62 (1.25)	0.92 (0.83)
Sep. 77 - Nov. 79	0.15 (0.92)	−0.60 (0.25)	0.56 (0.78)	0.19 (0.28)
Dec. 79 - Dec. 82	−1.05 (0.62)	−0.89 (0.29)	−0.08 (0.43)	−0.08 (0.53)
Jan. 83 - Sep. 88	−0.27 (0.33)	−0.25 (0.22)	−0.07 (0.11)	0.08 (0.23)

Note: Figures in parentheses are standard deviations.
†The total covered differential equals the sum of the other three differentials. Period averages may not sum exactly due to rounding errors.

Appendix: The Determinants of U.S.-Foreign Covered Interest Differentials *(continued)*

to capital mobility, while quite important in the past, have not been a significant proximate factor determining interest rate differentials during the 1980s.

A similar claim can be made regarding the importance of U.S. controls and political risk, factors embodied in the other components of the covered interest differentials, following 1982. Examining the interest differential between domestic U.S. and Eurodollar assets suggests that actions taken in U.S. markets might account, in part, for the large and volatile (uncovered) real interest differentials observed during 1980-82. Changes in Federal Reserve operating procedures in October 1979, combined with numerous reserve requirement shifts and the imposition of "voluntary" credit controls in 1980, led to increased interest rate divergence between these assets. Interest differentials on dollar assets here and in Euromarkets rose above 100 basis points during almost all of 1980, reaching a level that was double their average for the 1974-79 period.‖ At the same time, Euromarket covered differentials between dollar assets and assets denominated in foreign currencies became more volatile during 1980-82, reflecting increased political uncertainty in the wake of the second oil price shock and the LDC debt crisis. However, with the possible exception of dollar-yen rates, Euromarket covered differentials have been insignificant since 1982. Interest differentials between domestic U.S. and Eurodollar assets have also fallen considerably since 1982, reflecting both the removal of controls (November 1980) and the closer integration of domestic and Eurodollar markets in recent years.

‖For a detailed discussion of the links between Eurodollar and U.S. domestic money markets during this period, see Lawrence L. Kreicher, "Eurodollar Arbitrage," this *Quarterly Review*, Summer 1982.

Estimating the Funding Gap of the Pension Benefit Guaranty Corporation

The Pension Benefit Guaranty Corporation (PBGC), a self-financing government corporation created to insure private defined benefit pension plans, has experienced net losses in all but two years since its creation in 1974.[1] When a pension plan with a large funding deficiency is terminated, the PBGC is obligated to take on a well-defined portion of the net liability of the plan.[2] The cumulative effect of these net liabilities is a stated funding deficiency that stood at $3.8 billion as of the end of fiscal year 1986.[3] Although the stated funding deficiency of the PBGC fully reflects the plan terminations that have already taken place since 1974, it fails to take into account expectations about future terminations or about future premium income. The purpose of this article is to develop and apply a framework for evaluating the effects of expected future income and outflows.

The PBGC's main source of noninvestment income is the collection of insurance premiums from corporations. The chronic funding problems experienced over the years have prompted Congress to raise the premium rates on several occasions and, effective in 1987, to make the rates sensitive to the level of underfunding of each particular plan. These measures have improved the situation somewhat but have fallen short of stemming the rising trend in funding deficiencies.

Because this picture only looks at the past, however, it actually understates the true funding problems of the PBGC. If the corporation were a private pension fund subject to the Employees Retirement Income Security Act (ERISA), it would have to make some provision for the funding of projected future acquisitions of net liabilities.[4] The general principle behind such funding practices is that, even if future outflows are not known with certainty at present, the fund is liable for any future outflows that result from current plan provisions and should fund them as they accrue on the basis of the best available expectations.

In the case of past plan terminations, PBGC accounting adheres to this principle. The assets acquired from terminated plans and their sponsors are earmarked for the payment of future benefits corresponding to those plans. The net liabilities that may be expected to arise from future pension plan terminations, however, are ignored in current financial statements, as are future premium payments. This means that even if Congress were to provide the approximately $4 billion it would take to restore the PBGC to momentary solvency, the burden of future plan terminations could undo the effects of such provisions.

In this article, we estimate the current level of fund-

[1] The accompanying glossary provides definitions of pension terms used in this article.

[2] The PBGC's share is the liability for guaranteed benefits minus the sum of the assets of the plan and 30 percent of the sponsor's equity.

[3] As of the end of fiscal year 1987, the deficiency had declined to $1.5 billion, mainly because of a reversal in the LTV case, which is still being contested. We use the 1986 deficiency because the most recent company data available for use in the empirical part of the article covers this period. The stated deficiency represents the net worth position of the PBGC rather than a cash flow deficit. The PBGC has experienced cash flow deficits in only two of the seven fiscal years from 1980 to 1986. For a brief history and analysis of the PBGC, turn to Appendix A.

[4] A pension plan's "accrued liability" is defined in ERISA as "the excess of the present value... of the projected benefit costs and administrative expenses... over the present value of future contributions for the normal cost" (ERISA, Title I, Subtitle A, Section 3(29)).

ing necessary for the PBGC to provide for future plan terminations. Our estimates suggest that the present value of PBGC liabilities resulting from future terminations is more than $30 billion. Our estimate of the value of future premium payments is only $14 billion, however, resulting in an additional net PBGC liability of nearly $17 billion. This projected shortfall represents a further burden to the PBGC beyond its stated accounting deficiency of $4 billion. While our estimates are sensitive to a variety of assumptions made in the specification of our model and its parameters, we give extensive consideration to the real world behavior of corporations and pension funds in making our assumptions. We incorporate in our model both the actual regulatory restrictions on pension fund activity and the basic characteristics of pension fund assets and liabilities.

If the PBGC were a private insurance company with bottom line motivations, it would be essential that it set its premiums according to such actuarial calculations. Only the public nature of the institution and its presumed access to public revenues make it possible for it to operate without reliance on explicit estimates of future net liabilities.

Glossary of Pension Terms

Accrued pension benefits:
Vested pension benefits plus benefits earned but not yet vested by active employees.

Defined benefit pension plan:
A pension plan in which benefits take the form of a promised annual payment to retirees, usually based on length of service and average salary.

Defined contribution pension plan:
A pension plan in which benefits take the form of periodic contributions to an investment fund dedicated to the worker and transferred to the worker at retirement.

ERISA:
The Employees Retirement Income Security Act of 1974. This legislation established the Pension Benefit Guaranty Corporation and mandated rules for the funding and termination of *defined benefit pension plans.*

Full funding:
The level of *pension plan assets* that just equals the level of *pension plan liabilities.*

Funding ratio:
The ratio of *pension fund assets* to *pension fund liabilities.*

Maximum funding limitation:
The maximum tax-deductible *pension plan contribution* permitted by the IRS and *ERISA.* Essentially, tax-deductible employer contributions may not push *pension plan assets* beyond the *full funding* level.

Minimum funding requirement:
The minimum *pension plan contribution* required under the terms of *ERISA.* It equals the sum of *normal costs* and amortization of any underfunding.

Normal cost:
The present value of pension plan benefits earned by active workers during the year. A component of the *pension contribution* made by the *pension plan sponsor*, it represents the amount that the sponsor would have to contribute to maintain the current level of overfunding or underfunding if all actuarial and market assumptions were met.

Overfunding:
The amount by which *pension plan assets* exceed *pension plan liabilities.*

Pension plan assets:
The market value of all securities held by the pension fund. It equals the current value of all past *pension plan contributions* and investment earnings, net of all past *pension plan benefit payments* and administrative expenses.

Pension plan benefit payments:
Cash payments made to retired workers during the year.

Pension plan contribution:
The cash value of contributions made by the *pension plan sponsor* during the year. It equals the sum of *normal costs* and the amortization of any overfunding or underfunding.

Pension plan liabilities:
The present value of future *pension plan benefit payments* minus the present value of future *normal costs.*

Pension plan participants:
Active workers with both vested and unvested pension benefits, and retirees and former employees with vested pension benefits.

Pension plan sponsor:
The company whose employees and former employees (both retirees and former employees with vested benefits) are covered by the *defined benefit pension plan.*

Underfunding:
The amount by which *pension plan assets* fall short of *pension plan liabilities.*

Vested pension benefits:
Future benefit payments owed to retirees and future benefit payments that are guaranteed to active workers even if they leave the firm.

The PBGC funding problem: definition and methodology

Our primary goal here is to determine the appropriate level of current funding for the PBGC. Since the PBGC is essentially a provider of insurance, we turn for guidance to the methods used by actuaries to value insurance policies and pension funds.[5] These methods provide a framework for modeling the assets and liabilities of the pension funds insured by PBGC and for describing their behavior over time. The evolution of the funding status of these plans, together with the changing financial condition of the firms sponsoring them, determines the size of the net liabilities that will accrue to the PBGC from future plan terminations.

In adopting the research strategy suggested by the actuarial approach to valuing PBGC liabilities, we use tools developed in the field of finance. First, we apply the mathematical tools devised in the theory of contingent claims, since insurance is a special case of such claims.[6] Second, we draw on the theory of business failures in analyzing pension fund terminations. By law, terminations of underfunded pension plans should occur only when the sponsor firm is in grave financial distress. This has been the de facto approach since the PBGC was created, even though it became a legal requirement only recently.

The next few sections present the various portions of the model. The fund and its sponsor firm are modeled as separate but related entities. The value of the PBGC insurance is determined by six variables associated with the fund and its sponsor, and the analysis focuses on the evolution of these variables over time. This evolution is determined by a series of dynamic relationships that describe the growth of firm assets and debt, the number of plan participants, the assets and liabilities of the fund, and the normal cost associated with the fund.[7] These relationships specify that the value of each of these variables in one time period is determined by its own value in the previous time period, as well as by the lagged values of other model variables, by institutional elements such as PBGC premium rules, and by unpredictable random shocks. In each case, assumptions are based on empirical research and on theoretical considerations.

These dynamic relationships are simulated over time by generating values of the random disturbances and "rolling" the equations forward. This process is repeated a large number of times, and averages are taken over all the individual realizations. Simulations are useful in handling complicated dynamics such as those involved in valuing PBGC insurance. They allow for precise and realistic modeling of the various aspects of pension funding and of the relationship between the fund and the sponsor. For example, in our analysis, the sponsor's contribution to the pension plan, as well as the PBGC premium, is charged to the firm in the model, potentially affecting cash flows and the firm's solvency. Although in general not very large, these effects may be central to the issue in some cases, as they were in the solvency problems of LTV and Chrysler.

Pension fund dynamics

The model of PBGC insurance used in the estimates differs from previous models of PBGC insurance in several important respects. In contrast to earlier formulations that make somewhat ad hoc assumptions about funding strategies, this model employs the legal and regulatory restrictions that actually govern pension plan contributions. It takes explicit account of ERISA minimum funding rules and of the PBGC premium rate structure. In addition, the model imbeds funding restrictions imposed by the IRS to limit tax-deductible contributions to overfunded pension funds. These assumptions mean that the modeled behavior of pension funds more closely follows the actual behavior of pension funds under existing law.

We assume that each firm sponsors a single pension fund for all of its workers. This pension fund is financed by contributions from the firm and by the investment return on the fund's assets.

Contributions

The contribution made by the firm to its pension fund during each period is based on minimum and maximum funding guidelines established in ERISA and amended by subsequent legislation. The minimum contribution under the funding requirements consists of the normal cost and a payment to amortize any funding deficiency.

The normal cost component of the contribution represents the present value of pension plan benefits earned by workers during the year. As such, normal costs will vary across firms according to the composition of the work force, the distribution of the length of

[5] A useful mathematical exposition of these actuarial principles is found in Howard E. Winklevoss, *Pension Mathematics* (Homewood, Illinois: Richard D. Irwin, Inc., 1977).

[6] The literature on this topic is extensive. An early (and rudimentary) example of the use of option pricing theory in the context of PBGC insurance is William F. Sharpe, "Corporate Pension Funding Policy," *Journal of Financial Economics*, vol. 3 (1976), pp. 183-94. A more recent example, with a more detailed framework, is Alan J. Marcus, "Corporate Pension Policy and the Value of PBGC Insurance," in Zvi Bodie and others, eds., *Issues in Pension Economics* (Chicago: University of Chicago Press, 1987).

[7] These equations and a mathematical discussion of the model are presented in Appendix B. For a complete analysis of the model, see A. Estrella and B. Hirtle, "The Implicit Liabilities of the Pension Benefit Guaranty Corporation," Federal Reserve Bank of New York Research Paper (forthcoming).

employment of workers at the firm, and the terms of the pension plan. Firms with a high ratio of active workers to retirees will tend to have normal costs that are a larger proportion of pension plan liabilities than firms with a low ratio of active workers to retirees.

The second component of the firm's contribution to its pension fund is the amortization of underfunding. This component is determined by a combination of ERISA funding rules and firm discretion. If the fund is underfunded at the beginning of the year, then the rate at which the firm must amortize this underfunding is determined by a complex set of guidelines imposed under ERISA. For purposes of the model, we assume that the firm amortizes each period's underfunding over a 20-year horizon using the expected rate of return on the pension fund assets as the discount rate.[8] On the other hand, if the firm is overfunded at the beginning of the year, then no amortization payment is required.

