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Exchange-market intervention is one of the more controversial policies that the Federal Reserve undertakes. Opponents of intervention fear that it can prove detrimental to the consistency and credibility of U.S. monetary policy. Their concern starts with the observation that sterilized intervention is of limited effectiveness, but equally important to the controversy are a number of institutional considerations. This article discusses the institutional aspects of U.S. intervention, from the decision to intervene to the investment of the proceeds. The author focuses primarily on interactions between the U.S. Treasury and the Federal Reserve System.

The 1995 Budget and Health Care Reform: A Generational Perspective 20
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Whereas the U.S. budget and deficit projections report government receipts and expenditures for only a year at a time, generational accounts reveal the long-term implications of prevailing fiscal policies for intergenerational wealth distribution. The accounts for 1992, which include the effects of the Omnibus Budget Reconciliation Act of 1993, indicate that a sizable imbalance remains: Under current policy, those born in 1992 will pay approximately 36 percent of their lifetime income in net taxes, while future generations will give up an average of 82 percent. Receipts and expenditures projected under the administration's health care reform proposal would reduce this imbalance by about half.

On Disinflation since 1982: An Application of Change-Point Tests 31
by Edward Bryden and John B. Carlson

This paper examines recent changes in the statistical properties of alternative measures of core inflation. For long periods since 1982, core inflation has behaved as if it were generated by a process with a fixed mean and serially independent error term. The authors use nonparametric tests to identify statistically significant change points in the fixed mean. For all measures of core inflation considered, changes in the inflation rate trend have been infrequent and, for the most part, rather abrupt.

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Institutional Aspects of U.S. Intervention

by Owen F. Humpage

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Introduction

Of the various policies that the Federal Reserve System undertakes, none seems as controversial as exchange-market intervention. Opponents of intervention sound four notes of discord: First, intervention that does not alter the domestic monetary base, or *sterilized* intervention, often has no apparent effect on exchange rates. When it does, the influence is usually temporary and small.[1]

Second, intervention that does alter the monetary base, or *nonsterilized* intervention, can interfere with the Federal Reserve's capacity to maintain price stability under certain circumstances (see appendix 1). Even if the System is not currently engaged in intervention, holding a large portfolio for that purpose creates uncertainty about the continuing commitment to price stability because it suggests that other policy goals might be considered.

Third, through recent interventions, the United States has acquired large foreign-exchange holdings that are subject to valuation loss when the dollar appreciates. In view of the first two concerns, some critics assert that we should reduce our exposure or adopt measures for financing intervention that do not result in exchange-rate risk.

Fourth, given that intervention in the United States falls primarily under the purview of the Treasury Department, opponents worry that participation by the Federal Reserve could appear at times to compromise the System's monetary policy independence or its relationship with Congress.

All of these issues have created the undertone for Federal Open Market Committee (FOMC) discussions about exchange-rate policies.[2] Official expressions of the first three concerns are found both in the 1989 policy dissents of FOMC Governors Angell and Johnson and in the 1990 dissents of Governors Angell and LaWare and Cleveland Federal Reserve Bank President Hoskins.[3] Todd (1992) offers evidence of official concern about item four.

■ 1 Edison (1993) and Humpage (1991) survey the literature on the effectiveness of intervention.

■ 2 The FOMC consists of the seven Governors and the 12 Presidents of the regional Federal Reserve Banks. The President of the Federal Reserve Bank of New York is the only President with a permanent vote, and he is the Vice Chairman of the FOMC. The other Presidents share voting privileges, with only five allowed to vote at any given time.

■ 3 See Board of Governors of the Federal Reserve System (1990), p. 117, and (1991), pp. 109–10.

When considering whether to intervene, the FOMC weighs the short-term, often questionable, benefits of pursuing an exchange-rate objective against the possible costs of direct interference with monetary policy, of reduced long-term policy credibility, and of heightened exchange-rate risk exposure. To appreciate the origins and importance of this controversy, one must understand the institutional setting for U.S. intervention. For this purpose, but also as a complement to the growing number of empirical studies of intervention's effectiveness, this article presents an institutional account of U.S. intervention. Generally, the discussion unfolds as an intervention might: from a decision to intervene, to arrangements for financing it, to its execution, and finally, to investment of the proceeds.

I. Authority to Intervene

Governments buy and sell foreign exchange for a variety of reasons, including financing embassies and foreign operations, altering the composition of reserves, and paying interest on foreign debts or receiving interest on foreign assets. Sometimes, they undertake these transactions directly with each other, operating through their central banks and avoiding the private market. Intervention then refers only to those transactions undertaken specifically between governments and the private market to influence market exchange rates.[4]

In the United States, the Foreign Desk of the Federal Reserve Bank of New York (FRBNY) conducts all official exchange-market transactions for the government. With respect to intervention, the Desk maintains two accounts: one for the U.S. Treasury and one for the FOMC. Both the Treasury and the Federal Reserve typically act in concert and split the transactions equally between their two accounts. If, for example, the Foreign Desk purchases $200 million equivalent German marks, it will usually allocate $100 million of these to each account.[5]

Preeminence of the U.S. Treasury

Although intervention necessarily involves both the U.S. Treasury and the Federal Reserve, the Gold Reserve Act of 1934 (Section 10) vested responsibility for intervention squarely with the Treasury and established the Exchange Stabilization Fund (ESF) specifically for that purpose. The Act capitalized the ESF with $2.0 billion in profits stemming from a revaluation of the official price of gold from $20.67 to $35 per ounce. The ESF is under exclusive control of the Secretary of the Treasury, who acts with the approval of the President. The Treasury's decisions regarding ESF operations are not subject to review by any other officers of the U.S. government (see Todd [1992], p. 102).

In addition to acting as an agent for the U.S. Treasury, the Federal Reserve System has maintained its own account for intervention since the early 1960s.[6] Although the Federal Reserve Act does not *specifically* authorize the System to intervene, the FOMC interprets various sections of the legislation — considered together — as indeed sanctioning such activities.[7]

Section 14, for example, allows the Federal Reserve to purchase or sell both spot and forward "cable transfers" in domestic or foreign markets. Since cable transfers were the standard means of acquiring foreign-currency-denominated deposits earlier in the century, this provision seems to allow the central bank to acquire foreign exchange in the form of a claim on a foreign bank account. Section 14 (e) further allows the Federal Reserve to hold foreign exchange in the form of open accounts in foreign countries, to appoint correspondents, and to establish agencies. These are all necessary aspects of intervention, since intervention affords the Fed a claim — in the form of a deposit or a liquid security — on a foreign central bank or foreign government. Section 14 likewise enables the Federal Reserve to conduct transactions through another bank in a foreign market. The System interprets this part of the Act as authority to engage in swaps with other central banks.[8] Finally, Section 12 (a) generally

■ 4 As Adams and Henderson (1983) note, central banks can "passively" intervene through the timing of their other transactions.

■ 5 This 50–50 split has not always been the case. Until the late 1970s, the Federal Reserve undertook most of the intervention for its own account. In 1990, the Treasury undertook some intervention through the Foreign Desk for its own account.

■ 6 For a historical perspective on U.S. intervention, see Pauls (1990) and Todd (1992).

■ 7 This interpretation is found in a November 22, 1961 memorandum to the FOMC from Howard H. Hackley, the Committee's general counsel. The Hackley memorandum is printed in U.S. Congress (1962).

■ 8 A swap is a transaction in which central banks exchange their currencies for repayment with interest at a specific future date. Central banks prearrange the terms and conditions for swaps annually. U.S swaps are discussed in more detail on pages 7 and 8.

authorizes operations — conceivably foreign-exchange intervention — that accommodate commerce and business and that maintain sound credit conditions in the United States.[9]

The relationship between the Treasury and the Federal Reserve forged through intervention is also a source of trepidation to many. In 1961 and 1962, when the United States intervened to defend its gold stock and the dollar, some FOMC members expressed concern that the System had overstepped its congressional mandate because the Gold Reserve Act gave primary responsibility for intervention to the U.S. Treasury, and because the Federal Reserve Act did not specifically mention intervention.[10] The fear was that the Fed could be seen as financing a Treasury operation that might otherwise require an additional congressional appropriation. Congress, however, has tacitly recognized the Federal Reserve's authority to intervene both through its continual review and acceptance of such operations and through a 1980 amendment to Section 14 (b) of the Federal Reserve Act that allowed the System to invest its foreign-exchange holdings in obligations of foreign governments.

More recently, concern has focused on the implications of the relationship between the Treasury and the Federal Reserve for perceived System independence and for the credibility of domestic monetary policy. The Secretary of the Treasury is the nation's primary financial officer and is responsible to the President and Congress for formulating and implementing international financial policies. He typically represents the United States at important international meetings where the Federal Reserve Chairman is often an active participant and where specific exchange-rate policies are sometimes recommended. U.S. administrations and foreign governments at times view exchange-rate changes as an instrument of international policy (more specifically, as a tool for closing a trade deficit or for avoiding protectionism) or as a signal for demonstrating cooperation with other countries. Participants at the G5 meeting in September 1985 and the G7 meeting in February 1987, for example, agreed to policies of concerted intervention for the respective purposes of depreciating and stabilizing the dollar.[11] Given the limited effectiveness of sterilized intervention, such agreements could pressure the Federal Reserve to focus monetary policy on an exchange-rate objective, which at any specific time may or may not be consistent with domestic price stability (see appendix 1). Destler and Henning (1989), pp. 108–12, provide an example of this type of pressure.

FOMC Oversight

Within the Federal Reserve System, the FOMC maintains authority over intervention operations because intervention involves a type of open-market transaction. A subcommittee consisting of the Chairman and Vice Chairman of the FOMC, the Vice Chairman of the Board of Governors, and one other member of the Board chosen by the Chairman (with responsibilities for international matters) is accountable for intervention when the full FOMC is not immediately available for consultation.

Generally, the FOMC's guidelines for intervention consist of three documents. The *Authorization for Foreign Currency Operations* sanctions the System's purchases and holdings of balances in specific foreign currencies and establishes an overall limit on the System's net open position (see figure 1).[12] Although the Fed typically holds and intervenes only in German marks and Japanese yen, the *Authorization* actually permits the holding of a wide range of currencies, including such relatively minor ones as Austrian schillings, Belgian francs, Norwegian kroners, Swedish kronors, and Mexican pesos. Mexico is the only developing country whose currency the FOMC has authorized the System to hold. The *Authorization* also permits swap lines and lists existing swap arrangements. In addition, it provides general guidelines for investing foreign currency balances, for the responsibilities of the Manager of the FRBNY's Foreign Desk, and for reporting intervention to Congress and the Treasury.

While the *Authorization* describes the means for conducting intervention, a second document, *The Foreign Currency Directive*, focuses more on the objectives of intervention and on the manner in which the Foreign Desk should undertake such transactions. Among other

■ **9** Lawyers for the Treasury and the U.S. Attorney General have agreed with the System's interpretation of the Federal Reserve Act. See U.S. House of Representatives (1962), pp. 156–58.

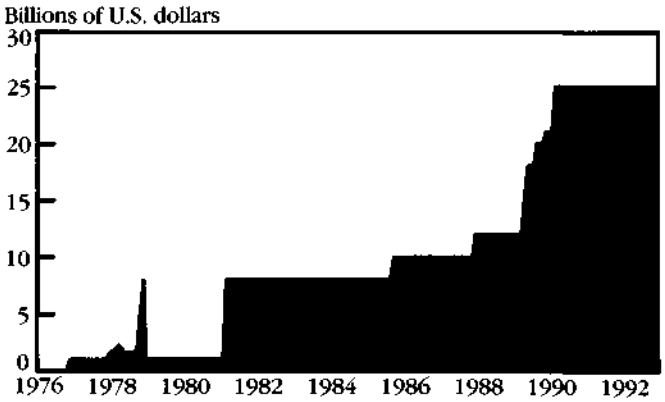
■ **10** See Governor Robinson's dissent on the motion for approval of Federal Reserve foreign-currency operations in Board of Governors of the Federal Reserve System (1963), pp. 55–56. See also Todd (1992), pp. 133–39.

■ **11** The G5 (Group of Five) comprises France, Germany, Japan, the United Kingdom, and the United States. The G7 (Group of Seven) comprises the G5 plus Canada and Italy.

■ **12** The net open position in any single currency, which equals current balances valued at historical exchange rates plus outstanding contracts for future receipt or delivery, represents the System's overall exposure to exchange-rate risk.

FIGURE 1

FOMC's Authorizations for Net Open Position



NOTE: At its December 1976 meeting, the FOMC replaced separate limits on various types of spot and forward transactions with a single limit on the System's overall open position.
SOURCE: Annual Report of the Board of Governors of the Federal Reserve System, various issues.

things, it directs intervention to counter disorderly market conditions and to maintain the dollar's value consistent with Article IV, Section 1 of the International Monetary Fund (IMF) Act.[13] The *Directive* also requires close and continuous consultation with the U.S. Treasury and cooperation, when appropriate, with foreign monetary authorities. The Board of Governors publishes both the *Authorization* and the *Directive* as a matter of public record once per year in its Annual Report or, when changes occur, in the *Federal Reserve Bulletin*.

Finally, *Procedural Instructions* clarifies the relationship among the FOMC, the Foreign Exchange Subcommittee, and the Foreign Desk Manager. It also sets limits on the amount of intervention and swap transactions, both daily and cumulative, that the Manager may undertake between FOMC meetings. *Procedural Instructions* is not published.[14]

Interpretation of the Directive

As noted in *The Foreign Currency Directive*, the Federal Reserve is authorized to intervene to counter disorderly market conditions, a concept that defies precise measurement. Official views about the nature of market disorder and about the role of intervention in the exchange market have varied from time to time since the inception of floating exchange rates in 1973. Through mid-1977, the Fed seemed to define disorderly markets in terms of the Foreign Desk's perception of the degree of confidence underlying the market's near-term exchange-rate forecast. Indicators of market uncertainty, such as abrupt changes in exchange rates, wide variation in quotes, rapid movements in one direction, and wide bid–ask spreads, figured in the Desk's determination. The Federal Reserve intervened frequently then, in relatively small amounts, and did not maintain a specific buy or sell posture for very long.

During the late 1970s, the dollar came under downward pressure because of rising U.S. inflation. At times between 1977 and 1980, both the Treasury and the Federal Reserve seemed to view a strategy of selling foreign exchange to moderate the dollar's depreciation as consistent with avoiding disorderly market conditions. As discussed below, the method of financing intervention necessitated the frequent repurchase of foreign exchange, leading to the back-and-forth pattern seen in figure 2. In late 1980 and 1981, the System took advantage of the dollar's strength to acquire foreign exchange for the nation's portfolio.

During the early 1980s, the Reagan administration viewed exchange markets as inherently stable and eschewed intervention in all but extremely unusual circumstances. Exchange-rate volatility was ascribed to erratic movements in underlying market fundamentals, which in the administration's view stemmed chiefly from uncertainty about government policies.

This perception changed in 1985, when the United States purchased large amounts of foreign exchange in order to encourage a faster depreciation of the dollar. The monetary authorities defined disorder in terms of differences between a market-quoted exchange rate and a rate that seemed consistent with a set of fundamental economic variables, such as interest rates, the current account, and relative inflation rates. Accordingly, U.S. and other G7 policymakers regarded the dollar as overvalued.

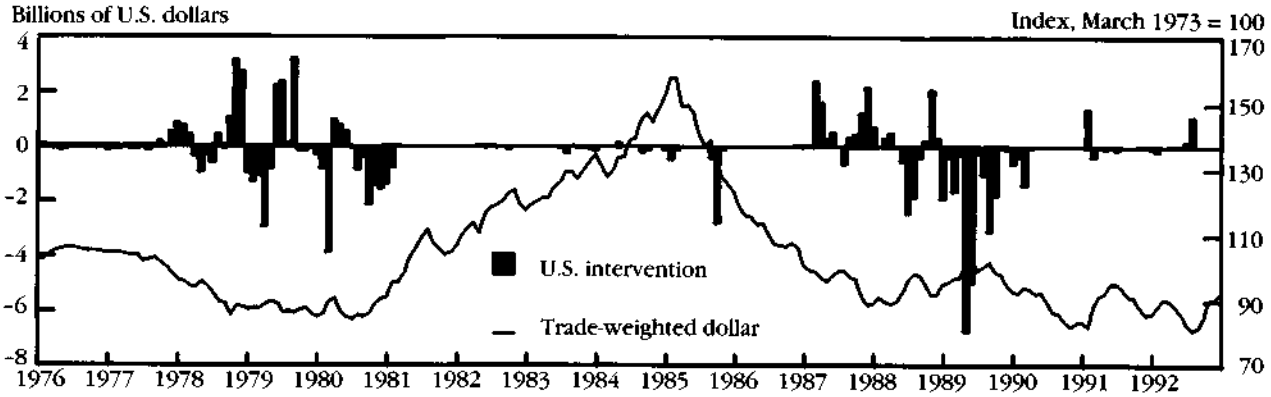
After a yearlong hiatus, the United States began a period of intensive intervention, in close

13 Article IV, Section 1 requires members to maintain orderly exchange markets through cooperation and by avoiding unilateral actions designed to gain unfair advantage.

