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Comparing Central Banks' Rulebooks

by E. J. Stevens

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Introduction

Banks' account relationships with their Federal Reserve Banks are changing because account regulations are changing. The Board of Governors of the Federal Reserve System began a program in 1986 to limit banks' use of daylight overdrafts, broadened the program in 1991, and beginning in 1994 will charge a fee for daylight overdrafts that exceed certain minimum amounts. The Board also reduced reserve requirements to zero on nontransactions deposits in 1990 and cut the highest reserve requirement on transactions deposits from 12 percent to 10 percent in 1992.

The purpose of this article is to examine how major changes in our central bank's rulebook might affect Federal Reserve operations and U.S. monetary and payments institutions. To this end, I contrast Federal Reserve overdraft and reserve requirement regulations — and the institutional setting in which they are administered — with analogous rules and institutional settings at three of the world's other leading central banks: the Deutsche Bundesbank, the Bank of Japan, and the Bank of England.

Do the account regulations in a central bank's rulebook matter? Central banks in industrialized countries all perform roughly the same functions, centered on controlling the issuance of base money and providing safe, final settlement of interbank payments. They do so, however, with apparently quite different regulations governing the accounts of their customer banks. Some central banks allow daylight overdrafts while others do not; some have no reserve requirements; and some are more ready to lend than others.

Of course, some central banks may perform better than others, with less inflation or more safety in their payments systems. Jürg Niehans has observed that "...the effects and the effectiveness of central bank policy depend to a large extent on technical and institutional details that vary from one country to another and in the course of time." (Niehans [1978], p. 263) Surely, however, major differences in performance have more to do with a central bank's objectives, and with its institutional and political will to achieve them, than with its rulebook of account regulations.

A central bank's rulebook is important, nonetheless. In addition to any costs imposed on banks, account regulations influence the operating techniques and involvement of the central bank in the money market. With unaltered objectives, substantial changes in the Federal Reserve's rulebook would require associated modifications in both its operating practices and the nation's payments institutions.

The curse of considering many questions labeled as "central banking" is the absence of an agreed-upon frame of reference within which to conduct the analysis. The grand perspective of monetary theory is too broad for this purpose; it says little about the mundane details of central bank operations. Likewise, marginal analysis of an individual bank's decisions under a particular set of central bank rules is too narrow; it fails to capture systemic implications of the relevant market institutions.

Comparison with other central banks is used here as a way to gain perspective on the Federal Reserve's rulebook. With or without daylight overdrafts, and with high, low, or no reserve requirements, each central bank is able to perform similar day-to-day monetary and payments system functions. Differences in rules can be associated with differences both in market institutions and in the way a central bank interacts with financial markets and the banking system.

The remainder of the article is divided into five sections. The first briefly reviews the unique monetary and payments system functions of any central bank. The next section compares the role of each of the four central banks considered here in financing customer banks' clearing imbalances during the course of a day.

Two sections then contrast the four central banks' techniques for maintaining policy-intended supplies of customer banks' balances and the monetary base. These practices involve central bank operations that monetize and demonetize debt (covered in section III). Some central banks avoid lending directly to individual banks, tending instead to use open-market operations in securities to adjust the aggregate supply of base money and relying on markets to allocate funds among banks. Others are more willing to bypass credit markets by lending directly to individual banks when adjusting aggregate supply.

The level and averaging features of reserve requirements (covered in section IV) influence the extent to which a central bank must respond to daily shocks to the aggregate supply of base money. Some rely more heavily than others on customer banks to absorb these shocks. The concluding section summarizes the international comparisons and extracts some apparent lessons about changing the Federal Reserve's rulebook.

I. Monetary and Payments Functions of a Central Bank

As the monetary authority, a modern central bank controls the supply of "outside," or base, money. This anchors the price level in the long run while allowing a central bank to respond to variations in the economy over the business cycle and to liquidity needs in the short run.

As the banker for commercial and other banks operating in its country, a central bank is able to settle interbank payments because it is the unique common site of banks' deposit accounts: A simple bookkeeping transfer from one account to another can settle payments involving any two banks. In the same way, a central bank is able to settle payments to and from its government or official foreign institutions that hold deposit accounts with it. In short, the central banks of most industrialized countries control the aggregate supply of base money while transferring ownership of banks' base-money balances to settle the daily clearing of payments.

Monetary policy deals with the growth rate of the monetary base. Raising or lowering this rate has the immediate effect of, or is brought about by, changing the interest rate at which banks can acquire very short-run funding of their accounts at the central bank. Ignoring completely any questions about monetary policy, the question I address here is how a central bank reconciles banks' need for settlement with its own need to maintain a targeted level of base money.

Rules about the account balances banks hold at the central bank are necessary if the central bank is to control the monetary base. Private banks have no earnings incentive to hold any substantial balance in their accounts with the central bank, because such balances typically earn no interest.[1] If a bank foresees ending the day with a positive balance, it can lend that amount overnight in markets for funds with same-day payment. Moreover, banks are no different from their own customers: Absent penalties, they have every incentive to use overdrafts as a dependable source of financing, not only during a day, but overnight. This means that in the absence of overdraft and reserve requirement rules, all banks would have an incentive to create balances at the central bank by overdraft, but no incentive to hold all the balances being created.

1 For a rare instance of interest-bearing reserve assets, see Dotsey (1991).

Sources of Daylight Credit

Enforcing a rule against overnight overdrafts allows a central bank to limit the supply of base money each day. Scarce base money is available only to those who pass a market test (by selling goods, services, or existing securities or by borrowing). This does not, however, limit the intraday supply of base money created by temporary, "daylight" extensions of credit. Much of the daily activity of banks involves daylight credit, which must be repaid by day's end to avoid overnight overdrafts.

In modern industrialized economies, depositors draw checks and other payment orders on their bank accounts as the immediate quid pro quo for many market transactions, and banks use base money (or deposits at other banks) to settle interbank clearing imbalances. Even payments with same-day settlement can involve delays that make it possible for banks to "pay out" more money than they have on hand at the moment. They rely on daylight credit provided by those institutions that must wait for settlement before being paid in safe base money.

Clearinghouses are a common source of daylight credit. Routine, standardized transactions within groups of banks, securities dealers, or members of exchanges can be covered by blanket agreements about who can do how much business on credit from the other members of the group prior to settlement, and about how to apportion losses if one of its members is unable to settle.

A central bank provides daylight credit if it makes final payments during the day for customer banks lacking sufficient balances to cover payments as they are made. The amount added to the supply of balances will be drained, all else equal, only when a borrowing bank repays the overdraft.

Repaying Daylight Credit

Repayment of daylight credit from either source should be routine even if banks hold zero balances at the central bank overnight. If all transactions simply involve payments among banks, zero balances are sufficient: What some banks lose from adverse clearings during a day, other banks gain. The losers should be able to borrow or buy what they need from the gainers to cover their positions, as long as they have access to markets with same-day payment.

Difficulties may arise if there is an aggregate shortage of balances in the banking system as a whole. If banks normally hold no excess balances at the central bank, such a shortage will occur on any day during which banks' balances at the central bank are drained into currency, government or foreign accounts, or other miscellaneous accounts on the central bank's balance sheet. With too few balances to go around, one or more banks will be unable to repay daylight credit extended by a clearinghouse or the central bank.

Three mechanisms might allow banks to acquire the funds needed to repay daylight credit, despite uncontrolled factors draining balances. One is a central bank's "defensive" market operations. These are designed specifically to offset uncontrolled factors draining (or adding) base money. Banks' balances decline whenever a central bank reduces its assets or increases its other liabilities or capital, all else equal. Defensive operations are simply central bank actions taken to offset an undesired net change in all of the factors affecting the aggregate amount of its constituent banks' balances. The central bank supplies or drains balances in the aggregate, relying on the market to distribute balances to those banks that need them.

Arbitrage associated with reserve requirements is a second mechanism that allows the banking system itself to absorb uncontrolled deviations of the aggregate supply of balances around a policy-intended level. A binding reserve requirement for an averaging period creates an aggregate average demand for central bank balances on the part of banks. The average quantity demanded, however, can be deferred or brought forward on any day in response to movements in interbank interest rates. This interday arbitrage both absorbs the "noise" from uncontrolled supply factors that are offsetting during a reserve averaging period and dampens associated variations in interest rates.[2]

A third mechanism is direct loans from the central bank, whereby it acts as a pure liquidity-motivated lender of last resort to the banking system. Direct lending is used primarily as an

■ 2 The power of a reserve requirement to produce noise-absorbing arbitrage has limits, however, at least in the short run. On the low side, problems can arise if payments are made by direct transfers of central bank balances, but the central bank limits the availability of daylight overdrafts. Even though banks may be willing to postpone holding overnight balances, there may be too few balances to allow all banks to meet their payment needs during a day within the existing institutional environment. On the high side, some banks might inadvertently accumulate such large reserve positions early in an averaging period that they could avoid excess reserves for the whole period only by running overnight overdrafts, which are prohibited (Dumitru and Stevens [1991]).

escape valve when defensive operations and reserve averaging fail to offset factors draining reserves from the nation's banks, or when unexpected factors increase reserve demand. Banks normally are discouraged from relying on direct central bank loans, with lending rationed by administrative decision (Banks of England and Japan), by banks' reluctance to borrow (Federal Reserve), or by a loan rate that generally exceeds market rates (Bundesbank). For these reasons, individual banks typically do not plan to repay daylight credit by borrowing directly from the central bank. Instead, they try to acquire balances in the market — balances created deliberately by the central bank and coaxed out of the holdings of other banks.

Repayment problems might arise, however, even with no aggregate shortage of balances at the central bank. A bank may be unable to repay daylight credit because either its incipient failure or an operational problem (such as a computer breakdown) prevents borrowing from, or selling assets to, other banks with excess balances at the central bank. Central bank, commercial bank, and clearinghouse rules that prevent unlimited use of daylight credit protect against this problem.

Conceptually, this source of repayment problems can be reserved for a fuller discussion of central banks' lender-of-last-resort and bank supervision functions.[3] As a practical matter, however, a central bank may have difficulty maintaining such a clean distinction between direct lending as a safety valve for aggregate shortages of reserve balances and the importuning of either troubled banks or (in the United States) banks attempting to take advantage of a below-market discount rate.

II. Daylight Credit

Private clearinghouses operate in each of the four countries considered here, with same-day net settlement on the books of the central bank. In addition, the Federal Reserve Banks, the Bundesbank, and the Bank of Japan operate their own on-line payment networks that enable banks to make immediate payments throughout a day by transferring central bank balances directly to other banks.[4]

Central bank daylight overdrafts are provided only in the United States and Germany, from payments made on the Fedwire electronic network operated by the regional Federal Reserve Banks, and on the express electronic and paper transfer network operated by the Bundesbank. Both systems include thousands of participants and are dominated by large-value payments. However, the incidence of daylight overdrafts might be expected to be greater on Fedwire, where they average more than $100 billion daily, than on the Bundesbank system. This is because the value of payments relative to gross domestic product (GDP) made on Fedwire is more than five times greater than on the Bundesbank network, and the ratio of payments to balances is more than 30 times larger (Bank for International Settlements [1990a], Board of Governors [1989]).

The Federal Reserve permits daylight overdrafts for most banks within established limits, but will begin phasing in a fee of 25 basis points (annual rate) in 1994.[5] Compliance with limits is verified on an ex post basis, rather than by preventing excess payments (as is now done, for instance, on the CHIPS large-value transfer system). The Bundesbank, in contrast, apparently does not execute payments that would produce a daylight overdraft exceeding a bank's preexisting collateral, and does not impose a fee.

The Bank of Japan's large-value same-day payments systems (Bank of Japan Cheque and Financial Network Systems) are comparable to those of the Federal Reserve Banks and the Bundesbank. However, the Bank of Japan will not execute payments that would result in a daylight overdraft. To acquire balances in time

■ 3 The daylight credit involved in making payments causes well-known payments system risk problems for banks, their clearinghouses, and their central banks. In particular, a central bank needs to manage credit risk.

Daylight credit extensions on private net settlement systems can involve systemic risk problems. If payment finality is guaranteed by a clearinghouse (a regulatory requirement advocated by the major central banks), failure of a bank to cover a negative position at settlement requires other participants to make up the difference. Such guarantees are now explicit in the rules of the Clearing House Interbank Payments System (CHIPS) in the United States and the Gaiteme (Foreign Exchange) Yen System in Japan.

An alternative structure makes payment finality contingent on successful completion of the settlement process at the end of a day, as in the Towne Clearing of same-day paper check payments in London. In such instances, a bank's failure to cover a negative position precludes settlement and implies disintegration of the day's payments, leaving their status subject to negotiation or litigation. Another possibility, explicit in the rules of some clearinghouses, is to "unwind" the settlement; that is, to exclude all payments to and from the offending bank and calculate a new settlement. However, at least in the case of large-value, same-day networks, the typical perception is that a central bank would prevent disintegration, or an unwinding, by lending to ensure successful completion of the original settlement (Stevens [1989], Bank for International Settlements [1990b]).

■ 4 Descriptions of the four nations' payment mechanisms can be found in Bank for International Settlements (1985, 1990a).

■ 5 A small number of banks with daylight overdrafts in excess of limits and arising from transfers of Treasury securities in the Federal Reserve book-entry system must post collateral.

TABLE 1

Combined Balance Sheet of the Federal Reserve Banks[a]

Assets		Liabilities	
Gold and Special Drawing Rights	11,068	Components of base money:	
Government securities:		Currency	267,657
Outright	241,431	Banks' balances	38,658
Repurchase agreements	18,354	Government balance	8,960
Loans to banks[b]	190	Other deposits	611
Denominated in foreign currencies	32,633	All other liabilities and capital accounts	11,691
All other assets	23,901		
Total	327,577	Total	327,577

a. As of December 31, 1990. All figures are expressed in millions of dollars.
b. 0.5 percent of balances.
SOURCE: Board of Governors of the Federal Reserve System.

to make payments, banks must manage their balances throughout a day, perhaps by borrowing intraday or overnight, or by selling assets during a day for payment over the network.

Whereas the Bank of Japan prohibits daylight overdrafts, the Bank of England does not provide them because it doesn't operate any payments systems. Interbank payments take place entirely through private clearinghouse arrangements, not on the books of the central bank. Each day, only the net settlement position of a bank vis-à-vis all other banks in one or more clearinghouses is settled using the bank's account at the central bank. Even if a bank could settle its clearinghouse position only with an overnight overdraft or loan from the Bank of England, the Bank has no formal responsibility to guarantee settlement.

In the past, Federal Reserve provision of daylight overdrafts clearly was more liberal than at the other three central banks. Until 1986, no limits were imposed and no collateral was required for healthy depository institutions. Provision began to move toward comparability in 1986, with the adoption of the potentially more restrictive current limits, based on a bank's capital. With the imposition of a fee in 1994, Federal Reserve provision will become somewhat more like that of the other central banks.