The maximum (tax-deductible) contribution is determined by the "full funding limitation" in ERISA, as amended in 1987.[9] The firm cannot contribute on a tax-deductible basis an amount that would push the assets of the plan, including the employer's contribution, beyond the sum of the plan's liabilities plus normal cost. If the normal cost exceeds one half the liabilities, the allowable tax-deductible contribution is further restricted to be less than the excess of 150 percent of liabilities over assets.[10] If the minimum contribution exceeds this full funding limitation, only the full funding amount is required. The firm may choose to make a contribution in excess of the full funding limitation on a non-tax-deductible basis, but our model assumes that firms do not do so. We assume that the sponsor's contribution to the pension fund is the lesser of the minimum funding amount specified in ERISA (assuming a 20-year amortization horizon) and the maximum funding amount specified by the IRS.[11]

Investment returns

The investment return is assumed to consist of two components: an expected return, which is realized with certainty during each period, and a random unexpected return, which varies from period to period and may be positive or negative.

Liabilities

Withdrawals from the fund are made during each period to cover pension plan benefit payments. The relationship between normal costs, pension plan benefit payments, and pension plan liabilities produces the dynamic behavior of liabilities. Normal costs and pension benefit payments are assumed to grow at the same rate per period. This growth reflects an increase in the number of pension plan participants rather than an increase in real benefit provisions over time. Participants are defined as active workers and retirees, and we assume that the number of plan participants grows at the same fixed rate per year as normal costs and pension benefit payments.

Benefit payments can also be expressed as the sum of normal costs and the expected return on the full funding level of pension plan assets (the level of assets that just equals pension plan liabilities). Combining these three relationships implies that pension fund liabilities grow at the same rate as benefit payments and normal costs.

Dynamics of the sponsor firm

This section discusses the dynamics of the sponsor firm and delineates the links between the firm and its pension fund. There are three principal links between the dynamics of the fund and those of the firm: the pension contribution, the PBGC premium, and the plan termination decision.

The pension contribution, which was discussed in the previous section, is modeled explicitly as an expense to the firm. The second link, the PBGC premium, is also modeled as a direct expense of the sponsoring firm. Following legislation adopted in 1987, the PBGC premium varies according to the funding status of each pension fund.[12] The PBGC charges a flat rate of $16 per plan participant. In addition, the PBGC levies an underfunding fee of $6 per $1000 of underfunding per participant. The total premium is capped at $50 per

[8]The 20-year amortization horizon was chosen as a rough average of the amortization horizons specified by the ERISA for underfunding arising from various sources. For instance, underfunding arising from past service credits (increases in benefits of ongoing plans or startup of plans in an underfunded condition) may be amortized over a 30-year horizon, while underfunding arising from actuarial gains and losses (when actual returns deviate from expected returns or when actuarial assumptions are not met) may be amortized over a 10-year horizon. On average, the 20-year assumption is probably on the low side. This would make our estimates of PBGC liabilities conservatively lower.

[9]Omnibus Budget Reconciliation Act of 1987, Subtitle D, Part 1, Section 9301.

[10]The 150 percent of liabilities restriction is additionally binding only if the normal cost exceeds one half the liabilities, a condition that is generally unlikely. Only companies that are growing at exceptionally fast rates would be subject to this further restriction. In the empirical part of the article, the assumed range of normal cost to liability ratios falls in the region in which the 150 percent constraint is nonbinding. Data on actual normal costs for individual firms are not conveniently accessible.

[11]The maximum funding provision is analogous to a requirement to amortize any overfunding. In fact, this amortization is faster for overfunding than for underfunding, especially since the portion of the normal cost that may be used to offset the overfunding is limited to 50 percent of liabilities. This asymmetry has the effect of producing an underfunded status in long-run equilibrium.

[12]Omnibus Budget Reconciliation Act of 1987.

participant. Under these regulations, the total premium cost to the plan sponsor is the premium rate times the number of plan participants.

Based on these pension-related expenses and general considerations, the final set of dynamic relationships used in the model concerns the debt and assets of the sponsoring firm. Firm debt is assumed to grow at a fixed rate per period and is unaffected by pension plan activity. The growth in firm assets is assumed to consist of two components. Like pension fund assets, firm assets have a return consisting of an expected return and a random component that varies across periods. The firm's contribution to its pension fund and the PBGC premium payment are subtracted from firm assets during each period.

Model summary

Six dynamic relationships describing the movement of the model variables over time emerge from the preceding discussion. These relationships are:

(1) Normal cost in year t = normal cost growth factor × normal cost in year t-1

(2) Fund liabilities end of year t = normal cost growth factor × fund liabilities end of year t-1

(3) Fund assets end of year t = fund assets end of year t-1
+ expected plus random rates of return × fund assets end of year t-1
+ pension contributions during year − pension benefit payments during year

(4) Plan participants in year t = plan participant growth factor × plan participants in year t-1

(5) Firm debt end of year t = firm debt growth factor × firm debt end of year t-1

(6) Firm assets end of year t = firm assets end of year t-1
+ expected plus random rates of return × firm assets end of year t-1
− pension contributions during year − PBGC premiums during year.

Plan termination conditions

Now that the basic dynamics for the firm are established, we may proceed to construct the final link between the fund and the firm, the firm failure/pension termination event. Under legislation adopted in 1986, underfunded pension plans may be terminated and PBGC insurance drawn upon only if the sponsoring firm is in a "distress situation."[13] Essentially, the PBGC limits terminations of underfunded plans to firms facing bankruptcy or severe economic distress. For purposes of this model, we assume that underfunded pension plans terminate only when the sponsoring firm enters formal bankruptcy.

The difficulty with this assumption is determining what conditions signal firm bankruptcy. One such condition is the technical insolvency of the firm, when the face value of the firm's debt exceeds the value of the firm's assets.[14] In many cases, however, a firm will declare bankruptcy before it has become technically insolvent. In these instances, the decision to declare bankruptcy may be related to cash-flow difficulties or to the inability to meet a scheduled debt payment. In order to model bankruptcy under these conditions, the simulation model superimposes a criterion of firm failure based on flows. This criterion is developed on the basis of an empirical bankruptcy model using financial statement data.

The basic premise of the empirical model is that flow variables—specifically, the determinants of changes in firm assets—affect the probability that the firm will enter bankruptcy. Firm asset growth may be financed by two sources: retained earnings, which reflect the operating profitability of the firm, and external financing (debt and equity issuance), which reflects balance sheet growth. In order to measure the impact of these two sources of asset growth in predicting bankruptcy probability, we estimate a statistical model using annual data on assets, debt, and retained earnings between 1973 and 1981 for a sample of 174 failed and ongoing firms.[15] Using the results of this estimation, we are able to generate a "critical level" for the change in assets for any given probability of bankruptcy. This critical level represents the change in firm assets necessary to generate the specified bankruptcy probability.

Our PBGC insurance model fixes a target bankruptcy probability P^* and assumes that if the probability of bankruptcy implied by the model simulation equals or exceeds this level, then the firm declares bankruptcy. This target bankruptcy probability is set at 95 percent,

[13]Single Employer Pension Plan Amendments Act of 1986.

[14]This formulation has been adopted in previous studies. For example, see Marcus, "Corporate Pension Policy."

[15]The statistical model chosen is a probit model. The results of this estimation and the data used are discussed fully in Estrella and Hirtle, "Implicit Liabilities."

which is associated with a critical asset-change level, %RV*, of approximately −36 percent. Although the critical level is a function of time-dependent flow variables and varies over time, this value is representative of the magnitude of the one-period change in assets necessary to generate a significant bankruptcy probability.

In the simulation, the procedure to check for firm bankruptcy is to calculate %RV* at the end of each period and to compare it to the actual percent change in firm assets, %RV. Any value of %RV smaller (more negative) than %RV* will produce a predicted probability of failure greater than 95 percent. If the actual change in firm assets is less than or equal to %RV*, then the firm is assumed to be bankrupt.

Data and parameter assumptions

In the case of the PBGC insurance estimates (and probably in general), the selection of data and parameter values is as important to the estimation procedure as the development of the model's equations. Earlier work on PBGC insurance has generally adopted typical parameter values from the literature on options without giving proper consideration to the specific nature of pension fund and corporate assets and liabilities. Since the model is quite sensitive to some of the assumptions, it is worthwhile to invest some time in the selection process.

In order to simulate the PBGC insurance model, it is first necessary to assign initial period values to the variables whose behavior is described by the six dynamic relationships dicussed above. The data needed consist of firm-level information about pension plan assets, liabilities, normal costs, and participants as well as information about firm assets, debt, and equity. These data are derived from information in the COMPUSTAT annual data tapes. The COMPUSTAT tapes contain balance sheet information on approximately 6000 publicly held firms that file reports with the SEC.

To obtain a comprehensive sample, we included all firms reporting complete data on firm assets, retained earnings, long-term and short-term debt, number of employees, and pension plan assets and liabilities for 1985, 1986, or 1987.[16] The final sample consists of 1586 firms from a wide variety of industries. These 1586 firms have aggregate pension fund assets of $437 billion and aggregate pension fund liabilities of $288 billion. Seventy-four of the 100 largest private pension funds in 1987 are represented in the sample. The sample contains nearly 19 million workers, a number which represents approximately two-thirds of the 30 million pension plan participants covered by the PBGC single-employer plan. This number may overstate the coverage of PBGC single-employer plan participants in the sample, however, since all employees of a given firm may not be covered by a PBGC-insured pension plan.[17]

For each of the 1586 firms in the sample, data on firm assets, retained earnings, and debt and pension plan assets and liabilities are taken directly from the COMPUSTAT tapes. Liabilities are reported as both vested and accrued liabilities.[18] The funding requirements imposed by ERISA are written in terms of accrued liabilities, but the benefits guaranteed by the PBGC more closely resemble vested liabilities. Hence, both liability figures are included in the data set. During model simulation, accrued liabilities are used in determining the funding status of a pension plan, and vested liabilities are used in calculating the value of the insurance at termination.

Pension plan assets and liabilities are reported on an aggregate basis for each firm on the COMPUSTAT tapes. That is, firms with multiple pension plans for their employees report only total assets and liabilities summed across all plans at the firm. Since a given firm could have both overfunded and underfunded pension plans, this procedure means that some underfunded plans will go undetected.[19]

[16]The final sample contained 63 firms with information from 1985, 1287 firms with information from 1986, and 236 firms with information from 1987.

[17]For instance, the pension plans of highly-compensated workers are not necessarily insured by the PBGC. In addition, certain workers at the firm could have pension plans covered by the PBGC multi-employer fund. These workers would be primarily production workers covered by certain collective bargaining agreements. Finally, some workers could be enrolled in defined contribution pension plans, which are not insured by the PBGC.

[18]Vested pension liabilities are liabilities arising from vested pension benefits. Vested benefits are benefits owed to retirees and benefits that are guaranteed to active workers even if they leave the firm. Accrued pension liabilities are vested liabilities plus the liabilities corresponding to nonvested but accrued benefits of active employees.

[19]To the degree that underfunded plans are hidden by aggregation at the firm level, the value of the total PBGC insurance liability could be underestimated. Consider a firm with two pension plans, one overfunded by $20 million and one underfunded by $10 million. On an aggregate basis the firm's plans are overfunded by $10 million, and the PBGC insurance would appear to be "out of the money." In fact, however, the underfunded plan might represent a liability for the PBGC, depending upon the net worth of the firm. Assuming that the $20 million of overfunding from the first plan is "returned" to the firm if the plans are terminated, the value of the PBGC's claim against the net worth of the firm is at least $6 million (30 percent of the $20 million of overfunding). If the remaining net worth of the firm is at least $13.3 million (so that the 30 percent claim is worth $4 million), then the $10 million of underfunding from the second pension plan is covered by the 30 percent of net worth claim against the firm and the insurance is out of the money. To the extent that the remaining

The remaining variables necessary for the simulation of the insurance model are not available directly from the COMPUSTAT tapes. The tapes contain neither the normal cost nor the number of pension plan participants. In order to arrive at initial period values for these variables, we make estimates using available information about pension plan liabilities and the number of firm employees. Pension plan normal costs in the initial period are estimated as a share of pension plan liabilities. The number of pension plan participants is similarly calculated as a ratio to the number of employees at the firm. The ratios used in these calculations are taken from simulations performed by Winklevoss of hypothetical "model" pension plans.[20]

Since the relationships between pension plan liabilities and normal costs and the number of pension plan participants and employees will change during the life cycle of a firm, the adjustment ratios are varied according to the growth characteristics of the firm. Firms in the sample are designated as either "stable" or "growing" based on the increase in employment at the firm over the five years before the year of the observation. Firms experiencing rapid employment growth over this period are assigned to the "growing" category while all other firms are designated as "stable." Firms less than five years old at the time of the observation are assumed to be "growing."[21] Growing firms are assumed to have a higher percentage of new workers than stable firms; consequently they will have both a lower ratio of pension plan participants to firm employees and normal costs that are a higher share of pension plan liabilities.[22]

Footnote 19 continued
net worth of the firm is less than $13.3 million, however, the PBGC insurance associated with the underfunded plan will have some value and the aggregation of the two plans will understate the value of the insurance.

[20]Winklevoss, *Pension Mathematics*. The ratios are based on the simulations reported by Winklevoss in Table 4-7.

[21]A cutoff value of 20 percent for the five-year growth in employment is used to determine whether or not a firm is "growing." The 20 percent level was chosen after an analysis of the employment growth rates for the firms in the sample. Of the 1586 firms, 441 (28 percent) had employment growth rates greater than or equal to 20 percent, 858 (54 percent) had growth rates less than 20 percent, and 298 (18 percent) were less than five years old. The median employment growth rate was approximately 10 percent for the sample as a whole, which reflects the rapid economic expansion over the 1982-87 period.