14 Foreign Desk actions are regularly summarized in the *Federal Reserve Bulletin* and in the FRBNY's *Quarterly Review*.

FIGURE 2

Monthly U.S. Intervention and the Trade-Weighted Dollar



NOTE: Positive (negative) values represent sales (purchases) of foreign exchange against dollars.
SOURCE: Board of Governors of the Federal Reserve System.

cooperation with other major central banks, following the Louvre Accord in February 1987. The plan was to stabilize the exchange value of the dollar and possibly to maintain the dollar within undisclosed target bands. The monetary authorities intervened frequently, in large amounts, and maintained a specific buy or sell posture for long periods.

Since early 1990, the United States has intervened rarely, though at times in heavy volumes. Officials once again seem to interpret the concept of disorder and the role of intervention more narrowly.

The Decision to Intervene

Intervention usually results from a joint decision by the U.S. Treasury and the Federal Reserve System. The process begins with a morning consultation between the staffs of the FRBNY and the Treasury prior to opening of the New York market. They discuss available information from markets open elsewhere in the world and from morning consultations with foreign central banks. In light of current market developments, the FRBNY's Foreign Desk may offer a recommendation on intervention consistent with the FOMC's directive, which the Treasury may or may not accept. If opinions about the merits of intervention differ, discussions would continue at higher levels of authority and eventually might involve the Treasury Secretary and Federal Reserve Chairman (see Smith and Madigan [1988], pp. 189–90). Ultimately, the Federal Reserve must act as an agent for the ESF, but the Treasury cannot require the System to intervene for its own account. Moreover, although it has never happened, if the Federal Reserve intervenes for its own account *against* the wishes of the Treasury, the Treasury could inform Congress that the System's actions are interfering with U.S. foreign policy. Hence, formal statutory independence between the organizations is maintained.

II. Financing Intervention

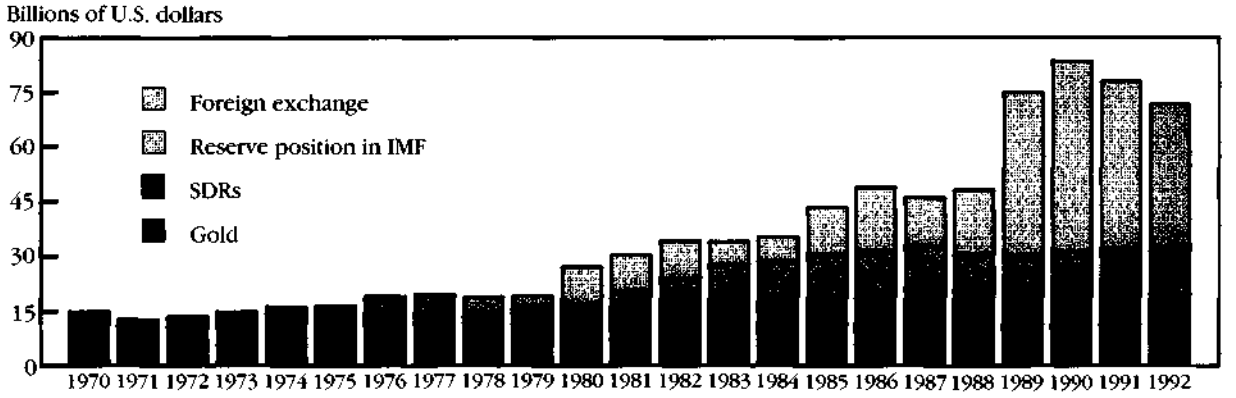
Once they decide to intervene, the Federal Reserve and the ESF must determine how they will finance the transactions. The method of financing depends first on whether the United States will sell or buy foreign exchange.

Sales of Foreign Exchange

All industrialized nations maintain international reserves, which are highly liquid assets unconditionally available to the monetary authorities for intervention. Exactly what types of assets qualify as international reserves is to some extent subjective, but generally, countries count their official holdings of gold and foreign exchange, their reserve position in the IMF, and

FIGURE 3

U.S. Official Reserve Holdings



SOURCE: International Monetary Fund.

their holdings of Special Drawing Rights (SDRs) (see figure 3).[15]

Foreign exchange refers to liquid claims on foreign governments that are denominated in convertible foreign currencies, typically U.S. dollars, German marks, Japanese yen, or British pounds. Usually, these take the form of foreign government securities or deposits at foreign central banks, but sometimes they include Eurocurrency deposits or deposits at the Bank for International Settlements (BIS). Nevertheless, we typically refer to foreign-exchange reserves as if they were currencies.

Under the Bretton Woods fixed-exchange-rate system, a primary function of the IMF was to provide a source of international reserves to member countries. When a country joins the IMF, it receives a quota that establishes its subscription to the organization as well as its voting rights. Related to its subscription is a country's reserve position in the Fund. This is the amount of its subscription that is automatically available in a foreign-currency equivalent and that is therefore considered a reserve asset. In addition, since 1968 the IMF has periodically created SDRs and allocated them to its member countries according to their quotas. All member countries agree to accept SDRs in official exchanges for their home currencies.

Besides financing intervention from their international reserve assets, countries can 1) borrow foreign exchange through swap lines with other central banks, 2) issue debt obligations (bonds) denominated in foreign currencies to public or private lenders, or 3) borrow from credit facilities at international organizations like the IMF and the European Monetary System. Chief among the possible instruments for borrowing foreign exchange are Reciprocal Currency Arrangements, or swaps. These are short-term, reciprocal credit lines available under prearranged terms, which countries set for a one-year period. (*Reciprocal* implies that either party can draw on the line.) Drawings are typically for three months and, by convention, may be renewed only once. The Federal Reserve maintains 14 swap lines. The Treasury also maintains swap lines, including some with developing countries that are not reciprocal and that are not necessarily intended for exchange-market intervention.

When drawing on a swap line, the parties simultaneously contract for both spot and forward currency exchanges. For example, in a swap with Germany, the United States would buy German marks in a spot transaction and simultaneously sell them back to the Bundesbank in a forward transaction, typically with a three-month settlement date. The United States would then sell the newly acquired German marks in the foreign-exchange market for dollars. To earn interest on its dollar holdings until the forward settlement date, the Bundesbank would invest its dollars through the Federal Reserve in special, nonmarketable interest-bearing U.S. Treasury securities.

The parties to an official swap calculate the forward exchange rate for the transaction from

15 Heller (1974) provides an excellent introduction to the topic of international reserves.

the covered-interest-parity (CIP) condition. This ensures that the cost to the United States of borrowing foreign exchange through a swap line equals the risk-free cost of borrowing in the foreign country.[16] When the term of the swap borrowing ends, the country that intervened must deliver the foreign exchange in repayment of the line. Although the swap itself involves no currency exposure, the intervention it finances involves exchange-risk exposure. (I discuss both of these issues in a later section.)

Though swaps are the most common form of borrowing to acquire funds for intervention, the United States has occasionally used other methods when seeking to extend the maturity of its debts. Roosa bonds, for example, were nonmarketable U.S. Treasury obligations denominated in foreign currencies and issued to foreign governments in the 1960s. Carter bonds were similar instruments issued in private markets during the late 1970s. Beyond this, the United States, like all IMF members, has various credit lines (tranches) available at the Fund.

Countries prefer to finance intervention out of reserves rather than through borrowing. One reason is that official creditors may condition loans on the adoption of specific macroeconomic policies or on the attainment of particular macroeconomic goals, reducing the borrower's sovereignty over its policy choices. Another problem is that the borrowing country may need to repay the loans before the exchange-market crisis has fully passed, thereby forcing the borrower to reverse its original exchange-market transactions.

Between 1977 and 1980, for example, when the dollar experienced heavy downward pressure, the United States relied on swap lines to augment its foreign-exchange reserves and to finance intervention. Moreover, in November 1978, the United States drew on its reserve position in the IMF, sold SDRs to foreign central banks, and issued Carter bonds. To conserve resources and to acquire funds to repay our borrowings, we often reversed our intervention before the crisis had completely passed (see figure 2).

To limit these problems, the United States began to acquire an open position in foreign exchange in the early 1980s. Prior to 1980, gold made up the main portion of U.S. official reserves. The most rapid growth in our foreign-exchange position occurred in 1989 and 1990, when we attempted to avoid a dollar appreciation by buying foreign exchange. In 1987, total reserves equaled nearly $36 billion, of which $13 billion, or approximately 36 percent, was foreign exchange. By 1990, U.S. official reserves had grown to $83 billion, of which $52 billion, or approximately 60 percent, was foreign exchange (mainly German marks and Japanese yen).

Purchases of Foreign Exchange

Because the Federal Reserve can create unlimited amounts of reserves in the U.S. banking system, only the FOMC's authorization restricts its ability to acquire foreign exchange. In contrast, the ESF has a finite balance sheet with a current net worth of $19.1 billion. The ESF has total assets of $37.5 billion, which includes $20.7 billion of foreign exchange, mostly Japanese yen and German marks.[17] As noted earlier, the ESF was initially capitalized with $2 billion in profits from a revaluation of official gold stocks. Since then, its resources have grown from interest earnings, intervention profits, and valuation adjustments.[18] With the exception of these sources of growth and warehousing (discussed below), the ESF would require an appropriation from Congress to increase its available resources for intervention.

Warehousing

At times, the ESF has needed to augment its dollar holdings temporarily and has done so by warehousing foreign exchange in its portfolio

■ **16** In our example, the return to the Bundesbank on each mark swapped with the Federal Reserve equals

$$S^{-1}(1+r)F, \tag{1}$$

where S is the spot exchange rate in German marks per U.S. dollar, r is the U.S. Treasury bill rate, and F is the forward exchange rate. CIP holds that

$$(1+r) = S(1+r^*)F^{-1}, \tag{2}$$

where r^* is the German Treasury bill rate. CIP implies that

$$F = \frac{S(1+r^*)}{(1+r)}, \tag{3}$$

and equation (1) becomes

$$S^{-1}(1+r)\frac{S(1+r^*)}{(1+r)} = (1+r^*). \tag{4}$$

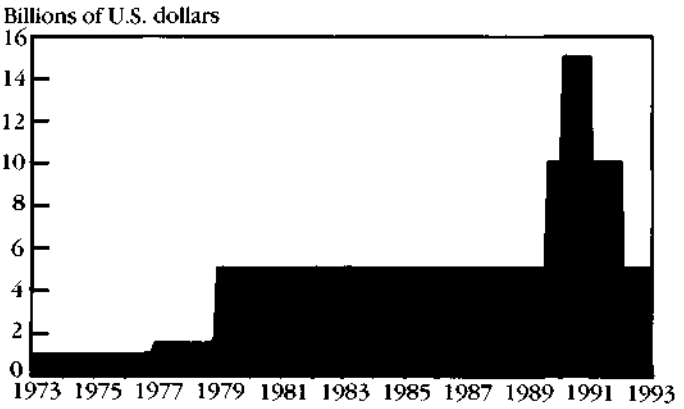
Hence, the United States pays a net interest cost of r^* for every mark borrowed through a swap.

■ **17** All data are as of September 30, 1992. See U.S. Treasury (1993), table ESF-1.

■ **18** In 1945, the United States paid two-thirds of its initial subscription to the IMF ($1.8 billion) out of its ESF holdings. See Todd (1992), p. 124.

FIGURE 4

FOMC Authorizations for Warehousing



SOURCE: Annual Report of the Board of Governors of the Federal Reserve System, various issues.

with the Federal Reserve System. Warehousing is a swap transaction in which the Fed buys foreign currency from the ESF in a spot transaction and sells it back to the ESF through a forward transaction. Currently, the spot and forward exchange rates in a warehouse transaction are market-based. The Federal Reserve holds the foreign exchange acquired from the ESF in an interest-bearing form. Although the Fed does not charge the ESF interest, if CIP holds, its earnings should approximate the opportunity cost of the dollars.[19]

Warehousing has been controversial. Some critics contend that it directly violates the Banking Act of 1935, which prohibits the Federal Reserve from purchasing U.S. government obligations, *except in the open market*. The Hackley memorandum, on the other hand, defends the practice by arguing that the Treasury is merely a part of the foreign-exchange market and, hence, that transactions with it *are* in the open market. In contrast, the Treasury creates the market for Treasury securities because it is the sole supplier; thus, direct Federal Reserve purchases of Treasury issues would not be in the open market.

Legal issues aside, opponents contend that warehousing is, in effect, a loan from the central bank to the Treasury, which is contrary to the tenets of central-bank independence. Proponents view warehousing not as a loan, but as an asset exchange. In a warehousing swap, the Federal Reserve acquires an asset of the Treasury (foreign currency), not a Treasury obligation. In either case, warehousing has sometimes weighed heavily on FOMC decisions pertaining to intervention (see Board of Governors [1991], p. 110). Figure 4 shows FOMC authorizations for warehousing, which increased sharply during the period of heavy U.S. dollar sales in 1989. In 1992, the FOMC reduced the authorized warehousing limits to $5 billion, and since early that year, no foreign-currency balances have been warehoused with the Federal Reserve.

III. Buying and Selling

The foreign-exchange market is a global one in which trades occur virtually around the clock. In April 1992, the BIS estimated the average daily volume of the foreign-exchange market at $880 billion (equivalent), with approximately 80 percent of all transactions involving U.S. dollars (see BIS [1993]). Although the typical amount of an intervention is small relative to the daily volume of dollars traded in the market, at the margin, intervention could still have an influence. Moreover, if intervention works by affecting market expectations, then the simple knowledge that the Federal Reserve is in the market — rather than the volume of the transaction — could be the decisive factor for expectations (see appendix 1).

In executing an intervention, the System either deals directly with commercial banks as counterparties or goes through the brokers' market, using a commercial bank as its agent. In dealing directly with commercial banks, the counterparty can make the information about the intervention public. In dealing through the brokers' market, however, the agent bank cannot reveal that it is acting on behalf of the Federal Reserve. The broker knows and announces only the names of the two commercial banks that are party to the transaction. Hence, interventions through the brokers' market give the Fed a greater degree of anonymity, which under certain circumstances might influence the effectiveness of an intervention.[20] Prior to the mid-1980s, the System typically operated through the brokers' market. Now it usually deals directly with banks. Following exchange-

■ **19** See footnote 16.

■ **20** Hung (1991) discusses whether discreet intervention is more effective than overt intervention.

FIGURE 5

The Federal Reserve Purchases Foreign Exchange for Its Own Account

1. The Federal Reserve (FED) acquires foreign exchange from a domestic commercial bank (cb) in the form of a claim on a deposit at a foreign commercial bank (fcb), which it immediately transfers to the appropriate foreign central bank (FCB). The FED pays for its acquisition by crediting the cb's reserve account at the FED. The FCB creates a deposit for the FED by debiting the fcb's reserve account.

Federal Reserve System (FED)		U.S. Commercial Bank (cb)		Foreign Commercial Bank (fcb)		Foreign Central Bank (FCB)		Foreign Treasury (FT)	
+ Deposit at FCB	+ Reserves	– Deposit at fcb		- Reserves	- Deposit of cb		+ Deposit of FED		
		+ Reserves					- Reserves		

2. The FED holds its foreign exchange in an interest-bearing security provided by the foreign Treasury (FT).

Federal Reserve System (FED)		U.S. Commercial Bank (cb)		Foreign Commercial Bank (fcb)		Foreign Central Bank (FCB)		Foreign Treasury (FT)	
- Deposit at FCB							- Deposit of FED	+ Deposit at FCB	+ FT bill
+ FT bill							+ Deposit of FT		

3. The FED sterilizes its intervention by selling a U.S. Treasury security from its own portfolio and then debiting the reserve account of the purchaser. The FCB sterilizes the intervention by purchasing FT securities and crediting the reserve account of the seller.

Federal Reserve System (FED)		U.S. Commercial Bank (cb)		Foreign Commercial Bank (fcb)		Foreign Central Bank (FCB)		Foreign Treasury (FT)	
- T bill	- Reserves	+ T bill		- FT bill		+ FT bill	+ Reserves		
		- Reserves		+ Reserves					

NOTE: Following convention, assets appear on the left-hand side of the T-account and liabilities appear on the right.
SOURCE: Author.

market conventions, foreign-exchange transactions typically settle after two business days.

The Federal Reserve commonly enters the New York market, but may intervene in a foreign market either directly with foreign commercial banks or by using a foreign central bank as an agent. Usually, the United States intervenes in the New York market while the European markets are still open. When the Federal Reserve or the ESF enters the market, its actions have an incipient effect on both domestic and foreign bank reserves. If the Fed and the appropriate foreign central bank each sterilize the effects of intervention on their bank reserves, the intervention will change the currency composition only of publicly held government debt. A substantial body of research questions how much, and through what channels, such changes might affect exchange rates (see Edison [1993]).

To demonstrate the mechanics of intervention, figures 5 through 7 present T-accounts for Federal Reserve and ESF operations financed through common alternatives. The examples do not include every possibility, but the main results are similar in all cases (see Balbach [1978]). Each of these examples assumes that the United States intervenes in the U.S. market with a domestic commercial bank as its counterparty.