III. Defensive Operations

The level of short-term interest rates is the effective policy instrument of each of the four central banks considered here. Defensive operations are deliberate actions taken to insulate the supply of base money, and thereby the level of directly affected short-term interest rates, from uncontrolled changes that are inconsistent with policy intentions. Most defensive operations take place within the daily market period in which shortest-term interest rates reflect the forces of demand and supply in the market for banks' balances — what Niehans calls "the ultrashort-run liquidity of the banking system." (Niehans [1978], chapter 12) The length of the ultrashort run — from a few minutes to as much as a week — may be related to reserve requirement arrangements, which are discussed in section IV.

All four central banks use one or both of two basic techniques in their defensive operations: 1) *managing* flows of banks' balances to and from government and official foreign accounts at the central bank, and 2) using market transactions and lending to *offset* unmanaged factors affecting the central bank balance sheet or interest rates. In what follows, I discuss the use of these techniques by each of the four banks.

Federal Reserve

The Fed uses both techniques. Monetizing government securities through outright purchases in the secondary market or directly from foreign customers is the dominant source of base money in the United States (see table 1). Fluctuations in the Treasury's balance at the Reserve Banks, if not offset, change the supply of banks' balances at the Fed. This is avoided, for the most part, by having the Treasury maintain two sets of deposit accounts: one with banks, to which its receipts are paid, and another at the Federal Reserve

TABLE 2

Balance Sheet of the Deutsche Bundesbank[a]

Assets		Liabilities	
Gold, Special Drawing Rights, and net claims on the European Monetary Cooperation Fund	39,219	Components of base money:	
Securities:		Currency	150,548
Outright		Banks' balances	66,874
Bills of exchange[b]	61,309	Government balance	5,149
Other	4,262	Other deposits	54,916
Repurchase agreements	108,828	All other liabilities and capital accounts	31,083
Lombard loans	5,187		
Denominated in foreign currencies	58,308		
All other assets	31,456		
Total	308,570	Total	308,570

a. As of December 31, 1989. All figures are expressed in millions of marks.
b. 92 percent of balances.
SOURCE: Deutsche Bundesbank.

Banks, from which its payments are made. The Treasury can transfer funds from the receiving accounts to the paying accounts each morning to offset the day's projected payments. This practice leaves a relatively constant projected target balance in the paying accounts, preventing Treasury operations from adding or draining banks' balances.[6]

Defensive operations are used to offset short-run variations in the public's demand for currency and in banks' demand for required balances, as well as in a host of miscellaneous items. The vehicle for temporary defensive operations is repurchase agreements (RPs) in the secondary market for Treasury securities — that is, purchases (to add balances) with an agreement to resell, or sales (to drain balances) with an agreement to buy back, one or a few days later. Transactions are conducted by inviting bids from designated (primary) dealers and by accepting enough bids to fill the projected need on a best-bid basis. These frequent, temporary adjustments can be used to fine-tune the supply of balances on a daily basis. When needed, transactions take place at about 11:30 a.m., based on projections of demand and of factors affecting supply. The banking system must accommodate any deviation of actual from projected balances for the day, although as noted above, a substantial shortfall could force banks to borrow at the discount window.

Defensive operations are not always based on projected quantities. The Fed's proximate monetary policy target is perceived as a level of the overnight interbank (federal funds) rate. Deviations of the funds rate from target can indicate projection errors or market expectations that are inconsistent with policy. Operations in the secondary market, therefore, may be intended to defend or to correct the market's perception of the interest-rate policy target (Meulendyke [1989]).

Bundesbank

In contrast to the Federal Reserve, the Bundesbank does not rely on outright purchases of government securities as its dominant means of supplying base money (see table 2). A large portion of base money is supplied (within established "refinancing" quotas) through purchases of domestic and foreign bills of exchange with maturities of several months. Banks sell these instruments to the central bank at the official discount rate, which is typically below market rates. An even larger source of base money originates from the continuous rollover of RPs of one- and two-month maturities.

■ 6 Banks' balances at the Federal Reserve Banks could be completely insulated from the effects of Treasury operations (within projection errors), were it not for occasional episodes when 1) paying accounts must move above the normal target because receipts exceed banks' limited willingness to hold Treasury deposits, or 2) receiving accounts are exhausted and the paying accounts must be drawn down below the normal target because the Treasury is constrained from issuing new debt.

TABLE 3

Balance Sheet of the Bank of Japan[a]

Assets		Liabilities	
Gold	140	Components of base money:	
Securities:		Currency	39,798
Government bonds	31,542	Banks' balances	4,881
Bills and commercial paper	6,906	Government balance	521
Bills discounted	144	Other deposits	424
Loans[b]	6,160	All other liabilities and capital accounts	3,533
Denominated in foreign currencies	2,996		
All other assets	1,269		
Total	49,157	Total	49,157

a. As of December 31, 1990. All figures are expressed in billions of yen.
b. 126 percent of balances.
SOURCE: Bank of Japan.

The Bundesbank adjusts the aggregate supply of banks' balances weekly, typically by regulating the volume of RPs accepted. Other means of adjustment include shifting federal government deposits to banks, foreign exchange swaps or RPs, and sales of special short-maturity Treasury bills. But, for the most part, any remaining need for short-run adjustments must come at the initiative of the banks themselves, by varying their Lombard borrowing from the Bundesbank (collateralized by eligible securities) at the Bank's Lombard rate. This rate always is higher than the discount rate and typically is higher than market rates (Deutsche Bundesbank [1985, 1990]).

The Bundesbank also has an opportunity to indicate when the overnight interbank rate has been affected by either projection errors (undersupply, for example, would be expected to drive the rate up toward the Lombard rate) or a market perception of rates inconsistent with actual policy intentions. Both the cutoff rate in accepting RPs and the volume accepted can provide short-run signals to the market. A more direct signal can be given by inviting tenders for RPs at a designated interest rate, rather than by simply accepting the best rates offered for a desired quantity.

Bank of Japan

Like the Federal Reserve, the Bank of Japan holds a large portfolio of government securities whose outright purchase is the dominant source of base money (see table 3). The Bank also can operate in a variety of other markets to adjust the monetary base and to influence conditions in specific markets. These actions include engaging in Treasury bill and commercial paper RPs, purchases and sales of commercial bills (including sales of Bank of Japan bills), and sales of government bills with an RP. In addition, a pivotal group of large banks is continuously indebted to the central bank, within established lines of credit, at the basic discount rate, which is typically below interbank lending rates (Tatewaki [1991]).

The Bank of Japan has two daily opportunities to adjust the supply of balances. One is through operations in the market (typified by commercial paper RPs) aimed at the market rate on uncollateralized interbank call loans — the counterpart to the federal funds rate in the United States. The second is by a later daily decision about the quantity of loans the Bank will extend or collect. This lending decision is made shortly before 3:00 p.m., when same-day transactions in the call loan market must end (because the Bank's same-day payments network closes), but about an hour after same-day net positions on the Gaiteme foreign-exchange net settlement network have been calculated. Thus, Bank of Japan lending decisions can accommodate a need for balances, or put upward or downward pressure on the call loan market, based on information accumulated during the day. The Bank assists the market in distinguishing defensive operations from those with policy implications by releasing data, also at 3:00 p.m., showing demand and supply of funds and its

TABLE 4

Balance Sheet of the Bank of England[a]

Assets		Liabilities	
Issue Department			
Securities:		Currency	15,021
Government	10,021	Other	9
Other	5,009		
Total	15,030	Total	15,030
Banking Department			
Securities:		Banks' operating balances	175
Government	843	Government balance	454
Bills discounted	1,540	Other deposits:	
Loans	651	Cash ratio	1,491
All other assets	1,302	Other	1,288
		All other liabilities and capital accounts	928
Total	4,336	Total	4,336

a. As of February 28, 1990. All figures are expressed in millions of pounds.
SOURCE: Bank of England.

own market operations for that day, as well as an estimate for the next day (Nakao and Horii [1991], Bank for International Settlements [1986, 1990a], and Bank of Japan [1991]).

Bank of England

The Bank of England maintains an accounting distinction between two departments. The Issue Department supplies currency, which finances outright holdings of government and other securities. The Banking Department supplies the small amount of banks' deposit balances (there are no reserve requirements), largely by discounting (purchasing) eligible securities and through collateralized lending (see table 4). Weekly government bill tenders normally drain enough funds from the banking system to the government's account to create a persistent shortage of balances, requiring daily defensive operations to add balances back into the system.

Procedures for defensive operations are elaborate, because banks' small cushion of desired "target" balances provides little room for error in draining or adding balances each day. Banks report their targets to the Bank of England, and at three times during the day, the Bank reports its estimate of the day's shortage or surplus of balances relative to the aggregate of these targets. Open-market operations typically are carried out with the discount houses, which in turn provide banks with daily financing facilities.

Operations might be conducted after publication of the first estimate of the day's balance position, if the need is large. More often, the Bank operates after releasing its noon update of estimated need. A third round of operations may come after the Bank's 2:00 p.m. update. A further opportunity to adjust comes through "late assistance" in the form of secured lending to discount houses and other money brokers, which may extend later into the afternoon.

Operations at any of these times can do more than simply adjust the quantity of balances. The Bank has discretion over the type of operation (outright, RP, lending), whether it invites transactions or responds to requests, and the terms on which it will engage in transactions (type of security, maturity, and "stop rate"). Manipulation of these variables, in conjunction with the Bank's published estimates of the day's position, provides an opportunity for the Bank to clarify its policy intentions while engaging in defensive operations (Bank for International Settlements [1986, 1990a], Bank of England [1988]).

Summary

All four central banks engage in defensive operations along the twin dimensions of quantity of balances and level of interest rates. Where control of the quantity of balances is not effective or, for some other reason, market expectations are not consistent with policy intentions, the central banks can manipulate the types and terms of their market operations to provide signals — interpreted on the basis of market traditions — about the level of interest rates thought to be consistent with policy intentions. No amount of such suasion can be effective, however, if not supported by control of the quantity of balances.

Clear differences are visible in the degree to which any of the four central banks might be expected to seek precise control of the daily aggregate supply of balances and relevant interest rates using defensive operations. The Bundesbank's reliance on weekly RPs leaves the daily supply of balances subject to uncontrolled factors that might move interest rates within the ceiling provided by the Lombard rate. Federal Reserve reliance on morning open-market operations, guided only by projections, means that the actual daily supply of balances is subject to projection errors, although daily signals may be sufficient to maintain clarity about the level of interest rates consistent with policy intentions.[7] The Bank of Japan, by making decisions about lending and repayment late in the day — after one clearinghouse has closed and immediately before the close of another — is in a better position to avoid projection errors in its daily defensive operations. The Bank of England, relying on successive estimates, operations, and late assistance over the course of a single day, can minimize projection errors by using repeated updates of market information to estimate the need to adjust the aggregate supply of balances.

IV. Reserve Requirements

A banking system is in a better position to absorb day-to-day uncontrolled variations in the supply of balances when banks must meet reserve requirements. The central bank must eliminate any net excess or deficiency of balances by the end of the reserve averaging period, but not every day.

A bank calculates its required reserves by matching various reservable deposits with their respective reserve ratios. Specifications of both reservable deposits and reserve ratios differ in widely inventive ways among the four central banks. These computational features influence the net after-reserves marginal cost of bank lending financed by various types of deposits. They also might be germane to monetary policy operations. For example, predictability of demand for reservable balances and the accuracy of projections underlying defensive operations are affected by shifts among deposit accounts having different reserve ratios.[8] However, these features will not be considered here because they are not of foremost importance to the interaction of central banks' reserve requirement rules with their monetary and payments system operations in the "ultrashort run." Rather, of interest here are 1) the average quantity of non-interest-bearing reserve balances that banks must hold and 2) the length of the averaging period over which banks can spread this artificial demand and over which the central bank can spread its supply.

Three of the four central banks had reserve requirement regulations in 1990. The aggregate quantity of required balances in each country can be compared directly only by choosing exchange rates at which to convert to a common currency. Examining the ratio of required balances to a country's GDP avoids this complication, while making a rough adjustment for differences in the scale of national economies.[9] Both methods of comparison are shown in table 5, with required and excess balances converted to U.S. dollars, as well as scaled by each country's nominal GDP.

■ 7 "Large" projection errors occurred on 27 days in 1991, according to the Federal Reserve Bank of New York, but "large" is undefined. The New York Bank conducts a weekly Thursday press briefing that reviews in general terms the factors affecting banks' reserve balances during the week ending the previous day. Among other items, the briefing indicates either 1) that there were no large net one-day deviations from projections, or 2) the days on which there were large deviations, giving their sign and source but not their dollar values.

■ 8 A convenient comparison of the basis for computing required reserves in the four countries can be found in Kneeshaw and Van den Bergh (1989). The irrelevance of methods of computation for monetary policy implementation is discussed in Stevens (1991).

■ 9 An alternative scale adjustment is to take the ratio of required balances to total deposits (whether subject to requirements or not) of all institutions that are subject to requirements. The rank order is the same as for GDP.

TABLE 5

Banks' Deposit Balances at Central Banks[a]

	Required		Excess			
	Millions of U.S. dollars	Percentage of GDP	Millions of U.S. dollars	Percentage of GDP	Days in Averaging Period	Penalty for Deficiency
Federal Reserve[b]	33,843[c]	0.61[c]	933	0.017	14[d]	Discount rate +2%
Bundesbank[e]	29,782	2.52	189	0.016	30	Lombard rate +3%
Bank of Japan[f]	33,410	1.14	28	0.001	30	Discount rate +3.75%
Bank of England[g]	n.a.	n.a.	232	0.024	1	n.a.

a. 1990 annual averages. Currency conversions are at the annual average exchange rate.
b. Reserve requirements were cut substantially in December 1990 and April 1992. The average dollar amount of required plus clearing balances declined 25 percent between May 1990 and May 1992.
c. Includes (after rounding) 0.59 percent of required balances and 0.03 percent of clearing balances.
d. Ninety-one days for small banks.
e. 1989 values are used to avoid discontinuity caused by reunification.
f. Holdings of vault cash cannot be deducted from required reserves in calculating required balances.
g. Excludes "cash ratio" deposits.
SOURCES: Bank of England, Board of Governors of the Federal Reserve System, Deutsche Bundesbank, Bank of Japan, and the International Monetary Fund.

Federal Reserve

In the United States, large banks must meet reserve requirements within a basic 14-day averaging period. Each bank can rely on daily market transactions to manage balances, aided by a provision for carryover of excesses or deficiencies into the next 14-day period that creates a limited 28-day averaging period.[10] A bank's holdings of vault cash, as well as its deposit balance at a regional Reserve Bank, are eligible to satisfy the legal reserve requirement. Even some of the largest institutions satisfy their entire requirement with vault cash.

In addition to a legal reserve requirement, many banks contract to hold required clearing balances during a reserve maintenance period. These required balances are administered on the same basis as the legal requirement, but yield earnings credits at the level of the federal funds rate with which to pay for Reserve Banks' priced services. Failure to maintain at least the required amount of vault cash plus legal and clearing balances, after carryover, results in a fee levied on the deficiency at a rate of 2 percentage points above the discount rate. This charge, in addition to administrative opprobrium, makes deficiencies rare.