[22]If N is the number of employees at the firm, NC normal cost, P pension plan participants, and L plan liabilities, the calculations are:

Category	N_0/N_{-5}	Calculations
Stable	Less than 20 percent	$NC_0 = .15\ L_0$ $P_0 = 1.427\ N_0$
Growing	More than 20 percent	$NC_0 = .25\ L_0$ $P_0 = 1.103\ N_0$

The remaining information necessary to simulate the PBGC insurance model consists of the expected growth rates associated with the various difference equations and the nature of the random disturbances to firm assets and pension fund assets. In order to make the behavior of the model variables during the simulation as realistic as possible, we derive these parameter values from the behavior of real world proxies for the various model variables. For instance, the basic growth rates characterizing the path of the sponsor firms over time are chosen so that several diagnostic model statistics—including the long-run aggregate funding ratio and the firm failure rate—produce reasonable values.

As part of the attempt to reflect real world behavior in the pension model, asset growth rates are assigned according to the growth categories described earlier. Stable and growing firms are allotted real "base" growth rates of 0 and ½ percent per period, respectively. Pension plan benefits, the number of plan participants, and firm debt are all assumed to grow at this base growth rate. Firm assets grow at the base rate plus the rate of growth of productivity, which is assumed to be 1 percent per period.[23]

The random disturbances to fund assets and firm assets are assumed to be jointly normally distributed with mean zero and standard deviations σ_A and σ_V, respectively. Since economy-wide events could affect firm assets and pension fund assets in similar ways, the disturbances are assumed to be correlated. The random characteristics of the pension fund are based on the performance of a portfolio of common stocks and bonds over the years from 1973 to 1987.[24] The 60/40 mix of stocks and bonds in the portfolio reflects the average relative shares of these securities held by pension funds according to the Federal Reserve Board's Flow of Funds Accounts. An analysis of the behavior of the inflation-adjusted returns on this portfolio suggests that $\sigma_A = .12$ is a reasonable value. In addition, the analysis suggests that the expected real rate of return on pension fund assets should be set to 2.5 percent per year.

We base the value for σ_V on estimates of the unexpected growth of real balance sheet assets of a sample of firms on the COMPUSTAT tapes. A sample consisting of all firms on the COMPUSTAT tapes reporting complete asset and debt data between 1977 and 1987 was collected. For each of the firms in this sample, the unexpected growth in firm assets on a year

[23]Note that the model is expressed completely in real (inflation-adjusted) terms.

[24]The basic returns are obtained from the Ibbotson Associates data base.

over year basis, $VGROW_t$, is calculated as follows:[25]

$$VGROW_t = (V_t - V_{t-1} - (D_t - D_{t-1}))/V_{t-1},$$

where V_t and D_t are the firm's assets and debt, respectively, in year t. The standard deviation of VGROW is calculated for each firm over the 10 observations in the sample. Using these results as a guide, we set the standard deviation of real firm assets, σ_V, to .10.[26] The correlation between the firm's assets and the return on the 60/40 portfolio is set at .25. This value is based on both theoretical and empirical considerations.[27]

To summarize, we assume that pension assets provide a real expected return of 2.5 percent per annum with a standard deviation of 12 percent. The expected value of 2.5 percent serves as the constant discounting rate for future real flows in the model or, more generally, as the constant interest rate. The assumption of a constant interest rate is reasonable in the present context, since we are most interested in present values calculated over the very long run. Although it is possible to experiment with other assumptions about the future course of interest rates and to examine the short-run implications of such scenarios on the PBGC's acquisition of new liabilities, such experiments lie beyond the scope of this article.

The real return on firm assets is either 1 or 1.5 percent, depending on the particular firm's recent growth performance, with a standard deviation of 10 percent. The correlation between the returns on firm assets and pension assets is 0.25. The return on firm assets is essentially a measure of earnings after interest as a proportion of the firm's assets. Thus, for a firm with a debt-to-assets ratio of one half (which is roughly the recent aggregate level in the United States[28]), the return on assets should be about one half of the return on equity. Our assumptions for the expected returns on firm assets (1 or 1.5 percent) and pension assets (2.5 percent) are consistent with the foregoing relationship.

Finally, firm liabilities as well as pension liabilities are assumed to grow at rates of 0 and 0.5 percent for stable and growing firms, respectively.

Model simulation and results

Simulation procedure

The six dynamic relationships describing the behavior of the six variables of the model (firm assets, debt, pension plan assets and liabilities, normal costs, and the number of pension plan participants), together with the plan termination conditions discussed earlier, are the basic elements necessary to evaluate the PBGC insurance. We perform this evaluation by dynamic simulation. After assigning period 0 values for the variables and specifying the nature of the random disturbances, we roll the difference equations forward over a fixed horizon of 100 periods.[29] At the end of each period, the conditions that signal the termination of the pension plan are checked.

When the pension plan is terminated because of technical insolvency or bankruptcy, the PBGC insurance is valued according to the procedure specified by ERISA and subsequent amendments. These procedures require that the PBGC assume the assets and guaranteed liabilities of any underfunded plan upon termination. In return for accepting the net liabilities of the underfunded plan, the PBGC is granted a claim of up to 30 percent of the net worth of the sponsoring firm.[30] This additional claim may not exceed the total amount of plan underfunding. Thus, for firms with overfunded pension plans at termination, the insurance is worth nothing. For firms with underfunded plans, the insurance is valuable only to the extent that the PBGC-guaranteed liabilities exceed the fund's assets plus 30 percent of the net worth of the firm. For plans terminating because of the technical insolvency of the firm, the

[25] Since the parameter σ_V is meant to represent the standard deviation of unexpected firm asset growth and since debt growth is planned for and controlled by the firm, the growth in firm debt, $D_t - D_{t-1}$, is removed in the asset growth calculation.

[26] The range of values for the standard deviation of VGROW is extensive, probably on account of the limited number of observations per firm. The median standard deviation is .13 and almost half of the observations fall into the range from .05 to .15, leading to the selection of .10 as a representative value.

[27] The lack of information about the market value of a firm's assets makes it difficult to estimate this correlation precisely. However, since the liabilities side of the balance sheet is similar in composition to the fund's assets, we would expect the correlation to be positive. In addition, if the average firm is more volatile than the diversified fund, the correlation should be less than perfect. Test simulations of the model suggest that the results are not very sensitive to changes in the correlation between 0 and 0.5, and we chose the midpoint of this range. Empirically, the median correlation with the firm's capitalization (a somewhat different measure) over the 1978-87 period was 0.11.

[28] Board of Governors of the Federal Reserve System, Flow of Funds Accounts.

[29] Theoretically, the simulation should proceed for an infinite number of periods. Since discounting reduces the present value of liabilities that occur in the distant future, a finite period generally produces a reasonable approximation. The choice of period here is dictated by the size of the discount factor and by practical computer time constraints.

[30] Recent changes in PBGC regulations make the firm liable for 100 percent of the underfunding with respect to guaranteed liabilities in terminated pension plans. However, the part of the PBGC claim exceeding 30 percent of firm net worth has a lower status in bankruptcy court than the portion of the claim falling within 30 percent of net worth. This more-than-30 percent portion has the same status as other unsecured creditors, and it is unclear whether this portion of the PBGC's claim has significant value. For purposes of our model, this part of the claim is assumed to be valueless. To the extent that the assumption is incorrect, our estimate of the value of the PBGC insurance will be reduced.

net worth portion of the PBGC's claim against the firm has no value. Once the net termination liability is determined, its present value is used as the value of the PBGC insurance under the particular sequence of random events.

In order to obtain a precise estimate of the value of the PBGC insurance for each firm, we repeat the entire simulation procedure a significant number of times and calculate an average present value for the insurance.[31]

Results

The basic results of this estimation are presented in Table 1. The aggregate value of the PBGC insurance is calculated at about $31 billion, which is within the general bounds of previous estimates.[32] This is the amount that firms would have to contribute now to prepay fully the PBGC insurance. Under the current premium structure, however, the expected present value of future premium payments is just $14 billion. Thus, the current funding deficiency of the PBGC with respect to future terminations is about $17 billion. Adding this figure to the stated underfunding of $4 billion for past terminations yields a total funding deficiency of $21 billion. Future terminations represent a major burden for the corporation relative to the current accounting obligations.

The new net liabilities of the PBGC are projected in our simulations to accrue at an average rate of $600 million per year and to peak after 15 years at about $2 billion. The precise timing of the liabilities is more difficult to estimate than their present value, which is in essence an average over time. Thus, the results relating to the time pattern of liabilities are of a lower order of certainty than those concerning present values. A couple of summary measures of timing may be useful, however. The liabilities occur over a period whose average length is 29 years and whose (Macaulay) duration is 22 years. These statistics suggest that the problems of the PBGC are long-run, rather than acute, in nature since the burden of the net liabilities incurred by the PBGC falls over a fairly long horizon.

Model diagnostics

To establish the plausibility of the basic results, we compute several additional statistics. Overestimation of the PBGC liabilities could result if either the frequency of terminations or the net liability per termination was overstated. The statistics in Table 2 help to clarify whether either of these problems is encountered in the simulations.

The assumed firm dynamics produce ex post firm failure rates that average 0.9 percent over the course of the simulations. On an annual basis, failure rates run from a low of .2 percent in the 2d year to a high of 1.3 percent in the 25th year (see Figure 1). A higher failure rate implies a greater level of underfunding with respect to the PBGC insurance. The average of the simulated rates is somewhat below the 1.1 percent rate observed over the last four years, a finding which indicates that the estimate of the PBGC's underfunding tends to be conservative in this respect.

The aggregate long-run funding ratio can be used as

[31] Tests suggest that 1,000 repetitions produce statistically stable results.

[32] For instance, Marcus ("Corporate Pension Policy"), operating on a sample of the 100 largest private pension funds in 1982, finds aggregate values ranging between $5.6 billion and $22 billion.

Table 1

Aggregate Simulation Results
Currently Active Firms

Fiscal Year 1986
(In Billions of Dollars)

Future terminations	
Present value of PBGC insurance	30.5
Present value of PBGC premiums	13.7
Underfunding	16.8
Memo:	
Past terminations—PBGC underfunding	3.8
Total PBGC underfunding	20.6
Net new liabilities (annual rate)	
Average	0.6
Maximum (15th year)	1.9
Average life†	29.2 years
Duration‡	21.5 years

†Weighted average time to incurring of net new liability, weighted by amount of net new liability.
‡Weighted average time to incurring of net new liability, weighted by present value of net new liability.

Table 2

Validation Statistics

	Percent
Firm failure rate	
(Equals plan termination rate)	
Average	0.9
Minimum	0.2
Maximum	1.3
Aggregate funding ratio	
(Plan assets/accrued liabilities)	
Initial	122
Long-run (after 100 years)	78

an indication of the relative size of the net liability per termination. Holding the size of the guaranteed liabilities fixed, the higher the funding ratio, the lower the potential cost to the PBGC of assuming the pension plan upon termination. The comparatively low value of 78 percent generated by the simulation results in large part from the tendency of the rules to amortize overfunding more quickly than underfunding. Although this value is lower than levels observed currently in most active pension plans, it is fully consistent with actual amortization rules.

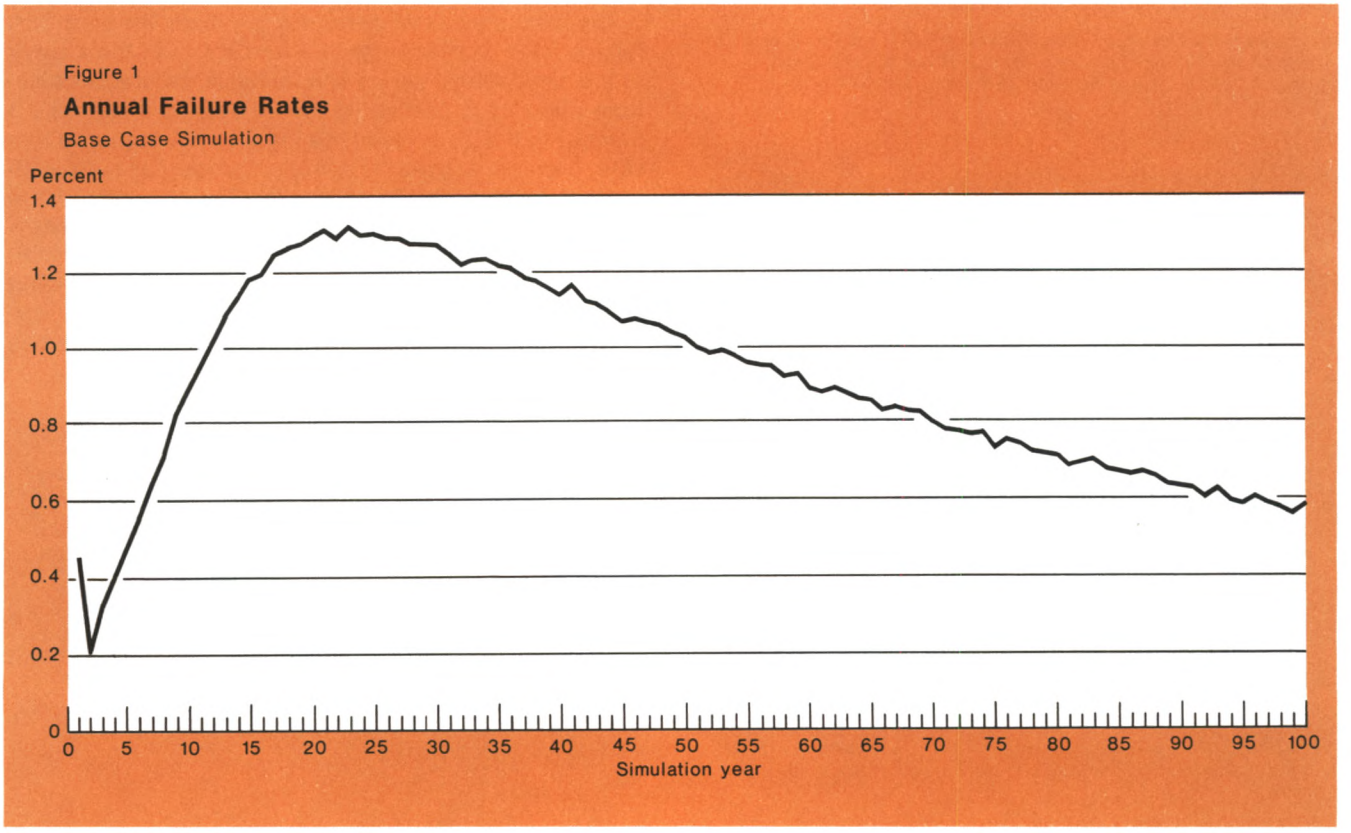
Table 3 contains analysis of the model's sensitivity to parameter values. The results tend to be quite sensitive to the choice of the growth rate of plan benefits (and, in the model, of the firm's debt). The table shows that PBGC underfunding increases by over 20 percent in response to an increase of one percentage point in the growth rate. The two percent growth case leads to a long-run funding ratio that seems low compared to actual experience. On the other hand, the no growth case produces the most favorable results for the PBGC but is unrealistic as a long-run average scenario since it allows for no employment growth over an extended period of time.

