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THE FEDERAL RESERVE BANK of ST. LOUIS

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In This Issue . . .

In the first article of this *Review*, Mack Ott investigates the relation between the increasingly large U.S. merchandise trade deficits occurring since the mid-1970s and a lesser-known, puzzling attribute of the U.S. balance of payments during this era — the increasingly large statistical discrepancy. Starting from the accounting relation between export reporting errors and the disagreement between the current and capital sides of the balance of payments, Ott builds the case for the discrepancy being evidence of a persistent underreporting of U.S. merchandise exports. Indirect evidence consistent with this view from studies of underreporting in international services trade and from U.S. domestic studies of understated taxable income are discussed to motivate the statistical tests which follow. The test results are consistent with an affirmative answer to the article's question: U.S. merchandise exports have been underreported since the mid-1970s.

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From the early 1930s through the late 1970s, per capita incomes rose faster in low-income states than in high-income states, resulting in a substantial reduction in state per capita income inequality. This long-standing trend has since reversed: since 1978, the interstate inequality of per capita incomes has risen in all but one year.

In this issue's second article, "Why Have State Per Capita Incomes Diverged Recently?" Cletus C. Coughlin and Thomas B. Mandelbaum find that the recent increase in income inequality stems from the rapid growth in 10 high-income Atlantic Coast states along with relatively slow growth in 10 low-income states scattered throughout the nation's interior. After considering several explanations of regional growth, including the movement of industrial activity from the Frost Belt to the Sun Belt and the "farm crisis," the authors conclude that declining energy prices during the 1980s was the primary contributor to the rising inequality of state per capita income.

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Explaining the behavior of interest rates has been a long-standing preoccupation for many economists. Although economic theory suggests that the relationship between short- and long-term interest rates is simple, empirical research, almost uniformly, has rejected it. In the third article of this issue, Michael T. Belongia and Kees G. Koedijk re-examine a basic model of interest rate determination by considering the effects of several well-known policy changes.

In their "Testing the Expectations Model of the Term Structure: Some Conjectures on the Effects of Institutional Changes," Belongia and Koedijk consider how changes in the Federal Reserve's implementation of monetary policy and the operation of the European Monetary System may have affected interest rate behavior. Using data for five countries, the authors find that forward rates are not related one-to-one with changes in actual three-month interest rates in the United States, Germany and Switzerland. Even though considering the operating procedures of the Fed and the EMS led to some improvement in the results, the persistent model rejections leave behind many unsolved puzzles.

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In the 1980s, the relationships between the growth of the monetary base and the growth of the major monetary aggregates, M1, M2 and M3, has changed dramatically. Historically, M1 had grown more slowly than the monetary base, while M2 and M3 had growth about 2 to 3 percentage points faster. Beginning in early 1984, however, M1 began to grow much faster than the monetary base, while M2 and M3 grew more slowly than the base. In the final article in this *Review*, "The Puzzling Growth of the Monetary Aggregates in the 1980s," Albert E. Burger presents a framework of analysis that helps unravel this mystery.

Burger derives multipliers that link the monetary base to M1, M2 and M3. The component ratios of these multipliers summarize the key asset portfolio decisions made by the public that affect the growth of the aggregates. The author presents the recent behavior of these ratios in a historical context to emphasize the dramatic nature of the changes that occurred in the 1980s. He traces the acceleration in M1 relative to base growth to the sharp rise in the public's holdings of checkable deposits relative to its holdings of currency, an unusual historical development. Burger also shows that M2 and M3, in addition to being affected by this development, also have been affected by a rise in the public's holdings of checkable deposits relative to the other financial assets that compose these aggregates.

The key developments associated with this changed behavior of the component ratios — the financial innovations in the 1970s and 1980s, and the sharp reduction of inflation and interest rates in the 1980s — are also discussed. The author shows that, although the relationships between the growth of the monetary base and the M1, M2 and M3 aggregates changed significantly in the 1980s, the growth of these monetary aggregates remains tied to the growth of the monetary base.

Mack Ott

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Have U.S. Exports Been Larger Than Reported?

IN LATE 1987, the U.S. Commerce Department announced that in its monthly trade reports, exports to Canada would henceforth use Canadian customs data on imports from the United States rather than U.S. export data. The rationale for this procedure is the documented inaccuracy since 1970 of U.S. customs data for exports to Canada. The discrepancies between the U.S. and Canadian data have become substantial both in absolute terms — nearly $11 billion in 1986 — and in terms of their effect on the U.S. trade balance — a 42 percent reduction in the 1986 U.S. trade deficit with Canada. While these errors are corrected in the annual reconciliation of U.S-Canadian trade data, their persistence raises a broader question: Are U.S. exports to other countries similarly understated?

This possibility raises some important political and economic issues. In recent years, the trade balance has been the focus of much economic policy debate, rivaling or complementing such traditional domestic issues as employment, inflation and growth. In this context, isolating large understatements in U.S. merchandise export data is clearly a topic with important policy implications.

In this article, the relationship between export underreporting and the statistical discrepancy in the balance of payments, which also rose from insignificance to prominence during the 1970s, is developed and is used to assess the validity of estimated U.S. export underreporting in the 1970s and 1980s.

BALANCE OF PAYMENTS ACCOUNTING, REPORTING ERRORS AND THE STATISTICAL DISCREPANCY

The first postwar U.S. trade deficit did not occur until 1971, a quarter of a century after World War II. During the early 1970s, the U.S. merchandise trade account alternated between deficits and surpluses; despite the comparatively weak growth of U.S. merchandise exports relative to imports, however, the declining U.S. current account balance remained in surplus during most years until 1982, primarily because of strong income from U.S. foreign investments.

Along with the declining current account balance, a persistently large discrepancy arose between the current and capital account balances. Since the first OPEC embargo in 1973–74, this discrepancy has averaged nearly $22 billion.[1] Before 1975, it had been generally small and negative, averaging −$1.1 billion from 1960 to 1974. The relation between the current account balance, errors in exports and the statistical discrepancy can be illustrated by reviewing balance of payments accounting.[2]

The Rudiments of Balance of Payments Accounting

Balance of payments accounting is structured by two basic principles: double-entry accounting and equality between net sales minus gifts and the change in financial claims. Balance of payments accounts record a country's sales (exports) and purchases (imports) of goods and services plus transfers to foreigners as well as its lending to (capital exports) and borrowing from (capital imports) other countries. The sum of goods and services purchased and sold to foreigners, minus transfers, in a given period is called the *current account balance*; the concomitant change during the same period in the country's financial position due to capital outflows and inflows is called its *capital account balance*. Oftentimes, discussion focuses on bilateral balances — for example, between the United States and Japan; however, countries generally have surpluses with some countries and deficits with others, and the overall balance with all countries is the most informative measure of a country's international economic condition. An illustration of these principles in a three-country example will highlight the offsetting equality of the current and capital account balances *assuming they are completely and accurately measured*.

An Illustration of Balance of Payments Accounting

Suppose that total world merchandise trade during a quarter consisted of a $1 million computer sold by the United States to Japan and $300,000 worth of crystal imported by the United States from Ireland, each paid for with short-term notes. These IOUs are capital imports (inflows) of the borrowers and capital exports (outflows) of the lenders. Suppose also that a corporation in Ireland, owned by U.S. residents, had profits during the period of $80,000, $50,000 of which remained with the subsidiary as retained earnings and $30,000 of which were paid to the U.S. owners out of the firm's deposits in a U.S. bank. The profits of the Irish firm, in effect, are the payment for the use of machines, buildings and financial resources that the U.S. owners have sent to Ireland — capital services exported by the United States to Ireland. The balance of payments for each of the three countries during the quarter is shown in figure 1.

Some Accounting Principles. The figure displays the transactions between the three countries in the T-accounts in the upper panel. Every transaction is entered twice, usually as a debit and a credit but also in a variety of other ways, depending on the transaction. For example, for the U.S. owned Irish firm's transactions, an $80,000 debit for capital services imported, a minus $30,000 debit for U.S. bank deposits drawn down, and a plus $50,000 credit for the reinvested retained earnings are the entries in the Irish accounts, while the opposite, balancing entries appear in the U.S. accounts. Note that debits (left-hand side of T-account) are entered with negative signs in the balance of payments (lower panel), while credits (right-hand side of T-accounts) are entered with positive signs. For example, the computer exported by the United States to Japan appears as a credit (export) in the U.S. current account and a debit (import) in the Japanese current account. In contrast, in the capital account, capital outflows (exports) appear with a negative sign while capital inflows (imports) appear with a positive sign. Thus, the Japanese note paying for the computer appears as a debit (capital export) in the U.S. capital account and a credit (capital import) in the Japanese capital account.