Bundesbank

Required balances in Germany are of an order of magnitude roughly comparable in dollar value to the aggregate quantity held by U.S. and Japanese banks, but are substantially higher relative to GDP. In addition, a long, 30-day averaging period provides the German banking system with a substantial ability to absorb offsetting variations in the daily supply of balances. All institutions subject to reserve requirements must maintain a required deposit balance. Vault cash is eligible to meet requirements, but only up to 50 percent of the amount of a bank's required reserve. Failure to satisfy the reserve requirement results in a penalty at a rate 3 percentage points above the Lombard rate (which itself is typically higher than market rates).

10 The Federal Reserve appears to be unique in allowing this additional averaging between adjacent periods (see Kneeshaw and Van den Bergh [1989]). A deficiency or excess of up to 4 percent of required reserves (increased from 2 percent in 1992) can be carried into the next averaging period (but not beyond). Because many banks satisfy a large portion of their reserve requirement with vault cash, eligible carryover can be much larger than 4 percent of required *balances*.

Bank of Japan

Required reserves in Japan, while of the same order of dollar magnitude as those in Germany and the United States, stand in an intermediate position when measured relative to GDP—almost twice the U.S. ratio, but only half the German ratio. Like German banks, Japanese banks maintain required reserves within a 30-day averaging period, providing the banking system with a significant ability to absorb offsetting daily variations in the supply of balances. All required reserves must be held as balances with the Bank of Japan: Vault cash holdings do not satisfy reserve requirements. The penalty for a reserve deficiency is a rate 3.75 percentage points above the official discount rate.

Bank of England

The United Kingdom is unique among the four countries in having no reserve requirement regulation.[11] Banks do target, and hold, self-determined levels of operating balances as a buffer against lower-than-expected clearing-house net positions at the end of a day. In the aggregate, however, this practice has almost none of the shock-absorbing function associated with a reserve requirement: It is impossible for banks to accommodate daily variations in the aggregate supply of balances by postponing or accelerating the accumulation of balances. Extra balances today are worthless on future days, while an unexpected shortage today can be no greater than target balances. And target balances are quite small — about one one-hundredth of required balances in Germany, and normally smaller than the size of daily defensive operations conducted by the Bank of England.

National Differences in Required Balances

There is no obvious rationale for the observed national differences in the level of balances a banking system is required to maintain on deposit at its central bank. One striking association can be detected: Less frequent defensive operations tend to be related to higher requirements that allow the banking system itself to absorb daily, offsetting variations in the supply of balances. The Bundesbank, with the highest level of required balances, tends to rely on weekly operations; the Federal Reserve, with an intermediate level of required balances, tends to rely on daily operations; the Bank of England, with no required balances, may take action as frequently as four times a day.

Association is not explanation, however. Are reserve requirements lower because a central bank is more assiduous in controlling the supply of balances, or does a central bank control the supply of balances more assiduously because reserve requirements are lower? Moreover, the association is not consistent across the four central banks: The relatively high level of requirements in Japan would seem to allow the Bank of Japan to be less attentive than it is in conducting defensive operations.

Other factors that might account for differences do not explain much, either. Longer averaging periods could be a substitute for higher requirements, but that is not the pattern actually observed (see table 5).[12] Provision of daylight overdrafts could likewise substitute for higher balances, but no such pattern is evident. For example, while the Bank of Japan prohibits daylight overdrafts, the level of required balances relative to GDP is only half that of the Bundesbank, which does allow such transactions.

Perhaps another factor is at work. A central bank might offset the "tax" of a relatively high reserve requirement with the "subsidy" of loans to banks at below-market rates. A perfect offset would leave the marginal cost of lending unaffected by reserve requirements, but none of the four central banks operates this way. More likely is a partial offset to the total cost of operating within all the rules of the central bank. The national basis for this offset is indicated in the footnotes to tables 1–3, as measured by total central bank assets acquired from the banking system at subsidy rates, divided by banks' required balances held with the central bank.

The ratio of subsidized assets to required balances varies from about zero at the Federal Reserve Banks to a high of 126 percent at the Bank of Japan. These values provide some evidence that the cost of required balances may

11 Institutions with more than minimum amounts of eligible liabilities must hold nonoperational, non-interest-bearing "cash ratio" deposits, fixed for six-month intervals at about one-half of 1 percent of both demand and term deposits (without averaging) to finance the Banking Department of the Bank of England. This arrangement is more nearly analogous to the Fed's requirement that member banks hold stock in a Federal Reserve Bank than to a reserve requirement.

12 Extra days could replace extra balances in deferring and accelerating the accumulation of required balances while accommodating a given pattern of variations in supply; supply variations might be more likely to be offsetting over longer averaging periods.

not be as unequal as their levels, but that the offset from the subsidy cannot equalize cost. For example, a simple calculation suggests that the Bundesbank would have to maintain a negative discount rate in refinancing bills of exchange if it were to offset the difference between the GDP-based measure of its required balances and that of the Federal Reserve.[13] Moreover, even a plausible association between required balances and subsidized assets would not explain why nations might choose these different institutional patterns.

Just as it is impossible to explain why reserve requirements differ, so, too, it is hard to explain variations in the average level of *excess* balances among the four banking systems (see table 5). One interpretation of excess balances might be that they measure the accuracy of a central bank's defensive operations. If banks have no incentive to hold non-interest-bearing idle balances, defensive operations must aim at zero excess balances to prevent extreme volatility in interbank interest rates.

Information about excess balances alone is not sufficient to justify this interpretation, however. Even if a central bank were able to achieve zero excess balances, normal practice would be to target a positive level, demanded by banks in the aggregate. Individual banks have an incentive to target small excess balances on the last day of a reserve averaging period. This reflects the monetary and nonmonetary penalties for failing to meet requirements, coupled with each bank's inevitable uncertainty about both the incidence of unplanned, last-minute transactions and the accuracy of its record keeping. Observed excess balances may reflect actual demand, not inaccurate supply.

A bank operating in the context of a positive requirement normally will have a cushion of balances so that it can operate closer to a zero target for excess balances than a bank with no balance requirement. With a requirement, the cushion is lacking only on the last day of a reserve maintenance period, when the bank can no longer postpone or accelerate the accumulation of required balances; without a requirement, the cushion is lacking every day. This may explain why excess balances are highest at the Bank of England — assuming, of course, that actual balances are an indication of banks' desired balances rather than of errors in defensive operations.

Lower excess balances at the Bundesbank may reflect another difference: German banks may be willing to set targets closer to zero excess balances because they can rely on Lombard borrowing to round out their reserve position at the last moment on the last day of an averaging period, albeit at an above-market price (and not repeatedly). The Bank of England and the Federal Reserve Banks do not maintain lending facilities as hospitable to last-minute borrowing by individual banks. Bank of Japan lending might account for the minuscule level of excess balances in that country, either as a means of achieving precision in supplying balances or, given such precision, as a reflection of low demand on the part of individual banks in anticipation of precise supply.

V. Conclusion

The central banks of the United States, Germany, Japan, and the United Kingdom perform the same basic functions. In the payments system, they provide safe, base money both as currency and as banks' deposit balances, as well as a facility for settling clearinghouse payments through bookkeeping transfers of banks' balances. In addition, the Federal Reserve, Bundesbank, and Bank of Japan all provide a system for making same-day payments by direct transfers of banks' balances. Each attempts to provide the quantity of base money required to maintain short-term interest rates at policy-desired levels.

To facilitate payments, some central banks (the Banks of Japan and England) rely entirely on clearinghouse organizations to supplement the supply of base money with daylight credit. Others (the Federal Reserve and Bundesbank) supplement the supply of base money themselves during the day by providing daylight overdrafts.

All four central banks engage in defensive operations designed to insulate the overnight supply of banks' balances and the level of short-term interest rates from the temporary effects of variations in currency holdings, government balances, and other uncontrolled factors. The four differ, however, in the extent to which reserve requirements enable the banking system itself to accommodate day-to-day shocks to the supply of banks' balances arising from these factors. The contrast is most apparent between the Bank of England, with no reserve requirements and multiple defensive operations each

13 Let R equal the market rate forgone on reserve balances, and s equal the subsidy to that rate for central bank loans. In the case of the Bundesbank, for example, from the values in tables 2 and 5,

$$0.92s = 2.52R - 0.61R.$$

That is, $s = 1.92R$. The level of the subsidy would be almost twice the level of the market rate, implying a negative loan rate at the central bank.

TABLE 6

Summary Comparison of Central Bank Rules and Operations, 1990

	Federal Reserve	Bundesbank	Bank of Japan	Bank of England
Sources of Daylight Credit				
Private clearinghouses	Yes	Yes	Yes	Yes
Central bank	Yes, within line of credit, monitored ex post (fee begins in 1994)	Yes, within limit of Lombard collateral; no fee	No	No
Sources of Overnight Balances				
Overnight overdraft	Penalty	Lombard loan	Prevented	Discretionary
Central bank defensive operations	Daily if needed; in morning, from projections of demand and supply	Weekly or more frequently	Twice daily if needed, before and after close of clearinghouse	Four times daily if needed, before and after close of clearinghouse
Reserve Requirement				
Level	High, but falling	Highest	Higher	None
Averaging period	14-day, with limited 28-day	30-day	30-day	None

SOURCES: See references in text.

day, and the Bundesbank, with high reserve requirements and major reliance on weekly defensive operations.

The fundamental lesson of this study is that there is no unique set of rules a central bank must impose on the banking system (see table 6). Monetary and payments system functions can be carried out under a variety of rules and regulations whose relative costs would be enormously difficult to establish.

Applying this lesson to the Federal Reserve helps to clarify some recent issues. A common apprehension about limiting banks' daylight overdrafts has been the possibility of payments system "gridlock," which some fear would require banks either to hold costly excess balances at the Federal Reserve Banks or to develop a finely tuned system for trading and transferring balances on an hourly or partial-day basis. Experience in nations whose central banks do not provide daylight credit suggests another likely alternative: Banks will rely more extensively on private clearinghouses in making payments.

Lowering, or even eliminating, reserve requirements has considerable appeal in the United States, where their apparent burden on banks' domestic and global competitiveness seems unrelated to their statutory monetary policy rationale. Deregulating the banking system by removing reserve requirements, however, would have the seemingly paradoxical effect of increasing, rather than decreasing, the pivotal role of the central bank in the money market. As in the case of the Bank of England, assiduous defensive market intervention could be necessary each day simply to match the daily supply of banks' balances with any residual precautionary demand. Alternatively, copying the Bundesbank's Lombard facility, the Federal Reserve Banks' discount window lending could play a larger defensive role if administrative and market discouragement of borrowing were abandoned in favor of a penalty discount rate.

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Forbearance, Subordinated Debt, and the Cost of Capital for Insured Depository Institutions

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Introduction

Among the proposals intended to prevent the commercial banking industry from suffering a fate similar to that of the nation's savings and loans (S&Ls) is the requirement that banks issue subordinated debt. The claims of the holders of such debt are subordinate to the claims of the Federal Deposit Insurance Corporation (FDIC), which reduces the agency's exposure to loss. Furthermore, the rates paid on subordinated debt theoretically reflect a bank's riskiness; thus, a subordinated debt requirement penalizes relatively risky institutions by imposing market discipline. However, as is the case with competing regulatory proposals, the efficacy of a subordinated debt requirement is directly affected by regulators' adherence to stated guidelines.

In this article, we emphasize that a subordinated debt requirement interacts with other regulatory forces such as deposit insurance. The role of subordinated debt will also change when the risk-based capital system for U.S. banks becomes effective in December. Under the old system of capital regulation, primary capital had to be at least 5.5 percent of on-balance-sheet assets and total capital had to be at least 6 percent of assets, with subordinated debt included in total capital but not in primary capital. Under the new system, subordinated debt is included in Tier 2 capital, and the total of Tier 1 and Tier 2 capital must be at least 8 percent of risk-weighted assets. Although the impact of subordinated debt will be affected by the process of risk-weighting, such debt is a relatively small component of total capital, amounting to only 10 percent of equity capital (the largest component of total capital) for FDIC-insured commercial banks in 1992:IQ (see FDIC [1992]).

As background for understanding the issues surrounding a subordinated debt requirement, it is worth considering recent experience in the S&L industry. Several of the same factors that contributed to losses incurred in the bailout may also be behind the current deficit in the FDIC's deposit insurance fund. These include fraud and mismanagement, outdated regulations, and regulatory laxity. In addition, mispriced deposit insurance has provided incentives for S&L managers to maintain relatively risky portfolios. With fixed-rate deposit insurance, the riskiness of an institution's portfolio does not impact the rate it must pay for deposits. Regulatory capital forbearance, which occurs when regulators supplement bank capital rather than adhering to stated guidelines, may have increased the incentives for insolvent S&Ls to take on more portfolio risk in an attempt to regain solvency. In fact, these incentives can become so perverse that speculative investments with little chance of paying off may be underwritten by insured institutions. The failure of deposit insurance premiums to correctly reflect risk and, to a lesser extent, regulatory forbearance are unfortunately also present in the commercial banking industry.[1]

Proposals to reform the current system of bank regulation can be described in terms of their reliance on market mechanisms. At one extreme are calls to replace government deposit insurance with a private, market-based system. More widely discussed is the proposal to implement a system of risk-based government deposit insurance in which an individual bank's premium would vary with the composition of its portfolio. The feasibility of this approach has been studied by Flannery (1991), Merton (1977, 1978), Ronn and Verma (1986), and Pennacchi (1987b).[2] An analogous system is the risk-based capital standard, which would reduce the subsidies to risk-taking embedded in the current system.

Some proposals are intended to lessen the exposure of the insurer. These include limiting coverage (by restricting coverage to one account per individual or by reducing the total dollar amount insured) or changing banks' capital structure through, among other techniques, a subordinated debt requirement.[3] The maturity of subordinated debt generally exceeds that of uninsured deposits, so holders of such debt are less likely to "run." Consequently, as we point out later in this paper, forbearance is more likely to be extended to uninsured depositors than to subordinated debt holders, who receive principal and interest payments only after the claims of senior creditors are satisfied. Since subordinated debt claims are junior to those of the FDIC, the agency's exposure would be reduced.

In addition, by increasing the risk exposure of claimants subordinate to the FDIC, this proposal would utilize market incentives; that is, rates on subordinated debt would presumably reflect a bank's riskiness. Baer (1985), Benston et al. (1986, chapter 7), and Wall (1989) favor such an approach. Osterberg and Thomson (1991) analyze the theoretical impact of a subordinated debt requirement on both the cost of capital and the value of deposit insurance. Unfortunately, the empirical evidence on using subordinated debt to enhance market discipline is mixed (see box 1).

This article provides a theoretical analysis of the extent to which subordinated debt prices apply market discipline to banks. In theory, the required rate of return will vary positively with the bank's riskiness, reducing the subsidy provided by deposit insurance and ensuring that the bank's investment decisions will take risk into account. In addition, regulators could utilize the information contained in the secondary market prices of subordinated debt. As is the case with other proposals that rely on market discipline, however, the effectiveness of such an approach will depend on whether the government implicitly insures the claims of subordinated debt holders or other technically uninsured claims. Several studies (Allen and Saunders [1990], Osterberg and Thomson [1990], and Thomson [1987a, 1987b]) show how forbearance influences the values of deposit insurance and insured institutions, as well as the rate of return on uninsured deposits.