Premium structure

In order to investigate the effects of the latest round of PBGC premium increases, we repeated the base case simulation using the previous flat premium structure of $8.50 per participant per year. The results appear in Table 4. Under the flat premium structure, the present value of future premium payments falls to $5 billion. Given that premiums currently range from $16 to $50, it is not surprising that the present value of the $8.50 constant rate premiums is less than half the $13.7 billion value under the current variable rate regime. Although the value of the insurance is about the same under the two structures, the value of the premiums is higher by about $8 billion when variable rate premiums are imposed, reducing the underfunding by about one third.

The impact of the change in the PBGC premium structure can also be seen by comparing the path of future liabilities implied by our model with the PBGC's own projections as presented in its 1986 annual report. The PBGC estimates are made under the constant premium rate structure and can be contrasted with estimates from our model assuming both constant and variable premium rates.

Figure 1
Annual Failure Rates
Base Case Simulation



To generate its projections, the PBGC report simply extrapolates recent trends in the growth of its assets, liabilities, and operating costs. It provides two sets of estimates, one (Forecast A) based on the trends since the creation of the agency in 1974 and the other (Forecast B) based on the trends over the most recent five-year period. The two sets of estimates are reproduced here in Table 5.

The average year-by-year results of our simulations may be used to produce alternative estimates of the PBGC's net liabilities as they would appear in future annual reports. These liabilities would change from year to year for three basic reasons: they would increase by the interest due on outstanding liabilities as well as by the net new liabilities incurred, and they would decline by the premium income received.

Since our model is estimated in real terms, the results must be adjusted for expected inflation in order to make them comparable to the current-dollar PBGC projections. This may be done by multiplying the resulting estimates by a factor representing the expected cumulative effect of inflation from 1986 to the year of the estimate. The PBGC forecasts assume a discount rate of 7.25 percent. Since our estimates are based on a real discount rate of 2.5 percent, we set the expected inflation rate at a level of 4.75 percent, which is consistent with both of these assumptions.

The PBGC estimates in Table 5 correspond to constant premium rates of $8.50 per employee per year. Hence, estimates from our model using this premium structure also appear in the table. In general, these estimates are close to the lower of the two PBGC projections for the early years and fall between the two projections for the later years.

When estimates based on the new variable-rate premium structure are used, the impact of the change in premiums becomes apparent. Because premiums are currently higher for all firms, the estimated future liabilities are all lower than in the constant premium case. In fact, the liabilities are generally lower than both of the PBGC projections, although they continue to grow significantly over time, more than tripling over the 10-year horizon.

Table 3

Sensitivity Analysis
Liabilities from Future Terminations

	No Growth	Base Case .5 Percent Growth	2 Percent Growth
	In Billions of Dollars		
Present value of PBGC insurance	28.0	30.5	40.3
Present value of PBGC premiums	13.0	13.7	16.9
Underfunding	15.0	16.8	23.4
	Percent		
Average failure rate	0.9	0.9	0.9
Long-run funding ratio	79	78	68

Table 4

Alternative Premium Structures
Base Case Growth (.5 Percent)
(In Billions of Dollars)

	Previous Premium Structure	Current Premium Structure
	($8.50 Per Participant Per Year)	
Present value of PBGC insurance	30.3	30.5
Present value of PBGC premiums	5.4	13.7
Underfunding	24.9	16.8

Alternatives for the future

According to our estimates, the funding status of the PBGC is significantly worse than its financial statements would indicate. If liabilities arising from future terminations are taken into account, its total funding

Table 5

Year-by-Year Projections of PBGC Reported Liabilities
(In Billions of Dollars)

Year	PBGC Forecast A†	PBGC Forecast B‡	Constant Premiums§	Current Premiums‖
1986	3.8	3.8	3.8	3.8
1987	4.2	4.6	4.0	3.8
1988	4.6	5.5	4.2	3.8
1989	5.2	6.7	4.8	4.0
1990	5.8	7.9	5.5	4.5
1991	6.5	9.4	6.4	5.0
1992	7.4	11.0	7.6	5.8
1993	8.3	12.9	9.2	6.8
1994	9.3	14.9	11.2	8.2
1995	10.5	17.3	13.5	10.0
1996	11.8	19.9	16.4	12.2

†Based on growth trends from 1974 to 1986.
‡Based on growth trends from 1982 to 1986.
§Our estimates, premium rate of $8.50.
‖Our estimates, variable premium rates of $16 to $50.

deficiency is more than five times the value reported. Thus, if the coverage of the insurance is to remain at current levels, additional funding is necessary. Since a deficit has already developed, the problem is particularly pressing.

Who should provide these new funds? When Congress created the PBGC, it intended the corporation to be self-financing. Perhaps the simplest way to resolve the funding problem while adhering to this legislative intent would be to raise the premiums to a level that makes their present value equal to the value of the future insurance provided to the plan participants. This approach is investigated in Table 6 using the results of the simulations. The ratio of the estimated value of the PBGC insurance to that of present value of the premium payments leads to a simple but usable approximation of the premium rate that would solve the current imbalance. The result is not exact in that the greater premiums could affect the financial integrity of the firms and alter the pattern of failures and terminations. In addition, a large increase in premiums could induce some firms to terminate their defined benefit pension plans in order to avoid the additional cost. However, since premiums tend to be small relative to other firm variables, these effects are likely to be of second order.

The simulation of the pre-1987 regime with premiums at a constant rate (Table 4) provides an estimate of the constant premium level that would be required for benefits to match costs. These calculations suggest that a contribution of $48 per employee per year would be necessary. The problem with this type of setup, however, is that it creates disincentives to full funding for sponsors whose plans are substantially underfunded. The variable rate structure was introduced precisely to deal with this kind of moral hazard problem.

An alternative is to retain the current structure that makes contributions dependent on the funding status of the plan—and therefore dependent on the risk to the PBGC—but to raise each of the components of the rate structure by the same proportion. As shown in Table 6, this change would imply premium rates ranging from $36 for fully funded plans to $111 for plans with serious underfunding. This scheme would produce the same present value of premiums as the constant $48, but the burden would be redistributed to reflect the individual risk of the given pension plan.[33]

A different way of dealing with the underfunding problem is related to the negative amortization of overfunding analyzed above. We argued that pension plans tend to be underfunded in the long run because, according to the present rules, overfunding tends to be amortized more quickly than underfunding. Liberalizing the full funding limitation could reduce or eliminate this asymmetry, thus raising the long-run funding level and reducing the PBGC's risk exposure.

The elimination of the full funding limitation would give an incentive to sponsors to contribute more heavily by making additional contributions tax-deductible. Table 7 reports simulation results for a scenario in which firms are always allowed to contribute the normal cost on a tax-deductible basis regardless of the funding status of the plan. The effects are dramatic in that the underfunding is reduced by $16 billion relative to the base case to only $1 billion. A somewhat

[33]This adjustment to the variable rate structure is not unique, in that many combinations will produce the same present value of premiums as the fixed premium system. The adjustment discussed here fixes (at $5667) the maximum per-worker level of underfunding for which the plan sponsor is penalized in the form of a higher PBGC premium. Other systems are possible. In particular, if reducing moral hazard in funding is the goal of the premium structure, a lower "penalty rate" than the $13 imposed by this adjustment could be combined with a higher maximum underfunding level in a way that would maintain the same premium present value.

Table 6

Self-Financing Premium Rates

(Dollars per Participant per Year)

	Actual Premium	Implied Self-Financing Premium
Fixed rate (To end of 1987) (Factor = 30.3/5.4 = 5.61)	8.50	48
Variable rate (1988) (Factor = 30.5/13.7 = 2.23)		
Fixed portion	16	36
Increment†	6	13
Maximum rate	50	111

†Per participant per $1000 of underfunding.

Table 7

No Full Funding Limitation Base Case Growth

(In Billions of Dollars)

Present value of PBGC insurance	11.7
Present value of PBGC premiums	10.7
Underfunding	1.0
Present value of additional contributions	74.0
Tax revenue loss	25.2
Average failure rate	0.9 percent
Long-run funding ratio	1071 percent

unrealistic feature of these results is that the long-run funding ratio increases to a level of more than 10 to 1. It seems unlikely that such levels would be reached in the aggregate, particularly since such gross overfunding could reasonably be expected to lead to a surge in voluntary plan terminations.[34] Such terminations would both reduce the aggregate funding level and weaken the position of the PBGC by removing the healthiest plans from the pool covered by PBGC insurance. High aggregate funding ratios are observed in this simulation at least in part because the pension model makes no provision for such voluntary terminations.

If the results are so attractive for the PBGC, what are the real costs of such an alternative? Aside from the voluntary terminations issue, one drawback is that tax revenues would be lost by making the additional contributions tax-deductible. In the example, the present value of the tax losses would amount to $25 billion.[35] Since this alternative involves a loss of general revenues, it may be compared to the benefits of providing the additional funding directly from general tax revenues. Bringing the underfunding down to $1 billion through a direct capital infusion would cost taxpayers $16 billion, an amount which is $9 billion less than the cost of eliminating the full funding limitation.

Thus our results suggest that raising the premium rates may be the best current alternative in dealing with the PBGC's funding problems. Relaxing funding limitations appears to be an expensive and ineffective way to keep the PBGC solvent. Even at the exaggerated level reached by the funding ratio when full funding limitations are liberalized, PBGC insurance has significant value and PBGC liabilities exceed assets by $1 billion. Moreover, a provision that bases the individual insurance premiums on the risks involved for the PBGC is the clear choice in handling the moral hazard issue. The present system of making rates dependent on the level of funding is a simple and effective first step. Further progress could be made by taking into account such factors as the riskiness of the fund's portfolio and of the firm's own equity.

In the short run, some stopgap measure may be necessary to prevent cash flow deficiencies resulting from a further deterioration of the PGBC's financial status. Any short-term public funding could be provided in the form of a loan if premium rates are raised to levels that would ultimately suffice to cover the expected liabilities.

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Beverly Hirtle

[34] The sponsor of an overfunded pension plan has the option to terminate the plan voluntarily and replace the pension coverage for its workers with annuities. In such terminations, the sponsor is able to recover a large share of the overfunding, since the firm is legally responsible to cover only accrued pension benefits at the time that the plan is terminated. For a more complete discussion of the motives and issues involved in voluntary terminations, see Arturo Estrella, "Corporate Use of Pension Overfunding," this *Quarterly Review*, Spring 1984.

[35] Most of this loss is experienced in the first year, and further losses are incurred for about a dozen years.

Appendix A: Historical Sketch of the PBGC

The PBGC was formed in 1974 under Title IV of the Employee Retirement Income Security Act (ERISA). Established as an independent, self-financing, wholly owned government corporation, the PBGC protects the pension benefits of workers in private defined benefit pension plans.

By year-end 1986, nearly 40 million Americans, or approximately one out of every three workers, were enrolled in pension plans insured by one of the two programs that the PBGC offers. One plan, which is the focus of this paper, covers single employer pension plans; the other covers multi-employer pension plans. Of the 40 million workers enrolled in PBGC plans, 30 million in 110,000 plans were covered by the single employer program in 1986.†

†Pension Benefit Guaranty Corporation, *Annual Report to the Congress*, FY 1986.