FIGURE 6

The Federal Reserve Sells Foreign Exchange Financed through a Swap Drawing

1. In a swap drawing, the Federal Reserve (FED) acquires a claim on a foreign central bank (FCB), and the FCB acquires a special Treasury (T) security, which the FED has purchased from the Treasury by crediting the Treasury's account at the FED.

U.S. Treasury (T)		Federal Reserve System (FED)		U.S. Commercial Bank (cb)		Foreign Commercial Bank (fcb)		Foreign Central Bank (FCB)	
+ Deposit at FED	+ T bill of FCB	+ Deposit at FCB	+ Deposit of T					+ T bill	+ Deposit of FED

2. The FED sells foreign exchange in the form of a claim on the FCB to a U.S. commercial bank (cb) and debits the cb's reserve account at the FED. The cb deposits the funds with a foreign commercial bank (fcb). The FCB facilitates the transaction by crediting the fcb's reserve account.

U.S. Treasury (T)		Federal Reserve System (FED)		U.S. Commercial Bank (cb)		Foreign Commercial Bank (fcb)		Foreign Central Bank (FCB)	
		- Deposit at FCB	- Reserves	- Reserves + Deposit at fcb		+ Reserves	+ Deposits of cb		- Deposit of FED + Reserves

3. The FED and the FCB sterilize any undesired change in reserves through open-market operations.

U.S. Treasury (T)		Federal Reserve System (FED)		U.S. Commercial Bank (cb)		Foreign Commercial Bank (fcb)		Foreign Central Bank (FCB)	
		+ T bill	+ Reserves	- T bill + Reserves		- Reserves + FT bill		- FT bill	- Reserves

4. To repay the swap, the FED acquires foreign exchange through sterilized intervention, which it holds as a deposit at the FCB (see figure 5).

U.S. Treasury (T)		Federal Reserve System (FED)		U.S. Commercial Bank (cb)		Foreign Commercial Bank (fcb)		Foreign Central Bank (FCB)	
		+ Deposit at FCB - T bill		- Deposit at fcb + T bill		- FT bill	- Deposit of cb	+ FT bill	+ Deposit of FED

5. When the swap matures, the FCB debits the FED's deposit and the Treasury retires the security held by the FCB by giving it a claim on the Treasury's account at the FED, which the FED then clears in repayment of the swap.

U.S. Treasury (T)		Federal Reserve System (FED)		U.S. Commercial Bank (cb)		Foreign Commercial Bank (fcb)		Foreign Central Bank (FCB)	
- Deposit at FED	- T bill of FCB	- Deposit at FCB	- Deposit of T					- T bill	- Deposit of FED

NOTE: Following convention, assets appear on the left-hand side of the T-account and liabilities appear on the right.
SOURCE: Author.

FIGURE 7

The ESF Buys Foreign Exchange

1. The ESF sells nonmarketable Treasury (T) bills to acquire a deposit at the Federal Reserve (FED).

U.S. Treasury (T)		Exchange Stabilization Fund (ESF)		Federal Reserve System (FED)	
- Deposit at Fed	- T bill	- T bill			- Deposit of T
		+ Deposit at FED			+ Deposit of ESF

2. The FED, acting as the ESF's agent, acquires foreign exchange from a domestic commercial bank (cb) in the form of a claim on a foreign commercial bank (fcb), which it immediately transfers to the appropriate foreign central bank (FCB). The FED debits the ESF account and credits the cb's account, thereby increasing reserves in the U.S. banking system. The FCB debits the fcb's reserve account in creating the deposit for the ESF.

Exchange Stabilization Fund (ESF)		Federal Reserve System (FED)		U.S. Commercial Bank (cb)		Foreign Commercial Bank (fcb)		Foreign Central Bank (FCB)	
- Deposit at FED			- Deposit of ESF	- Deposit at fcb		- Reserves	- Deposit of cb		+ Deposit of ESF
+ Deposit at FCB			+ Reserves	+ Reserves					- Reserves

3. The ESF holds its foreign exchange as an interest-bearing foreign Treasury (FT) security.

Exchange Stabilization Fund (ESF)		Federal Reserve System (FED)		Foreign Central Bank (FCB)		Foreign Treasury (FT)	
- Deposit at FCB					- Deposit of ESF	+ FT bill	+ Deposit at FCB
+ FT bill					+ Deposit of FT		

4. The FED sterilizes the effects on domestic bank reserves resulting from the change in ESF deposits by selling Treasury securities from its own account and debiting the reserve account of the cb's that buy them. The FCB sterilizes the effects of intervention on its bank reserves by buying FT securities and then crediting the fcb's reserve account.

Federal Reserve System (FED)		U.S. Commercial Bank (cb)		Foreign Commercial Bank (fcb)		Foreign Central Bank (FCB)	
- T bill	- Reserves	- Reserves		- FT securities		+ FT securities	+ Reserves
		+ T bill		+ Reserves			

NOTE: Following convention, assets appear on the left-hand side of the T-account and liabilities appear on the right.
SOURCE: Author.

Federal Reserve Purchase of Foreign Exchange

When the Federal Reserve System intervenes in support of a foreign currency, it contacts a domestic commercial bank as a customer.[21] As shown in line 1 of figure 5, the Federal Reserve System (FED) acquires foreign exchange in the form of a claim on a foreign-currency-denominated deposit that the U.S. commercial bank (cb) maintains with a foreign commercial bank (fcb). The FED does not maintain the deposit at the fcb, but presents the claim on it to the appropriate foreign central bank (FCB), which clears the transaction and establishes an account for the FED.

■ **21** Major commercial banks stand ready to buy or sell foreign exchange at any time. They adjust their bid (to buy) and offer (to sell) quotes to manage their positions. See Flood (1991) and the references therein.

The FED pays for its newly acquired foreign exchange by crediting the cb's reserve account. In so doing, the FED creates reserves in the U.S. banking system. Similarly, the FCB reduces reserves in its banking system when it transfers the funds into an account on its books for the FED.

As discussed in the next section, the Federal Reserve holds its foreign-exchange reserves in an interest-bearing form, which may vary depending on the arrangements made with specific foreign central banks. One possibility, shown in line 2 of figure 5, is that the FED holds a foreign Treasury (FT) obligation.

The net effect of these transactions is an increase in the U.S. monetary base and a contraction in the foreign monetary base. The Federal Reserve's Open Market Desk, however, will automatically offset any increase in bank reserves that is inconsistent with its near-term objectives of adding reserves to, or draining reserves from, the U.S. banking system (see Smith and Madigan [1988] and Lewis [1993]). As shown in line 3 of figure 5, the FED sterilizes a purchase of foreign exchange by selling Treasury bills in the open market to financial institutions, then debiting their reserve accounts accordingly. The figure also assumes that the FCB sterilizes the effects of intervention on its bank reserves by buying foreign Treasury securities.[22]

As noted, the Federal Reserve's Open Market Desk sterilizes only intervention that conflicts with the near-term target for reserve growth. Sometimes, however, the FOMC has considered exchange-rate objectives in establishing its overall monetary policy. Consequently, although U.S. intervention is routinely sterilized in the manner illustrated in the figure, the System does not always divorce its monetary and exchange-rate policies (see Furlong [1989] and Pauls [1990]).

Although the completely sterilized intervention described in figure 5 leaves the U.S. and foreign monetary bases unchanged, it does alter the currency composition of the stock of publicly held government securities. After the Federal Reserve's sterilized acquisition of foreign exchange, the public (domestic and foreign) holds more assets denominated in dollars and fewer assets denominated in the foreign currency (see appendix 1).

■ 22 See von Hagen (1989) and Neumann and von Hagen (1991) for a discussion of the Bundesbank, and Takagi (1989) for a discussion of the Bank of Japan. See also BIS (1988).

Federal Reserve Intervention Financed with a Swap Drawing

When the Federal Reserve intervenes to support the dollar, it usually sells foreign exchange out of an existing portfolio. In figure 6, however, I assume that the FED initially does not hold foreign exchange, but acquires it through drawing on a swap line.

As shown in line 1, in activating its swap line, the FED acquires foreign exchange in the form of a deposit at the FCB, while the FCB receives a deposit at the FED that is immediately converted to an interest-bearing, nonmarketable U.S. Treasury (T) security. The FED acquires the special Treasury security by crediting the Treasury's account at the Federal Reserve. On net, then, the System gains an asset in the form of a deposit at the FCB and incurs a liability in the form of a Treasury deposit at the FED.

In line 2, the FED intervenes by selling to a cb the foreign exchange that it holds as a claim on the FCB. The cb deposits the funds with its fcb. In clearing the transaction, the FCB credits the fcb's reserve account, increasing the foreign monetary base. For its part, the FED debits the cb's reserve account, contracting the U.S. monetary base.

Although intervention tends to reduce U.S. bank reserves and the monetary base, the extent to which the latter contracts also depends on the actions of the Treasury Department. If the Treasury draws down its deposit at the Federal Reserve, reserves in the U.S. banking system increase. (Figure 6 assumes no change in Treasury deposits.) In line 3, the Federal Reserve's Open Market Desk, which in conducting day-to-day operations also monitors Treasury deposits at the FED, sterilizes any net effect on reserves resulting from intervention or from U.S. Treasury actions that are inconsistent with the monetary policy designs of the FOMC. The FCB also sterilizes the effects of intervention on its bank reserves.

Eventually — typically within three or six months — the FED must repay its swap drawing by acquiring foreign exchange from the market through sterilized intervention, as described in figure 5. Accordingly, in line 4 of figure 6, the FED holds a newly acquired balance at the FCB. At the appropriate time, as line 5 illustrates, the FCB debits the FED's balance as repayment for the swap. The Treasury retires the security held by the FCB, giving the FCB a claim on the Treasury, with which it repays dollars to the FED.

ESF Purchases of Foreign Exchange

The ESF holds its dollar balances in nonmarketable Treasury securities. As figure 7 shows, to finance intervention, the ESF first sells securities back to the Treasury. In facilitating the transaction, the FED debits the Treasury's account and credits the ESF's account.

The FED, which now acts as the agent for the ESF, proceeds exactly as described in figure 5, except that when it buys foreign exchange from a cb, it debits the ESF's dollar balances in payment. As in figure 5, the ESF acquires a claim on the FCB, which it eventually converts to an interest-bearing asset such as a foreign Treasury security.

ESF intervention, like FED intervention, affects U.S. bank reserves, because ESF deposits at the FED are not counted as part of the monetary base. This does not pose a direct problem for U.S. monetary policy, however, because the Open Market Desk sterilizes the transactions. As noted previously, the Desk routinely considers changes in Treasury balances when conducting monetary policy operations.

ESF Sales of Foreign Exchange

To finance a sale of foreign exchange, the ESF must undertake some type of transaction (swap borrowing, foreign-currency bond sales, or SDR sales) that will give it a claim on a foreign central bank. Once the ESF obtains foreign exchange, the intervention transactions proceed in a manner similar to those described for the FED in figure 6.

From its sale of foreign exchange, the ESF acquires dollar deposits at the FED that it exchanges with the Treasury for a nonmarketable security. The FED then debits the ESF's account and credits the Treasury's account. As in all of the earlier cases, the intervention will tend to affect both U.S. and foreign bank reserves. However, the Open Market Desk routinely sterilizes any unwanted effects on domestic reserves, because in conducting its day-to-day operations, the Domestic Desk regularly adjusts for changes in Treasury balances and in the deposits of FCBs.

IV. Investing the Proceeds

Except for small working balances, the Federal Reserve holds all of the foreign exchange it acquires through intervention in highly liquid, interest-bearing forms, typically government or money-market instruments that mature in not more than 12 months. These foreign-exchange holdings appear as an asset on its balance sheet. If the System's foreign-exchange assets are not exactly matched by similarly denominated foreign-exchange liabilities, it holds a net open position, and exchange-rate changes will affect its net worth. A private company wishing to avoid such risk exposure covers foreign-currency assets (liabilities) by incurring liabilities (assets) of equal value in the same currency. This means that any exchange-rate change will affect both sides of its balance sheet similarly, leaving its net worth unchanged. A net open position, then, measures the Federal Reserve's exchange-rate exposure. The System *realizes* a profit or loss only when it sells foreign exchange from its portfolio. Nevertheless, the Fed values the portfolio monthly, and *unrealized* foreign-currency profits or losses affect the overall profits that it remits to the Treasury.

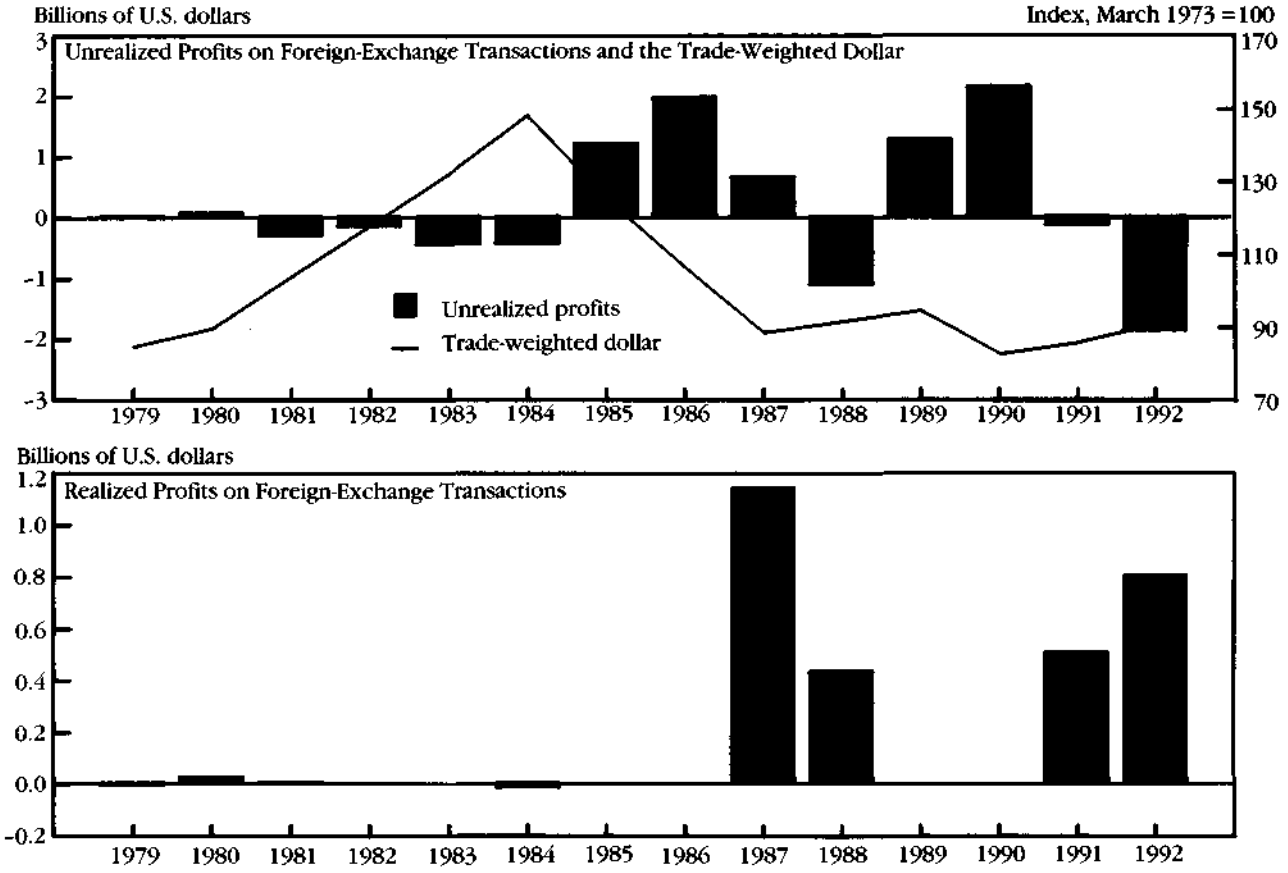
Calculating Profits and Losses

When the Federal Reserve buys or sells foreign exchange, whether for its own account or for the ESF, it books the transactions at current exchange rates. Foreign-currency-denominated interest payments on the account are treated similarly. Over time, however, the System books increments to the portfolio at different exchange rates. When it calculates the profit or loss associated with a subsequent foreign-exchange sale, the monetary authorities must decide which of the exchange rates used to book the foreign-exchange acquisitions is the appropriate base for the transaction. That is, did it sell foreign exchange booked at an exchange rate early on, or did it sell foreign exchange booked relatively more recently? The choice can make a substantial difference to the profit calculation when exchange rates fluctuate continuously.

The System resolves the problem by using a weighted-average exchange rate based on its entire existing portfolio. This rate equals the cumulative book value in a particular foreign currency divided by its cumulative book value in dollars (see appendix 2). Realized profits or

FIGURE 8

Intervention Profits



SOURCE: Annual Report of the Board of Governors of the Federal Reserve System, various issues.

losses compare the exchange rate at which currency is sold to this weighted-average rate.

The Fed also calculates the valuation, or unrealized profits, on the entire portfolio at particular times. To do so, it revalues the entire portfolio using an end-of-period exchange rate and compares this valuation with the aforementioned weighted average. Essentially, this reveals the profits from selling off the entire portfolio at a particular time. On this basis, the System and the ESF have generally profited from intervention, but not always (see Leahy [1989]).