In this paper, we analyze the impact of forbearance on the values of and required rates of return on subordinated debt, uninsured deposits, and deposit insurance. Our results are consistent with those of Gorton and Santomero (1990) in that we find ranges over which subordinated debt acts like either debt or equity. We also find a nonlinear relationship between asset risk and the rate of return required on subordinated debt. The manner in which we incorporate forbearance into our analysis is similar to techniques used by Allen

■ 1 Many studies have analyzed the risk-taking incentives embedded in the current deposit insurance system (see Kane [1985, 1989a, 1989b]). If deposit insurance were "fairly" priced, as discussed by Thomson (1987b), then the premium would set the value of the insurer's claim to zero and would not distort the market incentives for risk-taking. It is not clear, on average, whether deposit insurance is fairly priced (see Pennacchi [1987b]). However, since all banks pay the same premium per dollar of deposits, relatively risky banks are obviously being subsidized by relatively safe ones. Analyzing the impact of deposit insurance is also complicated by the presence of regulations. In fact, Buser, Chen, and Kane (1981) present a rationale for combining underpriced deposit insurance with capital regulation.

■ 2 The FDIC Improvement Act of 1991, which mandated that the agency do a similar study, is to some degree the driving force behind its recent announcement of a risk-sensitive deposit insurance schedule. While this proposed premium schedule is a step in the right direction, it will only marginally alter the degree of mispricing and hence will have little effect on adverse incentives. For a critical evaluation of the FDIC's plan, see the statement of the Shadow Financial Regulatory Committee (1992).

■ 3 One alternative proposal is to institute depositor preference laws. Without such laws, uninsured deposits, insured deposits, nondeposit claims, and the claims of the insurer have equal priority in the event of bankruptcy. With such laws, depository claims, which are inherited by the insurer, have priority over nondeposit claims. Hirschhorn and Zervos (1990) analyze these laws empirically and note that their effectiveness can be seriously diluted if they lead to an increase in the amount of collateralized claims. Another alternative is to require stockholders to post surety bonds, which would be used to offset creditors' losses if a bank failed (see Kane [1987] and Osterberg and Thomson [1991]). This would effectively reestablish the double call provision that existed prior to the Banking Act of 1935.

BOX 1

Empirical Evidence on Market Discipline

In general, evidence regarding the extent to which market prices reflect risk is mixed (see Gilbert [1990]). Except for Randall (1989), studies of bank equity prices show that they indeed reflect portfolio risk. Valid criticisms of Randall's work can be found in Gilbert's summary of this literature.

Studies of rates paid on certificates of deposit and on subordinated debt are more ambiguous. The two most relevant studies for our purposes are those of Avery, Belton, and Goldberg (1988) and Gorton and Santomero (1990). Both papers examine the empirical relationship between risk premia on bank subordinated debt and balance-sheet measures of bank risk. Each finds weak evidence that market risk premia on subordinated debt are related to risk proxies constructed from accounting data in the current regulatory environment. These results contrast with those of earlier studies by Baer and Brewer (1986) and Hannan and Hanweck (1988), who find a significant relationship between risk premia and risk proxies in deposit markets.

Gorton and Santomero develop an explicit pricing model for subordinated debt showing that sometimes it acts like equity and other times like debt. Specifically, when the bank's asset value is expected to be above (below) the value of claims against it, subordinated debt acts like debt (equity). Also crucial in the analysis are assumptions about the overall regulatory environment. Many studies (see Marcus [1984] and Pennacchi [1987a]) have emphasized the role that assumptions about closure policies play in analyzing deposit insurance. Gilbert (1990) points out that the banks analyzed by Avery, Belton, and Goldberg were mainly large firms whose subordinated debt holders were likely to have been insured de facto. This again highlights the important role that de facto regulation plays in interpreting the informativeness of market prices and rates of return.[a]

a. The test for market discipline in Gorton and Santomero and in Avery, Belton, and Goldberg simultaneously examines the assumptions regarding model specification, closure rules, and the accuracy of accounting ratios as measures of risk. In addition, the results may be sensitive to the particular sample period used. Gorton and Santomero's findings suggest that the weak relationship between the subordinated-debt risk premium and risk proxies constructed from accounting data in Avery, Belton, and Goldberg is not due to either model specification or closure rules. However, since the sample period encompasses the failure of Continental Illinois Bank, where the FDIC fully protected the subordinated debt holders of the parent holding company, it is not clear that these studies' results generalize to other sample periods.

and Saunders (1990) and others (see box 1). Our findings, which point out the need to specify carefully and correctly the regulatory environment in place when market performance is measured, are broadly consistent with those of Gilbert (1990).

The model is presented in section I. Section II reports the results of an earlier, single-period analysis of a bank with uninsured deposits, insured deposits, and subordinated debt (see Osterberg and Thomson [1991]). We show that subordinated debt affects the value of the insured bank only through its impact on the size of the deposit insurance subsidy, and that the fair value of deposit insurance is a function of the subordinated debt requirement. In section III, we extend the analysis to include the possibility of FDIC bailouts of uninsured liability holders. Section IV then investigates the effects of mispriced deposit insurance and FDIC forbearances on the values of subordinated debt capital and deposit insurance. We find that the usefulness of subordinated debt as an equity-like buffer is reduced by FDIC forbearance policy and that investors' required rate of return on subordinated debt is inversely related to forbearance. Conclusions and policy implications are presented in section V.

I. The Model

To determine the effects of subordinated debt and surety bonds on the cost of banks' debt and equity capital, we utilize the single-period capital asset pricing model (CAPM) as employed by Chen (1978) and Osterberg and Thomson (1991). The value of a bank equals the present value of its future cash flows. Debt and equity values are in turn equal to the present value of these respective claims on the firm's cash flows. Certain cash flows are discounted at the risk-free rate of return, while uncertain cash flows are converted to certainty-equivalent flows by deducting a risk premium from the expected cash flow. The CAPM implies that the risk premium is simply the market price of risk multiplied by nondiversifiable risk.

Our primary assumptions are 1) the risk-free rate of return is constant, 2) capital markets are perfectly competitive, 3) expectations are homogeneous with respect to the probability distributions of risky asset yields, 4) investors are risk averse, seeking to maximize the utility of terminal wealth, and 5) there are no taxes or bankruptcy costs.

In section II, we assume that at the end of the period, perfect "me-first" rules are enforced. That is, all claimants receive payment according to the

BOX 2

Variable Definitions

B_i = Total promised payments to insured depositors

B_u = Total promised payments to uninsured depositors

z = Total promised payments to the FDIC (= ρB_i)[a]

ρ = Deposit insurance premium per dollar of insured deposits

S = Total promised payments to subordinated debt holders

B = Total promised payments when subordinated debt (= $B_i + B_u + z$) is absent

K = Total promised payments when subordinated debt is present (= $B_i + B_u + z + S$)

Y_{bi}, Y_{bu}, Y_s, Y_e, and Y_{FDIC} = End-of-period cash flows to insured depositors, uninsured depositors, subordinated debt holders, stockholders, and the FDIC, respectively

V_{bi}, V_{bu}, V_s, V_e, and V_{FDIC} = Values of insured deposits, uninsured deposits, subordinated debt, bank equity, and the FDIC's claim, respectively

$E(R_{bi})$, $E(R_{bu})$, $E(R_s)$, and $E(R_e)$ = Expected rates of return on insured and uninsured deposits, subordinated debt, and equity, respectively

V_f = Value of the bank

r = Risk-free rate of return ($R = 1 + r$)

X = End-of-period gross return on bank assets

$F(X)$ = Cumulative probability distribution function for X

$CEQ(X)$ = Certainty equivalent of X (= $E[X] - \lambda\, COV[X, R_m]$)

λ = Market risk premium

R_m = Return on market portfolio

$\lambda COV(X, R_m)$ = Nondiversifiable risk

a. For simplicity, we express the premium as a function of insured deposits. However, the results of interest here would not be materially affected by adopting the more realistic assumption that premiums are levied on the total of domestic insured and uninsured deposits.

priority of their claim. Realized cash flows are used to satisfy the claims of senior creditors (depositors and the FDIC) before junior creditors (subordinated debt holders) are paid. Equity holders receive any residual cash flow after all creditor claims are satisfied. In sections III and IV, forbearance by the FDIC occurs when the agency fails to enforce me-first rules and allows payments to other creditors (senior or junior) or equity holders at the expense of its own claim.

Sections II through IV utilize the definitions in box 2. We assume that all debt instruments are discount instruments, so that the end-of-period promised payments to depositors and subordinated debt holders include principal plus interest. We also assume that the deposit insurance premium is paid at the end of the period.[4]

II. No FDIC Bailouts

In this section, we present results from Osterberg and Thomson (1991) for a bank with insured deposits, uninsured deposits, and subordinated debt. The FDIC charges a fixed premium of ρ on each dollar of insured deposits. Total liability claims against the bank, K, equal the sum of the end-of-period promised payments to uninsured depositors (B_u), to insured depositors (B_i), to subordinated debt holders, S, and to the FDIC ($z = \rho B_i$). We assume that on average the FDIC underprices its deposit guarantees and provides a subsidy that reduces the cost of capital for banks as it increases their value.[5]

Given these assumptions, the end-of-period cash flow to insured depositors, Y_{bi}, equals the promised payments, B_i, in every state. Regardless of capital structure, the value and expected return of one dollar of insured deposits are $V_{bi} = R^{-1} B_i$ and $E(R_{bi}) = r$, respectively.

The cash flows to uninsured depositors depend on promised payments as well as on the total level of promised payments net of the subordinated debt, $K - S$:

4 For simplicity, we view the premium as an end-of-period claim on the bank. This is equivalent to assuming that the premium is subordinate to B_i and that, in effect, the bank receives coverage without necessarily paying the full premium. Although this condition influences the size of the subsidy, it does not qualitatively affect the key results.

5 Buser, Chen, and Kane (1981) introduce regulatory taxes into a similar framework.

$$Y_{bu} = \begin{cases} B_u & \text{if } X > K - S = B_i + B_u + z, \\ B_u X/(K-S) & \text{if } K - S > X > 0, \\ 0 & \text{if } 0 > X. \end{cases}$$

Notice that although the total promised payments to debt holders and the FDIC equals K, the effective bankruptcy threshold equals K less the claims of subordinated debt holders. Assuming that $K - S$ is less than the previous threshold without subordinated debt, the value of uninsured deposits would rise with S. However, as we discuss below, whether or not this occurs depends on deposit insurance pricing, which influences z and thus K. The value of and the required rate of return on uninsured deposits are

$$(1) \quad V_{bu} = R^{-1}\left\{B_u[1 - F(K-S)] + [B_u/(K-S)]\, CEQ_0^{K-S}(X)\right\} \text{ and}$$

$$(2) \quad E(R_{bu}) = R\frac{1 - F(K-S) + [1/(K-S)]\, E_0^{K-S}(X)}{1 - F(K-S) + [1/(K-S)]\, CEQ_0^{K-S}(X)} - 1.$$

Equation (2) shows that the cost of uninsured deposit capital is a function of the bank's nondiversifiable risk, $\lambda COV(X, R_m)$, total promised payments to depositors and the FDIC, $K - S$, the probability that losses will exceed the level of subordinated debt, $F(K - S)$, and the risk-free rate of return, r. As stated above, the cost of uninsured deposit capital, $E(R_{bu})$, is influenced by deposit insurance pricing. Specifically, Osterberg and Thomson (1990, 1991) show that underpriced (overpriced) deposit guarantees lower (raise) both the effective bankruptcy threshold for senior claims, $F(K - S)$, and the bankruptcy threshold, $F(K)$. Furthermore, underpricing (overpricing) increases (reduces) uninsured depositors' claims relative to both senior claims, $B_u / (K - S)$, and total claims, B_u / K. The size of this effect depends on the FDIC's pricing error per dollar of insured deposits and the deposit mix.

The end-of-period expected cash flows accruing to the subordinated debt holders are

$$Y_s = \begin{cases} S & \text{if } X > K, \\ X + S - K & \text{if } K > X > K - S, \\ 0 & \text{if } K - S > X. \end{cases}$$

The value of the subordinated debt and the required rate of return on subordinated debt capital are

$$(3) \quad V_s = R^{-1}\left\{S[1 - F(K-S)] - K[F(K) - F(K-S)] + CEQ_{K-S}^{K}(X)\right\} \text{ and}$$

$$(4) \quad E(R_s) = \left\{[S[1 - F(K-S)] - K[F(K) - F(K-S)] + E_{K-S}^{S}(X)] / [S[1 - F(K-S)] - K[F(K) - F(K-S)] + CEQ_{K-S}^{K}(X)]\right\} - 1.0.$$

Equations (3) and (4) show that the cost and value of subordinated debt capital depend on the probability of bankruptcy, $F(K)$, the face value of subordinated debt, S, total promised payments, K, and the probability that senior claimants will not be repaid in full, $F(K - S)$. Again, since K is influenced by insurance pricing, so are V_s and $E(R_s)$. Note that the last two terms in equation (3) represent the claims of subordinated debt holders in states where they are the residual claimants.

Our expression for $E(R_s)$ is consistent with Gorton and Santomero's expression for the risk premium on subordinated debt. Here, senior claims, $K - S$, total claims, K, and the variance of X (which influences $F(\cdot)$ over the relevant ranges in equation [4]) have a nonlinear impact on the risk premium.

The end-of-period cash flows accruing to stockholders are

$$Y_e = \begin{cases} X - K & \text{if } X > K, \\ 0 & \text{if } K > X. \end{cases}$$

The value of equity and the expected return to stockholders are

$$(5) \quad V_e = R^{-1}\left\{CEQ_K(X) - K[1 - F(K)]\right\} \text{ and}$$

$$(6) \quad E(R_e) = R\frac{E_K(X) - K[1 - F(K)]}{CEQ_K(X) - K[1 - F(K)]} - 1.0.$$

The value of equity is unaffected by the subordinated debt requirement as long as total claims, K, remains unchanged. K, of course, is influenced by S and the pricing of the premium, z.

Equation (7) gives the total value of a bank with subordinated debt.

$$(7) \quad V_f = R^{-1}\Big\{CEQ_0(X) + B_i F(K-S) - z[1-F(K-S)] - [(B_i+z)/(K-S)]\, CEQ_0^{K-S}(X)\Big\}.$$

Subordinated debt affects the bank's value only through the last three terms on the right side of (7). As we show below, these terms equal the net value of deposit insurance to the bank. However, the definition of correct pricing of deposit insurance implies that its net value is zero, and that a subordinated debt requirement has no impact on bank value. Note, however, that pricing deposit insurance correctly requires the premium to vary with the size of the subordinated debt requirement. In this case, the impact of such a requirement depends on insurance pricing.