In the event that a covered pension plan terminates without sufficient assets to meet liabilities, the PBGC guarantees the enrolled workers' "basic" benefits. Benefits considered basic are all vested retirement benefits, including qualified preretirement survivor annuities and cost of living adjustments (COLAs) that became effective prior to plan termination. These benefits are subject to a maximum payment constraint defined as the lesser of a participant's average monthly earnings during the highest paid consecutive five years or a dollar limit based on the 1974 limit of $750, adjusted proportionally with the Social Security taxable wage base. In 1986, this dollar limit was $1789.77 per month. Although authorized to do so, the PBGC has not insured "nonbasic" benefits such as retiree medical insurance, lump sum payments, and COLAs that became effective after the termination date of the plan.

Appendix A: Historical Sketch of the PBGC *(continued)*

A prerequisite for the PBGC's full guaranty of all basic benefits is that the plan must have been insured for at least five years prior to termination. In addition, any plan amendments that change the basic benefit makeup of a plan must be in effect for at least five years before they are fully insured. Amendments adopted less than five years before plan termination are covered at a rate of 20 percent of the increase per year from the time of the change.

If a plan qualifies for PBGC coverage, the plan's sponsors pay a premium to the corporation in order to participate in the program. This premium is a variable rate equal to a flat rate of $16 per worker per year plus a funding charge of $6 per $1000 of "funding target insufficiency." A funding target insufficiency is defined as the difference between 125 percent of the present value of a plan's vested benefits and the value of the plan's assets. In order to limit a sponsor's costs should a plan be very underfunded, the PBGC imposes a cap of $50 per worker per year. Plans with fewer than 100 workers are exempt from this funding charge and are only subject to the flat rate. The variable rate premium structure was adopted by the PBGC in January 1988. Before this change, plan sponsors were charged a flat rate per participant per year. In 1974, this cost was $1; in 1977, $2.60; and in 1986, $8.50.

Plan sponsors can terminate a plan only under certain circumstances. The Single Employer Pension Plan Amendment Act of 1986 (SEPPAA) details the conditions under which a plan may be terminated. There are three types of terminations: standard, distress, and involuntary. The standard termination occurs when a terminating plan is fully funded or overfunded. In this situation, plan assets must be used to purchase annuity contracts from a licensed insurance company. Any excess assets from an overfunded plan may be recovered by the employer.

The second type of termination is a distress termination. A termination is so designated if a company meets at least one of the four following criteria:

1. It is in bankruptcy liquidation.
2. It is reorganizing under the Bankruptcy Act.
3. It cannot pay its debts and would be unable to continue in business unless the plan terminates.
4. It is experiencing unreasonably burdensome pension costs due solely to a declining work force.

The first two categories are objective. The second two criteria are subjective and require PBGC approval.

The third type of termination is an involuntary termination. In such cases, the PBGC initiates a plan termination if the sponsor is unable to pay benefits when due or to satisfy minimum funding requirements.

In both involuntary and distress terminations, the PBGC assumes ownership of the plan's assets and liabilities. Sponsors are also liable to the PBGC for the full amount of unfunded guaranteed benefits. This liability is separated into two parts. Immediately payable to the PBGC is that portion of the liability equal to the lesser of the value of the unfunded guaranteed benefits or 30 percent of the firm's net worth. The second part is that portion, if any, of unfunded guaranteed benefits in excess of 30 percent of net worth. The PBGC negotiates with the sponsor a package in which this remaining liability is deferred and paid under more commercially favorable circumstances. If an employer is in bankruptcy proceedings, then the first part of the PBGC's claim is given the priority status of a federal tax lien. The second part has the status of an unsecured general creditor. Historically, the PBGC has recovered an average of just 8 cents for every dollar of unfunded guaranteed benefits covered by both claims against plan sponsors.‡

Since its inception in 1974, the PBGC has run deficits in 11 of 13 years as of year-end 1986. By year-end 1986, the accumulated deficit of the PBGC stood at $3.8 billion, an increase of $2.5 billion from year-end 1985.

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‡Pension Benefit Guaranty Corporation, *Promises At Risk* (Washington, D.C., April 1987), p. 18.

Appendix B: The PBGC Insurance Model

This appendix presents the difference equations that compose the PBGC insurance model discussed in the text. The model consists of six equations that describe the dynamic behavior of firm assets and debt, pension plan normal costs and number of participants, and pension fund assets and liabilities. The equations contain the following variables (stock variables are measured at the end of the year):

- A_t = Pension fund assets in year t
- L_t = Pension fund liabilities in year t
- L_t^G = Guaranteed pension fund liabilities in year t
- B_t = Pension fund benefit payments during year t
- C_t = Pension fund contributions during year t
- NC_t = Normal cost portion of pension fund contributions during year t
- m_t = Amortization rate of pension fund overfunding/underfunding during year t
- V_t = Firm assets in year t
- D_t = Firm debt in year t
- P_t = Number of pension plan participants during year t
- π_t = PBGC premium per plan participant during year t.

Given the discussion in the text, the difference equation describing the movement of pension fund assets can be expressed as:

$$A_t = (1 + \alpha_A + z_{A,t})A_{t-1} + C_t - B_t,$$

where α_A is the expected return on pension fund assets (assumed to be constant across time) and $z_{A,t}$ is the random return on fund assets during year t.

The pension fund contribution is the sum of normal costs plus the amortization of any overfunding or underfunding:

$$C_t = NC_t + m_{t-1}(L_{t-1}-A_{t-1}).$$

Under the guidelines established by ERISA, when a pension fund is underfunded, the sponsoring firm must amortize the funding shortage over a period of years. For the purpose of this model, we assume that the amortization horizon is 20 years and that the sponsor uses the expected return on fund assets as the discount rate. These assumptions imply that for underfunded plans,

$$m_t = \alpha_A + \alpha_A/[(1 + \alpha_A)^{20}-1].$$

Sponsors of overfunded plans, on the other hand, are limited by the IRS in the size of the contribution that they may make. Specifically, the firm cannot contribute an amount that will push the assets of the plan beyond the liabilities plus normal costs.† These restrictions imply that:

$$m_t = 1 \quad \text{if } L_t \leq A_t < L_t + NC_t$$
$$m_t = NC_t/(A_t-L_t) \quad \text{if } A_t \geq L_t + NC_t.$$

The other component of the pension contribution is the normal cost of the pension plan. We assume that pension benefits and and normal costs grow at the same rate, α_B, per year:

$$B_t = (1 + \alpha_B)B_{t-1}, \text{ and}$$
$$NC_t = (1 + \alpha_B)NC_{t-1}.$$

Benefits may also be expressed as the sum of normal costs plus the expected return on pension fund liabilities:

$$B_t = NC_t + \alpha_A L_{t-1},$$

which leads to the difference equation for pension fund liabilities:

$$L_t = (1 + \alpha_B)L_{t-1}.$$

The sponsor firm's dynamic behavior is described by the movements of firm debt and assets. As noted in the text, firm assets can be expressed as:

$$V_t = (1 + \alpha_V + z_{V,t})V_{t-1} - C_t - \pi_t P_t,$$

where α_V is the expected return on firm assets and $z_{V,t}$ is the random return component. According to ERISA regulations, the PBGC premium is related to the funding status of the pension plan as follows:

$$\pi_t = 16 + MIN[34,MAX[0,6(L_t-A_t)/(1000\ P_t)]].$$

The number of pension plan participants is assumed to grow at a constant rate, α_P, per year:

$$P_t = (1 + \alpha_P)P_{t-1}.$$

Finally, firm debt is also assumed to grow at a constant rate, α_D, per year:

$$D_t = (1 + \alpha_D)D_{t-1}.$$

After substitution and simplification, these difference equations may be summarized as follows:

(1) $NC_t = (1 + \alpha_B)NC_{t-1}$
(2) $L_t = (1 + \alpha_B)L_{t-1}$
(3) $A_t = (1 + z_{A,t})A_{t-1} + (\alpha_A-m_{t-1})(A_{t-1}-L_{t-1})$
(4) $P_t = (1 + \alpha_P)P_{t-1}$
(5) $D_t = (1 + \alpha_D)D_{t-1}$
(6) $V_t = (1+\alpha_V+z_{V,t})V_{t-1}-NC_t-m_{t-1}(L_{t-1}-A_{t-1})-\pi_t P_t.$

These equations correspond exactly to those in the text.

When the plan terminates, the value of the PBGC insurance is determined by these six variables. If the pension plan is underfunded at termination, the PBGC assumes the assets and liabilities of the plan and assesses the firm sponsor a fee equal to 30 percent of the net worth of the firm. This fee may not exceed the amount of underfunding, however. Under these rules, the value of the PBGC insurance can be expressed as:

$$PBGC = MAX[0,L_t^G-A_t-.3MAX[0,V_t-D_t]].$$

†This limitation has been tightened by legislation adopted in 1987 that further limits the assets of the fund, including the employer's contribution, to no more than 150 percent of the plan's liabilities. This restriction is binding only if the normal cost exceeds one half of the liabilities. Because of assumptions made in the empirical part of the paper, this constraint is never binding in our model. For a more detailed discussion of this issue, see Estrella and Hirtle, "Implicit Liabilities."

In Brief
Economic Capsules

U.S. Trade with Taiwan and South Korea

The United States has been running large trade deficits with the two Asian economies of Taiwan and South Korea. By 1987 the combined U.S. trade deficit with these economies alone reached $27 billion, equal to 17 percent of the total U.S. trade deficit worldwide (Table 1). Although the U.S. deficit with these economies improved during the first half of 1988, it still remains very high. This note looks at U.S. trade with Taiwan and South Korea. It discusses both the composition of this trade and its recent growth path, giving particular attention to the factors behind the 1988 improvement in the U.S. trade position. The note ends by briefly considering the outlook for U.S. trade with the two economies in light of the current trade performance.

To summarize the main points, the United States exports primarily capital goods and industrial supplies to Taiwan and South Korea. Recent export growth has been across all commodity categories. The United States imports primarily consumer goods and capital goods components from Taiwan and South Korea. The slowdown in imports has been mainly in the consumer goods area. Appreciation of the Asian currencies, import liberalization measures undertaken particularly by Taiwan, and special circumstances in some key trade industries appear to explain most of the recent improvement in U.S. trade with these two economies. Even with this recent improvement, however, the U.S. trade deficits with both Taiwan and South Korea remain large. Further trade improvement with these economies will most likely require significant additional changes in some of the underlying trade determinants.

The Taiwanese and South Korean economies

There are some broad similarities in the Taiwanese and South Korean economies. Neither is endowed with a large natural resource base, but both have a well-educated, skilled labor force. As a consequence, the dominant industries in the two economies focus on manufacturing, both of capital and consumer goods. Both economies have, furthermore, relied on export growth to maintain a rapid pace of development, with exchange rates kept at levels necessary to insure the competitiveness of local products in world markets.

Productivity growth in the manufacturing sectors of both Taiwan and South Korea has been extremely rapid (Table 2). Supported by a very strong investment performance, this growth has kept unit labor costs competitive while wage rates have risen sharply.

Taiwan and South Korea differ somewhat in the composition of their output. Taiwan has tended to concentrate more on the production of consumer goods, while South Korea has devoted a greater percentage of its energy to producing capital goods and automobiles. In part because consumer goods production requires less investment expenditure, Taiwan has not relied as heavily as South Korea on foreign funds to finance development. In fact, while South Korea's foreign debt totaled about $35 billion at the end of 1987, Taiwan was actually a net creditor to the world.

An even sharper distinction between the two economies lies in the area of foreign trade. Taiwan has run current account surpluses since the middle 1970s. South Korea, in contrast, only began to run a current account surplus in 1986. Consequently, although recent surpluses have led both economies to appreciate their currencies, the New Taiwan dollar has appreciated more strongly against the U.S. dollar than has the South Korean won. The New Taiwan dollar rose 27 percent against the U.S. dollar between the first quarter of 1985 and the third quarter of 1988; the South Korean won rose 12 percent during this period. Adjusted for relative inflation rates, the New Taiwan dollar rose

17 percent in real terms against the U.S. dollar, the South Korean won 12 percent (Chart 1).[1]

[1]These changes are calculated in terms of movement in the Asian currency/U.S. dollar exchange rate. Real rates are calculated by deflating with wholesale price indexes. The Asian currency movements compare with nominal rises against the U.S. dollar of 43 percent for the German mark and 48 percent for the Japanese yen over the same period. In real terms the mark rose 38 percent and the yen 36 percent.

Table 1

U.S. Trade Balances with Taiwan and South Korea

(Billions of Dollars, BOP Basis)

	1985	1986	1987	1988†
Taiwan	−11.21	−14.64	−17.50	−10.83
(Percent of total U.S. trade deficit)	(9.2)	(10.1)	(10.9)	(8.3)
Korea	−4.25	−6.98	−9.39	−8.89
(Percent of total U.S. trade deficit)	(3.5)	(4.8)	(5.9)	(6.8)

†First half 1988 values, seasonally adjusted and annualized.

Taiwan has taken greater steps to remove import restrictions than has South Korea. Although Taiwanese tariffs still remain high on a number of goods, notably automobiles and agricultural products, recent measures have significantly reduced tariff rates for most items. South Korea continues to maintain relatively high tariff rates on a broad range of goods while concentrating recent import liberalization efforts on reducing the number of import items that require restrictive import licenses. Taiwan has no significant import licensing requirements.