The Balance of Payments Identity. When the transactions for each country are summed up, the resulting statement is the balance of payments

[1]Throughout this article, the statistical discrepancy reported will be the "total discrepancy" — that is, the statistical discrepancy as it would be without the reconciliation adjustment for unreported trade with Canada.

[2]For a more detailed discussion of balance of payments accounting, see chapter 15, "The Balance of Payments and Foreign Exchange Rate," in Caves and Jones (1981). For an application of these principles to the U.S. trade deficit, see Chrystal and Wood (1988).

Figure 1

The Relation Between International Transactions and the Balance of Payments

Transactions T-Accounts

(−) United States		(+)	
$1,000,000	note	$1,000,000	computer exported
300,000	crystal	300,000	note
50,000	foreign investment	80,000	services
		−30,000	U.S. deposits

(−) Ireland		(+)	
$300,000	note	$300,000	crystal exported
80,000	capital services	50,000	Corporate retained earnings of U.S. subsidiary
−30,000	U.S. deposits		

(−) Japan		(+)	
$1,000,000	computer imported	$1,000,000	note

Balance of Payments Accounts

	U.S. balance of payments	Irish balance of payments	Japanese balance of payments
Current Account:			
Exports	$1,080,000	$300,000	$0
Imports	− 300,000	− 80,000	−1,000,000
Balance on current account	$780,000	$220,000	−$1,000,000
Capital Account:			
Increase (−) in U.S. / Irish / Japanese assets abroad	−$1,050,000	−$270,000	$0
Increase (+) in foreign assets in U.S. / Ireland / Japan	270,000	50,000	1,000,000
Balance on capital account	−$780,000	−$220,000	$1,000,000
Statistical discrepancy	$0	$0	$0

shown in the lower panel of figure 1. Since goods and services exports (imports) have positive (negative) signs in the current account balance while capital exports (imports) have negative (positive) signs, the current account balance (CAB) is equal and opposite in sign to the capital account balance (KAB) for each country. This essential identity of balance of payments accounting,

$$(1)\quad CAB + KAB \equiv 0,$$

must hold as long as the international transactions are properly and completely recorded, as they are in figure 1. In other words, if there is a trade surplus, $CAB > 0$, there must be a capital deficit (net capital outflow) of an equal absolute amount, $KAB = -CAB < 0$, and vice versa.

The common sense of this fundamental identity is that if a country sells more goods and services to foreigners than it buys from them, foreigners must balance this shortfall with real assets and financial claims on themselves — equities, real property, bonds and money.[3] Consequently, the balance of payments statistical discrepancy for each country in figure 1, a correction equal to the sum of CAB and KAB with the opposite sign, is zero.

In the example in figure 1, the United States has an overall current account surplus ($780,000), but it has a trade *deficit* with Ireland ($220,000) and a trade *surplus* with Japan ($1,000,000). If reporting errors or omissions are made with any country, they will show up in either the statistical discrepancy, the world current account balance or both. To see why, consider what happens when reporting errors are made.

The Effects of Errors in Reported Exports. In practice, the statistical discrepancy typically is not zero; errors or omissions in the data result in a nonzero discrepancy. For example, suppose the U.S. exporter had filed export documents listing the computer sale incorrectly as $900,000 while the earnings of the Irish firm are correctly given as $80,000. If no offsetting errors were made, the U.S. balance of payments would be as shown in figure 2, panel a. In this case, there is a statistical discrepancy equal to the export underreporting, $100,000. Such errors can be labeled relative errors: they affect the current account balance (ε) or capital account balance (κ) *relative* to each other causing a statistical discrepancy of equal magnitude and opposite sign.

Alternatively, some errors affect both current and capital accounts. For example, suppose the $1 million computer export was correctly reported, but the $80,000 earnings of the U.S. owned firm in Ireland were not reported. As a result, the rise in U.S. claims on Ireland ($50,000) also would be unreported in the United States as shown in panel b of figure 2. In this case, the U.S. statistical discrepancy would be $30,000 because of the documented (bank reports) decline in Irish-owned U.S. assets; however, the other $50,000 of the U.S. export understatement would be offset so that the levels of both current and capital balances are understated by the absolute amount of this error, $50,000. That is, the unreported $50,000 in retained earnings — unreported service income on current account — is matched by the unreported $50,000 reinvested in the firm — unreported capital outflow on capital account. These offsetting errors, denoted by α, can be called absolute errors since they change the *absolute* level of both current and capital accounts. They do not affect the relative levels of the two accounts; thus, they have no effect on the statistical discrepancy.

The general relation of the reported balance of payments data with the actual trade and financial transactions can then be summarized as follows:

$$(2)\quad \hat{CAB} \equiv CAB + \varepsilon + \alpha$$

$$(3)\quad \hat{KAB} \equiv KAB + \kappa - \alpha$$

where the "ˆ" indicates the reported data, ε and κ are relative errors in the reported $\hat{CAB}$ and $\hat{KAB}$, respectively, and α is an absolute error. The logic of the accounting conventions requires that

$$\hat{CAB} + \hat{KAB} + SD \equiv 0,$$

so the statistical discrepancy (SD) is defined as the negative of the sum of the reported balances,

$$(4)\quad SD \equiv -[\hat{CAB} + \hat{KAB}].$$

[3]This is, of course, the same rule which describes any voluntary exchange between two people. Any imbalance in the value of goods and services received over time is equal and opposite in sign to the net value of financial flows between them. Each person gives to the other a collection of goods, money and assets equal in value to what he receives.

Figure 2

Source of Statistical Discrepancy

(a)
Statistical Discrepancy: Underreported Exports without Offsetting Errors ($\varepsilon = -\$100,000$)

U.S. Balance of Payments		
Current account		
Exports	$980,000	
Imports	− 300,000	
Balance on current account		$680,000
Capital account		
Change in U.S. assets abroad	−$1,040,000	
Change in foreign assets in U.S.	260,000	
Balance on capital account		−780,000
Statistical discrepancy		$100,000

(b)
Statistical Discrepancy: Underreported Exports with partly Offsetting Errors ($\alpha = -\$50,000$, $\varepsilon = -\$30,000$)

U.S. Balance of Payments		
Current account		
Exports	$1,000,000	
Imports	− 300,000	
Balance on current account		$700,000
Capital account		
Change in U.S. assets abroad	−$1,000,000	
Change in foreign assets in U.S.	270,000	
Balance on capital account		−730,000
Statistical discrepancy		$30,000

From (2), (3) and (4),

$$SD \equiv -[CAB + \varepsilon + \alpha + KAB + \kappa - \alpha],$$

so that, by (1), SD is simply the negative of the sum of the relative errors, ε and κ; that is,

(5) $SD \equiv -[\varepsilon + \kappa]$.

While absolute errors (α) do not affect any country's balance of payments discrepancy, such errors do show up in the world balance of payments totals. Panel a of figure 3 shows that, with no reporting errors, the current account balance of the world is zero. The common sense of this is that for the total trading system, the surpluses of the nations with more exports than imports must balance the deficits of the nations with less exports than imports.[4] Panel b of figure 3 shows that with relative current account errors (ε), the U.S. export

[4]In macroeconomic theory, this is referred to as Walras' Law of Markets — the sum of trades (planned or actual) must be zero — with excess demands (+) and supplies (−) cancelling. See Patinkin, (1965) pp. 34–36.

Figure 3

The World Current Account and the World Current Account Discrepancy

(a)
No Reporting Errors

U.S. current account		
Exports	$1,080,000	
Imports	− 300,000	
U.S. CAB		$780,000
Irish current account		
Exports	$300,000	
Imports	− 80,000	
Irish CAB		220,000
Japanese current account		
Exports	$0	
Imports	−1,000,000	
Japanese CAB		−1,000,000
World CAB		$0

(b)
Underreported Exports With Relative Errors ($\varepsilon = -$ $100,000)

U.S. current account		
Exports	$980,000	
Imports	−300,000	
U.S. CAB		$680,000
Irish current account		
Exports	$300,000	
Imports	− 80,000	
Irish CAB		220,000
Japanese current account		
Exports	$0	
Imports	−1,000,000	
Japanese CAB		−1,000,000
World CAB		−$100,000

Figure 3 cont'd.