The net value of deposit insurance is simply the value of the FDIC's claim on the bank. The end-of-period cash flows to the agency and the value of its position are

$$(8) \quad Y_{FDIC} = \begin{cases} z & \text{if } X > K-S, \\ (B_i+z)X/(K-S) - B_i & \text{if } K-S > X > 0, \\ -B_i & \text{if } 0 > X, \text{ and} \end{cases}$$

$$V_{FDIC} = R^{-1}\Big\{z[1-F(K-S)] + [(B_i+z)/(K-S)]\, CEQ_0^{K-S}(X) - B_i F(K-S)\Big\}.$$

Notice that the FDIC now receives the full premium z over a wider range, since $K-S < K$. Because the effective bankruptcy threshold has changed, equation (8) can be interpreted as showing the impact of the equity-like buffer provided by subordinated debt. The subordinated debt requirement affects the value of the FDIC's position by changing the probability that the put options corresponding to the agency's guarantee will be "in the money" at the end of the period. Equation (8) also makes clear that if deposit insurance is to be priced fairly ($V_{FDIC} = 0$), the premium must be influenced by the subordinated debt requirement.

III. Banks' Cost of Capital and the Value of the Insurance Fund: The Impact of Forbearance

Section II explained how subordinated debt affects a bank's value through its influence on the deposit insurance subsidy. Here, we show how forbearance affects the value of an insured bank with subordinated debt in its capital structure. Previous empirical analyses of subordinated debt prices have failed to account for the possibility that the FDIC conditionally guarantees some uninsured liabilities, a practice defined here as forbearance.

We consider two types of FDIC forbearances that differ in their assumed treatment of subordinated debt holders versus uninsured depositors. In case A, the FDIC bails out all uninsured creditors when earnings, X, fall between G_b and G_l and $K-S > G_b$. In other words, subordinated debt holders are paid in states where they would otherwise receive nothing. In the same states, uninsured depositors receive the balance of their promised claim from the FDIC.

In case B, the FDIC extends forbearances to all uninsured creditors when earnings are less than G_b but greater than G_l, and $K > G_b > K-S$. Subordinated debt holders are paid off when they otherwise would have received partial payment, as well as when they would have received nothing without forbearance.

We assume that the income range over which the FDIC forbears is known to market participants. For each case, we model only one set of bounds for FDIC bailouts of uninsured creditors. The analysis follows that in Osterberg and Thomson (1990) and also holds for multiple and disjoint bailout states.

Case A. For uninsured deposits, the introduction of FDIC forbearances into the capital structure results in the following end-of-period cash flows:

$$Y_{bu} = \begin{cases} B_u & \text{if } X > K-S = B_i + B_u + z, \\ B_u X/(K-S) & \text{if } K-S > X > G_b, \\ B_u & \text{if } G_b > X > G_l, \\ B_u X/(K-S) & \text{if } G_l > X > 0, \\ 0 & \text{if } 0 > X. \end{cases}$$

Comparing equations (9) and (10), below, to (1) and (2) makes apparent the difference between the two scenarios: In some states where uninsured depositors had previously received $B_u X/(K-S)$, they now receive B_u. Thus, it is clear that V_{bu} will increase and $E(R_{bu})$ will fall.

The value of and the required rate of return on uninsured deposits are now functions of the size and probability of the FDIC bailout. The threshold $K-S$ will be influenced by the impact of forbearance on the insurer's choice of premium, z.

$$(9)\quad V_{bu} = R^{-1}\left\{B_u[1-F(K-S)+F(G_b)-F(G_l)] + [B_u/(K-S)][CEQ_0^{K-S}(X) - CEQ_{G_l}^{G_b}(X)]\right\}.$$

$$(10)\quad E(R_{bu}) = R\left\{[1-F(K-S)+F(G_b)-F(G_l) + [1/(K-S)][E_0^{K-S}(X) - E_{G_l}^{G_b}(X)]] \div [1-F(K-S)+F(G_b)-F(G_l) + [1/(K-S)][CEQ_0^{K-S}(X) - CEQ_{G_l}^{G_b}(X)]]\right\} - 1.0.$$

The end-of-period cash flows to the subordinated debt holders are

$$Y_s = \begin{cases} S & \text{if } X > K, \\ X+S-K & \text{if } K > X > K-S, \\ 0 & \text{if } K-S > X > G_b, \\ S & \text{if } G_b > X > G_l, \\ 0 & \text{if } G_l > X. \end{cases}$$

The value of the subordinated debt and its required rate of return are

$$(11)\quad V_s = R^{-1}\left\{S[1-F(K-S)+F(G_b)-F(G_l)] - K[F(K)-F(K-S)] + CEQ_{K-S}^{K}(X)\right\} \text{ and}$$

$$(12)\quad E(R_s) = R\left\{[S[1-F(K-S)+F(G_b)-F(G_l)] - K[F(K)-F(K-S)] + E_{K-S}^{K}(X)] \div [S[1-F(K-S)+F(G_b)-F(G_l)] - K[F(K)-F(K-S)] + CEQ_{K-S}^{K}(X)]\right\} - 1.0.$$

In some states where X falls below $K-S$, S is now received instead of zero. Thus, V_s must rise and $E(R_s)$ must fall. We show this below through a formal comparison of equations (11) and (12) to (3) and (4). Failure to account for this effect could lead empirical investigators to conclude that risk premia for certain banks are too low to be consistent with market discipline. In Osterberg and Thomson (1990), we show that the impact of extending forbearance to uninsured creditors is entirely captured by those creditors and that there is no effect on equity holders. However, forbearance influences the values of deposit insurance and the bank.

Equations (13) and (14) indicate the value of the bank and of FDIC guarantees when the bailout occurs for X between G_b and G_l.

$$(13)\quad V_f = R^{-1}\left\{CEQ_0(X) - z[1-F(K-S)] - [(B_i+z)/(K-S)][CEQ_0^{K-S}(X) - CEQ_{G_l}^{G_b}(X)] - CEQ_{G_l}^{G_b}(X) + B_iF(K-S) + (S+B_u)[F(G_b) - F(G_l)]\right\}.$$

$$Y_{FDIC} = \begin{cases} z & \text{if } X > K-S, \\ (B_i+z)X/(K-S) - B_i & \text{if } K-S > X > G_b, \\ X - B_u - B_i - S & \text{if } G_b > X > G_l, \\ (B_i+z)X/(K-S) - B_i & \text{if } G_l > X > 0, \\ -B_i & \text{if } 0 > X, \text{ and} \end{cases}$$

$$(14)\quad V_{FDIC} = R^{-1}\left\{z[1-F(K-S)] + [(B_i+z)/(K-S)][CEQ_0^{K-S}(X) - CEQ_{G_l}^{G_b}(X)] + CEQ_{G_l}^{G_b}(X) - B_iF(K-S) - (S+B_u)[F(G_b) - F(G_l)]\right\}.$$

The crucial role of deposit insurance pricing in determining the impact of forbearance is most easily seen by noting that the bank's value in equation (13) is simply the sum of the value of an all-equity firm and the net value of implicit and explicit FDIC guarantees (from [14]): $V_f = R^{-1}\,CEQ_0(X) + V_{FDIC}$. Of course, if the FDIC prices its guarantees fairly, then $V_{FDIC} = 0$ and $V_f = R^{-1}\,CEQ_0(X)$, the value of the all-equity firm. The impacts of the subordinated debt requirement, forbearance, and capital structure are reflected in the value of the deposit insurance subsidy. In this case, the pricing of both the explicit and implicit guarantees will influence the impact of subordinated debt.

Case B. Introducing FDIC forbearances into the capital structure when X is less than G_b $(G_l > K-S > G_b)$ results in the following end-of-period cash flows to uninsured depositors:

$$
\begin{aligned}
Y_{bu} = \; & B_u && \text{if} \quad X > G_l, \\
& B_u X/(K-S) && \text{if} \quad G_l > X > 0, \\
& 0 && \text{if} \quad 0 > X.
\end{aligned}
$$

Again, the value of and the required rate of return on uninsured deposits are functions of the size and probability of the FDIC bailout. However, unlike the previous case, when the uninsured depositors suffered some losses after the subordinated debt was exhausted, this policy guarantees their claims for all values of X above G_l. Thus, V_{bu} will rise and $E(R_{bu})$ will fall.

$$
(15) \quad V_{bu} = R^{-1}\Big\{B_u[1-F(G_l)] + [B_u/(K-S)]\,[CEQ_0^{G_l}(X)]\Big\} \text{ and}
$$

$$
(16) \quad E(R_{bu}) = R\Big\{[1-F(G_l) + [1/(K-S)]\,E_0^{G_l}(X)] \div [1-F(G_l) + [1/(K-S)]\, CEQ_0^{G_l}(X)]\Big\} - 1.0.
$$

The end-of-period expected cash flows accruing to the subordinated debt holders are

$$
\begin{aligned}
Y_s = \; & S && \text{if} \quad X > K, \\
& X+S-K && \text{if} \quad K > X > G_b, \\
& S && \text{if} \quad G_b > X > G_l, \\
& 0 && \text{if} \quad G_l > X > 0.
\end{aligned}
$$

The value of subordinated debt and its required rate of return are

$$
(17) \quad V_s = R^{-1}\Big\{S[1-F(G_l)] - K[F(K)-F(G_b)] + CEQ_{G_b}^{K}(X)\Big\} \text{ and}
$$

$$
(18) \quad E(R_s) = R\Big\{[S[1-F(G_l)] - K[F(K)-F(G_b)] + E_{K-S}^{K}(X)]/[S[1-F(G_l)] - K[F(K)-F(G_l)] + CEQ_{K-S}^{K}(X)]\Big\} - 1.0.
$$

Since $G_l > K-S > G_b$, a comparison with the no-bailout case shows that V_s rises and $E(R_s)$ falls. Equations (19) and (20) indicate the value of the bank and of FDIC guarantees when the FDIC bailout occurs for X between G_b and G_l.

$$
\begin{aligned}
(19) \quad V_f = R^{-1}\Big\{ & CEQ_0(X) - z[1-F(K)] \\
& - [(K-S)/(K)]\, CEQ_{G_b}^{K}(X) - CEQ_{G_l}^{G_b}(X) \\
& + B_i F(K) + B_u[F(K)-F(G_l)] + S[F(G_b) \\
& - F(G_l)] - [(B_i+z)/(K-S)]\, CEQ_0^{G_l}(X)\Big\}.
\end{aligned}
$$

$$
\begin{aligned}
Y_{FDIC} = \; & z && \text{if} \quad X > K, \\
& K-S-B_i-B_u && \text{if} \quad K > X > G_b, \\
& X-B_u-B_i-S && \text{if} \quad G_b > X > G_1, \\
& (B_i+z)X/(K-S) - B_i && \text{if} \quad G_1 > X > 0, \\
& -B_i && \text{if} \quad 0 > X, \text{ and}
\end{aligned}
$$

$$
\begin{aligned}
(20) \quad V_{FDIC} = R^{-1}\Big\{ & z[1-F(K)] - (B_u+B_i+S) \\
& [F(G_b)-F(G_l)] - B_i F(G_l) \\
& + [(B_i+z)/(K-S)]\, CEQ_0^{G_b}(X) \\
& + [B_u/(K-S)]\, CEQ_{G_l}^{G_b}(X)\Big\}.
\end{aligned}
$$

As in case A, the bank's value depends on both the FDIC's pricing of its explicit guarantees and the value of its implicit guarantees via forbearance.

IV. The Effects of Mispriced Deposit Guarantees and Forbearance on the Value of Subordinated Debt Capital

In this section, we use the results of sections II and III to analyze explicitly the impact of mispriced deposit insurance and FDIC forbearance policies on the value of, and hence the required return on, subordinated debt.

Mispricing deposit insurance increases the value of subordinated debt. To see this, first define D as total promised payments to liability holders and $Y_{s,d}$ as the respective cash flows accruing to subordinated debt holders per dollar of promised payment when insurance is mispriced or fairly priced.[6]

In order to calculate the impact of mispricing on the value of subordinated debt, we construct a replicating portfolio for the one-dollar par-value subordinated debt claim when deposit guarantees are mispriced. This portfolio consists of one unit of a one-dollar par-value subordinated debt claim when deposit insurance is fairly priced, and a second security $\Delta_d Y_s$ $(= y_s - y_{s,d})$ with the following cash flows:

$$\Delta_d Y_s = \begin{cases} 0 & \text{if } X > D, \\ (D-X)/S & \text{if } D > X > K, \\ (D-K)/S & \text{if } K > X > D-S, \\ 1+(X-K)/S & \text{if } D-S > X > K-S, \\ 0 & \text{if } K-S > X. \end{cases}$$

The value of this security is

$$(21) \quad \Delta_d V_s = (RS)^{-1} \Big\{ D[F(D) - F(D-S)] - CEQ_K^D(X) - K[F(K) - F(K-S)] + CEQ_{K-S}^{D-S}(X) + S[F(D-S) - F(K-S)] \Big\},$$

which is positive if

$$CEQ_{K-S}^{D-S}(X) > (K-S)[F(D-S) - F(K-S)].$$

Equation (21) shows that mispricing deposit insurance affects the value of subordinated debt capital by altering the probability that subordinated debt holders will be repaid in full. In effect, deposit insurance subsidies alter the ranges over which subordinated debt prices behave like equity and debt prices. Forbearance policies also affect the value of, and thus the rate of return on, subordinated debt. In either case, however, forbearance both increases the value of subordinated debt and changes pricing.

Following the procedure used above, we next construct a replicating portfolio for a one-dollar par-value subordinated debt claim when the FDIC bails out liability holders. The replicating portfolio for case A (case B) consists of one share of subordinated debt without FDIC forbearances and a security $\Delta_a Y_s$ $(\Delta_b Y_s)$ with the following cash flows:

$$\Delta_a Y_s = \begin{cases} 0 & \text{if } X > G_b, \\ 1 & \text{if } G_b > X > G_l, \\ 0 & \text{if } G_l > X. \end{cases}$$

$$\Delta_b Y_s = \begin{cases} 0 & \text{if } X > G_b, \\ (K-X)/S & \text{if } G_b > X > K-S, \\ 1 & \text{if } K-S > X > G_l, \\ 0 & \text{if } G_l > X. \end{cases}$$

In case A, subordinated debt holders receive payment from the FDIC equal to the par value of their claim for all values of X between G_b and G_l. In case B, they receive a partial bailout when X is between G_b and $K-S$ and a full bailout when X is between $K-S$ and G_l. The difference between the cash flows in the two cases reflects the difference in the assumed bailout policy. In case A, the FDIC extends forbearances only when losses exceed the value of the subordinated debt. In case B, forbearances are extended before losses totally exhaust the subordinated debt.

Equations (22) and (23) show that the value of the securities that replicates the value of forbearance to subordinated debt holders is positive and that $\Delta_b Y_s > \Delta_a Y_s$.[7]

$$(22) \quad \Delta_a V_s = R^{-1} [F(G_b) - F(G_l)] > 0.$$

$$(23) \quad \Delta_b V_s = (RS)^{-1} \Big\{ K[F(G_b) - F(K-S)] - CEQ_{K-S}^{G_b}(X) + S[F(K-S) - F(G_l)] \Big\} > 0.$$

As noted by Gorton and Santomero, subordinated debt is a hybrid instrument whose price and return behave like debt for high values of X, but like equity for low values of X. The possibility of FDIC bailouts when X is in the range for which subordinated debt would typically behave like equity complicates the pricing dynamics. Specifically, without forbearance, there is a range of values for X such that subordinated debt prices switch from acting like debt to acting like equity as earnings increase. The introduction of FDIC forbearances may change the switch point or introduce multiple switch points.