Table 2

Growth in Productivity, Real Investment, Unit Labor Costs, and Wages in Manufacturing

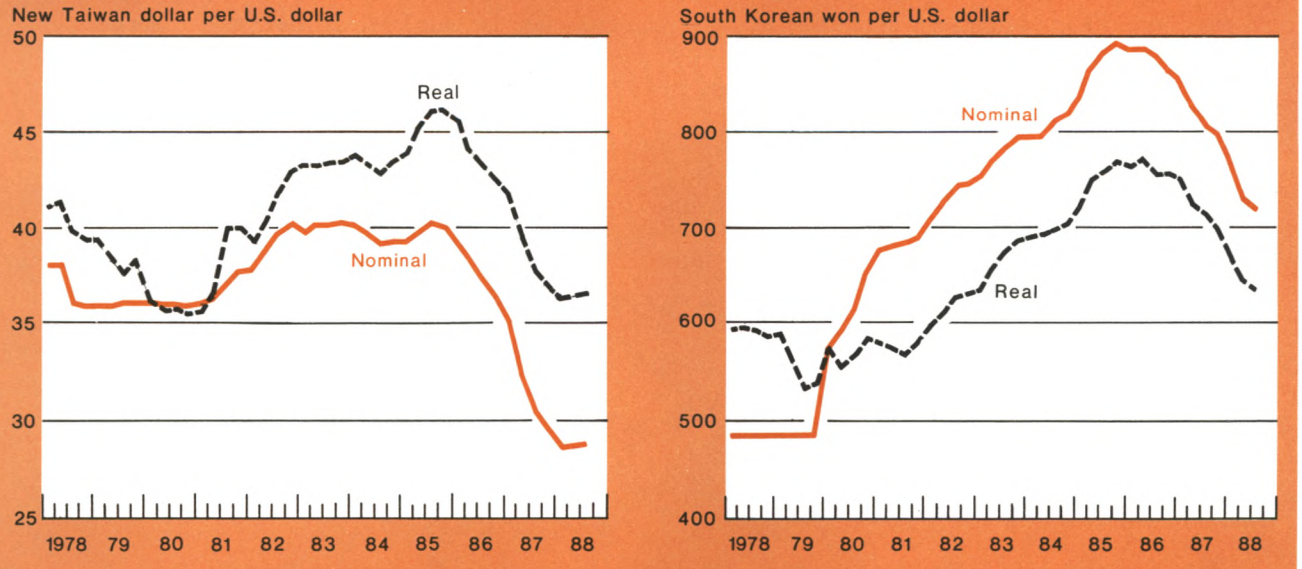
(Averaged Annualized Percent Change 1985-87)

	Productivity Growth	Increase in Investment	Growth in Unit Labor Costs	Change in Average Hourly Wage
Taiwan	10.4	14.2	−1.9	9.5
South Korea	12.7	14.5	1.5	11.5

Chart 1

Asian Exchange Rates versus U.S. Dollar

Quarterly Averages



Note: Real exchange rates are calculated as nominal exchange rates multiplied by the ratio of U.S. to Asian wholesale price indexes with 1980:I=100 for all three price indexes.

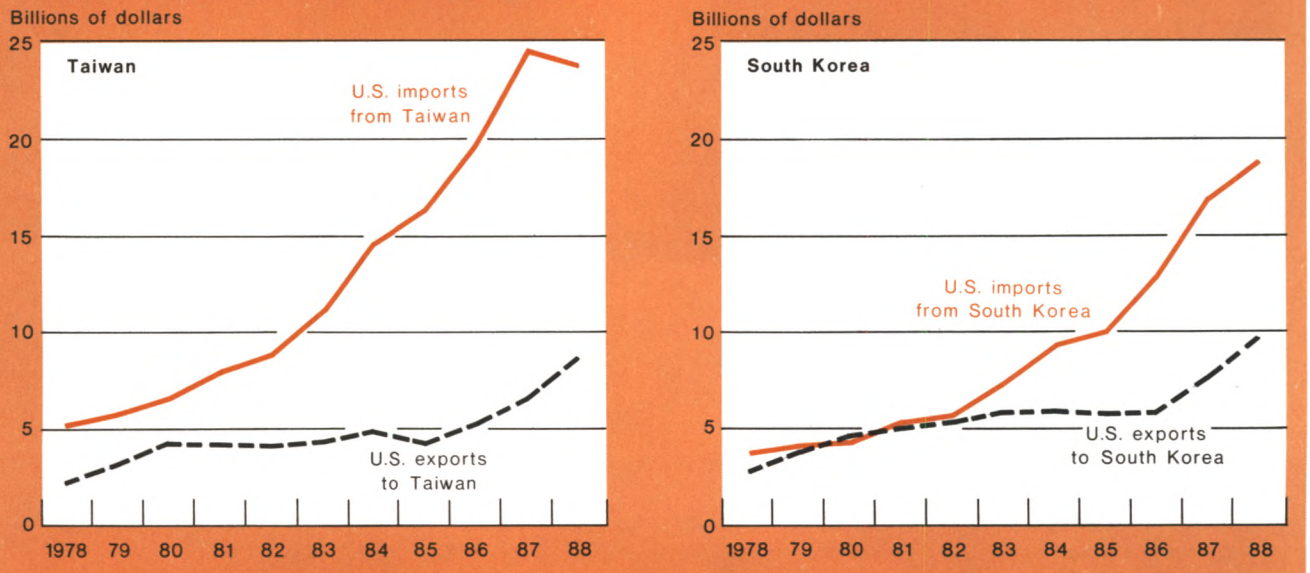
Composition and growth of U.S. trade with Taiwan and South Korea

U.S. trade with Taiwan and South Korea has grown rapidly during the 1980s, on both the export and the import side. However, U.S. imports have until recently outpaced U.S. exports, leading to growing U.S. bilateral trade deficits with both economies (Chart 2).

The United States exports primarily capital goods and industrial supplies to Taiwan and South Korea (Table 3). Agricultural sales are the next largest U.S. export category despite strong agricultural import protection by both Asian economies. U.S. automobile exports are effectively limited by high tariff rates in both Taiwan and South Korea.

Chart 2

U.S. Trade with Taiwan* and South Korea



Note: The 1988 point represents the first two quarters' value annualized and seasonally adjusted. Exports are on a f.o.b. basis and imports are on a customs basis.

*Excluding gold.

Table 3

Composition of U.S. Exports to Taiwan and South Korea in 1987

	Total	Capital Goods	Industrial Supplies	Autos	Other Consumer Goods	Agricultural Products
Taiwan (In billions of dollars)	6.5†	2.2	2.6†	0.2	0.4	0.9
South Korea (In billions of dollars)	7.5	2.5	3.6	0.2	0.2	0.9
Exports to Taiwan and South Korea as a percent of total U.S. exports	6	6	9	2	3	8

†Excluding gold.

U.S. export growth to Taiwan and South Korea has been remarkably fast over the last few quarters. In part this reflects an artificial boost to exports in 1988 from transshipment of foreign gold through the United States to Taiwan, a development that caused a sharp increase in reported U.S. sales to Taiwan. Even abstracting from gold sales, however, U.S. exports to Taiwan grew at an average annual rate of 47 percent and to South Korea at an average annual rate of 33 percent over the last half of 1987 and the first half of 1988. These rates contrast with average annual U.S. export growth rates of 9 and 13 percent to Taiwan and South Korea respectively from the beginning of 1985 through mid-1987. Recent growth was spread across most export categories (Table 4).

U.S. imports from Taiwan and South Korea are primarily consumer goods, although capital goods and, in the case of South Korea, automobiles are becoming increasingly important (Table 5). Clothing and footwear are still the largest consumer goods imports, followed by consumer electronics. Capital goods imports are mainly parts and components such as semiconductors.

U.S. imports from Taiwan and South Korea grew rapidly through mid-1987 before slowing significantly in pace by year end and through the beginning of 1988 (Table 6). After growing at an average annual rate of 28 percent over the previous two and a half years, imports from Taiwan actually fell 3 percent during the four quarters ending 1988-II. Imports from South Korea grew only 10 percent over these last four quarters, after growing at an average annual rate of 34 percent during the previous period. Although imports of industrial supplies and agricultural products declined recently, these commodity imports are relatively small; the marked slowdown in total imports from mid-1987 until mid-1988 was primarily the result of weakness in consumer goods and automobile sales.

Overall, the U.S. trade deficits with Taiwan and South

Table 4

U.S. Export Growth to Taiwan and South Korea 1988-II/1987-II

(In Percent)

	Total Growth	Capital Goods	Industrial Supplies	Autos	Other Consumer Goods	Agricultural Products
Taiwan	47.2†	29.8	37.9†	292.5	93.8	54.6
(Export share‡)	(100)	(31.2)	(37.9)	(6.8)	(6.8)	(14.7)
South Korea	33.5	18.2	42.6	−25.0	70.4	46.4
(Export share‡)	(100)	(30.7)	(51.4)	(1.3)	(3.0)	(10.6)

†Excluding gold.
‡Percentage share of each commodity category in total U.S.exports to each Asian economy in 1988-II.

Table 5

Composition of U.S. Imports from Taiwan and South Korea in 1987

	Total	Capital Goods	Industrial Supplies	Autos	Other Consumer Goods	Agricultural Products
Taiwan (In billions of dollars)	24.6	5.8	1.9	0.4	15.6	0.5
South Korea (In billions of dollars)	16.9	3.0	1.6	2.5	9.3	0.3
Imports from Taiwan and South Korea as a percent of total U.S. imports	10	10	3	3	28	3

Korea, at $11 billion and $9 billion respectively in the first half of 1988,[2] still remain exceptionally large relative to the size of the actual export and import flows between the United States and these two economies. U.S. imports from Taiwan are still three times the level of U.S. exports to Taiwan while U.S. imports from South Korea are more than double the level of U.S. exports to that economy.

Factors behind the recent strength in U.S. exports and moderation in U.S. imports

Several factors lay behind the recent strength in U.S. exports to Taiwan (abstracting from gold sales) and to South Korea and the moderation in U.S. imports from these economies. Policy decisions, general economic developments, and special circumstances in some key trade industries all played a role. Econometric analysis, described in the Box, suggests the relative importance of these various factors in improving U.S. trade with Taiwan and South Korea over the four quarters ending 1988-II (Table 7).

The Taiwanese and South Korean policy decisions to let their currencies appreciate relative to the U.S. dollar and to undertake import liberalization measures appear to have been the most important factors boosting U.S. export sales to Taiwan and South Korea during this period. The fall in U.S. prices relative to Taiwanese and South Korean prices that resulted from New Taiwan dollar and won appreciation significantly increased demand in both Asian economies for U.S. products. Import liberalization measures, along with some special policies to promote purchases of U.S. products, apparently had an even larger impact on Taiwanese demand for U.S. goods. Much weaker liberalization efforts in South Korea had a correspondingly smaller impact.

[2]These figures are seasonally adjusted and annualized.

The two other major factors raising the dollar value of U.S. exports to Taiwan and South Korea were Asian economic growth and a rise in U.S. export prices. Domestic economic growth in Taiwan and South Korea, entailing heavy investment expenditure, was particularly beneficial to U.S. exporters concentrated in capital goods and industrial supplies. U.S. export prices were up because of a significant rise in commodity prices as well as U.S. inflation in general. The commodity price factor was important because industrial supplies are a major U.S. export item to Taiwan and South Korea. U.S. export prices also appeared to be up because the dollar prices of competing Japanese products rose with yen appreciation, providing U.S. producers a little leeway to raise their own prices.

On the import side, currency appreciation and problems in specific consumer goods industries were apparently the main factors behind the slowdown in Asian sales to the United States. Foreign currency appreciation has two effects: it raises the price of imports while reducing the volume of demand. The price effect occurs first. In the case of Taiwan, the volume effect of appreciation over the four quarters ending 1988-II appears to have been greater than the price effect. Thus, Taiwanese currency appreciation significantly depressed the value of U.S. purchases from Taiwan.[3] For South Korea, whose appreciation timing pattern was different, the price effect apparently offset the volume effect during this period (although further volume effects are presumably yet to come). South Korean appreciation, therefore, seemingly did not change the value of U.S. import purchases over these

[3]During this period Taiwanese and South Korean prices rose relative to Japanese prices because of the timing of new Taiwan dollar, won, and yen appreciation. This relative price movement depressed the volume of U.S. demand for Taiwanese and South Korean goods as some purchasers switched over to Japanese items. This switch is included in the volume effect described above.

Table 6

U.S. Import Growth from Taiwan and South Korea 1988-II/1987-II

(In Percent)

	Total Growth	Capital Goods	Industrial Supplies	Autos	Other Consumer Goods	Agricultural Products
Taiwan	−2.9	14.7	−6.6	4.3	−9.0	−8.0
(Import share†)	(100)	(26.9)	(8.0)	(2.0)	(60.2)	(1.7)
South Korea	10.5	36.4	20.1	−4.2	6.6	−3.6
(Import share†)	(100)	(20.2)	(9.8)	(15.0)	(52.8)	(1.7)

†Percentage share of each commodity category in total U.S. imports from each Asian economy in 1988-II.

four quarters.

Special industry factors clearly depressed U.S. purchases from both Taiwan and South Korea. The 1987-88 slump in U.S. clothing demand significantly cut apparel imports from the two Asian economies. Financial difficulties of two U.S.-owned toy companies manufacturing in Taiwan lowered Taiwanese toy sales to the United States. An automotive industry strike in South Korea dramatically cut U.S. imports of South Korean cars. The saturation of demand in the United States for microwave ovens and VCRs also hurt sales from both Asian economies.

Appreciation and special industry factors depressing U.S. imports were balanced against two factors promoting U.S. purchases from Taiwan and South Korea—robust U.S. economic growth and growing Asian supply capacity.[4] For Taiwan, currency appreciation and special industry problems more than offset these latter factors supporting U.S. import growth, producing the outright decline in imports noted earlier. For South Korea, special industry factors cut the growth in U.S. import purchases to about half the rate suggested by these import-supporting factors alone.