Figure 8 shows year-end over year-end changes in the cumulative valuation of the System's portfolio (unrealized profits) and realized profits from 1979 through 1992.[23] Most of the shifts in the portfolio's value seem to result from exchange-rate movements. As the dollar depreciates, the value of the foreign-exchange portfolio appreciates, generating unrealized profits. Moreover, since 1988, as the size of the portfolio has increased, relatively small movements in the dollar have seemed to create relatively large valuation changes. In contrast, the System typically realizes profits on actual sales of foreign exchange.

Table 1 relates profits from foreign-exchange operations to both total Federal Reserve remittances to the Treasury and total Treasury receipts. Because the Federal Reserve data are on a calendar-year basis while the Treasury data are on a fiscal-year basis, strict year-to-year comparisons are not accurate. Nevertheless, the summary statistics are instructive. Over the sample period, the average year-to-year percentage contribution of exchange operations to Federal Reserve remittances to the Treasury

23 Annual data are found in the section entitled "International Developments," and in the table entitled "Income and Expenses of the Federal Reserve Banks," in the Board of Governors' Annual Reports. Data showing the cumulative value of the portfolio and realized profits at a quarterly frequency are found in "Treasury and Federal Reserve Foreign-Exchange Operations," published regularly in the FRBNY's *Quarterly Review*.

TABLE 1

Federal Reserve Profits from Foreign-Exchange Operations and Their Relationship to Treasury Receipts[a]

Year	Federal Reserve Profits[b]	Payments to Treasury	Ratio of Profits to Treasury Payments	Total Receipts[c]	Ratio of Payments to Total Receipts
1975	$ –241.8	$ 5,382.1	– 4.49 %	$ 280,642	1.92 %
1976	–25.1	5,870.5	– 0.43	318,508	1.84
1977	–146.4	5,937.1	–2.47	365,199	1.63
1978	–505.7	7,005.8	–7.22	416,110	1.68
1979	–3.7	9,278.6	–0.04	480,526	1.93
1980	96.1	11,706.4	0.82	533,017	2.20
1981	–306.0	14,023.7	–2.18	662,485	2.25
1982	–149.6	15,204.6	– 0.98	608,822	2.50
1983	– 456.3	14,228.8	–3.21	612,915	2.32
1984	– 454.8	16,054.1	–2.83	683,209	2.35
1985[d]	1,210.0	17,796.5	6.80	745,084	2.39
1986[d]	1,970.0	17,803.5	11.07	781,869	2.28
1987	1,804.3	17,738.9	10.17	868,996	2.04
1988	–510.9	17,364.3	–2.94	925,979	1.88
1989	1,204.2	21,646.4	5.56	979,923	2.21
1990	2,139.0	23,929.4	8.94	1,031,462	2.32
1991	366.5	20,777.6	1.76	1,054,260	1.97
1992	–1,078.0	16,774.5	– 6.43	1,091,692	1.54
Summary Statistics:					
Mean		0.66 %		2.07 %	
Standard deviation		5.59		0.28	
Minimum		–7.22		1.54	
Maximum		11.07		2.50	

a. Profits, payments, and receipts are expressed in millions of dollars.
b. Realized and unrealized.
c. Off-budget plus on-budget items.
d. Unrealized profits; total profits were not reported as a separate item.
SOURCES: "Income and Expenses of Federal Reserve Banks," Board of Governors of the Federal Reserve System, Annual Report, years 1975–1992; and "On-budget and Off-budget Receipts by Source," Table FFO–2, Department of the Treasury, *Treasury Bulletin*, years 1975–1992.

is essentially zero (0.7 percent), but the variance and range are high. Total Federal Reserve remittance, however, is a minor and reasonably stable share of total Treasury receipts (2.1 percent).[24]

V. Conclusion

Exchange-market intervention has created an interesting type of institutional symbiosis between the Federal Reserve System and the U.S. Treasury, which this article has traced. Through this relationship, the Treasury acquires additional support for an operation that federal law places directly under its purview, and the System gains influence — as an active participant rather than as a passive agent — over an important financial policy closely involving the commercial banking network and having possible monetary policy implications.

Although this relationship does not directly impinge on the statutory independence of the Federal Reserve, opponents of intervention fear that the alliance could ultimately prove detrimental to the consistency and credibility of price stability in the United States. Their misgivings start with the observation that sterilized intervention has little lasting influence on ex-

■ **24** This raises questions about the credibility of using intervention as a signal of monetary policy.

change rates, if any. Consequently, intervention does not afford the Treasury or the Federal Reserve a means of influencing exchange-rate trends independent of monetary policy. Moreover, when the exchange-market disturbance is neither domestic in origin nor monetary in nature, nonsterilized intervention conflicts with price stability.

This basic concern, together with several institutional considerations, has established the atmosphere surrounding FOMC deliberations on intervention in recent years. Thus, one cannot fully understand U.S. intervention policy without an appreciation of its institutional aspects, and one should not recommend intervention as an effective means of influencing exchange-rate patterns without considering its possible implications for the consistency and credibility of monetary policy.

Appendix 1

Theories about How Intervention Might Work

Studies suggest a number of channels through which intervention might affect exchange rates. Edison (1993) and Humpage (1991) survey the literature, and Kaminsky and Lewis (1993) discuss passive signaling.

Monetary Channel (Nonsterilized Intervention)

Central banks can alter nominal exchange rates by changing the relative growth rates of their monetary bases, either through intervention or through other policies. Depending on the nature of the exchange-rate disturbance, such intervention can promote price stability or interfere with it. If, for example, the underlying disturbance is real in nature or foreign in origin, nonsterilized intervention by the home country is inconsistent with price stability there.

Portfolio-Balance Channel

Sterilized intervention alters the currency composition of the stock of publicly held government securities. If international investors view these securities as net wealth and as imperfect substitutes, sterilized intervention can alter nominal exchange rates by affecting the risk premium embedded in the uncovered arbitrage condition between securities. Little support for this channel exists.

Signaling

Active: Sterilized intervention could influence exchange rates by providing new information about future monetary policy to an otherwise efficient (semi-strong form) market. Thus, a central bank might use intervention as a strategic signal of future monetary policy. By incurring an open position that is subject to valuation loss if the signaled policy is not adopted, the central bank increases its credibility.

Passive: If a monetary disturbance simultaneously affects exchange rates and prices, the Federal Reserve's Foreign and Domestic Desks might respond independently, but in a consistent manner. It is then conceivable that intervention might occur ahead of open-market transactions, that it would be correlated with changes in monetary policy, and that exchange traders could learn to discern something about future monetary policy from it (see Kaminsky and Lewis [1993]).

Transactions Costs

Although generally small, transactions costs — including the costs of acquiring information — are significant, and they may increase when markets become volatile. If the Federal Reserve System has an advantage in the acquisition of information, realizes when the exchange market is uncertain about available information, and can provide the necessary information to the market through intervention, it could reduce transactions costs.

Appendix 2

Profit and Loss Calculations

Assume that the New York Trading Desk undertakes only three purchases of German marks, so that the entire portfolio consists of DM638 million as follows:

Time Period	Millions of Dollars	Exchange Rate	Millions of Marks
1	200	1.76 DM/$	352
2	50	1.80 DM/$	90
3	100	1.96 DM/$	196
Total	350		638

The book value of the total portfolio is $350 million. To calculate a *realized* profit or loss, the System uses a weighted-average exchange rate based on the entire existing portfolio. Assume that at a current (time period 4) exchange rate of 1.78 DM/$, the System sells DM100 million from the portfolio. The dollar value of this transaction is approximately $56 million ([DM100(1/1.78)]). To estimate the associated profit or loss, the System first calculates the weighted-average exchange rate implied by the entire portfolio as DM638/$350 = 1.823 DM/$. Using this rate, the base value of the transaction is nearly $55 million ([DM100(1/1.823)]), and the realized profit from the sale of DM100 million is $1 million ($56 million – $55 million). The profit results because the mark appreciated over the average value at which the portfolio was booked.

To calculate the cumulative valuation (unrealized) profits on the portfolio at any particular time, the Federal Reserve revalues the entire portfolio using end-of-period exchange rates. Assume, for example, that the System undertook no DM sales in period 4. The value of the portfolio at that time is $358 million [DM638 (1/1.78)], and the unrealized profit is $8 million ($358 million – $350 million).

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The 1995 Budget and Health Care Reform: A Generational Perspective

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Introduction

Generational accounting is a new way of considering how government deficits, taxes, transfer payments, and other expenditures impact the distribution of income and wealth among various generations.[1] The technique is still being refined, and a number of the assumptions used to estimate the accounts are controversial.[2] Further development will be needed to improve the quality of the estimates and the usefulness of the method.

Generational accounts indicate, in present-value terms, the average net taxes (taxes paid less transfers received) that members of each generation can expect to pay both now and in the future. This is shown for existing as well as future generations. The method can also be used to calculate a given generation's lifetime net tax rate, defined as the present value of the net taxes it pays as a percentage of its lifetime labor income.

Generational accounts for 1991 were presented in the 1993:IQ issue of this publication. That article explained the basic concept and provided some examples of how the accounts would be affected by policy changes. It also reported lifetime net tax rates by generation, beginning in 1900. The present article provides baseline generational accounts for 1992, estimates the effect of the Omnibus Budget Reconciliation Act of 1993 (OBRA93), and examines the further effects of the administration's health care reform proposal.

Our analysis reaches the following major conclusions:

- The lifetime net tax rates of baby boomers and later generations will be higher than the rates paid by those born earlier.
- Future generations' lifetime net tax rate will be much higher than the rates estimated for existing generations.
- OBRA93 will significantly lower the lifetime net tax rate facing future generations.
- The lifetime net tax rate facing future generations will be still lower if federal outlays and receipts are altered to equal those projected by the administration under its health care reform proposals.

1 See Auerbach, Gokhale, and Kotlikoff (1991) and Kotlikoff (1992).

2 The merits of generational accounting are debated in Auerbach, Gokhale, and Kotlikoff (1994) and Haveman (1994).

I. The Nature of Generational Accounts and Lifetime Net Tax Rates

The federal budget normally measures receipts and outlays for one year at a time and shows these estimates for only a few years into the future. Moreover, while the standard budget presentation divides receipts and outlays into a number of categories, it does not do so in a way that reveals the effects of the budget on different generations.

Generational accounts, in contrast, look ahead many decades and classify taxes paid and transfers received (such as Social Security, Medicare, and food stamps) according to the generation that pays or receives the money. For an existing generation, taxes and transfers are estimated year by year over its entire remaining lifespan. These amounts are then summarized in terms of one number, the present value of the generation's entire annual series of average future tax payments net of transfers received. For future generations, the accounts estimate net tax payments based on the proposition that any government bills not paid by current generations will accrue to them. Future generations' average payment to the government, above the amount they will receive in transfers, assumes that total government spending remains on its projected path and that those now alive do not pay more than anticipated.

Defined more precisely, generational accounts measure, as of a particular base year, the present value of the average future taxes that a member of each generation will pay minus the present value of the average future transfers that he or she will receive. This difference is called the "net tax" in the following discussion. A generation is defined as all males or females born in a given year.

The generational accounts as such — that is, these net tax payments — are prospective in that they consider only the present value of future taxes and transfers as of a base year. A prospective analysis can do two things: It can estimate the effect of policy changes, because all of these effects occur in the future, and it can compare the lifetime net taxes of the newly born and future generations, because their entire lifetime taxes and transfers are also in the future. It cannot, however, compare the lifetime net taxes paid by one existing generation with those of either a different existing generation or future generations, because part of any living generation's taxes and transfers occurred in the past and thus are not taken into account.

A comparison of one existing generation with another, or with future generations, must be based on their entire lifetime taxes and transfers. The lifetime net tax rate of a generation represents the present value of its lifetime net taxes divided by the present value of its lifetime labor income. Present values are calculated as of the generation's year of birth in order to facilitate a comparison of the lifetime fiscal treatment of different generations. Because lifetime taxes, transfers, and income have tended to rise over time and have fluctuated to some extent, we compare the relative net taxes paid by various generations in terms of lifetime net tax rates rather than in terms of the absolute amounts of lifetime net tax payments.

Generational accounting can be used for two types of comparisons. First, it can compare the lifetime net taxes of future generations, of the generation just born, and of different generations born in the past. The lifetime net taxes of generations born in the past are based on estimates of actual taxes paid and transfers received through 1992, and on projections of taxes to be paid and transfers to be received in the future.

Second, the accounts can be used to compare the effects of actual or proposed policy changes on the remaining lifetime net tax payments of current and future generations. Such comparisons may be made in terms of either lifetime net tax rates or the absolute amounts of the generational accounts, because the changes in all lifetime taxes and transfers occur in the future for every generation and thus are included in the calculations. The comparisons can be made equally well for policies that 1) alter *total* receipts or expenditures while also changing the deficit, 2) alter *the composition* of receipts or expenditures without changing the deficit, and 3) alter *the level* of receipts and expenditures together without changing the deficit.

Unfortunately, generational accounts have a number of limitations as currently constructed. First, they include the taxes and transfers of all levels of government — federal, state, and local. While this approach is appropriate for some analyses, it does not allow us to separate the effect of the federal budget from that of the state and local sector. However, the difference in generational accounts due to a federal government policy *change* can be analyzed separately.

Second, generational accounts reflect only taxes paid and transfers received. They do not impute to particular generations the value of government purchases of goods and services

that provide them with education, highways, national defense, and so on. Therefore, the numbers do not reveal the full net benefit or burden that any generation receives from government fiscal policy as a whole. Insofar as the benefits of purchases could be imputed, they would reduce net tax payments. This omission may be important, because government purchases of goods and services account for about half of total government expenditures. Nevertheless, generational accounts can reveal a generation's net benefit or burden from a particular policy change that affects only taxes and transfers. Although the accounts do not show how the benefits of government purchases are spread across generations, they do illuminate which generations will pay for this spending.

Third, generational accounts do not yet incorporate any policy feedback on the economy's growth and interest rates. Feedback effects can be significant, but because they generally occur slowly, their impact on the discounted values used in the accounts is likely to be small. Moreover, there is reason to believe that they would reinforce the conclusions derived in this chapter. For example, policies that decrease the net tax payment of existing generations and increase the payment of future generations are likely to stimulate more current consumption and thereby reduce the savings available to finance investment. This, in turn, would lower productivity and real wage growth and raise real interest rates, which on balance would harm future generations.

Finally, generational accounting divides people born in the same year into only two categories, males and females, with each designated a "generation." This is an important distinction, since the sexes differ significantly in characteristics such as lifetime earnings and longevity. However, the accounts do not reveal differences with respect to other characteristics, such as income level or race, nor do they show the wide diversity among individuals within any grouping. The categories would be expanded if more data were available.

Lifetime net tax rates introduce a number of further conceptual issues. For example, how should lifetime income be measured? Lifetime income is defined as a present value, like lifetime taxes and transfers. The present-value calculation should factor in all income that increases a generation's resources, including labor earnings, inherited wealth, and capital gains over and above the normal return to saving. The normal return to saving is not included in income, because that would be double counting. Saving out of labor income and then earning a normal rate of return does not increase the present value of a household's resources. Data do not exist on the share of each generation's income that stems from inherited wealth or supernormal capital gains, so labor earnings are used to represent income.[3]

Even within the scope of generational accounts as now constructed, the results presented here should be viewed as experimental and illustrative. They are limited by the availability and quality of the data, especially for earlier years. Lifetime net tax rates are calculated from historical data on taxes, transfers, and income up to 1992 as well as on projections of future data. The historical information, however, is sparse compared to the data for recent years and in some cases is not available at all. As work on generational accounting progresses, the estimates will likely be revised due to improvements in the data and refinements in the method. Some of the changes that have occurred since last year are discussed in the appendix.

In addition, generational accounts are necessarily based on a number of simplifying assumptions about which reasonable people may disagree. For instance, government intergenerational redistribution does not substitute for, and is not offset by, private intergenerational transfers in our calculations. This is similar to the usual assumption made in cross-section estimates of the distributional effect of taxes and transfers by income class or other characteristic. The accounts are also based on assumptions about the pattern of future taxes and spending, the interest rate used to discount future taxes and transfers to form present values, mortality and birth rates, and so forth. The absolute amounts of the generational accounts are sensitive to all of these.

Projections of government expenditures are especially affected by assumptions about health care costs. From 9 percent of GDP in 1980, health care expenditures have risen to 14 percent currently and have been projected to reach more than 20 percent of total output early in the next century unless constrained by cost controls. The government pays about 45 percent of all health care costs, and its bill has been rising more rapidly than the private sector's; thus, future trends in government spending will be strongly influenced by future trends in health care costs. The estimates without

■ **3** The error due to this omission is relatively small in the aggregate, given that labor income has long accounted for approximately four-fifths of all income and that only part of the remaining income from capital should be included. However, errors for different generations could vary depending on trends and fluctuations in asset values and bequest behavior.