(c)
Underreported Exports with Absolute Errors (α = − $50,000) and Relative Errors (ε = − $30,000)

U.S. current account		
Exports	$1,000,000	
Imports	− 300,000	
U.S. CAB		$700,000
Irish current account		
Exports	$300,000	
Imports	− 80,000	
Irish CAB		220,000
Japanese current account		
Exports	$0	
Imports	− 1,000,000	
Japanese CAB		−1,000,000
World CAB		−$80,000

underreporting results in figure 2, panel a in an equivalent deviation from the logical world zero current account balance. Finally, panel c shows that both the absolute (α) and relative (ε) errors — the unreported U.S.-owned Irish firm's $50,000 retained earnings in figure 2, panel b *and* the $30,000 of unreported dividends — are reflected in the world CAB even though the U.S. SD shows only the relative ($30,000) error.

Some indirect evidence on the world current account discrepancy (see shaded insert) implies that the U.S. current account reflects both absolute (α) and relative (ε) errors, a mix illustrated in the distribution of the profits of the U.S.-owned Irish corporation in figures 2 and 3.[5] By its definition in identity 5, the U.S. balance of payments statistical discrepancy reflects only relative errors. Still, the indirect implication of unreported U.S. investment

[5]In testimony before the Joint Economic Committee, Heller (1984), p. 67, argued that such unreported investment earnings might be large enough to offset the reported CAB deficit:

> There is some reason to believe that the bulk of the unrecorded transactions is due to an underrecording of receipts of service items such as reinvested earnings abroad, investment income and fees. Consequently, the U.S. current account deficit, if measured properly, is likely to have been substantially smaller than indicated by the officially reported data. Thus it is entirely possible that the U.S. was in substantial current account surplus in 1983.

Stekler provides evidence that U.S. service exports are understated because of unreported interest; she uses differences between the data on U.S. claims on foreigners from three non-Treasury sources and the U.S. Treasury International Capital Reporting System (TIC) to generate estimates of unreported foreign source interest income. Her estimates suggest that unreported interest income was substantial during the early 1980s:

> In summary, in the three cases where data on U.S. claims on foreigners from the TIC reports can be compared with data from other sources it appears that the TIC data seriously understate U.S. claims. The size of the discrepancy between the data sources can only be roughly measured, but for example, a total on the order of $100 billion would not seem impossible. This would imply that U.S. interest receipts are underestimated by about $12 billion a year currently (assuming an average return of 12 percent). Stekler (1984), p. 7.

The World's Current Account Discrepancy

Any exported good from the country of origin is an imported good for the country of destination. As a consequence, if the data are complete and accurate, the world can have neither a trade deficit nor surplus; it must have a balance (see figure 3). Yet, as shown in the accompanying table, the world trade data do not yield a balance on current account.

Throughout the first half of the 1980s, world merchandise trade was in "surplus," substantially so in 1980 and 1981, and negligibly so since then. More broadly throughout the 1980s, the current account — the sum of merchandise and service trade minus transfers — has been in substantial deficit with no clear trend toward balance. The implication of these statistical discrepancies is that substantial export income is not being reported; that is, exports of services are understated.

The data in the table document a world current account deficit averaging $70.9 billion during the early 1980s. This world CAB discrepancy can be accounted for by a negative service account balance, with unreported shipping income, unreported direct investment income and unreported portfolio investment income the largest contributors. Shipping income is irrelevant for the United States; the IMF working party found it attributable to "several economies with large maritime interests (notably those of Greece, Hong Kong and Eastern Europe)."[1] The other two discrepancy items, direct

Selected Balances of World Current Account Transactions (billions of U.S. dollars)

	1980	1981	1982	1983	1984	1985
Merchandise trade balance	$31.1	$25.5	−$0.9	$3.0	$9.7	$7.8
Service balance	−46.8	−75.7	−88.5	−73.4	−85.1	−60.6
Shipment	−31.9	−35.3	−34.5	−33.2	−33.3	−27.4
Other transportation	−2.9	−5.3	−3.8	−2.8	−2.3	0.2
Travel	−0.5	0.8	1.6	4.1	4.7	5.3
Reinvested earnings on direct investment	13.0	11.0	2.0	8.4	10.0	21.0
Other direct investment income	−9.9	−13.1	−9.0	−11.6	−14.9	−12.5
Other (portfolio) investment income	−7.9	−18.6	−31.1	−28.8	−38.9	−46.6
Other official transactions	−11.6	−15.2	−12.2	−14.0	−12.1	−4.5
Other private transactions	4.9	0.1	−1.5	4.6	1.6	4.0
Private transfers	6.5	5.2	3.6	6.3	6.6	2.7
Current account (excluding official transfers)	−9.2	−45.0	−85.8	−64.1	−68.8	−50.1
Official transfers	−19.6	−17.6	−17.5	−15.3	−16.9	−15.5
Current account (including official transfers)	−28.8	−62.6	−103.4	−79.4	−85.7	−65.6

SOURCE: International Monetary Fund, *Report on the World Current Account Discrepancy*, table 6.

[1]International Monetary Fund (1987), p. 3.

and portfolio investment income, were found to be attributable in large part to U.S. investors' unreported or misreported foreign income.[2]

There are several common elements in these major unreported service exports comprising the world CAB discrepancy. First, in each case, the importer has reported receiving a service and paying for it, but the creditor has not acknowledged the income receipt or financial arrangement. Second, U.S. investments are either directly implicated by the evidence (direct investment) or indirectly implicated by the size of portfolio earnings (service exports). Third, for both direct and portfolio unreported earnings, there will be both absolute (α) and relative errors (ε) in the U.S. balance of payments: an unreported credit for service export and an unreported debit for the capital outflow represented by the unrepatriated earnings (see figure 3, panel c). Thus, these unreported exports do not affect the U.S. SD, but they illustrate that the world current account statistical discrepancy is primarily the result of underreported exports and that U.S. firms and individuals are involved in underreporting exports.

[2]For a discussion of direct investment adjustments attributed to U.S. nonreported or misreported income, see pp. 35–39 of International Monetary Fund (1987). For portfolio investment adjustments, the U.S. role is more conjectural in that the working party was able only to pin down adjustments to industrial countries and others. Yet, it is plausible that the United States, as the largest holder of foreign securities in the year (1983) analyzed in detail — 27.8 percent of world cross-border bond holdings and 44 percent of cross-border equities (p. 68) — is a substantial nonreporter. See pp. 45–80, in particular tables 29 and 30 where unreported U.S. nonbank deposit interest is estimated at $7.7 billion; see also Stekler (1984).

earnings is that U.S. exports have been understated during the 1980s and that this understatement is reflected partly (ε) in the U.S. statistical discrepancy. It is especially noteworthy how large and persistent both the statistical discrepancy and the world current account balance have been since the mid-1970s.

The U.S. Balance of Payments Statistical Discrepancy: 1960–86

As chart 1 shows, the statistical discrepancy has become quite large since the mid-1970s. Two versions of the discrepancy are shown in chart 1: the reported SD (SDHAT) and the total SD (SDTOT). SDTOT includes the discrepancy due to U.S. underreporting of U.S. exports to Canada. SDHAT has been purged of this error by the annual reconciliation agreed upon between the U.S. Census Bureau of the Commerce Department and its Canadian counterpart, Statistics Canada.