[4]Growing Asian supply capacity is used here to refer to the rapid economic development of the two Asian economies that has enabled them to increase their share in world markets substantially over the

Box: Estimating the Impact of the Various Factors Affecting U.S. Export and Import Growth Rates with Taiwan and South Korea

The text assessments of the importance of the various factors underlying bilateral trade growth rates between the United States and Taiwan and South Korea were primarily based on regression analysis. Regressions for export and import price and volume were run for U.S. trade with Taiwan and South Korea over the period 1979 to 1987. On the whole, the regression results are fairly robust, but in some cases they are sensitive to significant changes in the sample period.

The regression coefficients for the major factors mentioned in the text are shown in the table. The t-statistics are given in parentheses.

Regression Coefficients

U.S. Export Growth

	Growth in Asian Industrial Production	Change in U.S./Asian Relative Prices	Change in U.S. Wholesale Price Index	Change in Japanese/ Asian Relative Prices
To Taiwan	1.16	−1.15	0.83	−.20
	(3.5)	(2.8)	(3.7)	(1.0)
To South Korea	0.37	−1.45	0.81	−.44
	(1.1)	(3.0)	(3..9)	(2.4)

U.S. Import Growth

	Growth in U.S. Industrial Production	Change in Asian Supply Capacity and Other Trend Effects	Change in Asian/U.S. Relative Prices	Change in Japanese/ Asian Relative Prices
From Taiwan	1.09	12.22	−1.07	0.53
	(3.3)	(5.5)	(3.7)	(2.4)
From South Korea	1.21	13.78	−0.72	0.51
	(4.9)	(2.9)	(2.3)	(2.9)

The factor labeled "Change in Asian Supply Capacity and Other Trend Effects" was run in the regressions as a simple trend growth term. The reason is that manufacturing capacity in Taiwan and South Korea has been growing fairly steadily over the regression period and is, consequently, difficult to separate from other trend effects. The other factors are fairly standard. Some factors were entered with a lag in the regressions, with t-statistics used to choose the appropriate lag length.

The estimated impact of other important factors affecting U.S. trade flows with Taiwan and South Korea was derived separately. The effect of Asian import liberalization was determined by applying the regression-derived price coefficients to the average change in tariff rates and to other policy-induced price changes in each Asian economy. Because tariff and other price changes did not apply to all product categories equally, these estimates should be viewed more as order of magnitude figures than as precise numerical results. In combination with the regression analysis, this estimation procedure works well in explaining U.S. export growth over different quarters in the recent past.

Estimates of the impact of special industry factors were based on deviations in U.S. import growth in the affected industries from rates expected given overall U.S. import growth from Taiwan and South Korea. Specifically it was assumed that, in the absence of special industry problems, the import growth rates for clothing, toys, and automobiles would have slowed relative to their 1986-87 growth rates by the same percent as total import growth rates slowed. The derived growth rates based on this assumption were then compared to actual growth rates for these industries to gauge the magnitude of special problems.

* * * *

The outlook for U.S. trade with Taiwan and South Korea

The U.S. trade balance with Taiwan and South Korea has improved significantly in recent quarters. However, given the still large discrepancy between the size of U.S. exports and U.S. imports with these two economies, trade improvement can only be sustained if U.S. exports continue to grow rapidly while U.S. import growth remains more subdued.

In the absence of further policy adjustment this required growth pattern may be difficult to achieve. Some of the key factors behind the recent strength in U.S. exports and moderation in U.S. imports are apt to diminish over time. The effect of past currency appreciation on trade growth rates fades with time. The same holds true for the effect of import liberalization measures. The effects of special industry factors that were favorable to trade adjustment appear to have begun to dissipate already—for example, the South Korean automobile industry strike is over.

On the positive side, at least two possible developments favorable to trade adjustment are on the horizon. Current U.S. discussions with Taiwan and South Korea may lead to further Asian trade liberalization, while U.S. demand growth may moderate as the U.S. economy slows from its very strong recent rate of expansion. The foreseeable impact of these two developments by themselves, however, is unlikely to prove sufficient to eliminate, or perhaps even reduce substantially, the U.S. trade deficits with Taiwan and South Korea.

Susan Hickok
Thomas Klitgaard

Footnote 4 continued
last decade. In the regression analysis, the contribution that Asian economic development has made to U.S. import growth is estimated by a trend growth rate (see Box).

Table 7

Accounting for U.S. Trade Growth with Taiwan and South Korea

(Percentage Point Contributions over the Period 1987-II to 1988-II)

		Due to:				
U.S. Export Growth	Total	Relative Price Changes	Asian Trade Policy Changes	Asian Economic Growth	U.S. Price Increases Including Special Price Factors	Other†
To Taiwan (Excluding gold sales)	47	10	15	8	7	7
To South Korea	33	10	5	7	7	4

		Due to:				
U.S. Import Growth	Total	Relative Price Changes	Special Clothing, Toy, and Automobile Factors	U.S. Economic Growth	Increased Asian Supply Capacity and Other Trend Factors	Other‡
From Taiwan	−3	−10	−5	7	13	−7
From South Korea	10	−2	−7	7	17	−6

†Trend and unexplained residual.
‡Market saturation in specific consumer goods products and unexplained residual.

Treasury and Federal Reserve Foreign Exchange Operations

August-October 1988

During the early weeks of the period under review, the dollar continued the generally upward trend that had prevailed throughout the summer, moving higher against all major foreign currencies but especially the German mark. At times during August and to a lesser extent during September, there were episodes of upward pressure whereupon the U.S. authorities intervened, selling dollars to restrain the dollar's rise. As the period progressed, shifts in expectations about the U.S. economic outlook, about the prospects for further increases in U.S. short-term interest rates, and about the progress of external adjustment led to a more cautious attitude toward the dollar, and the currency started to ease. During October selling pressures intensified, and late that month the U.S. authorities intervened in the foreign exchange market to support the dollar. On balance, the dollar ended the three-month period about 5½ percent lower against the Japanese yen and 5 percent lower against the German mark from end July levels.

In the opening weeks of the period, the dollar was buttressed by the release of economic statistics indicating continued strength in the U.S. economy. The August 5 announcement of preliminary employment data for July, together with an upward revision to June employment data and evidence of increasing capacity utilization, suggested that U.S. economic growth was proceeding at a pace that could give rise to new inflationary pressures. Market participants interpreted these economic statistics as increasing the likelihood that the Federal Reserve would tighten its monetary policy stance. Some observers already claimed to see signs of Federal Reserve tightening and were attracted by the prospects of rising short-term interest rates and the relatively high yields available on dollar-denominated assets. Even so, market participants were somewhat surprised when the Federal Reserve raised the discount rate by ½ percentage point to 6½ percent on August 9. Subsequently, short-term interest rate differentials favoring the dollar against both the German mark and the Japanese yen widened. On August 10, the dollar reached its period high of DM 1.9245 against the mark while trading as high as ¥ 135.20 against the yen. At that time, the dollar was 2½ percent higher against the mark and 1½ percent higher against the yen from the start of the period. From its low point around the turn of the year, the dollar had moved up more than 23 percent against the mark and more than 12 percent against the yen.

For several weeks thereafter the dollar traded firmly as market participants adjusted commercial leads and lags and implemented other hedging strategies to take account of the dollar's renewed strength. Sentiment toward the dollar remained bullish, with traders interpreting even potentially unfavorable news as favorable for the dollar. In these circumstances, market participants questioned the degree of the Administration's concern over the dollar's rise.

Perceptions that external adjustment was proceeding on track encouraged positive sentiment toward the dollar. Market participants noted that the trade deficit had

A report presented by Sam Y. Cross, Executive Vice President in charge of the Foreign Group at the Federal Reserve Bank of New York and Manager of Foreign Operations for the System Open Market Account. Cathy McHugh was primarily responsible for preparation of the report.

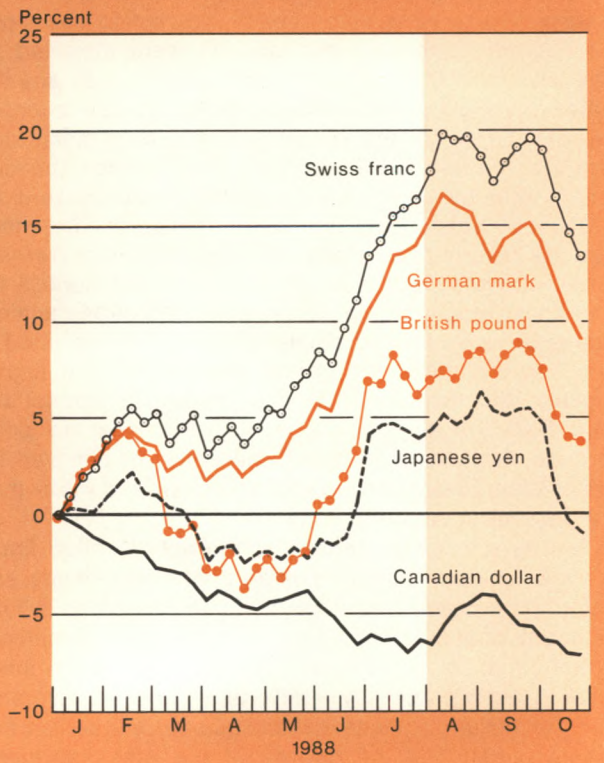
narrowed with each of the prior three monthly reports, setting in place a trend of improved performance based on varying combinations of strong export performance and slower growth of imports. The August 16 report that the U.S. trade deficit for June had widened to a seasonally adjusted $12.5 billion from a revised $9.8 billion in May initially disappointed the market, and the dollar briefly declined. But strong upward pressure on the dollar soon reemerged as some market participants seemed to view the widening of the deficit — and in particular the rise in imports — as yet another indication that the Federal Reserve might further tighten its policy stance to counter inflationary pressures. Meanwhile, others noted that the substantial rise in imports of capital goods had favorable implications for increasing U.S. industrial capacity.

The dollar moved as high as DM 1.9230 against the mark on August 22 and ¥ 134.70 against the yen on August 24, almost matching the highs reached earlier in the month. Between August 5 and August 23, the U.S. monetary authorities at times intervened heavily in the foreign exchange market to resist the tendency for the dollar to advance, selling a total of $1,806 million against marks in operations often coordinated with other central banks. The intervention operations, reinforced by official commentary both in the United States and abroad expressing concern that any further rise of the dollar against the German unit might impede improvement in the trade balances, were, by the end of August, beginning to be viewed as a forceful demonstration that international agreements to foster exchange market stability remained intact.

Then on August 25, in a move prompted by developments in the foreign exchange market as well as domestic conditions in the individual countries, the German Bundesbank and several other European central banks raised their official interest rates. As German interest rates edged higher following the Bundesbank's announcement of a ½ percentage point rise in the discount rate, interest rate differentials favoring the dollar against the mark narrowed, diminishing the relative attractiveness of dollar-denominated assets.

Chart 1

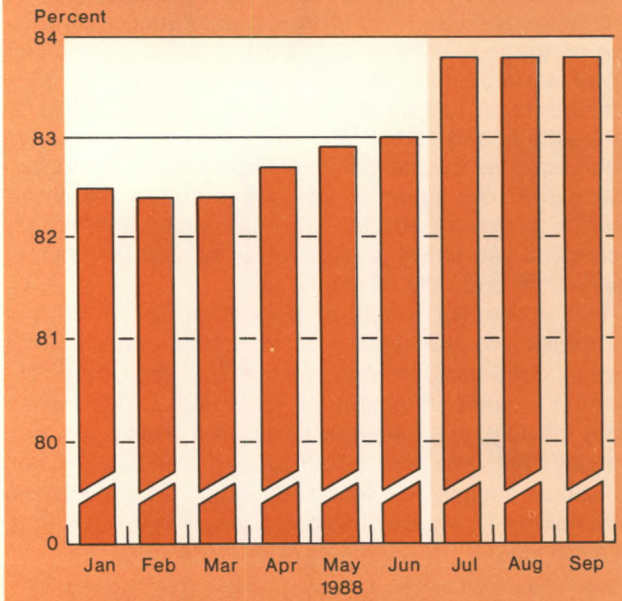
After rising gradually in August, the dollar declined later in the period.



The chart shows the percent change of weekly average rates for the dollar from January 8, 1988. All figures are calculated from New York noon quotations.

Chart 2

Data reported in the period showed continuing high levels of capacity utilization.



The chart shows the degree of capacity utilization in U.S. industry.