■ 6 When there are no FDIC forbearances and deposit insurance is fairly priced, the end-of-period expected cash flows accruing to the subordinated debt holders are

$$Y_{s,d} = \begin{cases} S & \text{if } X > D, \\ X+S-D & \text{if } D > X > D-S, \\ 0 & \text{if } D-S > X. \end{cases}$$

■ 7 To see this, note that

$$F(K-S) - F(G_l) > F(G_b) - F(G_l)$$

and $(K/S)[F(G_b) - F(K-S)] > (1/S)\, CEQ_{K-S}^{G_b}(X)$.

Previous empirical studies of the relationship between subordinated debt prices and balance sheets by Gorton and Santomero and Avery, Belton, and Goldberg do not account for the possible impact of FDIC forbearance policy. The theory presented above provides one possible explanation of previous empirical findings that risk premia on subordinated debt are weakly related to risk proxies.

V. Conclusion

Using the cash-flow version of the CAPM developed by Chen (1978) and extended by Osterberg and Thomson (1990, 1991), we develop an explicit pricing model for subordinated debt that considers the possibility of implicit guarantees of nominally uninsured debt capital. Similar guarantees have been present during the sample periods of recent empirical studies of subordinated debt prices. Our findings indicate that FDIC forbearance increases the value of subordinated debt and thus alters investors' required rates of return.

Forbearance reduces the usefulness of subordinated debt in two ways. First, the possibility of FDIC bailouts directly increases the deposit insurance subsidy. However, given the possibility of such bailouts, the size of the subsidy is reduced by a subordinated debt requirement as long as there is some chance that subordinated creditors will realize losses.

Second, forbearance reduces the rate of return required on subordinated debt of a given risk, a policy that may easily impede market discipline of bank risk-taking. This in turn reduces the amount of information in secondary market prices of subordinated debt. Forbearance thus introduces a potential source of specification error in empirical studies of the risk premium in subordinated debt markets.

As we have emphasized previously (Osterberg and Thomson [1990, 1991]), the impact of capital structure changes on insured banks depends on deposit insurance pricing. If deposit insurance is fairly priced, neither subordinated debt requirements nor forbearance will impact overall bank value. However, in the more realistic case of deposit insurance mispricing, the effects of expected capital structure changes are altered through their interaction with the overall regulatory environment.

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An Introduction to the International Implications of U.S. Fiscal Policy

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Introduction

A predominant characteristic of U.S. macroeconomic developments in the 1980s was the simultaneous emergence of large federal budget deficits and unprecedented international trade deficits. Many economists, relying on open-economy variants of the standard income–expenditure model, have linked these deficits in a causal chain that also ties them to high U.S. interest rates and to the dollar's appreciation earlier in the decade (see Hutchison and Pigott [1984]). The description has now become part of popular economic lore, but as is often the case with legend or myth, many of the intricacies of and important qualifications to a fundamentally plausible story have been lost in its common transmittal. Moreover, a paucity of hard empirical support for the simple and direct relationship offered by this popular view has done little to curtail its telling.[1]

This paper acknowledges that fiscal policies can create trade deficits, but argues that this need not be the case and typically has not been the case in the United States. Section I offers a simplified version of the two-period, representative-agent model found in Frenkel and Razin (1987).[2] Unlike the standard income–expenditure approach, this model does not assign a predominantly causal role to government budget deficits, but it does allow that, under certain circumstances, fiscal policies can influence the trade balance, real interest rates, and real exchange rates. The outcome depends on how the government's propensities to import and to consume out of current income compare with those of the private sector, and on the distortionary effects of taxes.

Section II offers an empirical investigation of U.S. fiscal policy during the floating-exchange-rate period, using Engle–Granger (1987) cointegration techniques. The empirical tests search for common long-run trends between economic variables suggested by the theoretical analysis and aggregate measures of U.S. federal fiscal policy. The results do not support the common contention of simple, direct relationships among these measures and U.S. trade balances, interest rates, or exchange rates. As

■ 1 The popular accounts derive from the open-economy version of the income–expenditure (or Keynesian) model. Frenkel and Razin (1987, part II) offer an unabridged account of this model.

■ 2 See also Aschauer (1986), Hill (1990), and Koenig (1989).

noted in the concluding section, however, such tests are subject to important qualifications and do not preclude the possibility of short-term relationships.

I. A Simple Model

A nation running a current account deficit absorbs more real economic resources than it produces. Its citizens accommodate differences between their desired consumption and production by purchasing additional goods from abroad, and they finance their activity by borrowing in world money markets. Because government spending and tax policies affect consumption and production decisions, a nation's fiscal policies can strongly influence its international trade patterns.

Frenkel and Razin (1987) show that the relationship is often similar to that described in international economics as the *transfer problem.* Because fiscal policies typically involve a transfer of funds from the private sector to the government sector, their international implications depend on a comparison of both the government's and the private sector's propensities to save and to import. Moreover, when government activities are deficit financed, the outcomes depend more on the existence of tax distortions than on public borrowing per se. Following Frenkel and Razin, this section develops a simple model to illustrate these points. To appreciate the argument, however, one must first understand the motives for international trade and the intertemporal nature of trade deficits.

Two-Period Trade and the Nature of a Deficit

Consider a hypothetical economy consisting of two countries (home and rest-of-world), each possessing and consuming quantities of two goods over two time periods. Each country consists of a single representative consumer and a government, which taxes and spends. Assume that no production takes place, but that both countries start each time period with a specific endowment of the two goods.

Let a single consumer with homothetic preferences represent each country.[3] Each consumer maximizes utility over two periods, subject to the constraint that the present value of private intertemporal consumption equals the present value of his two-period after-tax endowments. The consumer maximizes

$$(1) \qquad U = \sum_{t=0}^{1} \beta^t U_t(C_t)$$

subject to

$$(2) \qquad C_0(1+t_0) + T_0 + \frac{C_1(1+t_1)}{(1+r_x)} + \frac{T_1}{(1+r_x)} = Y_0 + \frac{Y_1}{(1+r_x)}.$$

Here, C_t refers to private after-tax consumption in time $t\,(=0,1)$, such that

$$(3) \qquad C_t = c_{x,t} + \rho c_{m,t},$$

where $c_{x,t}$ and $c_{m,t}$ represent consumption of goods X and M in specific time periods. The terms of trade, ρ, expresses units of M in terms of units of X, β^t is a subjective discount factor applied to future utility, and r_x is the real interest rate. I express each in terms of good X, but the following arbitrage condition makes measurement arbitrary:

$$(4) \qquad (1+r_x) = {}^{\rho_t}\!/_{\rho_0}\,(1+r_m).$$

With two goods and two time periods, however, unanticipated changes in the terms of trade within any period can affect intertemporal decisions.[4] The T_t terms represent lump-sum taxes, whereas the t_t terms are tax rates applied to private consumption.

At the beginning of each period, consumers receive an endowment, Y_t, of the two goods, such that

$$(5) \qquad Y_t = q_{xt} + \rho q_{mt},$$

where $q_{i,t}(i = x, m)$ refers to quantities of the two goods, X and M. I assume that consumers seek to smooth consumption over the two periods by borrowing or lending through international credit markets.

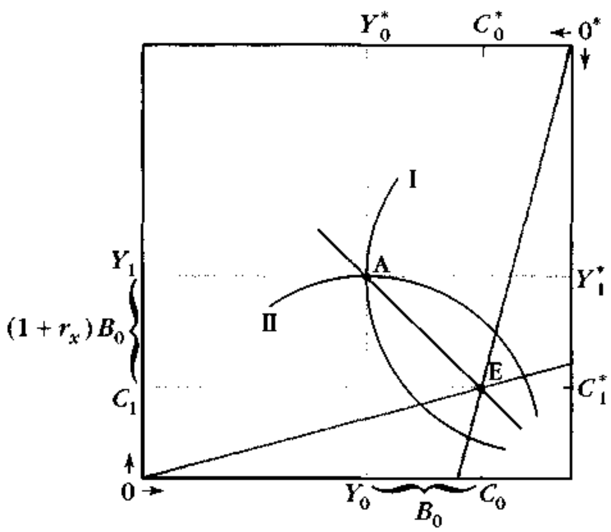
The government uses tax revenue to finance expenditures, G_t, subject to the constraint that the present discounted value of government expenditures over the two periods equals the present discounted value of tax revenue:

3 Homothetic preferences are such that, for constant relative prices, any given percentage change in income results in the same percentage change in the consumption of all goods. Homothetic preferences cause the income expansion curves in figures 1 through 5 to be straight lines.

4 For a discussion, see Frenkel and Razin (1987), pp. 168–71.

FIGURE 1

Optimization over Time and the Trade Deficit



SOURCE: Author.

$$(6) \quad G_0 + \frac{G_1}{(1 + r_x)} = T_0 + t_0 C_0 + \frac{T_1}{(1 + r_x)} + \frac{t_1 C_1}{(1 + r_x)}.$$

Solvency requires that the government retire any budget deficit incurred in the first period during the second period.

For each nation as a whole, the first-period budget constraint is

$$(7) \quad C_0 + G_0 = Y_0 + B_0.$$

Any nation can absorb, through private consumption and government spending, more or less than its current endowment, as equation (5) shows, but if it absorbs more than its endowment, the nation must borrow $(B_0 > 0)$, and if it consumes less, it will lend the excess $(B_0 < 0)$. The second-period budget constraint is given by

$$(8) \quad C_1 + G_1 = Y_1 - (1 + r_x)B_0.$$

Since this model contains only two periods, each country must retire any first-period debts in the second period. Therefore, solvency requires that over the two periods,

$$(9) \quad C_0 + G_0 + \frac{C_1}{(1 + r_x)} = Y_0 + \frac{Y_1}{(1 + r_x)}.$$

Accordingly, the present value of private after-tax consumption plus government spending over the two periods must equal the present value of the endowments. The trade account must balance, and the countries must extinguish all international debts.

Equation (1) assumes that utility is intertemporally separable. Each consumer desires an optimal expenditure over the two periods. Within each period, the consumer chooses an optimal consumption bundle of the two goods, one that maximizes U_t. Although this choice is constrained by the overall level of expenditure within a period and by relative prices, the choice of a consumption bundle in any period is otherwise independent of the choice in any other period.

Intertemporal Consumption

Assuming no government sector for the moment, the representative individual allocates his consumption over the two time periods until the following condition holds:

$$(10) \quad \frac{U_0'}{\beta U_1'} = (1 + r_x),$$

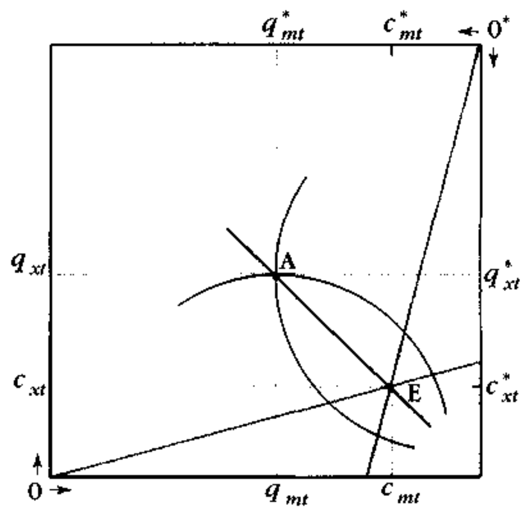
where U_t' is the marginal utility derived from consumption in period t. The first term in equation (10), the consumer's marginal rate of substitution between present and future consumption, measures his willingness to trade current for future consumption. The higher his subjective discount factor, the more the consumer prefers present to future consumption. The second term, one plus the real interest rate, is the intertemporal terms of trade—the market terms at which a consumer can trade current for future consumption. As equation (10) indicates, the utility-maximizing consumer will allocate his consumption over the two periods until his willingness to substitute between them equals the terms offered for this exchange in the market. If at any time this condition is not met, an exchange of resources can enhance the consumer's utility.

In figure 1, this maximization process is illustrated with an Edgeworth-box diagram, which shows the home country's origin in the lower left corner and the foreign country's origin in the upper right corner. (An asterisk designates foreign variables.) The utility curves I and II show, for a given level of utility, the willingness of the home country and the rest of the world to trade current for future consumption.[5] The ray extending from each origin, the income expansion path, shows

5 See also Hill (1990) and Koenig (1989).

FIGURE 2

Optimization across Goods and Trade at Time *t*



SOURCE: Author.

the respective country's optimal level of consumption for changing levels of income and a fixed real interest rate. The slopes of these two rays indicate that the home country prefers current consumption relatively more than does the foreign country.

Point A, at the center of the diagram, marks initial endowments and shows that each country receives equal consumption bundles in each period, $Y_t = Y_t^*\ (t = 0,1)$. At point A, however, the countries' subjective temporal preferences for consumption differ. The home country values present consumption more highly than does the foreign country. Consequently, both can increase their utility by agreeing to trade at some rate of intertemporal exchange passing within the ellipse formed by their utility curves. The line passing through points A and E, whose slope is $-(1 + r_x)$, is one such rate of exchange. Given the real interest rate r_x, the nations will trade to point E, at which the conditions for optimal consumption, given by equation (10), hold.[6] The home country now consumes more than its initial endowment in the first period, running a trade deficit, B_0, but it will run a surplus, $(1 + r_x)\,B_0$, in the second period. At point E, each country is on a higher utility curve than at point A. In fact, point E is a Pareto optimum; no country can be made better off without making the other worse off.

■ 6 The home and foreign countries will negotiate the optimal interest rate.

Intratemporal Consumption

After allocating consumption across time, each representative consumer will choose quantities of the two goods that maximize utility at each point in time. Consumers will choose among the two goods X and M until

$$(11)\quad \frac{U'_{m,t}}{U'_{x,t}} = \rho\,.$$

The term on the left side of equation (11) gives the marginal rate of substitution, the rate at which each consumer is willing to substitute between goods X and M. The term on the right side is the market-based relative price of the two goods, or the temporal terms of trade. If during any time period the condition depicted in equation (11) is not fulfilled, an opportunity exists for welfare-enhancing trade.

I again illustrate the maximization process by reproducing the Edgeworth box in figure 2 with appropriate changes in the axis and in the terms-of-trade line. I depict the home country as favoring consumption of good M, the importable good. At the initial endowment point, A, the home country values consumption of this good more than does the foreign country, and both countries can gain from exchange along the terms-of-trade line (with slope $-\rho$) to point E, where the condition given in equation (11) holds. At point E, the home country consumes the importable good in excess of its initial endowment, but it consumes less than its initial endowment of the exportable good.

Nature of Trade and Trade Deficits

Despite the simplicity of the model, figures 1 and 2 offer important insights into the nature of international trade and the causes of trade imbalances. Trade takes place in this model because of 1) differences in nations' time preference for consumption at the initial endowment point, or 2) differences in the relative preferences for the two goods in any time period given endowments.[7]

A trade imbalance results when a country desires a consumption profile that differs from its endowment profile. A country that consumes more (less) than its current endowment will run

■ 7 I do not include comparative advantage as a motive for trade, despite its predominance in the literature, because the model does not include production.

a trade deficit (surplus).[8] Changes in the real interest rate act to clear the intertemporal imbalance between endowments and consumption. This suggests that factors that influence decisions about intertemporal consumption—including government policies—also affect the trade balance. Hill (1989), for example, argues that a country's demographic profile influences its trade balance because younger households tend to save less than older households.