TABLE 1

Lifetime Net Tax Rates before OBRA93 (percent)

Generation's Year of Birth	Net Tax Rate	Components of Net Tax: Gross Rate	Components of Net Tax: Transfer Rate
1900	23.6	27.3	3.7
1910	27.2	33.0	5.8
1920	29.0	35.9	6.9
1930	30.5	38.7	8.2
1940	31.6	40.9	9.2
1950	32.8	43.7	10.9
1960	34.4	46.7	12.3
1970	35.7	49.8	14.1
1980	36.0	51.5	15.0
1990	35.5	51.5	16.0
1992	35.4	51.5	16.2
Future generations	93.7	—	—
	Percentage Difference in Net Payment		
Future generations and age zero	165.1	—	—

SOURCE: Office of Management and Budget (1993).

health care reform reflect continued rapid growth in costs, but the probable pattern is uncertain.

Despite these qualifications, generational accounts can be useful when considered in light of their assumptions, as is the case for the 75-year projections made annually by the Social Security trustees. Moreover, our most fundamental result — that future generations' net tax payment will be relatively much larger than that of the newly born or other existing generations — holds for a wide range of reasonable changes in the assumptions. The following sections illustrate the results of generational accounting.[4]

II. Lifetime Net Tax Rates before Deficit Reduction

Table 1 reports where lifetime net tax rates for different generations stood before OBRA93 was enacted. Rates are shown for the generations born in 1900 and every tenth year thereafter, for the generation born in 1992 (the "newly born" in this year's analysis), and for future generations (those born in 1993 or later). All federal, state, and local taxes and transfers are included in the calculations, and data for males and females are combined.[5] The calculations in this table and throughout the article are as of calendar year 1992. Because of the time needed to prepare these estimates, we based them on receipts and outlays reported in the Office of Management and Budget's (OMB) *Mid-Session Review of the 1994 Budget* rather than on the current budget. Since the budget outlook has improved since the *Mid-Session Review* was issued, the lifetime net tax rates for both existing and future generations would probably fall if based on the updated numbers.

Lifetime net tax rates have exhibited a strong upward trend over the past century, rising from 23.6 percent for the generation born in 1900 to 35.4 – 36.0 percent for those born since 1970.[6] The rate for future generations was much higher before OBRA93 was enacted — 93.7 percent, or 165.1 percent greater than the lifetime net tax rate facing the newly born.[7]

Table 1 also breaks down the net tax rates between gross rates and transfer rates. To calculate the latter, the present value of a generation's lifetime taxes (or transfers) is divided by the present value of its lifetime labor income. This decomposition reveals the expanded role of government transfer payments over the past century. The lifetime transfer rate more than *quadrupled* between 1900 and 1992, starting at 3.7 percent and rising each decade to a rate of 16.2 percent. The increase was more rapid, in both relative and absolute terms, for the generations born before World War II than afterward.

The gross tax rate has risen substantially more than the net tax rate. It nearly doubled between the generations born in 1900 and 1992, starting at 27.3 percent and increasing each decade to a rate of 51.5 percent. In contrast, the net tax rate rose by about half. The larger increase in the gross tax rate is because a generation's lifetime gross taxes pay for the

■ 4 For a detailed explanation of the concepts, data sources, calculations, and other assumptions used here, see Auerbach, Gokhale, and Kotlikoff (1993).

■ 5 Data for the sexes were combined because of the conceptual problem of how to attribute taxes, transfers, and income within a family. For a description of the methodology and data sources used in the underlying calculations, see the appendix to Auerbach, Gokhale, and Kotlikoff (1993).

■ 6 The lifetime net tax rate for the generation born in 1900 was estimated as 21.5 percent last year. The increase is primarily due to a reduction in the estimate of its lifetime labor earnings. This revision also raises the lifetime net tax rate of generations born after 1900, including future generations, by roughly 10 percent.

■ 7 For a discussion of the equitable distribution of net tax burdens over different generations, see Kotlikoff and Gokhale (1994).

TABLE 2

Percentage Difference in Net Payments between Future Generations and Age Zero

Interest Rate	Productivity Growth Rate 0.25	0.75	1.25
3.0	167	127	93
6.0	205	165	131
9.0	350	297	249

SOURCE: Office of Management and Budget (1993).

government's purchases of goods and services as well as for public transfers to its own members and other generations.

Estimates of lifetime net tax rates by generation, such as those shown in table 1, are affected by the amounts of future taxes, transfers, and other government expenditures that are assumed year by year in the underlying projections. These assumptions differ widely, and the amounts that result could vary substantially based on the figures chosen. The projection methods generally seek to maintain current policy in some sense. However, "current policy" can be interpreted in various ways, especially for discretionary expenditures such as defense. Furthermore, the long-term projections for Medicare and Medicaid assume that even if the administration's health care reform initiative fails, other policy actions or forces will eventually hold spending growth to the overall rate of economic expansion (adjusted for shifts in the age and sex composition of the population), although the projected growth rate is still quite rapid relative to GDP for the next few decades.[8]

Lifetime net tax rates — and hence the imbalance between future and existing generations — are defined in such a way that the generations now alive, including the newly born, do not pay any more taxes (or receive any less transfers) than projected under the specified fiscal policy. This assumption is an analytical device for determining the size of the fiscal imbalance; it is not meant to suggest that future generations will in fact close the gap all by themselves. Any actual policy change, whether enacted in the past or proposed for the future, is almost certain to bear in some degree on generations now living as well as on the unborn. Thus, if a policy change were implemented today, the net tax rates paid by the newly born and other existing generations would be different than those shown in table 1. Policy changes of this kind are considered below.

The generational imbalance shown in table 1 depends on the assumption that all future generations of the same sex have the same lifetime net tax rate. Alternatively, suppose that generations born during 1993–2000 pay the same lifetime net tax rate as those born in 1992. Because these future generations would pay less than otherwise assumed, those born after 2000 would have to pay more. The greater the number of future generations who pay no more than the newly born, the larger is the lifetime net tax rate that will be required of those generations born still later.

The size of the imbalance estimated between future generations and the newly born is also sensitive to assumptions about both the interest rate used for discounting future payments and receipts and the growth rate of the economy. Table 2 shows the percentage differential under interest rates of 3.0, 6.0, and 9.0 percent and productivity growth rates of 0.25, 0.75, and 1.25 percent. The assumptions used for all other calculations in this article are a 6 percent interest rate and a 0.75 percent growth rate. This leads to a 165.1 percent larger net payment by future generations than by the newly born. Under the alternatives in table 2, the difference ranges from 93 percent to 350 percent. While this spread is wide, our basic conclusion still holds for all of the alternatives; that is, future generations will face a much larger tax bill, net of transfers received, than the generation just born or other existing generations.

III. Effects of OBRA93

OBRA93 slashed the estimated budget deficits from 1994 through 1998 by a cumulative total of about $500 billion. As a result, the lifetime net tax rate of future generations is reduced from 93.7 percent to 82.0 percent (see table 3). To accomplish this, the Act raises the lifetime net tax rate on existing generations: The very young will pay roughly 1 percentage point more, baby boomers about 0.3 to 0.6 percentage point more, and older generations less than 0.3 percentage point more. The lower impact on the elderly is partly because they have fewer remaining years of life to be affected, and also because any given dollar amount of taxes or transfers is discounted over more years in order to calculate the present value as of a generation's year of birth.

8 A pure extrapolation of recent trends, in contrast, implies that health care costs will eventually bankrupt the government.

TABLE 3

Lifetime Net Tax Rates under Alternative Policies (percent)

Generation's Year of Birth	Before OBRA93	After OBRA93: Without Health Care Reform	After OBRA93: Administration's Plan	After OBRA93: With Faster Cost Growth
1900	23.6	23.6	23.6	23.6
1910	27.2	27.2	27.2	27.2
1920	29.0	29.0	29.1	29.1
1930	30.5	30.6	30.9	30.9
1940	31.6	31.9	32.4	32.2
1950	32.8	33.2	34.0	33.5
1960	34.4	35.0	35.9	35.2
1970	35.7	36.5	37.6	36.6
1980	36.0	36.9	38.2	36.7
1990	35.5	36.5	38.3	36.2
1992	35.4	36.3	38.3	36.0
Future generations	93.7	82.0	66.5	75.2
	Percentage Difference in Net Payment			
Future generations and age zero	165.1	126.0	73.9	108.8

SOURCE: Office of Management and Budget (1993).

OBRA93 thus narrows the gap between the lifetime net tax rates of future and existing generations. The generational imbalance — defined as the percentage difference in lifetime net tax rates between future generations and the newly born — is reduced by about a fourth, from 165.1 percent to 126.0 percent. These calculations show roughly where lifetime net tax rates now stand. The main reason the generational imbalance remains substantial despite OBRA93 is that, to a great extent, government health care spending is projected to continue rising rapidly relative to GDP.

IV. Effects of Health Care Reform

The administration's health care reform initiative would provide every American with comprehensive medical benefits and would limit the rapid growth of health care costs as a share of GDP. If future health care outlays are reduced and revenues are increased as projected under the Clinton plan, the current generational imbalance would be substantially reduced.[9] Table 3 reports lifetime net tax rates with health care reform. Under the Clinton plan, future generations would see their net rate of taxation reduced beyond the effect of OBRA93 — from 82.0 percent to 66.5 percent. Because estimates of the effect of health care reform on taxes and spending are not available after 2000, this calculation is based on rough projections for subsequent years. Medicare and Medicaid transfers are assumed to grow at a rate similar to that of benefits under the reform package, although neither program is directly limited by the administration's plan. Our estimates do not include the premiums paid to health alliances or the benefits financed by these premiums.

Health care reform would increase the lifetime net tax rates of all existing generations by decreasing the lifetime transfers that they would be recorded as receiving. This is because government health care spending is recorded as a direct transfer to the individuals receiving the care. However, one of the basic principles of the administration's proposal is to reduce the complexity and improve the efficiency of the current health care system. To the extent that the plan succeeds, it will allow lower government transfer payments, but people will not receive less health care. Thus, the measured decline in lifetime transfers to existing generations would overstate the change in the value of benefits they receive, and the increase in the lifetime net tax rates from this effect would not represent a rise in their actual fiscal burden.

As shown in table 3, the administration's plan reduces the generational imbalance by about two-fifths, from 126.0 percent to 73.9 percent. In combination, OBRA93 and health care reform would eliminate more than half of the previous imbalance of 165.1 percent.

Table 3 also illustrates the importance of implementing the cost-containment principle of health care reform. Column 4 reports lifetime net tax rates with the administration's proposal modified so that all government health care transfers from 2000 through 2020 grow 2 percentage points faster than warranted by demographic change and economywide productivity growth. In this case, the generational imbalance would be reduced from 126.0 percent to only 108.8 percent.

9 Our calculations are based on the OMB's projections of changes in revenues and expenditures that would follow adoption of the administration's health care reform proposal.

TABLE 4

Generational Accounts for Males: Present Value of Taxes and Transfers under OBRA93 (thousands of dollars)

Generation's Age in 1992	Net Tax Payment	Taxes Paid: Labor Income Taxes	Capital Income Taxes	Payroll Taxes	Excise Taxes	Transfers Received: Social Security	Health	Welfare
0	78.4	32.2	7.9	34.7	30.2	6.8	16.2	3.6
5	99.3	41.3	10.1	44.6	35.6	8.6	19.1	4.6
10	124.8	52.6	12.9	56.9	41.3	10.3	22.7	5.9
15	157.2	67.1	16.6	72.8	47.4	11.9	27.3	7.6
20	187.7	80.8	21.0	88.2	51.4	13.3	31.0	9.2
25	203.0	88.2	25.2	96.7	52.2	16.4	33.0	9.9
30	201.6	87.8	30.2	96.5	51.4	20.1	34.7	9.4
35	192.4	84.5	36.1	93.2	50.4	25.2	37.9	8.7
40	170.9	77.2	40.8	85.4	49.4	31.7	42.3	8.0
45	132.5	64.9	43.5	72.0	46.7	39.8	47.5	7.2
50	81.0	49.6	44.0	55.2	42.8	50.4	53.6	6.5
55	19.5	32.7	42.2	36.6	37.8	63.7	60.2	5.8
60	−43.9	17.5	38.9	19.6	32.2	80.4	66.7	5.1
65	−94.1	6.2	34.3	6.9	26.9	90.6	73.4	4.4
70	−98.6	2.5	27.1	2.9	21.5	82.7	66.1	3.8
75	−92.9	1.2	18.2	1.3	16.4	69.0	57.8	3.2
80	−79.4	0.6	9.2	0.7	11.5	52.0	47.2	2.2
85	−69.4	0.3	0.0	0.3	7.9	39.4	37.5	1.0
90	−11.6	0.0	0.0	0.0	1.7	6.9	6.4	0.0
Future generations	177.1	—	—	—	—	—	—	—
	Percentage Difference in Net Payment							
Future generations and age zero	126.0	—	—	—	—	—	—	—

SOURCE: Office of Management and Budget (1993).

V. Net Tax Payments by Different Generations

Tables 4 and 5 provide a complementary perspective to lifetime net tax rates by presenting, in absolute amounts, the net tax payments for different generations based solely on those taxes and transfers to be paid or received in the future. These are the "generational accounts" as defined previously and as emphasized in most presentations of the method. The accounts in the year of a generation's birth are the same as its lifetime net tax payments.

The numbers in these tables represent the generational accounts as of calendar year 1992 for every fifth generation alive in that year. The first column, "net tax payment," is the difference between the present value of taxes that a member of each generation will pay, on average, over his or her remaining life and the present value of transfers that he or she will receive. The other columns show the average present values of different taxes and transfers. As with lifetime net tax rates, all federal, state, and local taxes and transfers are factored into these calculations. Federal spending and receipts include the effects of OBRA93.

Remaining Net Tax Payments by Existing Generations

The present value of future taxes to be paid by young and middle-aged generations far exceeds the present value of the future transfers they will receive. For males age 40 in 1992 — a group that is close to its peak taxpaying years — the present value of future taxes is $170,900 more than

TABLE 5

Generational Accounts for Females: Present Value of Taxes and Transfers under OBRA93 (thousands of dollars)

Generation's Age in 1992	Net Tax Payment	Taxes Paid: Labor Income Taxes	Taxes Paid: Capital Income Taxes	Taxes Paid: Payroll Taxes	Taxes Paid: Excise Taxes	Transfers Received: Social Security	Transfers Received: Health	Transfers Received: Welfare
0	44.1	16.6	8.4	18.0	29.2	6.4	13.1	8.6
5	54.8	21.3	10.8	23.0	34.2	8.1	15.5	11.0
10	67.3	27.1	13.8	29.4	39.3	9.7	18.6	14.0
15	82.5	34.4	17.7	37.5	44.5	11.1	22.6	17.9
20	96.9	40.7	22.3	44.6	48.0	12.4	25.8	20.5
25	101.5	42.1	27.3	46.2	49.1	15.4	29.4	18.5
30	96.9	39.5	32.2	43.5	49.0	18.9	33.4	15.0
35	87.8	36.3	37.3	40.0	48.9	23.7	39.1	11.9
40	69.1	31.5	40.5	34.9	47.8	29.9	46.6	9.1
45	39.7	25.1	41.4	27.8	45.4	37.9	55.3	6.8
50	2.4	18.1	40.2	20.2	41.5	48.4	64.1	5.2
55	–40.2	11.6	38.1	13.0	37.0	62.0	73.9	4.1
60	–86.3	6.0	34.9	6.8	31.8	79.2	83.2	3.5
65	–122.5	2.2	29.5	2.4	26.6	88.4	91.6	3.1
70	–124.6	0.9	20.7	1.0	21.7	81.4	84.6	2.8
75	–117.9	0.4	11.4	0.5	16.5	69.1	75.2	2.4
80	–100.5	0.2	4.3	0.2	12.1	54.1	61.2	2.0
85	–79.3	0.1	0.0	0.1	9.2	39.9	47.1	1.6
90	–11.3	0.0	0.0	0.0	1.6	5.9	6.7	0.3
Future generations	99.6	—	—	—	—	—	—	—
	Percentage Difference in Net Payment							
Future generations and age zero	126.0	—	—	—	—	—	—	—

SOURCE: Office of Management and Budget (1993).

the present value of future transfers. For newborn males, on the other hand, the comparable figure is much smaller, $78,400, because they will pay minimal taxes for a number of years.

Older generations, who are largely retired, will receive more Social Security, Medicare, and other future benefits than they will pay in future taxes. That is, they have negative net tax payments. Females will have smaller net payments than males, mostly because they earn less and therefore pay lower income and Social Security taxes.

Because the figures in these tables show the remaining lifetime net tax payments of particular generations, they do not include taxes paid or transfers received in the past. This should be kept in mind when considering the net tax payments of those now alive. The portion of a generation's lifetime net payment that remains depends on whether its members are 10, 40, or 65 years old. The fact that 40-year-old males can expect to pay more in the future than they receive, in present-value terms, while the reverse is true for 65-year-old males, does not mean that the government is treating 40-year-olds unfairly. Men who are now 65 paid substantial taxes when younger, and these amounts are not reflected in the remaining lifetime net tax payments shown in their generational accounts. Thus, the remaining lifetime payment of one existing generation cannot be compared directly with that of another. The lifetime payment of existing generations can be compared, however, using the net tax rates presented previously.