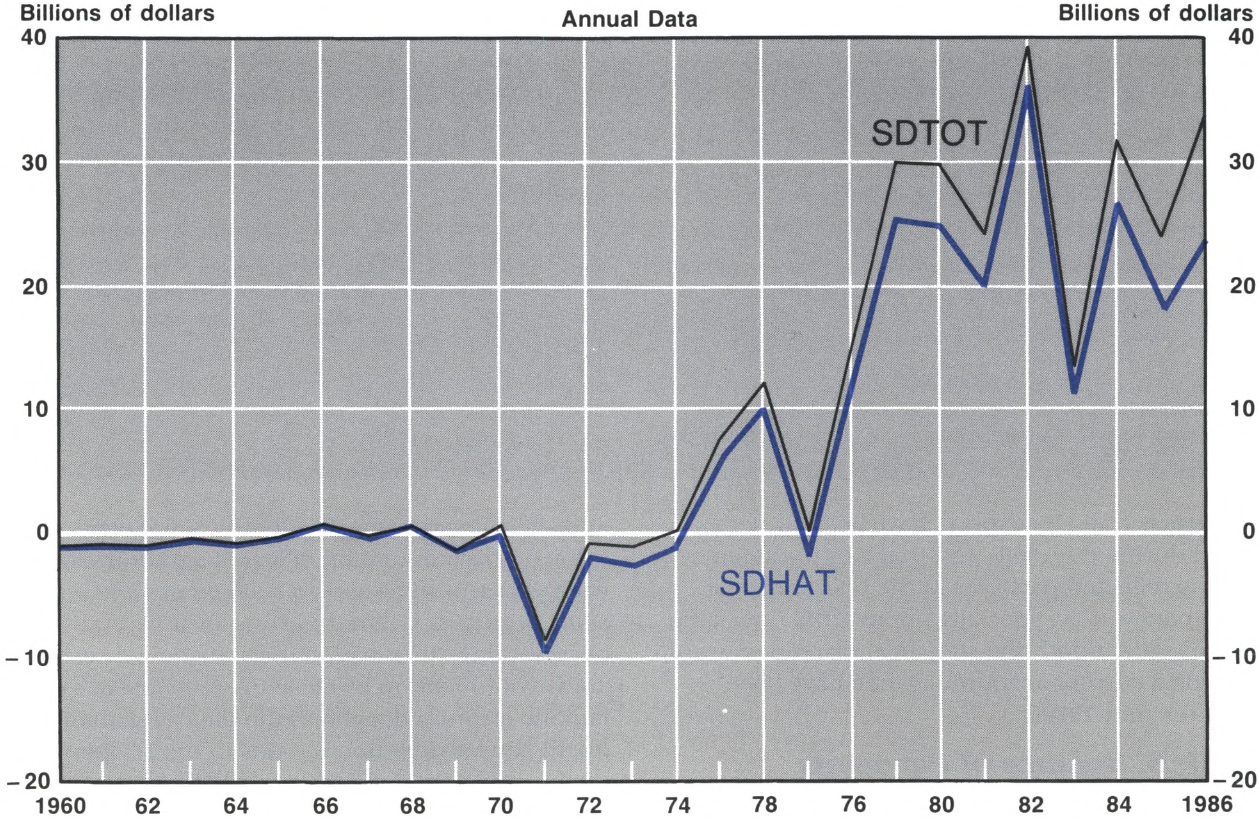
The persistence of large positive values of the statistical discrepancy from 1975 onward suggests that there are non-random errors in the U.S. balance of payments data. From the definition of the statistical discrepancy in identity 5, the expected value of this summation of errors and omissions in each year would be zero, *if such errors and omissions were not systematic*. Thus, over several years' observations, the mean of the statistical discrepancy would tend to be close to zero. Absent systematic errors, a decline in the data's reliability might cause wider fluctuations in the SD; persistent positive SDs since the mid-1970s, however, suggest systematic errors.

The Source of the Statistical Discrepancy: Capital or Current Account Errors?

By its definition in identity 5, the statistical discrepancy must be due to either relative overstatement (ε) of the current account deficit or relative understatement (κ) of the capital account surplus. If capital account errors are responsible for the SD, capital inflows must have been persistently understated: as equation 4 shows, the capital surplus would have to be increased in order to drive SD to zero.[6]

[6]From a strictly logical point of view, there is also the possibility of overstatement of U.S. gross capital outflows — that is, an exaggeration of U.S. investment abroad; however, there is neither empirical evidence nor *a priori* behavioral foundation for its occurrence.

Chart 1
U.S. Balance of Payments Statistical Discrepancies, Unreconciled and Adjusted



NOTE: The reported statistical discrepancy, SDHAT, reflects the U.S.-Canadian merchandise trade reconciliation; the unreconciled statistical discrepancy, SDTOT, is the statistical discrepancy as it would be without the U.S.-Canadian reconciliation.

Although most observers argue that capital account understatements are to blame for the SD's large deviations, this hypothesis is implausible from a behavioral standpoint.[7] Capital inflows primarily represent increases in debt for U.S. firms and individuals, and they have strong incentives to report them since the interest payments to service these debts are tax-deductible. This supposition has been supported by the IMF Working Group's study, *The World Current Account Dis-*

[7]The Department of Commerce intimates that the statistical discrepancy is likely to be relative capital account errors (κ): "If one assumes that a large part of cumulative net unrecorded inflows of about $140 billion from 1979 through 1984 was accounted for by capital inflows, foreign assets would have been understated by that amount . . ." Jack Bame, quoted in Scholl (1984), p. 26. Stekler (1983), p. 3, observes that "When the Interagency Work Group on the Statistical Discrepancy was set up in mid-1980, it was assumed that the bulk of the huge positive statistical discrepancy in 1979 and 1980 was accounted for by unrecorded capital inflows." Amuzegar (1988), p. 18, a former IMF Executive Director, reinforces this: ". . . capital inflows into the United States are probably unrecorded." Pluckhahn (1988) reports that Commerce officials still downplay the notion of current account errors explaining the discrepancy: "More likely, they say, capital flow statistics — measuring international financial transactions — have not kept up with the ongoing deregulation of financial markets." That SD has been KAB error is also assumed in textbook discussions, such as Krugman and Obstfeld (1988), p. 299, and empirical applications of the balance of payments data; for example, see Hooper and Morton (1982), p. 45: "The sum of the current account plus official intervention purchases of domestic currency (I) *define net private capital flows . . ." [italics added]*

crepancy, and by the Internal Revenue Service (1979) study of U.S. domestic unreported income. The Working Group found that borrowers worldwide do consistently report international capital inflows, while lenders have been found consistently to underreport their capital exports:

> The main result of analyzing the gaps in portfolio investment income reporting is that the discrepancy results mainly from the understatement of receipts by the private nonbank sector and that this deficiency is widespread across countries.[8]

Unreported capital inflows are the requisite explanation if the U.S. SD is due to capital account relative errors (κ); yet, debt increments have been found to be dependably reported. Unreported capital inflows would be inconsistent with both worldwide findings and the debtors' tax-minimizing incentives to report such debt increments. If anything, the IMF finding suggests that the capital account may be *overstated* because some capital outflows associated with reinvested earnings may be unreported.[9]

Conversely, if U.S. merchandise exports can be shown to be understated generally — as they have been in the specific case of Canada — then understatement of the CAB is a plausible culprit. There are three behavioral foundations for U.S. export understatement. First, is simple negligence or the costs of reporting, especially if the penalties for nonreporting are small. Second, sellers have an incentive to underreport sales because, if undetected, it reduces their taxable income. Third, the United States imposes restrictions on about 40 percent of U.S.-manufactured merchandise exports; to avoid outright export prohibitions or reduce the higher costs imposed on foreign buyers of U.S. machinery by such restrictions, some unreported sales are likely.[10]

U.S. MERCHANDISE EXPORTS: THE COMPARATIVE RELIABILITY OF U.S. EXPORT DATA VS. COUNTRY-OF-DESTINATION IMPORT DATA

In principle, as illustrated in the balance of payments figures 1–3, U.S. exports could be measured by U.S. data or country-of-destination import data. Yet, beginning in 1970, the U.S. Commerce Department has documented a persistent understatement of U.S. exports to Canada. Referred to as "undocumented exports," the extent of this problem is revealed in the annual reconciliation of U.S. and Canadian trade data through comparisons of U.S. export and Canadian import data.[11]

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[8]International Monetary Fund (1987), p. 78. Consistent with these IMF findings indirectly implicating U.S. investors, Stekler (1984), p. 3, observes that:

> Some have argued that since the United States accounts for about 20 percent of world services exports, that the United States probably accounts for the same share of the global services discrepancy ($15 billion in 1982).

[9]Note that in the 1980s, while the world current account discrepancy has been a substantial deficit, the world merchandise discrepancy has been slightly in surplus; see table a in the shaded insert. The world current account discrepancy and the large U.S. holding of foreign assets creates a presumption that U.S. service exports are understated. By itself, this provides a counter argument to the claim that unreported capital inflows are the explanation for the statistical discrepancy. In contrast, the absence of a worldwide merchandise export understatement does not in and of itself imply anything about errors in U.S. merchandise exports data.

[10]The first explanation is documented by the Commerce Department and is one of the reasons implied for the late 1960s episode of export underreporting in the United Kingdom. See "Under-recording of exports" (1969). The second has been substantiated by the IMF Working Party *Report on the World Current Account Discrepancy*, by the IRS (1979) study of unreported U.S. income, in the OECD study by Veil (1982) and in Stekler (1983). The third conjecture receives a variety of supporting argument in terms of costs and competitive disadvantage imposed on U.S. producers in the National Academy of Sciences (1987) study of U.S. export controls.