Moreover, because this model specifies the interest rate in terms of good X, and as a result of the arbitrage condition (4), factors that cause an unexpected change in the terms of trade can also influence the interest rate, intertemporal decisions, and the trade balance. The relationship between changes in the terms of trade and the trade balance depends on whether these changes are permanent or temporary, on the initial position of the trade balance, and on the parameters of the model (see Frenkel and Razin [1987], pp. 176–82).

The analysis in figure 1 also helps to dispel the notion that a trade deficit represents a state of economic disequilibrium or a deterioration in the economic well-being of the deficit country. Instead, the model illustrates that both the surplus and the deficit countries improve their economic welfare by running trade imbalances. A developing country, for example, might run a trade deficit in order to acquire capital goods, with the intention of eventually financing the acquisition by running a trade surplus. Such strategies are typically considered welfare enhancing.

Nevertheless, the figure does illustrate that the deficit country must eventually finance its debts though a reduction in future consumption. In the comparative static model presented here, the reduction is absolute. In a dynamic model, with growing economies, any change in future consumption is measured relative to where it would have been in the absence of trade. In such a model, it is not necessarily the case that a trade deficit must lower future standards of living.[9]

■ 8 In the National Income and Product Accounts, gross national product (GNP) equals consumption (C) plus investment (I) plus government purchases (G) plus exports (X) minus imports (M): GNP = C + I + G + X – M. Rearranging this expression, one obtains GNP – C – I – G = X – M, which shows the relationship between national savings on the left side and the trade balance on the right side.

■ 9 See Anderson and Bryan (1989).

Government Fiscal Policy and the Trade Deficit

Much of the recent concern about U.S. fiscal policy centers on the impact of federal budget deficits on real interest rates, exchange rates, and the trade balance. The theoretical analysis of fiscal policy, therefore, begins by considering the effects of deficit-financed tax reductions, including 1) a lump-sum tax cut, and 2) a reduction in the tax rate on consumption.

Because many politicians and economists favor a balanced-budget amendment, I next consider the effects of balanced-budget fiscal policies in the form of 1) temporary and permanent balanced-budget spending, and 2) balanced-budget spending on the exportable commodity. As we shall see, different types of policies can have different combinations of effects on real interest rates, the terms of trade, and the trade balance.

Deficit-Financed Cut in Lump-Sum Taxes

With the introduction of taxes into the model, equation (12) gives the condition for optimal intertemporal consumption:

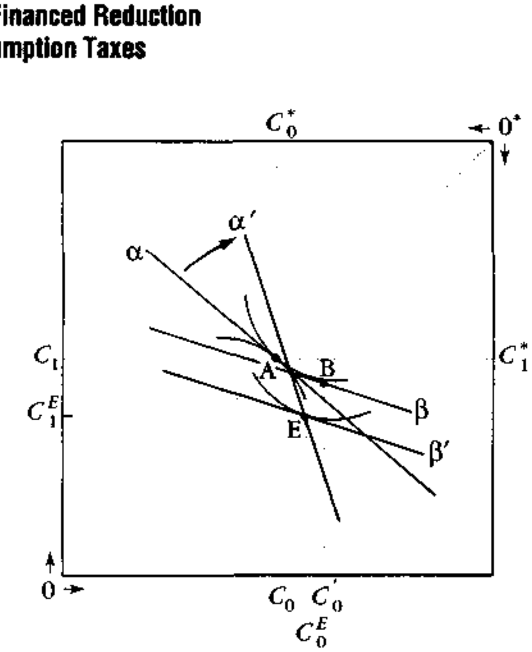
$$(12) \quad \frac{U_0'}{\beta U_1'} = \frac{(1+t_0)}{(1+t_1)}(1+r_x).$$

In maximizing welfare, the representative consumer now chooses an intertemporal consumption pattern that equates his marginal rate of substitution between current and future consumption to intertemporal terms of trade that include taxes on current and future consumption as well as on real interest rates. As is well known, lump-sum taxes in the consumer's budget constraint (equation [2]) do not affect the choice of the optimal consumption pattern, and therefore will have no effect on real interest rates or on the trade balance.

According to the principle of Ricardian equivalence, the intertemporal path of private consumption is invariant with respect to whether the government finances a given level of expenditure via lump-sum taxes or via borrowing. If consumers understand that the issuance of government debt implies a future tax liability to retire that debt, and if they also desire a smooth intertemporal consumption path, then a deficit-financed cut in taxes will not cause them to increase their present consumption. Instead, they

FIGURE 3

Deficit-Financed Reduction in Consumption Taxes



SOURCE: Author.

will save the additional purchasing power resulting from the tax cut in order to meet the future tax liabilities associated with retiring the government debt. The method of financing will, therefore, leave the interest rate unaffected.

The simple two-period model outlined above incorporates Ricardian equivalence in that the single representative agent must retire any government debt in the second period. The real-world application of Ricardian equivalence, however, seems more problematic given that taxes are distortionary, that the present generation might push the burden of retiring the debt onto future generations, or that the tax cut redistributes income to segments of the population with high marginal propensities to consume, while leaving the burden of servicing the debt spread across all citizens.[10]

Deficit-Financed Reduction in Consumption Taxes

When I allow a deficit-financed reduction in consumption taxes, equation (12) indicates that it will distort that optimal intertemporal consumption choice. This can be seen in figure 3, which illustrates the effects of a deficit-inducing reduction in taxes on current consumption.

Point A represents an initial equilibrium, at which present and future taxes on consumption are equal at home and abroad. Now consider a temporary tax reduction on current domestic consumption in time period 0. The line for tax-adjusted intertemporal terms of trade for the home country shifts from that designated as α in figure 3 to that designated as β. (The foreign country continues to face intertemporal terms of trade given by line α.)

As the figure shows, the deficit-inducing tax cut encourages current domestic consumption and results in an excess demand for current output given by $(C_0' - C_0)$. The real interest rate will subsequently rise, causing the world terms-of-trade line α to become steeper, until the markets for current and future consumption clear at a point such as E. Because at point E the home country is consuming more than its initial endowment, it runs a trade deficit amounting to $(C_0^E - C_0)$. At point E, the home country consumes less than its endowment of the future goods, thereby running a trade surplus in period 1, given by $(C_1 - C_1^E)$. Point E is also on a lower indifference curve because the higher interest reduces the present value of future income. Although not shown, the foreign country might share part of this effect.

At the new market-clearing point E, the tax creates a distortion between the market intertemporal terms of trade, given by line α′, which the foreigner faces, and the tax-adjusted intertemporal terms of trade, given by line β′, which the home country faces. The resulting lens between the two utility curves, which pass through point E, represents the welfare costs of the tax distortion.[11]

Figure 3 shows that a deficit-inducing tax reduction that encourages current consumption over future consumption will raise the real interest rate and create a trade deficit in the home country. Although the model does not include production, extrapolating from its underlying logic, one would expect that a deficit-financed tax reduction (for example, a payroll tax cut or a lower capital gains tax that stimulated current production relative to current consumption) could lower real interest rates and generate a trade surplus.

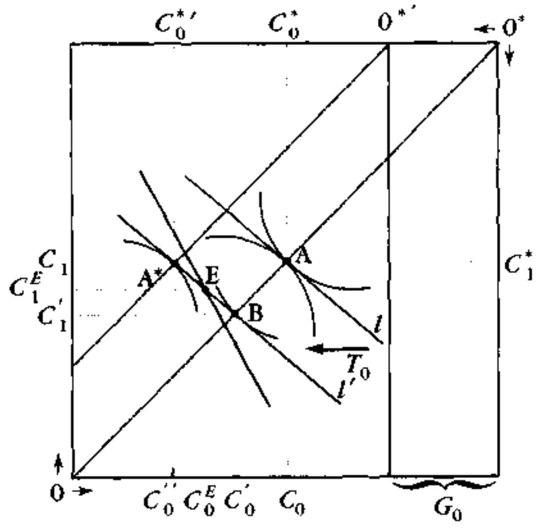
As the model suggests, no simple relationship exists among government budget deficits, real interest rates, and the trade deficit. In comparing the results of this section with those of the previous one, I find that it is the distortionary nature of the

■ 10 For an empirical application to the twin deficit issue, see Enders and Lee (1990).

■ 11 Although not drawn as such, the slope of line β′ will be higher than that of line β because of the rise in the world interest rate.

FIGURE 4

Balanced-Budget Spending on Current Output



SOURCE: Author.

tax that is crucial and not the deficit per se (see Frenkel and Razin [1987], p. 223).[12]

Balanced-Budget Spending

The preceding suggests that the relationships among fiscal policy, real interest rates, and the trade deficit depend on the distortionary nature of taxes rather than on the use of deficit financing. This section extends the investigation by considering balanced-budget spending measures. If the observed correlations between deficits and the trade balance in the early 1980s stemmed from specific tax and spending policies, then a balanced-budget amendment would be of little avail in lowering real interest rates or eliminating the trade deficit.

Assume that the economy is initially in equilibrium with a balanced trade account. Point A in figure 4, which is similar to figure 1 in its initial construction, depicts such a situation, with the home country consuming C_0 in the current period and C_1 in the future period. In equilibrium at point A, the intertemporal terms of trade are given by line l with slope $-(1+r_x)$.

Now allow a temporary rise in home-country government spending, financed entirely with a lump-sum tax on the home-country consumers.[13] The model depicts this as an increase in government spending on the current good only. The government's fiscal action reduces the amount of current output available for both domestic and foreign private consumption, which figure 4 shows as a shortening by G_0 in the horizontal dimensions of the Edgeworth box. Two other adjustments follow: First, for the foreign country only, point A shifts to point A*, where both current and future consumption are unaffected by the home government's fiscal policy. Second, because of the tax, T_0, home-country consumption shifts from point A to point B. (Notice that the horizontal distance measured by T_0 equals the horizontal distance G_0.) As its after-tax income falls, the home-country private sector reduces its consumption of both C_0 and C_1, but because individuals will attempt to smooth consumption over both periods, the reduction in current consumption will not match the increase in the government's current consumption.

Taking account of all of these initial effects in figure 4, we see that balanced-budget government spending initially creates an excess demand for current output, designated by $(C_0^{\prime} - C_0^{\prime\prime})$, and an excess supply of future output, designated by $(C_1 - C_1^{\prime})$. These imbalances will cause the real interest rate to rise, increasing the attractiveness of future private consumption relative to current private consumption. Graphically, the rise in the real interest rate will pivot the intertemporal terms-of-trade line to a position such as that shown by $l^{\prime}$ until a new equilibrium, as defined by equation (10), obtains. Figure 4 shows such an equilibrium at point E. Here, the home country records a current-period trade deficit equal to $(C_0^E - C_0^{\prime})$.

The model indicates that a temporary increase in home-government, balanced-budget spending reduces both domestic and foreign private consumption and causes a home-country trade deficit. Intertemporal aspects of these resource transfers are accommodated through a rise in real interest rates.

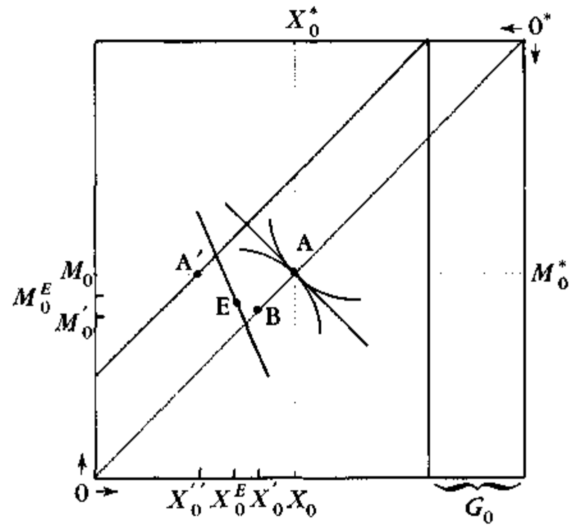
Extending the analysis to consider the effects of a permanent increase in balanced-budget spending helps to illustrate more clearly the nature of the relationship between government spending and the trade deficit. One can show the effects of a permanent increase in government spending in an Edgeworth-box diagram by altering both its horizontal and vertical dimensions. When both dimensions change,

12 I do not consider taxes on specific commodities (such as tariffs); they are a standard topic of trade theory.

13 Assume that the propensity of the government to spend on goods X and M exactly matches that of the private sector, so that the terms of trade do not change. This assumption is discussed below.

FIGURE 5

Balanced-Budget Spending on Exportables



SOURCE: Author.

however, many different configurations of results are possible, depending on the propensities of the government to spend on current and future consumption (see Frenkel and Razin [1987], pp. 195–98). If, for example, the government's propensities to consume current and future output exactly match those of the private sector, as indicated by the slope of the diagonal running from 0 to 0* in figure 4, then no trade imbalance or change in real interest rates would result from government spending. The equilibrium point would simply slide down the diagonal from A toward 0.

Frenkel and Razin argue that international repercussions of government spending are similar to those typically discussed in the literature as the *transfer problem*. Balanced-budget spending transfers resources from the home-country private sector to the government sector. If the home-country government's intertemporal preference for consumption differs from that of the private sector, the transfer will alter the overall world equilibrium for intertemporal consumption. If the overall propensity to spend on current output rises, as depicted in figure 4, real interest rates will increase and a home-country trade deficit may ensue. Conversely, if the overall world propensity to consume current output falls, real interest rates will decline and the home country may experience a trade surplus. According to the model, one must know more to predict the effects than simply that government spending increased.

Government Spending on Export Goods

The effects of government spending on a particular commodity within a specific time period are analytically similar. Assume that the private sector has obtained the optimal pattern of consumption over both time periods and across both goods. Figure 5 depicts the optimal domestic and foreign private consumption of the exportable and importable goods for a given time period at point A. I assume that the government has the same rate of time preference as does the private sector.

The initial effects of government balanced-budget spending on the export good are depicted as shifting the initial foreign position to point A′ and as shifting the initial domestic private-sector position to point B for reasons paralleling those offered in the explanation of the similar shift in figure 4. The tax and spending patterns then create an excess demand for the export good given by $(X_0' - X_0'')$ and create an excess supply for the import good equal to $(M_0 - M_0')$. The terms of trade will improve (the relative price of the exportable good will rise) until an equilibrium such as point E obtains.

The example outlined above is not a general case. I have assumed that domestic and foreign propensities to spend on the importable good are exactly the same and less than one, but I have set the government's propensity to spend on this good at zero. Allowing the government to spend on both the exportable and the importable good, additional outcomes are possible and reasonable. Frenkel and Razin (1987, pp. 202–03) explain this, again following the arguments that underlie the transfer problems. In general, the terms of trade will deteriorate (improve) if the government's propensity to import exceeds (is less than) the home country's propensity to import. The terms of trade will be unchanged when the propensities are exactly alike.