Tables 4 and 5 also show the different generational effects of various taxes and transfers. For example, the present value of future labor income taxes and payroll taxes is much higher for generations 60 years of age or less than for older generations, whereas the present value

TABLE 6

Generational Accounts under Different Policies (thousands of dollars)

Generation's Age in 1992	Before OBRA93		After OBRA93: Without Health Care Reform		After OBRA93: Administration's Plan		After OBRA93: With Faster Cost Growth	
	Males	Females	Males	Females	Males	Females	Males	Females
0	76.4	42.9	78.4	44.1	83.2	45.8	79.3	42.2
5	96.8	53.3	99.3	54.8	104.8	56.5	100.3	52.5
10	121.6	65.5	124.8	67.3	130.8	68.9	126.0	64.6
15	153.2	80.3	157.2	82.5	163.8	84.3	158.7	79.6
20	183.0	94.2	187.7	96.9	194.7	100.1	189.5	95.0
25	197.8	98.4	203.0	101.5	210.2	106.5	204.9	101.0
30	196.2	93.4	201.6	96.9	209.3	103.8	203.9	97.9
35	186.9	84.0	192.4	87.8	200.9	96.7	195.2	90.2
40	165.2	65.0	170.9	69.1	180.3	80.1	174.4	73.0
45	127.0	35.4	132.5	39.7	142.6	52.1	137.1	45.1
50	75.9	−2.0	81.0	2.4	91.1	15.2	87.0	9.4
55	14.7	−44.8	19.5	−40.2	29.3	−27.4	27.5	−30.9
60	−48.4	−91.2	−43.9	−86.3	−35.0	−74.4	−35.5	−76.3
65	−98.1	−127.1	−94.1	−122.5	−87.6	−113.2	−87.0	−113.4
70	−101.9	−128.4	−98.6	−124.6	−94.2	−118.0	−93.2	−116.9
75	−95.3	−120.9	−92.9	−117.9	−90.3	−114.0	−89.4	−112.5
80	−80.9	−102.6	−79.4	−100.5	−77.9	−98.2	−77.5	−97.4
85	−70.4	−80.7	−69.4	−79.3	−68.9	−78.5	−68.9	−78.5
90	−11.6	−11.3	−11.6	−11.3	−11.6	−11.3	−11.6	−11.3
Future generations	202.5	113.8	177.1	99.6	144.7	79.7	165.6	88.2
	Percentage Difference in Net Payment							
Future generations and age zero	165.1	165.1	126.0	126.0	73.9	108.8	108.8	108.8

SOURCE: Office of Management and Budget (1993).

of future capital income taxes and excise taxes is somewhat higher for those under 60. This is because the elderly tend to retire from the labor force, but still own homes and buy goods and services subject to property tax, sales tax, and other excises. As another example, the present value of Social Security and health care transfers is much higher for the elderly than for the young and middle-aged, because these kinds of transfers primarily accrue to the elderly and thus are discounted in the calculations over relatively few years. Welfare benefits, on the other hand, provide comparatively large benefits to the young, so their present value is higher for these age groups than for others.

Net Tax Payments by Future Generations

The estimates in tables 4 and 5 show that future generations will have to pay 126.0 percent more to the government, on average, than those born in 1992. The $177,100 average net tax payment for future males and the $99,600 payment for future females are calculated assuming that the ratio of net tax payments by males to that of females is the same for future generations as for those born in 1992.

The numbers also assume that all future Americans of a particular sex will make the same average net tax payment over their lifetimes after adjusting for overall economic growth. This growth adjustment is needed because future generations will pay more in taxes, net of the transfers received, simply because their incomes will be higher. This does not

represent a heavier fiscal burden. To properly assess the net tax payment by future generations relative to the newly born, it is necessary to calculate the net payment they will make above and beyond the amount due to economic growth. The generational accounts assume that all future generations pay the same net taxes apart from the effect of growth. This net tax is the number shown in the tables for all future generations of the same sex.

OBRA93 and Health Care Reform

Table 6 displays the generational accounts for the three policy regimes previously evaluated using lifetime net tax rates: a baseline before the enactment of OBRA93, estimates including OBRA93 (as shown in more detail in tables 4 and 5), and estimates including both OBRA93 and health care reform.

These numbers represent a different way of viewing the generational effects of policy changes and complement the effects of lifetime net tax rates revealed in table 3. OBRA93 and health care reform substantially reduce the generational imbalance between future and living generations. The net tax payments of future males (in present value) are reduced by both policies: $25,400 by OBRA93 and $32,400 by health care reform. For females, the comparable figures are $14,200 and $19,900. Each existing generation pays a larger net amount in present value, but the increase is not as much as the reduction for future generations. For example, 50-year-old males pay $5,100 more due to OBRA93 and $10,100 more due to health care reform. As explained above, the lower transfer payments under the health care initiative do not represent less care to the extent that they reflect a more efficient system.

VI. Conclusion

The generational accounting exercise presented here reveals a severe imbalance in current fiscal policy, in that future generations will have to remit a huge portion of their lifetime income to the government if the tax treatment of current generations remains unchanged. Under post–OBRA93 policy, this share is estimated at *82 percent.*

We do not mean to imply, however, that such a massive burden will necessarily be borne by future generations. By pointing out the dire consequences of continuing on our current policy path, this analysis suggests that legislative changes are imperative. Thus, the results of this exercise should be viewed as a projection based on the *assumption* that current policies will remain in force for the forseeable future, and not on a forecast that they will actually do so.

Appendix

Differences in Projections from the 1991 Estimates

The imbalance in the lifetime net tax rate between future generations and those born in 1992 is estimated at 165.1 percent before taking into account OBRA93 and health care reform. This baseline figure is much higher than the 111.1 percent estimated a year ago between future generations and those born in 1991.[10] Half of the difference can be traced to incorporating the Health Care Financing Administration's projection of Medicaid transfers through 2004 instead of assuming that these amounts will remain constant relative to GDP at the last actual ratio. If last year's method had been used, the current imbalance would be 145.0 percent.

The jump from 111.1 to 145.0 percent can be attributed to three factors: First, one more generation — those born in 1992 — will not make the higher lifetime net tax payments required of future generations. As a result, those born after 1992 will have still larger bills to pay. This effect accounts for about 8 percentage points of the increase. Second, of the remaining difference, a little less than half reflects the use of actual 1992 aggregate taxes, transfers, and purchases rather than projections. The rest of the increase can be explained by improvements in the cross-section profiles used to distribute taxes and transfers by age and sex, as well as to interactions among the various factors.

■ **10** See Auerbach, Gokhale, and Kotlikoff (1993).

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On Disinflation since 1982: An Application of Change-Point Tests

by Edward Bryden and John B. Carlson

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Introduction

On October 6, 1979, the Federal Open Market Committee of the Federal Reserve System embarked on an aggressive policy to lower the inflation rate, which then stood near 12 percent. That effort succeeded: By the mid-1980s, the rate of change in the Consumer Price Index (CPI) was reduced to less than 4 percent on a three-year moving-average basis, as shown in figure 1. The commonly reported measure of core inflation — the CPI less food and energy— also fell substantially. Since then, both inflation measures have been relatively stable, ranging between 3 and 5 percent for the CPI and between 4 and 5 percent for the CPI less food and energy. In the most recent three-year period, however, both measures have fallen to rates not seen since the mid-1960s.[1]

The behavior of inflation since the early 1980s evokes some interesting policy questions. Has inflation stabilized around some particular rate over the long term? Or will it be even lower in the 1990s, as the recent pattern in core inflation suggests? Moreover, how can one account for the relative stability of inflation in the face of the increased variability of money growth since 1980?

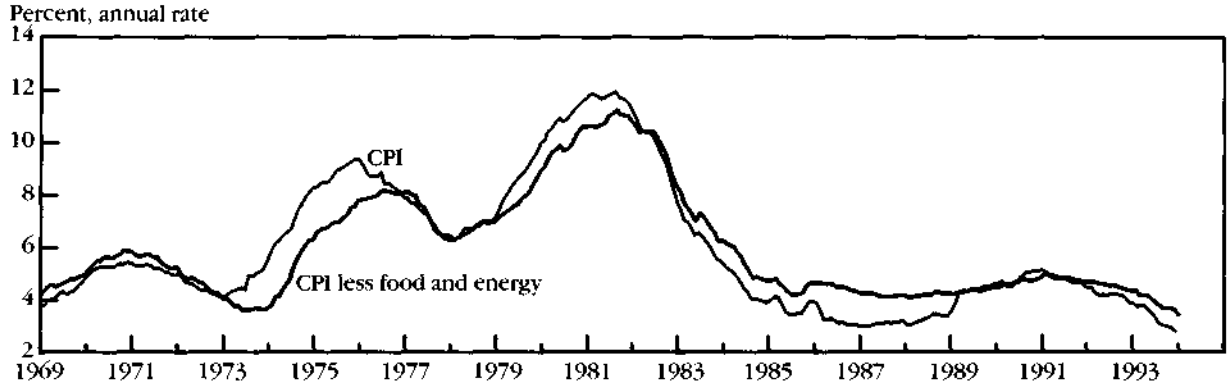
As an initial investigation into these issues, we examine more closely some recent changes in the univariate properties of alternative measures of core inflation. The data indicate that autocorrelation dropped sharply for all core measures after 1982. Indeed, for long periods, core inflation appears to behave as though it is generated by a process with a fixed mean and serially independent error term. Our chief purpose is to identify and explain periods over which the core measures exhibit such stationarity.

To address the question of whether disinflation has continued into the 1990s, we take an agnostic approach. Because the measures of core inflation appear to be essentially unchanged over long periods, we apply nonparametric tests suggested by Lombard (1987) to identify statistically significant change points in the distribution of inflation since 1982. If inflation has stabilized, then we would not expect to find any change in the distribution. Our results indicate that for all three core measures considered, permanent changes in the inflation

■ 1 Although CPI inflation dipped to around 1 percent in 1986 on a 12-month moving-average basis, this is widely viewed as a consequence of the transitory weakness in oil prices.

FIGURE 1

Inflation: Three-Year Moving-Average Basis



SOURCE: U.S. Department of Labor, Bureau of Labor Statistics.

rate have been infrequent and, for the most part, rather abrupt.

Although our approach does not rely on a particular structural context, the findings offer a benchmark against which structural results may be compared. Moreover, we are encouraged by the fact that the change points identified are coincident with economically significant events such as the onset and victory of the Persian Gulf War. We contend that such events may be watersheds of change in price-setting behavior; hence, we argue that change-point analysis may well be useful for detecting the timing of "permanent" changes in the rate of inflation.

The paper proceeds as follows: The next section introduces the concept of core inflation as developed by Bryan and Cecchetti (1993). We describe their measures and present an overview of the behavior of core inflation since 1982. The statistical framework we employ in testing for change points is outlined and the results are presented and discussed in section II. Although we offer no structural analysis, our findings have important implications for the current inflation rate. These implications are developed in section III, along with suitable caveats.

I. Core Inflation

Core inflation measures are generally designed to extract the long-run or permanent component of the measured price index by filtering out transitory elements of inflation.[2] For example, food and energy components of the CPI are subject to periodic supply shocks that produce relatively large but transitory (although sometimes persistent) changes in the CPI that are unrelated to more permanent changes. Although food and energy are among the more volatile components of the CPI, other comparably volatile components are not excluded; thus, the CPI excluding food and energy is somewhat arbitrary.

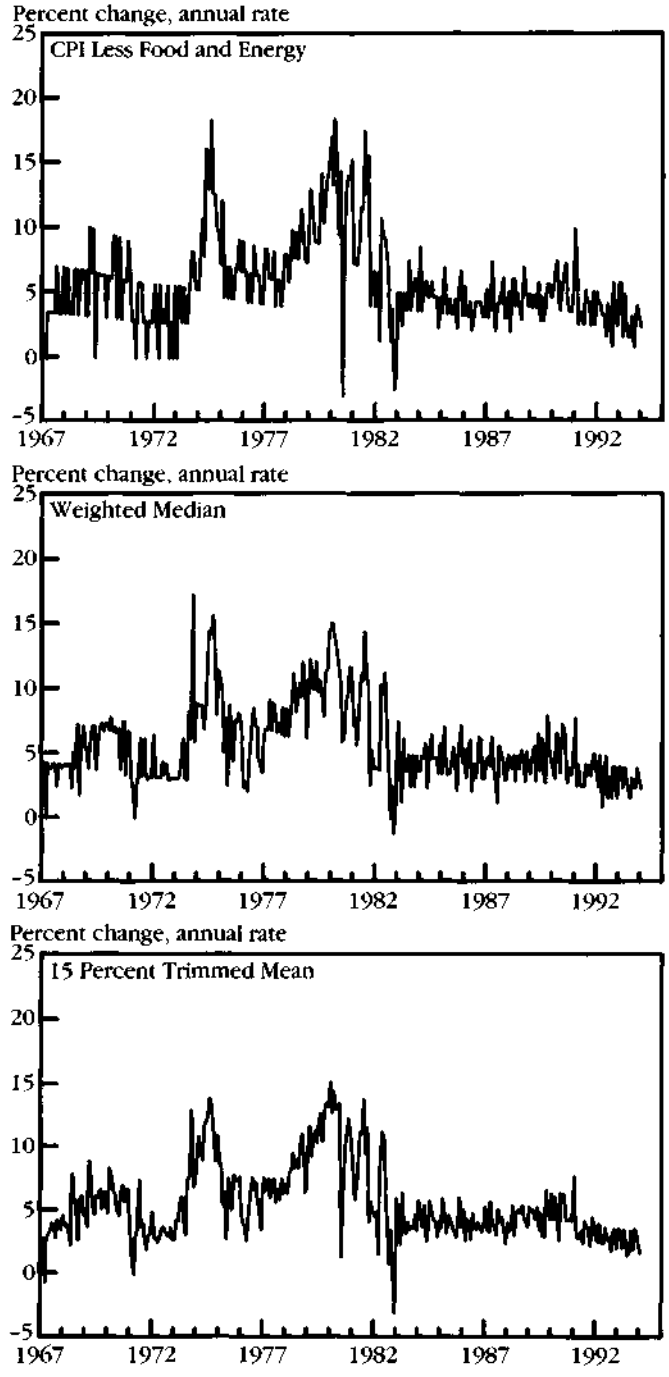
Alternative measures of core inflation suggested by Bryan and Cecchetti (1993) do not preselect any particular sectors for exclusion. Rather, their estimators are calculated by trimming the outlying portions of the cross-sectional distribution of the component parts of aggregate price indices in each month. Thus, these "limited-influence" estimators do not single out any specific sectors as the primary source of transitory noise for all periods.

Among this class of measures, Bryan and Cecchetti consider two particular estimators: the weighted median and the 15 percent trimmed mean. Both are computed using the fixed 1985 CPI expenditure weights as proximate measures of the number of prices in each category. More precisely, when computing the histogram for inflation, the weights are treated as the percentage of the distribution of all prices that experience the amount of inflation reported for that category. The weighted median

■ 2 In defining core inflation, Bryan and Cecchetti use the term *persistent* component of inflation as opposed to the permanent component. Because their example treats core inflation as an equilibrium concept determined solely by money growth, and since they operate in a single-period context, we believe the term *permanent* is more accurate

FIGURE 2

Monthly Change in Core Inflation Measures, 1967–92



SOURCES: U.S. Department of Labor, Bureau of Labor Statistics; and the Federal Reserve Bank of Cleveland.

is measured as the central point, as implied by the CPI expenditure weights, in the cross-sectional histogram of inflation each month. The 15 percent trimmed mean, which is the weighted average of the central 85 percent of the price-change distribution, was chosen because it had the smallest monthly variance of all trimmed estimators of this type.[3]

Figure 2 contrasts monthly changes in the weighted median and the 15 percent trimmed mean with the CPI excluding food and energy. Although the general patterns are the same since 1967, the alternatives proposed by Bryan and Cecchetti exhibit less variability, especially the 15 percent trimmed mean, which has a variance of around 1 percent after 1982. What is noteworthy is that all three series appear to have shifted downward sometime around the beginning of 1991. Within each of these subperiods, the core measures appear to be stationary and serially independent. We are thus motivated to look more closely at their time-series properties since 1982.

II. Univariate Properties of Core Inflation Measures

Figure 3 illustrates the substantial change in autocorrelation in core inflation measures before and after January 1983. The persistence of shocks, so evident in the earlier period, is virtually absent after 1982.[4] When dividing the latter period at the beginning of 1991, we find

■ **3** Bryan and Cecchetti also deal explicitly with conceptual issues. They note that although the term *core inflation* enjoys widespread use, it appears to have no clear definition. They argue that general usage of the term implies that it is tied in some way to money growth. Thus, excluding transitory components from the price index should result in a measure of monetary inflation.