[11]For example, the cover page of the U.S. Department of Commerce release, "Summary of U.S. Export and Import Merchandise Trade" for March 1987 described the discrepancy in export reporting as follows:

> The annual trade data reconciliation study with Canada (scheduled for release in June) indicates a substantial and growing undercount of exports from the United States to Canada in 1986, amounting to approximately 20 percent. This is due primarily to the non-filing of export documents with the U.S. Customs Service. A number of joint U.S./Canadian efforts are underway to address this issue (informational mailings, bilateral collection of export documents, data exchange, etc.). The annual reconciliation studies also confirm that import data are more accurate than export data.

See also *Daily Report for Executives* for August 5, 1987. Such discrepancies are not unprecedented — see below, table 2 and footnotes 21, 22, 24 and 25. More generally, smuggling is a topic of longstanding interest to economists, both theoretically and empirically — see Bhagwati (1974). In industrial countries, the United Kingdom documented a pervasive period of export understatement in the late 1960s, amounting to about 3 percent of exports and, more significantly, as high as 58.2 percent of the reported trade balance in 1966. See "Underrecording of Exports" (1969), p. 667. While greatly reduced from the troublesome levels of the late 1960s, export underreporting in the United Kingdom continues and is accommodated in the national income accounts by a 1 percent allowance in exports in the CIF/FAS conversion procedure (private correspondence, Stephen Wright, Bank of England). There is also evidence that the Canadian export data are subject to similar lapses: During 1978–79, a refinery in New Brunswick did not file customs reports on exports to the United States; this resulted in a $700 million understatement in petroleum products exported by ship to the United States. See Rose (1979).

Table 1

U.S.-Canadian Merchandise Trade, 1980-86 (billions of dollars)

	Northbound Trade[1]			Southbound Trade[1]		U.S.-Canadian Trade Balances[2]		
	U.S. exports	Undocumented[3]	Canadian imports (FAS)	U.S. imports[4] (FAS)	Canadian exports	U.S. compiled	Canadian compiled	Reconciled
1980	$35.4	$4.9	$41.2	$41.2	$41.1	−$6.1	$0.2	−$1.4
1981	39.6	5.0	45.2	45.9	46.5	−6.9	−1.2	−2.8
1982	33.7	4.2	38.5	45.9	46.5	−12.8	−7.9	−9.7
1983	38.2	5.1	44.2	51.5	53.8	−13.9	−9.9	−11.7
1984	46.5	5.3	53.0	65.6	66.3	−20.0	−12.4	−15.4
1985	47.3	6.0	54.6	68.1	68.3	−21.7	−13.6	−15.7
1986	45.3	10.2	56.1	67.3	67.2	−22.9	−11.4	−13.3

[1]Reported exports and imports from IMF *Directions of Trade Statistics Yearbook, 1987*.
[2]U.S.-Canadian trade balances from U.S. Bureau of Census, Department of Commerce, "Reconciliation of Canada-United States Merchandise Trade, 1986."
[3]Undocumented exports from U.S. Department of Commerce (1987b), table 14.
[4]U.S. FAS imports estimated from CIF data, adjusted using 2.0 percent CIF/FAS margin; this choice is based on a comparison of FAS and CIF Canadian import data in the 1980s; see footnote 14.

The persistent understatement of U.S. exports to Canada and the resulting overstatement of the U.S. bilateral trade deficit with Canada in the 1980s is shown in table 1. The first five columns in the body of the table show the northbound trade (U.S. exports/Canadian imports) and southbound trade (U.S. imports/Canadian exports) as recorded by each of the countries' customs authorities, and their reconciled estimate of undocumented U.S. exports. While the southbound trade evinces no substantive disparities between the U.S. and Canadian data, the northbound trade data exhibit differences ranging from 14 percent to 24 percent of the U.S. export figures. As the undocumented exports column shows, most of this discrepancy has been acknowledged by the U.S. authorities as an understatement of exports. The sum of the compiled and undocumented U.S. exports approximate the Canadian import data, indicating that the Canadian import data are a far superior gauge of U.S. exports.

The last three columns of the table show the bilateral trade balances during the 1980s as compiled by each country and as reconciled during conferences between their respective customs authorities. Of course, the understatement of exports results in an underestimate of the U.S. trade balance — that is, an overstatement of the trade deficit. The acknowledged U.S. errors — U.S. exports — ranged from 27 percent to 80 percent of the U.S.-compiled bilateral deficit with Canada and from 4 percent to 19 percent of the U.S.-compiled total trade deficit with the world in the 1980s.[12]

In summary, the Canadian data are substantially more accurate than the U.S. data as the reconciled bilateral balance is far closer to the initial Canadian balance. More generally, these documented errors suggest that other country-of-destination import data may also offer a superior alternative to U.S. export data.

Two Problems with Using Country-of-Destination Import Data to Estimate U.S. Exports

There are two basic problems with using country-of-destination import data. First, most import data are reported CIF (Cost + Insurance + Freight), while export data are reported FAS (Free Alongside Ship) — that is, not including in-

[12]Computed from data in U.S. Department of Commerce (1987b), Table 14.

surance and freight charges.[13] These CIF import data must be adjusted to approximate the FAS export data.[14] This adjustment has been the subject of some research with inconclusive results.[15] Second, there is the issue of smuggling, especially in less-developed or nonindustrial countries, in which the omitted imports in the country-of-destination data could well exceed the omitted exports in the export data.[16]

Choosing the CIF/FAS Margin. One solution to the first problem is simply to choose a reasonable CIF/FAS margin to convert CIF data to FAS data. That is, the adjustment should make sense in light of what is known, at least anecdotally, about freight and insurance charges, but should not bias statistical tests of the export understatement hypothesis.

The evidence suggests a true margin for the industrial countries well below the 10 percent traditionally used by the IMF in its *Directions of Trade Statistics (DOTS)* data on bilateral merchandise trade. For example, the U.S. Commerce Department reports that, for U.S. imports, the average CIF-FAS margin is 5.2 percent; the Bank of England estimates 5.0 percent for U.K. imports; the Bank of Netherlands estimates a 5.6 percent CIF/FAS margin for Dutch imports during 1980–87; and Geraci and Prewo (1977) found a 5.2 percent transport margin for intra-European trade in 1970.[17] For the 15 countries in DOTS (see footnote 14) which report both FAS and CIF import data, the computed margins for the 1980s range from 2.4 percent for Canada to 20 percent for Peru, Solomon Islands and Zambia.

In general, these computed CIF/FAS margins were lower for industrial than for nonindustrial countries and for countries whose trade is predominantly with nearby trading partners.[18] For example, Mexico, a nonindustrial country, has a relatively low 4.6 percent margin, while Australia, an industrial country, has a moderate, but higher 10.0 percent margin. Mexico's margin is kept low by short transport lines with the United States from which it obtains nearly two-thirds of its reported imports; Australia's margin is raised by its relatively long transport lines with North America and Europe from which it obtains more than half its imports.

In light of the reported estimates and the computed CIF-FAS ratios, the empirical tests in this article assume that the CIF/FAS margin for industrial countries is 5.2 percent, the same as the average computed by the Commerce Department for all U.S. imports.[19]

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[13]Another reporting valuation, FOB (Free On Board) is frequently used as a synonym for FAS as it will be here. Strictly, FAS and FOB differ by the amount of loading and cargo handling charges included in the latter.

[14]Of the 151 IMF member countries whose bilateral trading volumes are covered in the *Directions of Trade Statistics*, 15 countries report imports FAS: Australia, Bermuda, Canada, Dominican Republic, Mexico, Papua New Guinea, Paraguay, Peru, Poland, Romania, Solomon Islands, South Africa, Venezuela, Zambia, Zimbabwe. Moreover, the IMF's annual IFS Yearbook reports CIF/FAS margins for each of the member countries; however, these margins are multilateral and cannot be used to isolate the appropriate margin on imports from the United States.

[15]Since insurance and freight are services, they should not appear in the merchandise trade account; moreover, these services may be rendered by a domestic or a foreign seller. Thus, they must be removed from the import data in order to make valid comparisons. See Geraci and Prewo (1977) and Yeats (1978).

[16]For an important collection of theoretical and empirical papers on this issue, see Bhagwati (1974).