As noted earlier, with the interest rate defined in terms of the exportable good, unanticipated changes in the terms of trade can affect intertemporal decisions and, hence, the trade deficit. This results because of the arbitrage condition depicted in equation (4).

II. Empirical Evidence

The simple theoretical model shows that fiscal policy can be related to trade deficits, real interest rates, and real exchange rates, but that the connection need not necessarily hold. Whether, as is often asserted, a simple, direct relationship between U.S. fiscal policies and the U.S. trade balance exists seems largely a matter for empirical analysis. Using Engle–Granger cointegration techniques, this section tests for a long-term relationship among various measures of U.S. fiscal policy, the trade balance, exchange rates, and interest rates.[14] Because cointegration looks for long-term relationships, one might view this exercise as testing the effects of the permanent component of fiscal policies.

Cointegration

Many macroeconomic time series are not stationary; that is, their mean, variance, and covariance can change over time. Intuitively, this suggests that, given a random shock, these series will move off to new time paths instead of returning to their original ones. The presence of nonstationarity can invalidate many standard statistical techniques for hypothesis testing, making it difficult to determine if two nonstationary series, such as government spending and interest rates, are related. Economists often model time series as ARIMA (*p, d, q*) processes, where *d* is the number of times the series must be differenced to achieve stationarity.[15] For most economic time series, $d = 1$. Economists refer to such series as containing a unit root or as being integrated of order 1, and designate such series I(1).

Engle and Granger (1987) propose a method by which one can determine whether two I(1) times series tend to move in tandem or drift apart over time. In the former case, even though the individual series are nonstationary, their joint relationship is stationary. Engle and Granger refer to such series as being cointegrated.

The Engle–Granger cointegration test is similar to the Dickey–Fuller (1979) test for unit roots. One must perform the latter tests as a first step in the cointegration test to see if the relevant series are each I(1), because time series that are integrated of different orders generally are not cointegrated. The Dickey–Fuller (DF) test involves regressing a time-series variable Y on its past value to see if the resulting coefficient is equal to 1. As is common, I specify the DF test with a constant and a time trend

$$(13) \quad Y_t = \beta_0 + \beta_1 t + \beta_2 Y_{t-1} + u_t,$$

where u_t is the error term.

Failure to reject the null hypothesis that $\beta_2 = 1$ indicates that Y is I(1). One calculates the DF test statistic exactly like a standard *t* statistic, but the DF statistic does not have a *t* distribution. TSP version 4.20 provides critical values based on the appropriate distribution. Fuller (1976, table 8.5.2) also provides critical values.

The presence of serial correlation in the error terms greatly weakens the power of the DF test, but one can correct for serial correlation by augmenting the above specification with lagged first differences of the dependent variable.[16] The augmented Dickey–Fuller (ADF) test is

$$(14) \quad Y_t = \beta_0 + \beta_1 t + \beta_2 Y_{t-1} + \sum_{i=0}^{\rho} \beta_{i+3} \Delta Y_{t-i-1} + \varepsilon_t,$$

where ε_t is the error term. The null hypothesis remains the same: $\beta_2 = 1$.

According to Engle and Granger, two I(1) time series, Y and X, are cointegrated if a linear combination of these two variables is stationary. Such a combination can be obtained from an ordinary least squares regression of Y on X, called the *cointegrating regression*. In what follows, I consistently specify the cointegrating regression to include a constant term (β_0):

$$(15) \quad Y_t = \beta_0 + \beta_2 X_t + \varepsilon_t.$$

The error term, ε_t, from the cointegrating regression is then a linear combination of X and Y, and one can use the DF procedures to test for a unit root in the error term. Following convention, I specify the test as

$$(16) \quad \varepsilon_t = \beta_1 \varepsilon_{t-1} + \sum_{i=0}^{\rho} \beta_{i+2} \Delta \varepsilon_{t-i-1},$$

including lagged first differences of the error term when necessary to adjust for possible serial correlation.

The null hypothesis is $\beta_1 = 1$. Failure to reject the null hypothesis indicates that the error term is not stationary and that it tends to drift away from its expected value, zero, over the sample period.

■ 14 Boucher (1991) uses similar cointegration tests to study the relationship between the nominal current account balance and a set of variables either related by virtue of the savings–investment identity or commonly held to "cause" the current account. Included among Boucher's causal variables is the nominal federal budget deficit.

■ 15 ARIMA (*p, d, q*) refers to Autoregressive Integrated Moving Average (see Box and Jenkins [1970]).

■ 16 DF tests are robust to heteroscedasticity.

BOX 1

Data Description

Description (Code)	Source
Trade-weighted dollar (*TWD*)	Board of Governors of the Federal Reserve System
10-year Treasury bill (*LTR*)	DRI/McGraw-Hill, Inc.
Trade balance:	
Net exports of goods and services (*NEX*)	National Income and Product Accounts
Government deficit:	
Change in publicly held federal debt (*DEF*)	Flow of Funds
Government spending:	
Federal expenditures (*FEXP*)	National Income and Product Accounts
Federal purchases (*FPUR*)	National Income and Product Accounts

NOTE: All series are inflation adjusted. I deflated *LTR*, *DEF*, and *FEXP* using the Consumer Price Index. Others are published in an inflation-adjusted format.

TABLE 1

Unit Root Tests

Variables	Dickey-Fuller Statistic	Augmented Dickey-Fuller Statistic
TWD	–1.11	–2.17
LTR	–3.06	–2.10
NEX	–1.31	–2.75
DEF	–6.14	–3.14
FEXP	–2.41	–1.66
FPUR	–2.74	–2.05

Critical values for:
α = .01, DF = –4.09
α = .05, DF = –3.47
α = .10, DF = –3.16

NOTE: All variables are inflation adjusted. All series start in 1973:IVQ and end in 1991:IIIQ. Dickey–Fuller tests include a constant and a time trend. Augmented Dickey–Fuller tests include four lagged first-differences of the dependent variables, which shorten the estimation period by four quarters.
SOURCE: Author's calculations on TSP version 4.20.

This, in turn, implies that the two time series *Y* and *X* do not share a common underlying trend; they tend to drift apart over the sample period.

One can extend the approach to consider cointegration among three or more time-series variables, each of which is I(1). In such a case, one adds the additional variables to the right side of the cointegrating regression (equation [15]) and proceeds with the DF tests described above. The test statistic, however, is sensitive to the number of right-side variables (exclusive of the constant) in the cointegrating equation. TSP version 4.20 provides appropriate critical values, based on work by MacKinnon (1990).

Causality is not an issue in cointegration tests. Consequently, the designation of dependent and independent variables for both bivariate and multivariate tests is arbitrary. Often, however, the results are sensitive to the ordering of the variables in the cointegrating regression. One should test all possibilities.

Data

Most popular discussions of the international ramifications of U.S. fiscal policy focus on the federal budget deficit and federal spending, so my measures of fiscal policy exclude the state and local sectors. I test for cointegration between either the federal budget deficit (*DEF*), federal government spending (*FEXP*), or federal government purchases of goods and services (*FPUR*), and long-term interest rates (*LTR*), the trade-weighted dollar (*TWD*), and net exports of goods and services (*NEX*). Box 1 describes the data sources.

Consistent with the theoretical analysis, all variables are in real, or inflation-adjusted, form. If an individual series was unavailable in this form, I deflated the nominal series with the Consumer Price Index. I initially ran all tests from 1973:IVQ through 1991:IIIQ to include 74 observations, but because augmented versions include four lagged variables, the tests run from 1974:IVQ to 1991:IIIQ and include 70 observations.

Results

Because cointegration presumes that the series under consideration are I(1), table 1 shows the results of applying DF and ADF tests to the individual time series. All of the series except *FEXP* and *FPUR* were serially correlated, so ADF tests were appropriate in most cases. None of the results, after any necessary adjustments for serial correlation, reject the null hypothesis of a unit root. Cointegration is an appropriate way to proceed with these data.

Table 2 presents the results of bivariate Engle–Granger cointegration tests. The first column lists the two relevant variables. The second column shows the ADF test statistics. The first sta-

TABLE 2

Bivariate Engle–Granger Cointegration Tests

Variables	Augmented Dickey–Fuller Statistic (1974:IVQ–1991:IIIQ)
DEF, LTR	−3.55; −2.46
DEF, TWD	−3.31; −2.44
DEF, NEX	−3.19; −2.50
FEXP, LTR	−0.84; −2.11
FEXP, TWD	−0.84; −2.27
FEXP, NEX	−1.35; −2.76
FPUR, LTR	−0.83; −2.36
FPUR, TWD	−0.37; −2.24
FPUR, NEX	−1.14; −2.64

Critical values for:
α = .01, DF = −4.56
α = .05, DF = −3.92
α = .10, DF = −3.60

NOTE: All variables are inflation adjusted. The first statistic in each pair is for the regression of the first variable on the second. The second statistic in each pair is for the regression of the second variable on the first. Because serial correlation was present in nearly all cases, I conducted ADF tests with four lagged first-differences of the dependent variables. In the few cases where serial correlation was not present, using ADF tests did not change any conclusions reached with a simple DF test.
SOURCE: Author's calculations on TSP version 4.20.

tistic in each set is for the cointegrating regression (equation [1]) of the first variable from column 1 on the second variable, and the second statistic is for the cointegrating regression of the second variable on the first variable. Because serial correlation was a problem in nearly every case, table 2 presents only the results of the ADF test. In the few cases where serial correlation was not present, using the ADF tests did not alter any conclusions reached with the DF test.

The bivariate results indicate that neither the federal deficit (*DEF*) nor federal expenditures (*FEXP*) nor federal purchases (*FPUR*) is cointegrated with real long-term interest rates (*LTR*), with the real effective dollar exchange rate (*TWD*), or with real net exports (*NEX*). Moreover, the results are robust to the designation of the dependent variable in the cointegrating regression.

Table 3 presents the results of multivariate cointegration tests. In these cases, I regressed the first variable listed in the table (to the left of the semicolon) on a constant and on the remaining three variables. Because serial correlation was again a problem in nearly all cases, I present only the results for ADF tests. The tests find no evidence of cointegration.

Interpretation of Empirical Results

The empirical test found no evidence that the U.S. trade balance, long-term U.S. interest rates, and the real trade-weighted dollar have shared a common trend with the U.S. federal budget deficit or with alternative measures of federal spending during the floating-exchange-rate regime. Such results, of course, do not preclude the existence of a relationship between fiscal policies and these economic variables.

Cointegration tests search for a stationary linear combination of hypothetically related variables. The inclusion of other variables could reveal a linear combination that is stationary. I did not, for example, include foreign variables, such as interest rates. Moreover, I did not scale the deficit relative to GNP, as many researchers do, nor have I attempted to take direct account of the level of public debt. Deficit-financed fiscal policies, when the level of public debt is very high, could have substantially different effects on real interest rates, exchange rates, and the trade balance than would similar policies at a low level of public borrowing. Similarly, the relationship between fiscal policy measures and the trade deficit might not be linear, and a linear approximation of that relationship might fail to show any connection at all. For these reasons, cointegration tests of times series may be sensitive to the time period investigated.

Although cointegration tests reveal long-term relationships among the hypothetically related variables, they may not find a shorter-term relationship. I have interpreted the cointegration tests as measuring the effects of the permanent components of U.S. fiscal policies. The temporary aspects, as the theoretical model shows, can have different and profound effects on important economic variables. Boucher (1991), for example, concludes that nominal U.S. current accounts and nominal U.S. government budget deficits are not cointegrated, but using Granger causality tests, she finds evidence that U.S. government budget deficits do help to predict current account deficits. Similarly, Abell (1990) considers the twin deficit relationship in a VAR model estimated strictly over the period of the dollar's rapid appreciation: February 1979 to February 1985. Although he does not find that budget deficits Granger-cause trade deficits over this period, he does conclude that deficits

TABLE 3

Multivariate Engle–Granger Cointegration Tests

Variables	Augmented Dickey-Fuller Statistic (1974:IVQ-1991:IIIQ)
DEF; LTR, TWD, NEX	–3.77
LTR; TWD, NEX, DEF	–2.94
TWD; NEX, DEF, LTR	–2.17
NEX; DEF, LTR, TWD	–2.53
FEXP; LTR, TWD, NEX	–1.22
LTR; TWD, NEX, FEXP	–3.27
TWD; NEX, FEXP, LTR	–2.50
NEX; FEXP, LTR, TWD	–2.16
FPUR; LTR, TWD, NEX	–1.53
LTR; TWD, NEX, FPUR	–3.77
TWD; NEX, FPUR, LTR	–2.75
NEX; FPUR, LTR, TWD	–2.53

Critical values for:
α = .01, DF = –5.29
α = .05, DF = –4.63
α = .10, DF = –4.30

NOTE: All variables are inflation adjusted. Because serial correlation was present in nearly all cases, I conducted ADF tests with four lagged first-differences of the dependent variables. In the few cases where serial correlation was not present, using ADF tests did not change any conclusions reached with a simple DF test.
SOURCE: Author's calculations on TSP version 4.20.

affect interest rates, which then influence exchange rates, which then alter the trade balances.[17] Hence, one should interpret the results here as a general conclusion about the relationship between federal fiscal policies and the trade deficit during the period of floating exchange rates, rather than as a comment on fiscal policy over a subperiod, such as the early 1980s, or as a prediction about possible future effects of U.S. fiscal policies.

■ 17 Because of the enormous volume of empirical studies on the relationships among measures of fiscal policy and interest rates, exchange rates, and the trade deficit, I do not survey the literature. The overwhelming conclusion from even a cursory review is that the results are mixed, with no clear pattern as to the source of the differences among the studies. In addition to articles cited in the text, other avenues for pursuing the empirical literature are the following: For results from large structural models, see Hooper and Mann (1987) and Throop (1989a, 1989b). For articles using VAR techniques, see Darrat (1988) and Rosensweig and Tallman (1991). For some cross-country results, see Bernheim (1988) and Laney (1984). For a look at deficits and interest rates, see Evans (1985) and Hoelscher (1986). On deficits and exchange rates, see Evans (1986) and Hutchison and Throop (1985).

III. Conclusion

This paper challenges the commonly held belief that aggregate U.S. fiscal policy measures, notably the federal budget deficit, bear a simple and direct causal relationship with U.S. trade deficits in particular, and with U.S. interest rates and exchange rates. The simple two-period, two-country models developed here from earlier work by Frenkel and Razin (1987) illustrate a complex relationship that is dependent, in terms of both degree and direction, on the distortionary nature of taxes and on relative differences between public and private propensities to consume and to import. Although fiscal policies and the trade balance can be related, they need not be.

The Engle–Granger cointegration tests, which this paper employs, find no evidence of a long-term relationship between common aggregate measures of U.S. fiscal policy and real long-term interest rates, real dollar exchange rates, and real net exports. This does not mean that the large U.S. federal budget deficits of the 1980s did not contribute to the sharp deterioration of U.S. trade in the early 1980s; nor does it imply that a rising federal deficit in the 1990s will not prevent further improvements in the U.S. trade balance. The findings, however, do serve to strengthen my main proposition, that the common story about the simple and direct relationship between federal fiscal policies and the trade balance is largely economic folklore.

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