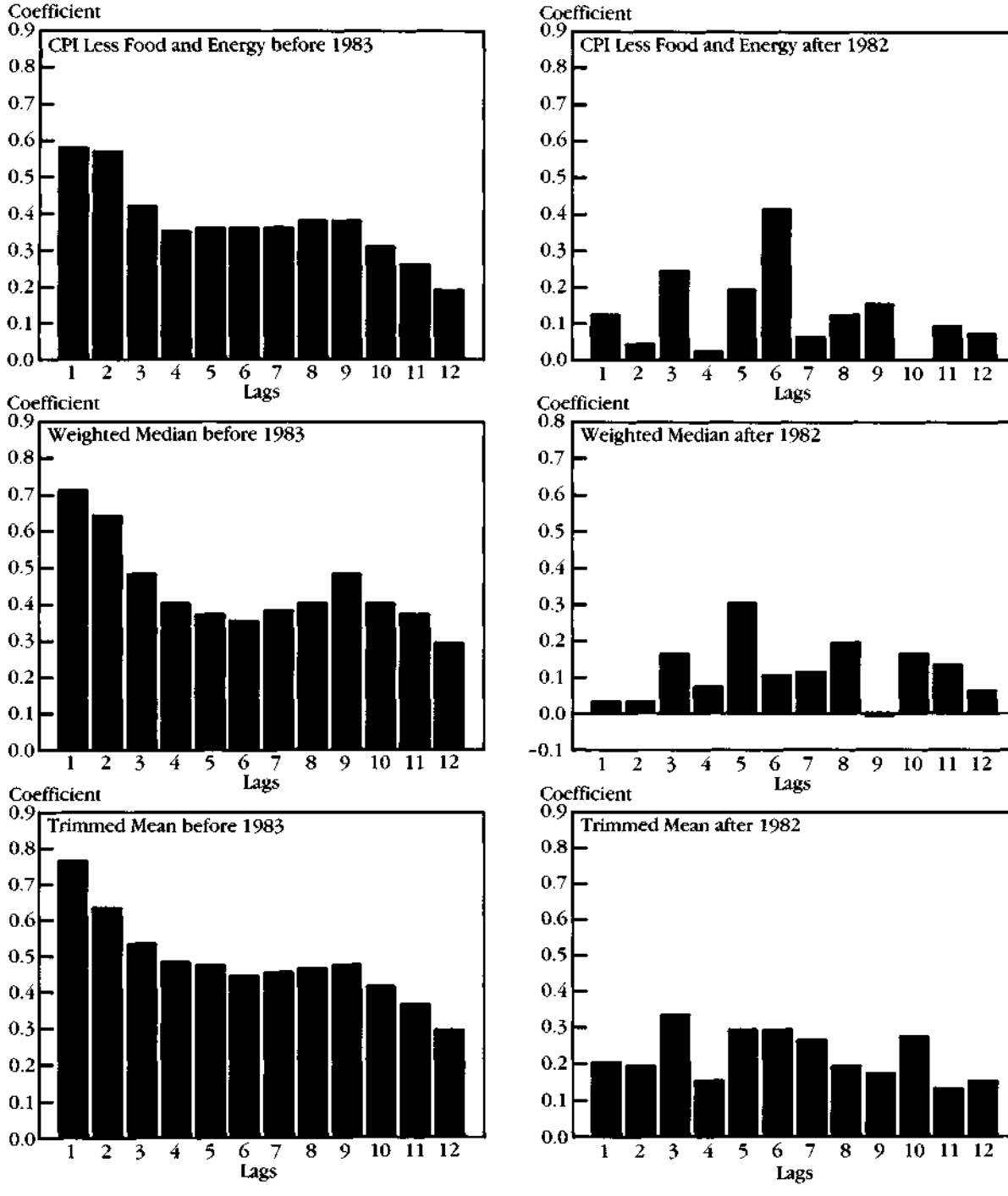
However, as Bryan and Cecchetti stress, a clear definition of core inflation necessarily requires a model of how prices and money are determined in the economy. Any such formal structure is difficult to formulate and easy to criticize, so they offer an illustrative example to highlight some desirable features for core measures. In this example, the money growth rate is the sole determinant of core inflation. Velocity is assumed to be constant.

Under assumptions of asymmetric supply disturbances, with costly price adjustment, they show that the observed skewness in the cross-sectional distribution of inflation can cause substantial noise in the aggregate CPI at high frequencies. Moreover, in this framework they can demonstrate that limited-influence estimators provide superior short-run measures of core (monetary) inflation. They also document that their estimates of inflation have a higher correlation with past money growth and provide improved forecasts of future inflation relative to the CPI.

■ **4** It is useful to note that the method for calculating the CPI housing component was changed around this time. Given that this component accounts for more than a third of the total measure, the change itself could explain some of the difference in time-series properties.

FIGURE 3

Autocorrelation Function of Core Inflation Measures



SOURCE: Authors' calculations.

TABLE 1

First-Order Serial Autocorrelation

Measure	Sample Period: January 1983–December 1990	Sample Period: January 1991–December 1993
CPI	0.4278[a]	−0.1743
CPI less food and energy	−0.0804	0.2783
Weighted median	−0.1304	−0.2033
15 percent trimmed mean	−0.0767	0.0508

a. Significantly different from zero at the 5 percent confidence level.
SOURCE: Authors' calculations.

little or no evidence of positive first-order serial correlation in the core measures in either of the subperiods; indeed, the estimated first-order correlation coefficients of the median or 15 percent trimmed mean are negative, albeit statistically insignificant (see table 1). It is interesting to note, however, that the CPI exhibits significant serial correlation in the January 1983 to December 1990 period, but not afterward. This probably reflects the impact of the transitory but somewhat persistent drop in oil prices from 1985 to 1986 that seemed to dominate CPI inflation but not core inflation (see figure 1).

To address the question of whether trend inflation has fallen in the 1990s, we apply nonparametric change-point tests proposed by Pettitt (1979) and Lombard (1987). Essentially, these procedures test the null hypothesis that a time series is drawn from a distribution having an unchanged mean. A change point essentially identifies a month after which the series mean changes. All test procedures assume serial independence, a condition satisfied by both the median and 15 percent trimmed mean.

The Pettitt procedure formulates a test statistic for a single (abrupt) change point; it also estimates a probable change-point date. Lombard proposes test statistics for the existence of one change point, multiple change points, smooth changes, and an onset of a trend. For abrupt change points, the Lombard procedure uses a heuristic approach: A series change point is identified when a cumulative rank score exhibits a pronounced and sustained change in direction (see box 1). We use the Pettitt estimate for identifying abrupt change-point dates. When a smooth (continuing) change is indicated, the Lombard procedure provides estimates for the beginning and ending points.

The test results, presented in table 2, indicate that core inflation measures were stationary over substantial periods during the 1980s. That is, over periods as long as eight years, core inflation was essentially impervious to other economic events. If any systematic effects occurred, presumably they were offsetting.

The test results are most dramatic for the 15 percent trimmed mean, confirming one or more series breaks since 1982. The Pettitt procedure indicates that the most likely change point occurred between January and February 1991.[5] Lombard test statistics reveal multiple change points — as many as three over the

BOX 1

Change-Point Test Methodology

Lombard (1987) has proposed several procedures to test for change points in the following context. Consider a sequence of independent random variables, $x_1, \ldots, x_T$ with continuous distribution functions $F(x, \theta_1), \ldots, F(x, \theta_T)$. The series has a change point at τ if $\theta_1 = \ldots = \theta_\tau = \theta$, while $\theta_{\tau+1}, \ldots, \theta_T$ differ from the unknown θ in some way. Since some procedures may be sensitive to distributional specifications, Lombard (1987), Pettitt (1979), and others have proposed nonparametric tests that are robust against deviations from tentative distributional assumptions. Essentially, data are replaced by the ranks of their magnitudes (or functions of these ranks), enabling "distribution free" tests of the null hypothesis of no change.

It is often more realistic to assume that a change occurs smoothly over a period of time rather than abruptly. For this purpose, Lombard considers a smooth change specification:

$$\theta_i = \begin{cases} \xi_1 & (i \le \tau_1), \\ \xi_1 + (i - \tau_1)(\xi_2 - \xi_1)/(\tau_2 - \tau_1) & (\tau_1 < i \le \tau_2), \\ \xi_2 & (i > \tau_2), \end{cases}$$

where ξ_1, ξ_2, τ_1, and τ_2 are unknown. Note that the abrupt-change model is a special case where $\tau_2 = \tau_1 + 1$. Moreover, an onset of a trend is a special case characterized by $\tau_2 = T$ and $\tau_1 < \tau_2 - 1$.

Lombard derives rank test statistics of H_0: $\xi_1 = \xi_2$ against hypotheses of one, two, and three abrupt changes, smooth change, and an onset of a trend. He also provides a table of significance points for each of these test statistics based on asymptotic null distributions. Asymptotic significance points are shown to be applicable when sample sizes are at least 30. A method for estimating both τ_1 and τ_2 is also provided.

5 Here, we adopt the convention that the break-point month is the last month of the former series.

TABLE 2

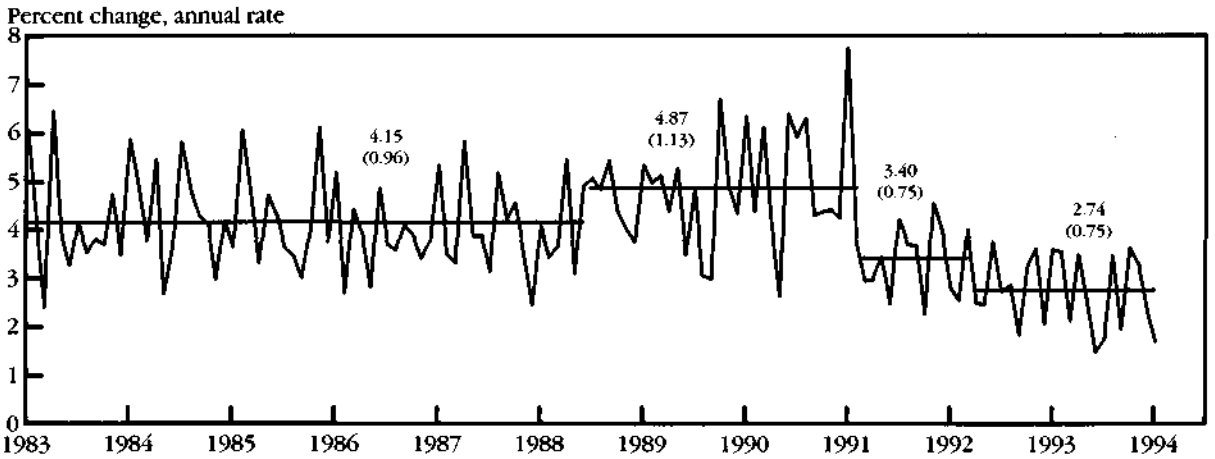
Change-Point Test Results

		Pettitt Statistics		Lombard Test Statistics: Number of Change Points				
Measure	Sample	Z	Date	One	Two	Three	Trend	Smooth
Trimmed mean	Jan. 1983–Jan. 1994	6.201469[a]	Jan. 1991	1.791591[a]	2.139584[a]	0.770881[a]	0.608218[a]	0.138368[a]
	Jan. 1983–Jan. 1991	3.283853[a]	May 1988	0.607060[a]	0.683709[a]	0.240834[a]	0.201422[a]	0.051301[a]
	Jan. 1983–May 1988	**1.401437**	**June 1985**	**0.145309**	**0.130436**	**0.045509**	**0.041794**	**0.013277**
	June 1988–Jan. 1991	**1.302128**	**Sept. 1989**	**0.064473**	**0.089653**	**0.035695**	**0.011791**	**0.003384**
	Feb. 1991–Jan. 1994	2.482423	March 1992	0.615216[a]	0.546649	0.171301	0.174561[a]	0.060578[a]
	Feb. 1991–March 1992	**0.993333**	**June 1991**	**0.043076**	**0.079633**	**0.029932**	**0.002808**	**0.001200**
	April 1992–Jan. 1994	**1.402339**	**April 1993**	**0.130472**	**0.119259**	**0.043223**	**0.031432**	**0.010101**
CPI less food and energy	Jan. 1983–Jan. 1994	4.361086[a]	Feb. 1991	0.996035[a]	1.051311[a]	0.381942[a]	0.327599[a]	0.075705[a]
	Jan. 1983–Feb. 1991	**2.092511**	**Feb. 1988**	**0.334410**	**0.553035**	**0.221737**	**0.066939**	**0.013824**
	March 1991–Jan. 1994	2.744248[a]	April 1992	0.908470[a]	0.827892[a]	0.255431[a]	0.269128[a]	0.090047[a]
	March 1991–April 1992	**1.405528**	**Sept. 1991**	**0.116254**	**0.147022**	**0.052344**	**0.018456**	**0.006603**
	May 1992–Jan. 1994	2.353672	May 1993	0.446918[a]	0.348901	0.104977	0.124092	0.042628[a]
Median	Jan. 1983–Jan. 1994	4.694689[a]	Jan. 1991	1.283018[a]	1.461698[a]	0.499620[a]	0.453666[a]	0.112148[a]
	Jan. 1983–Jan. 1991	**1.486857**	**Sept. 1989**	**0.064562**	**0.066373**	**0.027522**	**0.016832**	**0.003710**
	Feb. 1991–Jan. 1994	2.385073	March 1992	0.428849	0.423835	0.139890	0.118737	0.040678[a]
	Feb. 1991–March 1992	**1.660001**	**June 1991**	**0.170773**	**0.201458**	**0.070506**	**0.022328**	**0.011380**
	April 1992–Jan. 1994	**1.126164**	**May 1993**	**0.076230**	**0.124559**	**0.047927**	**0.008267**	**0.002577**

a. Significant at the 5 percent confidence level.
NOTE: Lines highlighted in blue indicate periods with no evidence of change in distribution.
SOURCE: Authors' calculations.

FIGURE 4

15 Percent Trimmed Mean, 1983–93



NOTE: Numbers appearing above solid rules indicate averages for the period shown. Numbers in parentheses represent standard deviations.
SOURCE: The Federal Reserve Bank of Cleveland.

whole period. The cumulative rank score peaks around January, confirming the Pettitt estimate of a probable change-point date. The Lombard procedure also indicates a possible smooth change. However, the procedure estimates for beginning and ending dates of smooth change are in adjacent months of January and February 1991, and hence corroborate the Pettitt change-point date.

Applying the same battery of tests to the data prior to February 1991 indicates another statistically significant change point, which according to the Pettitt procedure occurred in May 1988. Although the Lombard procedure corroborates the existence of an abrupt change point in that month, the test statistics for the onset of trend and smooth change are also significant. Inspection of the cumulative rank scores indicates an unambiguous turnaround in May 1988, corroborating other evidence of an abrupt change point in that month.

Applying the tests to further subperiods of the series reveals no other statistically significant change points. Thus, we conclude that the data in the periods from January 1983 to May 1988 and from June 1988 to January 1991 are from homogeneous groups.

Similarly, we find evidence of one abrupt change point after 1991. The Pettitt date indicates that this break occurred around April 1993.

The series change points are illustrated in figure 4. Average inflation rates (and standard deviations) within the homogeneous groups are also shown. Time-series methods proposed by Box and Jenkins (1970) indicate that the series is essentially white noise around a fixed mean. The autocorrelations of deviations of the 15 percent trimmed mean around its estimated trend levels are negligible (see the appendix).[6] Thus, as required by the Pettitt and Lombard tests, the assumption of serial independence is supported by the data. We conclude that inflation — as measured by the 15 percent trimmed mean — appears to have changed three times since 1982. Most noteworthy are the stability of this measure of core inflation within each of the four periods delineated by the change-point dates and the abruptness of the changes in inflation rates.

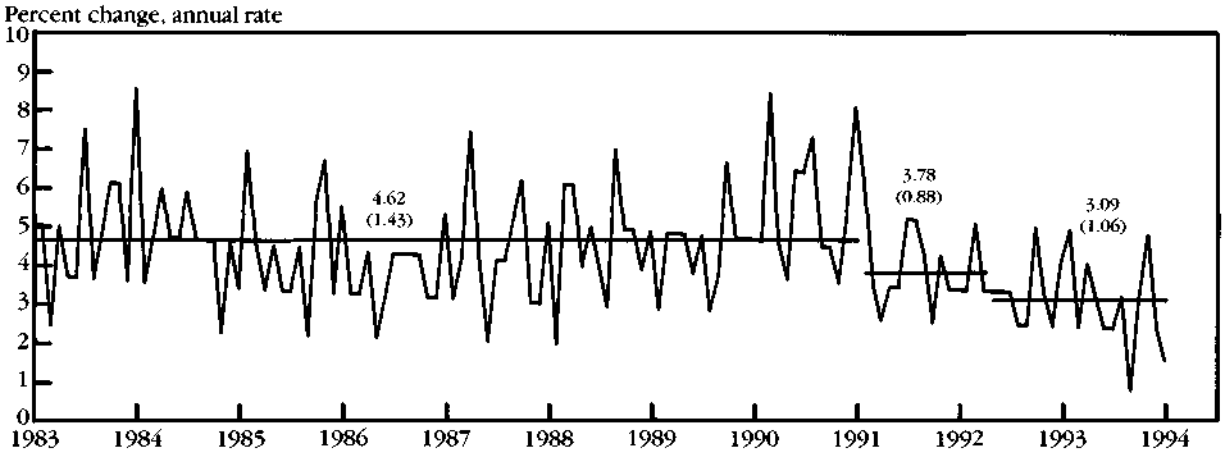
The test results for the CPI excluding food and energy are somewhat comparable, although they indicate a change point between February and March 1991, rather than between January and February 1991. Moreover, no significant change point is found in the sample prior to that date. However, the tests indicate another change point around the spring of 1992 comparable to the break found in the trimmed mean series. Although the Lombard test statistics are consistent with the existence of one change after April 1992, the Pettitt statistic is not. Given that little is known about the properties of the Lombard estimators for samples less than 30, we conclude that there is no break after April 1992.