[17]The U.S. CIF/FAS margin was published in *Daily Report for Executives*, No. 159, August 19, 1987, p.2. The U.K. margin was obtained by telephone from Gordon Midgely of the Bank of England and the Dutch estimate was supplied by M. van Nieuwkerk and A.C.J. Stokman of De Nederlandsche Bank in private correspondence.

[18]Both of these tendencies concur with the findings of Geraci and Prewo (1977); however, their point estimates (based on 1970 OECD data) are much higher: for example, 13.8 percent for UK imports, 22.9 percent for Canadian imports and 18.3 percent for U.S. imports; however, their estimates were obtained from the ratio of CIF imports in country of destination to FAS exports in country of origin. If, as we argue here, exports are understated, their approximation to the CIF/FAS margin will be biased upward. See Yeats (1978).

[19]This margin also conforms with anecdotal evidence on current U.S. shipping charges and insurance rates for both trans-Atlantic and trans-Pacific routes. In fact, it is actually somewhat high relative to examples of transport and insurance rates for ocean-shipped containers quoted in the St. Louis area in April 1988: $1400–$1600 pier-to-pier, for a 40-foot container (2680 cubic feet) Los Angeles to Yokohama, Japan. Examples of products a 40-foot container could transport include $1 million worth of small sporting firearms or $80,000 worth of liqueurs. With insurance at $4 per $1000 of declared value, these examples would have CIF/FAS margins of 0.6 percent and 2.4 percent, respectively. (I am indebted to Jerry Kausch, International Import-Export Services, St. Louis, for these examples). Bulk grain shipping rates, conversely, bracket the traditional 10 percent margin. From U.S. Gulf of Mexico ports to Rotterdam, the Netherlands, large deep draft bulk carriers of up to 110,000 tons displacement charge $15/metric ton (April 1988) and insurance of 0.15 percent of value. This implies a 4.95 percent CIF/FAS margin for soybeans, 16.3 percent for corn and 12.2 percent for hard red winter wheat given their April 1988 prices per metric ton, $248, $92 and $123, respectively. (I am indebted to John Muller of Bunge Grain Co., St. Louis, for these examples).

Table 2

Trade Discrepancies — Selected Areas and Country Imports from the World Compared with World Exports to Those Areas and Countries, 1980–86 (annual averages, billions of dollars)

	World exports to	Imports from the world by[1]	Discrepancy	Discrepancy as percentage of world exports to
Nonindustrial-131	$522.4	$492.1	$30.3	5.8%
Western Hemisphere	95.5	80.9	14.6	15.3
Egypt	11.8	8.6	3.2	27.1
Greece	12.0	9.1	2.9	24.2
Israel	7.4	9.1	−1.7	−23.0
Mexico	18.6	13.3	5.3	28.5
Panama	6.4	1.7	4.7	73.4
Phillipines	7.4	6.5	0.9	12.2
Singapore	27.0	24.5	2.5	9.3
South Africa	11.5	16.7	−5.2	−45.2
Industrial – 20[2]	1,240.9	1,260.6	−20.7	−1.7
Netherlands	80.1	64.1	16.0	20.0
Switzerland	36.0	31.8	4.2	11.7
Industrial-18[3]	1,124.8	1,166.6	−41.8	−3.7
Industrial-17[4]	843.1	873.8	−30.7	−3.6
United States	281.7	292.8	−11.1	−3.9

SOURCE: Data from *Directions of Trade Statistics, Yearbook 1987*, World exports and imports table.

[1]FAS imports estimated from CIF data using 10 percent CIF/FAS margin for nonindustrial countries and the *IFS Yearbook* CIF/FAS margin for industrial countries (see footnote 14).

[2]The 20 countries classified as industrial are Australia, Austria, Belgium-Luxembourg, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, the United Kingdom and the United States. (Note that Belgium and Luxembourg are counted as one country.)

[3]Industrial countries less the Netherlands and Switzerland.

[4]Industrial-18 less United States.

Screening for Valid Import Data. The other empirical problem with using country-of-destination import data to estimate U.S. exports is that the import data may not be valid. If all countries' import data were equally valid, then an estimate of the worldwide U.S. export understatement could be obtained easily from data on imports from the United States for all 151 countries in *DOTS*. The IMF classifies 20 of these countries as "industrial" and the others as "nonindustrial."[20] Table 2 provides a comparative assessment of the validity or completeness of the import data of the nonindustrial and industrial countries.

An impartial basis for evaluating the validity of a country's import data is to compare its own data compiling total imports from all of the countries in the world with the sum of the data compiled by the IMF of all the individual countries' exports to that country. Since countries obtain revenues from

[20]The 20 countries classified as industrial by the IMF in its *DOTS* are Australia, Austria, Belgium-Luxembourg, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, the United Kingdom and the United States. (Note that Belgium and Luxembourg are counted as one country.)

tariffs and police quotas on politically sensitive imports, a strong presumption exists that import data should be more complete — as in the U.S.-Canadian case — than export data. By this postulate, a country's trade data can be judged invalid if its reported FAS imports are less than the sum of world exports to it. For example, during the 1980s, as shown in table 2, the reported level of world exports to Mexico exceeded by 28.5 percent the level of FAS imports from the world reported by Mexico.[21] For Greece and the Phillipines, the corresponding shortfalls were 24.2 percent and 12.2 percent, respectively, while for Panama it was a whopping 73.4 percent. For nonindustrial countries in the Western Hemisphere, the understatement was 15.3 percent, while for all 131 nonindustrial countries, it averaged 5.8 percent. Such underreporting of imports in developing nations has been widely documented in the trade literature and often used as a measure of smuggling induced by tariff avoidance.[22]

These illustrations are not isolated; they reflect generally the characteristics of the nonindustrial countries' data. A more systematic analysis rejected all but 6 of the 131 nonindustrial countries' import data.[23] Given these problems, such data are not useful in testing the relationship between U.S. export understatement and the U.S. SD.

Applying the same criterion to the industrial country data results in a general acceptance of the validity of the import data for 18 of the 20 countries. Only the data of the Netherlands and Switzerland are rejected (discrepancies statistically significant at 1 percent level). Excluding these two countries more than doubles the average percentage discrepancy between imports from the world and world exports to the industrial countries from −1.7 percent to −3.7 percent. These two countries have a long tradition of re-exporting imported goods, referred to as "merchanting" in the Dutch data; re-exported goods are omitted from their import data. Consequently, world exports to them exceed their recorded net imports by substantial amounts, as the table shows.[24]

The exclusion of re-exported goods suggests that some U.S. exports may simply be unrecorded anywhere. That is, if a U.S. shipment to the Netherlands that is re-exported by a Dutch merchant to France is not reported as a Netherlands' import from the United States, but is measured solely as a Dutch export to France, foreign import data understate U.S. exports. The omission of the re-exported goods would cause the import-based estimate of U.S. exports to be understated; however, it would not cause errors in the two countries' own international data.[25]

Given the evidence of inaccurate import data illustrated in table 2, the estimates of the U.S. export understatement and tests of its hypothesized relationship to the U.S. balance of payments discrepancy employ a data set that includes 17 of the industrial countries: only the Netherlands, Switz-

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[21]The full discrepancy between the U.S. and Mexican data is further complicated by the U.S. Commerce Department's rough estimate that exports to Mexico are underreported by about 10 percent. (I am indebted to Gerald Kotwas, Assistant Chief Foreign Trade Division of Census Bureau, U.S. Department of Commerce, for this estimate.)

[22]See Bhagwati (1974), especially Part III — "Partner-Country Data Comparisons and Faked Invoicing." Sometimes, the errors are positive: Probably resulting from ineffective embargoes, the level of imports from the world by South Africa has exceeded acknowledged world exports by an average of 33.7 percent during the 1980s. Similarly, the level of Israeli imports has exceeded acknowledged world exports to Israel by 22.6 percent during the 1980s.

[23]The general testing of the nonindustrial countries was accomplished using a three-part screen:

(1) Availability of data on imports from the United States in each year, 1960–86; (2) Substantial trade volume with the United States (annual imports from the U.S. of at least $400 million 1980–86); and (3) Imports (FAS) reported from the world at least as large as reported world exports to the country.

Only 6 of the IMF 131 nonindustrial countries passed this screen: Indonesia, Israel, Korea, South Africa, Trinidad-Tobago and Venezuela. These countries accounted for only about 20 percent of U.S. exports to nonindustrial countries and about 7 percent of total U.S. exports in 1986.