Table 1

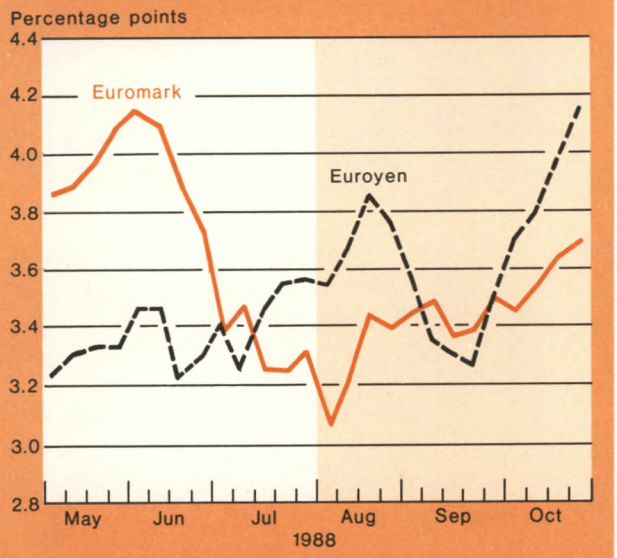
Federal Reserve Reciprocal Currency Arrangements

In Millions of Dollars

Institution	Amount of Facility October 31, 1988
Austrian National Bank	250
National Bank of Belgium	1,000
Bank of Canada	2,000
National Bank of Denmark	250
Bank of England	3,000
Bank of France	2,000
German Federal Bank	6,000
Bank of Italy	3,000
Bank of Japan	5,000
Bank of Mexico	700
Netherlands Bank	500
Bank of Norway	250
Bank of Sweden	300
Swiss National Bank	4,000
Bank for International Settlements:	
Dollars against Swiss francs	600
Dollars against other authorized European currencies	1,250
Total	30,100

Chart 3

Short-term interest rate differentials favoring the dollar widened in August and again in October.



The chart shows weekly average interest rate differentials between three-month Eurodollar rates and three-month Euromarket deposit rates for German marks and Japanese yen.

That day the dollar declined almost 1 percent against the mark, bringing the dollar to about the same level as at the opening of the period. The yen declined even more against the mark on that and subsequent days because the Bank of Japan was not expected to follow actions by the other central banks to raise official interest rates. As the yen weakened, the dollar moved to its period high against the yen of ¥ 137.25 on September 2.

Throughout much of September, the dollar traded within a relatively narrow range. Market participants expressed renewed confidence in the official commitments to promote exchange rate stability and perceived that monetary authorities would not welcome any further rise of the dollar. Many of the factors that had contributed to the upward pressure during late summer also had become much less evident. In particular, a new round of statistics suggested that U.S. economic growth was slowing to a more sustainable pace. While that development was viewed as generally favorable for long-run economic prospects, it weakened some of the short-term demand for dollars by contributing to expectations that upward pressure on dollar interest rates was likely to subside. The financial markets took special note of the September 2 release of U.S. nonfarm payroll figures for August that showed slower employment growth than the market had previously anticipated. Inflation concerns were also allayed by the outlook for declining oil prices and the report of unchanged average earnings during August.

As the upward pressures on the dollar eased and as market participants perceived prospects for greater exchange rate stability, investors were increasingly attracted to certain relatively high-yielding currencies, such as the Canadian dollar. The Canadian dollar also benefited from early public opinion polls in advance of the Canadian elections showing strong support for the incumbent Conservative party that favored the enactment of the U.S.-Canadian free trade agreement. The U.S. dollar declined steadily against the Canadian unit from early September through mid-October.

Although the positive outlook that had prevailed during the summer tended to erode during September, there were episodes of upward pressure on the dollar. One occasion followed the September 14 announcement of a smaller-than-expected U.S. trade deficit for July that provided reassurance to the market that the correction of global imbalances was continuing. Another occurred following the release of a statement by the Group of Seven (G-7) finance ministers and central bank governors attending a meeting in Berlin over the weekend of September 24. Although that statement reaffirmed the basic objectives of previous commitments regarding cooperative efforts, including exchange rate stability, it contained no precise refer-

ence to dollar exchange rates. Some market participants, therefore, concluded that the G-7 was prepared to tolerate further dollar appreciation.

During these episodes, the dollar moved up smartly, and the U.S. authorities intervened to resist these pressures. Between September 14 and September 22, the Desk sold $230 million against marks. On September 26, the first business day after the G-7 meeting, the Desk sold an additional $100 million against marks, and a substantial number of other central banks intervened forcefully to sell dollars at the same time. The visible, concerted intervention operations provided a clear signal to the market that the G-7 had not changed its exchange market objectives.

At the end of September, market participants noted that there was significant concerted intervention to sell dollars against the mark when the dollar, at about DM 1.89, was still well below the levels reached the previous month. Furthermore, subsequent official statements from various sources pointed to the economic risks of a further dollar rise and gave new weight to the September 24 statement.

During October, market sentiment toward the dollar turned negative. For one thing, the prospect of upward

Table 2

Drawings and Repayments by Foreign Central Banks under Reciprocal Currency Arrangements with the Federal Reserve System

In Millions of Dollars; Drawings (+) or Repayments (−)

Central Bank Drawing on the Federal Reserve System	Amount of Facility	Outstanding as of July 31, 1988	August	September	October	Outstanding as of October 31, 1988
Bank of Mexico	700.0	0	+700.0	−700.0	0	0

Data are on a value-date basis.

Table 3

Drawings and Repayments by Foreign Central Banks under Reciprocal Currency Arrangements with the U.S. Treasury

In Millions of Dollars; Drawings (+) or Repayments (−)

Central Bank Drawing on the U.S. Treasury	Amount of Facility	Outstanding as of July 31, 1988	August	September	October	Outstanding as of October 31, 1988
Bank of Mexico	300.0	0	+300.0	−300.0	0	0

Data are on a value-date basis.

Table 4

Drawings and Repayments by Foreign Central Banks under Special Swap Arrangements with the U.S. Treasury

In Millions of Dollars; Drawings (+) or Repayments (−)

Central Bank Drawing on the U.S. Treasury	Amount of Facility	Outstanding as of July 31, 1988	August	September	October	Outstanding as of October 31, 1988
National Bank of Yugoslavia	50.0	33.8	0	−33.8	0	0
Central Bank of Brazil	250.0	232.5	−232.5	0	0	0
Central Bank of the Argentine Republic	265.0*	—	—	—	0	0

Data are on a value-date basis.
*Arrangement was in effect as of October 20, 1988.

pressure on short-term dollar interest rates appeared to diminish further. Release of a series of economic reports indicated that U.S. economic activity, while still showing strength, was moderating even more. News of smaller-than-forecast increases in U.S. employment during September (later revised upward) and preliminary third-quarter U.S. GNP figures reinforced the view that a further tightening of U.S. monetary policy was less likely in the near term.

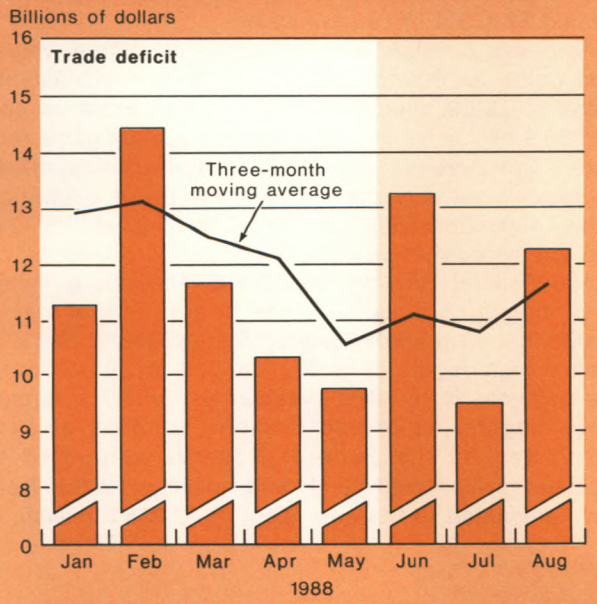
Moreover, market participants, having seen repeated evidence of coordinated central bank sales of dollars during the summer and early autumn, remained convinced that the monetary authorities would firmly resist any further substantial rise of the dollar.

In addition, concerns were aroused about the pace of adjustment of global imbalances by the October 13 release of U.S. trade data for August showing a widening of the trade deficit to $12.2 billion. Despite comments of U.S. officials cautioning that wide fluctuations in monthly trade data were of little significance and noting the clear trend of improvement in the U.S. trade accounts over a longer period, the market continued to focus closely on these monthly trade releases. Participants expressed growing concern about the sustainability of U.S. progress in reducing its external deficit.

The dollar's decline against the yen during October was particularly noteworthy. Over the course of the month, the dollar moved approximately 6 percent lower against the Japanese unit. Widespread reports circulated of substantial sales of dollars against yen by

Chart 4

The monthly U.S. trade deficit figures continued to show fluctuations against a background of a declining trend.



The chart shows the monthly and three-month moving average U.S. merchandise trade deficit, seasonally adjusted and reported on a census basis. The trade figures for June, July, and August were released on August 16, September 14, and October 13, respectively.

Table 5

Net Profits (+) or Losses (−) on United States Treasury and Federal Reserve Foreign Exchange Operations

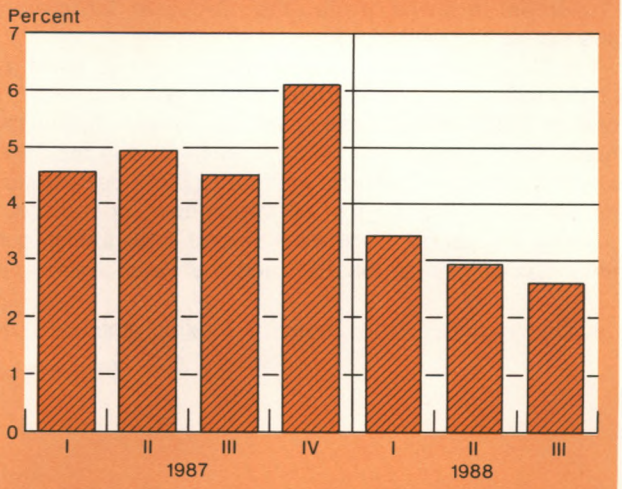
In Millions of Dollars

Period	Federal Reserve	United States Treasury Exchange Stabilization Fund
August 1, 1988 to October 31, 1988	0	0
Valuation profits and losses on outstanding assets and liabilities as of October 31, 1988	+1,536.9	+1,258.9

Data are on a value-date basis.

Chart 5

During the period, the U.S. economy grew at a slightly less vigorous pace.



The chart shows the annualized change in U.S. Gross National Product.

Japanese institutional investors and U.S. investment banks seeking to hedge an increasing proportion of their dollar portfolios in anticipation of further dollar declines. Furthermore, the yen's strength seemed to reflect a relatively favorable market assessment of Japan's progress in adapting to the rise in its currency since 1985. Selling pressure intensified as the dollar moved below important technical and psychological levels, reaching the period lows of about ¥ 124.50 against the yen and DM 1.76 against the mark at one point on October 31. Under these circumstances, the U.S. authorities entered the market to buy dollars for the first and only time in the period, purchasing that day $200 million against yen to support the dollar.

As the period ended, the dollar was underpinned by a widely held market view that the authorities would act to prevent any sharp fall in the dollar at least through early November in advance of the U.S. presidential election. In addition, interest rate differentials favoring the dollar widened slightly as Japanese money market rates eased by a modest amount. However, market sentiment toward the dollar remained distinctly negative as skepticism deepened that the policy initiatives needed to keep the international adjustment process intact, both here and abroad, would be undertaken promptly enough.

The dollar closed the three-month period at ¥ 125.50 against the yen, barely 4½ percent above its record low of ¥ 120.20 recorded on January 4, 1988. Against the mark, the dollar closed the reporting period at around DM 1.79, more than 14½ percent above its record low of DM 1.5615 in January. On a trade-weighted basis, as measured by the index of the Federal Reserve Board staff, the dollar declined by 4½ percent in terms of the other Group of Ten currencies during the period.

The U.S. monetary authorities sold a total of $2,136 million against German marks and purchased a total of $200 million against Japanese yen during the three-month period. The Federal Reserve and the Treasury's Exchange Stabilization Fund (ESF) participated equally in the financing of all intervention operations.

During the period, there were several other foreign currency transactions of the ESF and the Federal Reserve:

- On August 1, the Bank of Mexico activated its reciprocal arrangements with the Federal Reserve and the U.S. Treasury, drawing $700 million and $300 million, respectively. On September 15, both amounts were fully repaid.
- On August 26, the Central Bank of Brazil repaid an outstanding $232.5 million drawing on a $250 million short-term ESF financing facility. The remaining $17.5 million was not drawn during the period.
- The National Bank of Yugoslavia repaid $17.2 million to the U.S. Treasury on September 26 and $16.6 million on September 30, thereby liquidating the $50 million ESF facility. This facility was provided to Yugoslavia in June along with a $200 million facility by the Bank for International Settlements, acting for a number of central banks.
- On October 20, the U.S. Treasury through the ESF, together with a number of other monetary institutions, agreed to establish a facility to provide up to $500 million in short-term financing to Argentina. The ESF's share was $265 million. No drawings were made as of October 31.

As in previous periods, the U.S. authorities acquired foreign currencies through sales of dollars to other official institutions and through receipt of principal repayments and interest payments received under the Supplementary Financing Facility of the International Monetary Fund. Such foreign currency acquisition totaled $2,103.4 million equivalent.

As of end October, cumulative bookkeeping or valuation gains on outstanding foreign currency balances were $1,536.9 million for the Federal Reserve and $1,258.9 million for the ESF. These valuation gains represent the increase in the dollar value of outstanding currency assets valued at end-of-period exchange rates, compared with the rates prevailing at the time the foreign currencies were acquired.

The Federal Reserve and the ESF regularly invest their foreign currency balances in a variety of instruments that yield market-related rates of return and that have a high degree of quality and liquidity. A portion of the balances is invested in securities issued by foreign governments. As of end October, holdings of such securities by the Federal Reserve amounted to $2,540.1 million equivalent, and holdings by the Treasury amounted to the equivalent of $2,816.9 million.

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