The CPI less food and energy and its mean values within the three homogeneous groups are

■ 6 The Box–Pierce portmanteau statistic for 12 lags is estimated to be 16.12, well below the critical value at the 5 percent significance level.

FIGURE 5

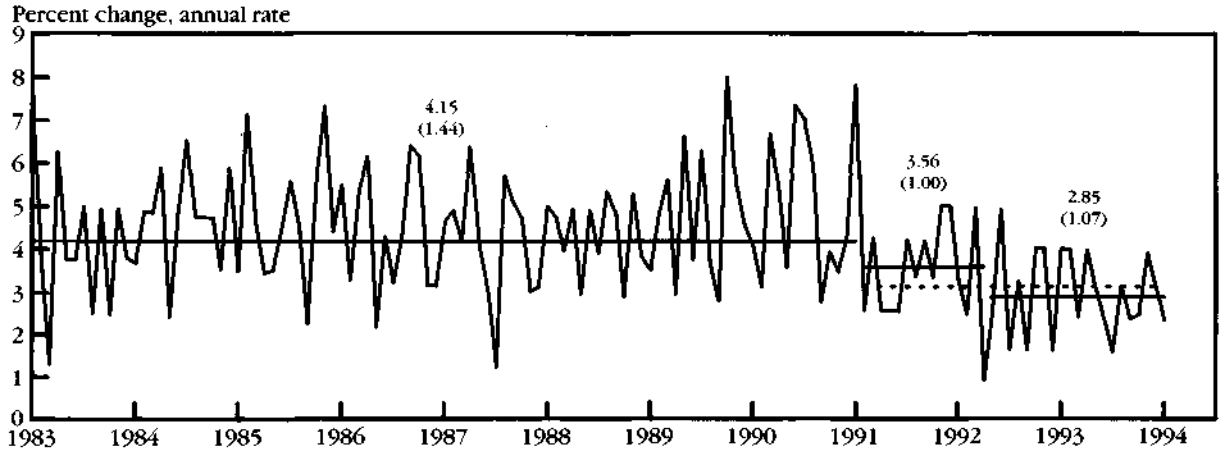
CPI Less Food and Energy, 1983–93



NOTE: Numbers appearing above solid rules indicate averages for the period shown. Numbers in parentheses represent standard deviations.
SOURCE: U.S. Department of Labor, Bureau of Labor Statistics.

FIGURE 6

Weighted Median, 1983–93



NOTE: Numbers appearing above solid rules indicate averages for the period shown. Numbers in parentheses represent standard deviations. Dotted line indicates trend after 1991 only.
SOURCE: The Federal Reserve Bank of Cleveland.

illustrated in figure 5. The autocorrelation function of deviations of this core inflation measure from its estimated trends is found in the appendix. Although there is some evidence of sixth-order autocorrelation, the coefficient is small and may reflect incomplete seasonal adjustment of the series, especially before 1990.[7] We conclude that there is not sufficient evidence of more persistent forms of autocorrelation.

The test results for the median CPI are mixed. Both Lombard and Pettitt procedures agree on the existence of a break between January and February 1991 and not in the prior period. After January 1991, the smooth-change statistic is significant, but beginning and ending points are in March and April 1992, consistent with an abrupt change. Inspection of the data (see figure 6) suggests a persistent if not permanent decrease in the inflation rate after this point.

■ 7 Individual components of the CPI are seasonally adjusted if they have historically exhibited a seasonal element. The seasonally adjusted CPI is a weighted average of components, some of which are seasonally adjusted. The aggregate index has tended to exhibit residual seasonality, raising questions about the validity of the method. Although a new seasonal adjustment procedure adopted in early 1994 has reduced residual seasonality, it has not completely eliminated the problem.

In light of this and the strong evidence of corresponding downward shifts in both the 15 percent trimmed mean and the CPI less food and energy, we are inclined to accept the hypothesis that the median inflation rate fell further in 1992.[8]

To summarize, several common properties emerge from this analysis. First, the tests performed on our measures indicate that the core inflation rate was surprisingly stable. During long periods over the last economic expansion, these measures behaved as though they were stationary processes with fixed means. The 15 percent trimmed mean series, however, suggests that inflation accelerated moderately, but rather abruptly, sometime around May 1988 and hovered around 4⅞ percent until early 1991. Neither of the other core measures exhibited a change point over the January 1983 to January 1991 period.

By early 1991, however, all series indicated that the core inflation rate declined substantially, again rather abruptly, and it may still be falling. The 15 percent trimmed mean and the CPI less food and energy tests suggest that inflation fell again around March 1992 to a rate below 3 percent. Although the median also appears to shift downward around this time, the statistical evidence is less compelling.

III. Interpretation of Results

Economists, as a rule, are reluctant to put much weight on univariate time-series results. After all, lending credence to univariate models is tantamount to admitting that economic theory is of little use. The absence of serial correlation, however, does have some interesting structural implications.

One obvious interpretation is that serial independence could be a manifestation of a systematic monetary policy that has effectively offset persistent or permanent shocks to inflation (at least for sustained periods). Under these circumstances, the stability of inflation in the 1980s could be the consequence of a reactive policy regime in which policy actions are based on deviations of inflation from a specified objective.

Such a regime would in principle require a well-defined, reliable model of the economy and a precise identification of policy objectives. The implied degree of understanding of such a system is surely beyond that which many policymakers would admit having. Furthermore, the Federal Open Market Committee (FOMC) does not choose an explicit objective for inflation. Although it reports the central tendency of members' expectations for inflation at the beginning of each year, these projections are not said to be policy *objectives*.

An alternative, and perhaps related, explanation for the serial independence of core inflation measures is that inflation expectations may play an important role in stabilizing month-to-month inflation rates. Inflation expectations themselves could have stabilized around lower rates because the Federal Reserve has established a consistent and credible policy of preventing persistent increases in inflation. Perhaps the central bank has done so by effectively anticipating and accommodating substantive shocks to money demand. Thus, although money growth — as measured by M2 — may have been quite variable over the last 10 years, its trend has been contained and even reduced.

To the extent that the FOMC has established a credible policy on inflation, price-setters are able to infer some inflation "norm." As long as policy remains consistent with that norm, price-setters have no basis for changing the prevailing set of expectations embodied in it; hence, the norm tends to act as a stabilizing force in price-setting.

The idea of a stable inflation norm is distinct from the expectations process embodied in popular forecasting models. These models, based on Phillips curves, are generally augmented with some mechanism to incorporate adaptive expectations. Such models include lagged values of inflation as determinants of current and future inflation. Indeed, lagged inflation typically accounts for the lion's share of their explanatory power.

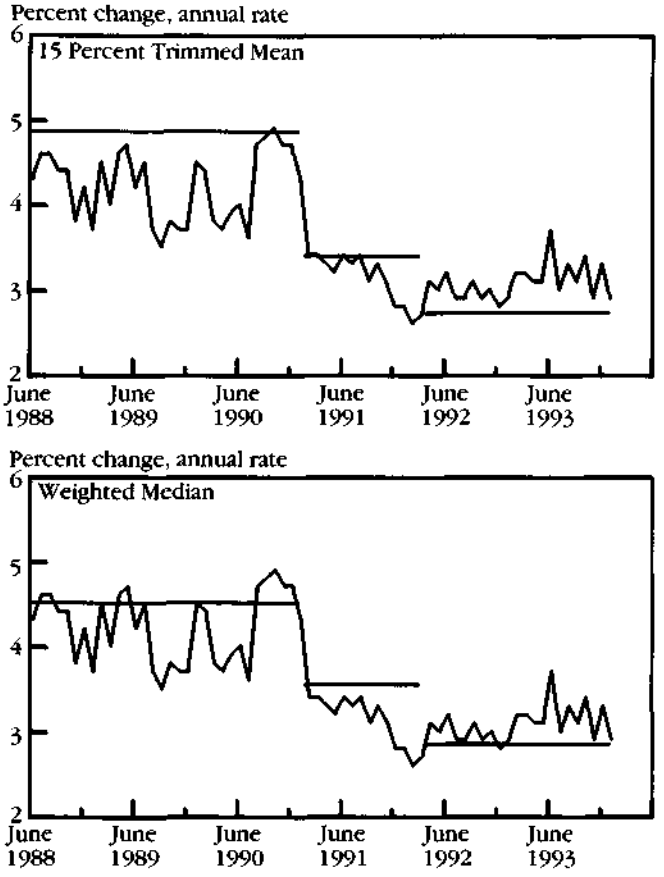
Our analysis of the inflation experience since 1982, however, raises questions about the short-run reliability of models that assume adaptive expectations. The absence of serial correlation since 1982 suggests that lagged inflation may matter only when inflation is high or variable, as in the period from 1966 through 1982. Indeed, the autoregressive nature of inflation seems to be unique to this period. Persistence of CPI inflation was negligible from 1955 to 1965, when the inflation rate (like now) was low and less variable. In fact, first-order autocorrelation of the CPI less food and energy was marginally *negative* from 1959 (when it was first reported) to 1967.

We speculate that the high degree of autocorrelation between 1968 and 1983 may be an

■ 8 The cumulative rank scores provided by the Lombard test suggest a potential change in April 1992.

FIGURE 7

Expected Inflation versus Core Trends, 1988–93



SOURCE: University of Michigan, Survey of Consumers.

artifact of an environment in which inflation policy was perceived as nonstationary or nearly so. In such a world, current inflation is the best predictor of future inflation. However, when a deliberate policy succeeds in maintaining inflation at low levels, expectations naturally tend to stabilize. The clearly articulated disinflation policy adopted in 1979 was to some extent a deliberate attempt to make inflation a stable process again. The univariate results presented above offer some evidence of the success of this policy.

Our speculation that the persistence of inflation shocks in the 1970s is largely an artifact of an unstable policy regime is consistent with the results of Schultze (1986). He finds no significant serial correlation in inflation (based on annual data) in the period 1871 to 1914, when the gold standard was in operation. On the contrary, Schultze finds evidence that inflation during the gold standard era was regressive on the *price level*. That is, whenever the price level rose above its trend path, it tended to have a negative influence on inflation in the next year. Schultze attributes this result to an implicitly accepted reference norm (or, if you will, a prevailing set of expectations) that appeared to emerge naturally under the gold standard regime.

Our hypothesis about the importance of expectations in determining actual inflation may also be supported by the change-point test findings of relatively abrupt changes in core inflation. The most substantial reductions in the trend inflation rates of all core measures occurred in either January or February 1991, coincident with the climax of the Persian Gulf War. We conjecture that events like the Gulf War can lead to watershed changes in expectations when coupled with a deliberate, if not precisely specified, policy.

Figure 7 provides some basis for identifying expectations as a factor accounting for the abruptness in inflation changes. Household expectations of inflation appeared to stabilize around substantially lower levels immediately after the Gulf War was resolved. In contrast, household expectations were quite variable and on average higher in the 30 months or so prior to the climax of the conflict.

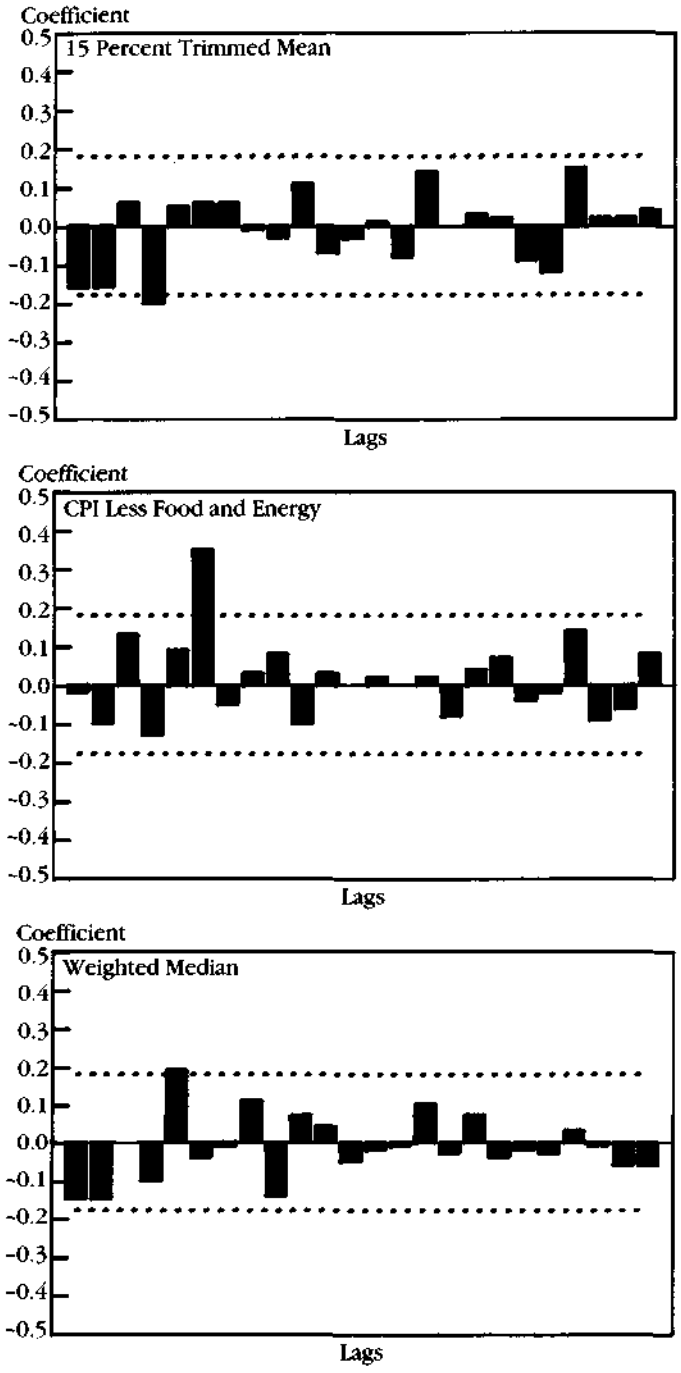
Given the history of oil price shocks (associated with Mideast crises) and subsequent policy responses, it is perhaps surprising that inflation expectations would actually fall. We note, however, that events of the late 1980s and early 1990s occurred in the context of a longer-term policy strategy that sought to achieve further progress toward price stability.

Although the FOMC does not specify a numerical objective for inflation, its monetary policy report to Congress has consistently contained language indicating that the longer-run intent of policy is to reduce inflation further. By the end of the Gulf War, policymakers had taken a series of actions over a number of years that helped to prevent the surge in oil prices from interfering with the longer-term objective of price stability.[9] The inflationary pressures leading up to and during the war in some sense provided a test of this resolve.

■ 9 For an analysis of the events surrounding the most recent oil price shock, see Taylor (1993).

APPENDIX

Autocorrelation Function of Deviations around Trend Means



NOTE: Dotted lines denote 5 percent confidence ranges. When series are serially independent, we might expect one estimate in 20 to be outside the range.
SOURCE: Authors' calculations.

IV. Concluding Remarks

Fourteen years have passed since the Federal Reserve embarked on its long-run policy of disinflation. Despite a slight acceleration in the inflation rate in the late 1980s, the trend appears to be one consistent with continuing, but episodic, declines. Over the last three years, core measures of inflation have averaged around 3 percent, more than a full percentage point less than the average rate over the previous eight years.

Inspection of the time-series properties of core measures suggests that it is not unreasonable to conclude that over substantial periods (say, five to eight years), the inflation rate varied around a fixed mean. To the extent that any significant systematic movements in inflation occurred within such periods, they seem to have been dwarfed by noise at monthly frequencies. This is not to say that core inflation did not change, only that at monthly frequencies, any potential permanent or persistent changes have been relatively small and hard to detect. More substantial changes in inflation since 1982 have been infrequent and rather abrupt.

The relative stability of core inflation measures within extended periods is difficult to reconcile in models commonly used to explain changes in inflation. We conjecture that consistent monetary policy can lead to the development of an inflation norm. The prevailing set of expectations embedded in the norm could play a considerable role in stabilizing the inflation rate.

Although the Federal Reserve has consistently identified continuing progress toward price stability as one of its objectives, an exact numerical path is not specified. Thus, households and financial market participants have no precisely defined benchmark against which to monitor the process of disinflation. Events like the Gulf War appear to be a focal point. To the extent that the inflationary pressures preceding and during the war provided a test of the central bank's resolve to make continuing progress toward price stability, the resolution of the conflict may have triggered a watershed for changing expectations.

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