[24]Net imports are imports less re-exported goods. The Netherlands, for example, does not count a landed shipment of merchandise as a Dutch import if it neither a) changes title to a Dutch resident, nor b) crosses the border (i.e. — passes through customs). Hence, goods landed in the Netherlands and reexported apparently have been counted by exporting countries as an export to the Netherlands; however, according to the Bank of the Netherlands, which compiles the Dutch trade data, the Netherlands has not counted them as an import.

[25]In principle, since the Netherlands and Switzerland report net exports as well as net imports, the omission of U.S. exports to any of them should be captured in their exports to other countries being similarly understated relative to the importing country's data; that is, the sum of the two discrepancies should be approximately zero. This offsetting does occur in the data for Switzerland but not for the Netherlands trade data (billions of dollars) 1980–86 averages:

	Discrepancy between world exports and country imports	Discrepancy between world imports and country exports	Sum
Netherlands	16.00	1.55	17.55
Switzerland	4.20	–5.05	–0.85

Table 3

U.S. Balance of Payments Statistical Discrepancies, Observed and Adjusted, 1960–86 (billions of dollars)

	1960–86			1960–74			1975–86		
Data	Mean	Standard error	t-test[1]	Mean	Standard error	t-test[1]	Mean	Standard error	t-test[1]
SDHAT	$7.11	$2.32	3.07**	–$1.43	$0.64	2.25*	$17.78	$3.05	5.82**
SDTOT	9.03	2.69	3.36**	–1.07	0.58	1.83	21.64	3.44	6.28**
SDAI[2]	3.24	1.80	1.80	–2.84	0.75	3.76**	10.85	2.63	4.12**
SDAINC[3]	5.67	2.28	2.28*	–2.50	0.69	3.64**	15.88	3.13	5.08**

[1]Test of statistical significance of mean SD; ** indicates significance at 1 percent level and * indicates significance at 5 percent level.
[2]SDTOT adjusted by U.S. export discrepancy with industrial countries other than the Netherlands and Switzerland.
[3]SDTOT adjusted by U.S. export discrepancy with industrial countries other than Canada, the Netherlands, and Switzerland.

erland and, of course, the United States are omitted. A detailed description and listing of the data are contained in the appendix.

TESTS OF THE UNDERSTATED U.S. EXPORT HYPOTHESIS

Testing the proposition that U.S. merchandise exports have been understated employs the discrepancy between country-of-destination import data and U.S. export data to determine how much, if any, of SDTOT can be accounted for by underreporting of U.S. merchandise exports.[26] First, the country-of-destination import data are used (analogously to the Commerce Department's use of Canadian import data) to revise the U.S. balance of payments statistical discrepancy data; the mean of the revised SD series is then tested for statistical significance. Second, regression analysis is used to test whether the export adjustment variable significantly explains the U.S. statistical discrepancy.

The Adjusted U.S. Balance of Payments Statistical Discrepancy

The U.S. balance of payments statistical discrepancy, as reported in the U.S. balance of payments data, SD, is net of the U.S.-Canadian trade discrepancy. The inclusive measure of the discrepancy is the appropriate form to test its relationship to export underreporting, since neither U.S. data are adjusted nor is any country excluded *a priori* on the basis of an assumed relationship. Therefore, we use SDTOT, the inclusive measure as in chart 1,

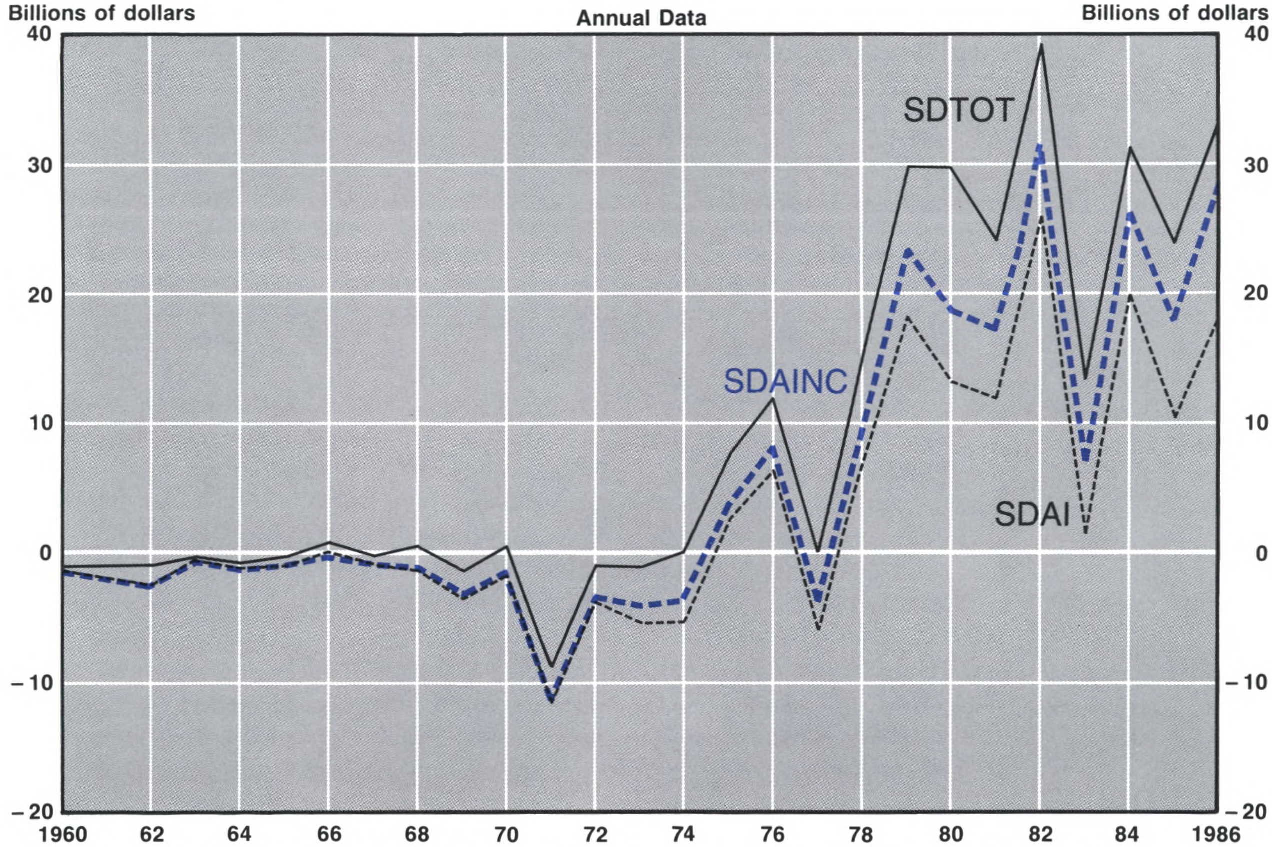
$$(6)\quad SDTOT_t \equiv SDHAT_t - RAUSCA_t,$$

where $RAUSCA_t$ is the reconciled adjustment to the U.S.-Canadian merchandise trade balance.[27] In other words, $SDTOT_t$ is the statistical discrepancy that would exist if U.S. merchandise trade with Canada had been compiled, unadjusted, in the

[26]Since underreported service exports, conjectured in Heller (1984) and documented in Stekler (1984), also form part of ε in identity 5, a portion of SDs should depend on non-merchandise export errors.

[27]See the data appendix for a more detailed explanation of SDTOT. It may appear to be possible to test the relationship between the data on the U.S. statistical discrepancy either with or without the Canadian errors — SDTOT and SDHAT, respectively — against corresponding data on the U.S. export underreporting (compiled from the IMF *DOTS*) with or without the Canadian component — XDI17 and XDINC, respectively. Yet, this cannot be accomplished consistently because the corresponding data are not available. SDTOT contains the U.S. errors as compiled and, likewise, XDI17 contains the U.S.-country-of-destination discrepancies as compiled; however, the adjustment RAUSCA to obtain SDHAT from SDTOT in identity 6 removes less than the total U.S.-Canadian export discrepancy but also deletes some import discrepancies. This distinction can be seen in table 1 by comparing the column of undocumented U.S. exports against the difference between the U.S. and the reconciled bilateral trade balance. In each year, RAUSCA, the difference between the U.S. compiled and the reconciled trade balance, is a smaller adjustment than the undocumented exports. Moreover, as can also be seen in the table, the undocumented exports agreed upon between the two countries' customs authorities do not incorporate the year's full difference between the U.S. and the Canadian measures of northbound trade as obtained from the IMF *DOTS*. Consequently, RAUSCA adjusts the statistical discrepancy in a fashion that does not correspond with deleting the *DOTS* Canadian export discrepancy from the total 17-country *DOTS* U.S. export discrepancy. While the agreed-upon changes predominantly reflect northbound trade statistics, southbound trade (U.S. imports) data are also affected. Data separating RAUSCA into northbound and southbound changes are not available. Nonetheless, there is a high correlation between RAUSCA and the bilateral U.S.-Canadian export discrepancy from *DOTS* during 1970–86: .943; moreover, a regression of SDTOT on XDINC, reported in table 4, has results similar to the regressions based on equation 7.

Chart 2
U.S. Balance of Payments Statistical Discrepancies, Total and Adjusted



NOTE: The adjusted statistical descrepancies are SDTOT less the estimated U.S. export discrepancy: SDAI is adjusted by the 17-country discrepancy; SDAINC is equal to SDAI with Canada omitted.

same fashion as merchandise trade with other countries.

Using the discrepancy in the U.S. exports to the industrial countries' (less the Netherlands and Switzerland) $XDI17_t$, an adjusted statistical discrepancy, $SDAI_t$, was computed:

$$SDAI_t \equiv SDTOT_t - XDI17_t.$$

See the appendix for details. To assess the possibility that only the U.S.-Canadian export discrepancy is meaningful in the analysis of SDTOT, adjusted SDs both with and without the Canadian discrepancy — SDAI and SDAINC, respectively, — are computed and reported in table 3. The mean and standard errors of means for SDHAT, SDTOT, SDAI and SDAINC are displayed in table 3 for the full period 1960–86 and for the two subperiods, before and after 1975.

The reported discrepancy in the balance of payments, SDHAT, averaged about $7 billion while SDTOT averaged about $9 billion during the 1960–86 period, both statistically significant; however, each was comparatively small and negative during 1960–74 and large and positive during 1975–86. The industrial country adjusted SDs, SDAI and SDAINC, are smaller but still substantial and statistically significant in both subperiods. As chart 2 shows, the industrial country discrepancy (XDI17) accounts for about half of the total discrepancy since 1975. Chart 2 also shows that the non-Canadian component of the export discrepancy is large and persistent.

Table 4

Regression Analyses of Total Statistical Discrepancy's Relation to Industrial Countries Export Discrepancy

	Estimated Coefficients[1]				Summary Statistics			Hypotheses Tests[2]	
Specification	Intercept (a)	Dummy (b)	Export discrepancy slope (c)	Export discrepancy dummy (d)	$\bar{R}^2$	DW	$\hat{\rho}$	Specification F-test[3]	Slope coefficients ≤1.0[4] t-test
i	−4.78		2.39		.82	2.42	−.22	N/A	6.46**
	(2.85)**		(11.10)**						
ii	−4.68	4.32	2.04		.82	2.41	−.22	ii vs. i: 0.96	2.48*
	(2.78)**	(0.98)	(4.88)**						
iii	−1.41		0.01	2.16	.86	3.05	−.53	iii vs. i: 7.99**	5.72**
	(0.74)		(0.02)	(2.83)**					
iv	−0.62	−4.61	−0.25	2.74	.86	3.18	−.59	iv vs. i: 4.38*	3.67**
	(0.30)	(0.91)	(0.27)	(2.74)*				iv vs. ii: 7.52*	
								iv vs. iii: 0.82	
v[5]	−1.32		−0.07	2.24	.91	—	—	N/A	9.36**
	(1.13)		(0.13)	(4.62)**					
vi[6]	0.20		−0.77	4.45	.77	2.13	−.19	N/A	5.01**
	(0.07)		(0.46)	(3.18)**					

[1]The letters under the coefficient-column headings refer to the coefficients in equation 6; absolute value of t-statistics appear in parentheses beneath estimated coefficients; * indicates significance at 5 percent level and ** indicates significance at 1 percent level.

[2]*Indicates rejection at 5 percent level; ** indicates rejection at 1 percent level.

[3]Test of null hypothesis that added variables in unrestricted specification are zero.

[4]One-tail test of null hypothesis that slope coefficient is less than or equal to 1.0. In i and ii, the test reported is for full period; in iii-vi, the test reported is for slope coefficient (c + d) for period 1975–86.

[5]Specification v is specification iii with corrected for serial correlated residuals, AUTOREG procedure in SAS.

[6]Specification vi is specification iii with the U.S.-Canadian export discrepancy removed from the independent variable; see footnote 25.

Regression Analysis of the Relation Between SD and XD

The mean SDs reported in table 3 for each subperiod are each statistically significant, and the industrial country-based adjustment fails to reduce SDTOT to a level insignificantly different from zero. Consequently, the non-zero means of the adjusted SDs imply that other errors remain, including underreported service exports not included in the *DOTS* merchandise trade data as well as unreported merchandise exports to countries not included in XDI17. Thus, it is still unclear that the U.S. merchandise export discrepancy is substantively related to the SDTOT. A direct way to test this hypothesis can be inferred from identity 5.

Identity 5 implies that a regression of SDTOT on XDI17 should have an intercept not significantly different from zero and a positive, unitary slope coefficient if each of three conditions are met:

1. the discrepancy is due entirely to CAB errors, ε;
2. these errors arise totally from merchandise trade export omissions; and
3. U.S. errors in reported exports to nonindustrial and the three omitted industrial countries are negligible.

Allowing for shifts in this relationship between the two subperiods, 1960–74 and 1975–86, we have

$$(7)\quad SDTOT_t = a + b\lambda_t + c\,XDI17_t + d\lambda_t XDI17_t + \eta_t,$$

$$\lambda_t = \begin{cases} 0, & t < 1975 \\ 1, & t \geq 1975. \end{cases}$$

Equation 7 provides three tests of the relation of SDTOT to XD. First, it permits tests of the relevance of the U.S.-industrial country export discrepancy in the significance of the coefficients c and d on XDI17: If unreported U.S. exports of merchandise to industrial countries have been the sole source of SDTOT, c should be statistically significant and not significantly different from unity. On the other hand, if either unreported U.S. service exports or merchandise exports to countries not included in XDI17 also matter, then c (or c + d) should be significantly larger than unity. If XDI17 is irrelevant to SDTOT, neither c nor d will be significantly different from zero. Second, equation 7 permits testing for the differences in the two subperiods by means of the dummy variable λ. Third, it permits a test of omitted variables' relevance in the significance test of the intercept: If the intercept is not significantly different from zero, then either omitted variables are highly correlated with XDI17 or they have zero means. The results of the regression estimates and these specification tests are reported in table 4.

The estimates of specifications (i) – (iv) test the relevance of the subperiod dummy λ. The F-tests for the three specifications with intercept or slope dummies (ii, iii, iv) against the null hypothesis of no dummies (i) indicate that (iii), the specification with the slope dummy, rejects the null hypothesis and is not rejected by the specification with both slope and intercept dummies (iv). Uniformly, however, the strong form of the hypothesis — that is, only the 17 industrial country merchandise exports are relevant and, consequently, that the coefficient on XDI17 is 1.0 — is rejected by the t-test in the last column of the table.

Two additional specifications, v and vi, are also reported in table 4. The specification tests require the use of the same data in the alternative specifications i, ii, iii, iv. Yet, their Durbin-Watson statistics indicate that specifications iii and iv have negatively serially correlated residuals. Since this biases the estimated standard errors of their coefficients, a corrected estimate of the preferred specification iii, designated as specification v, is also reported in table 4. A comparison of v with iii shows only negligible differences. Finally, specification vi is a regression of SDTOT on the non-Canadian export discrepancy, XDI17NC. The significance of the estimated coefficient d refutes the contention that only the Canadian export discrepancy is related to SDTOT.

These test results demonstrate that the U.S. export discrepancy with the industrial countries has a statistically significant relation with the balance of payments discrepancy; that is, the claim that U.S. merchandise export underreporting is a cause of the statistical discrepancy is not rejected. The industrial country merchandise export discrepancy is not the whole story since the coefficient is greater than unity; however, the *DOTS* nonindustrial data are of no avail in explaining it.[28] Consistent with the IMF study findings (see pp. 10–11), the leading candidate for addition to the model seems to be U.S. service exports.[29]

Finally, the coefficients on neither the intercept nor its dummy variable are significantly different from zero in the preferred specifications (iii, v, vi). This suggests that if any variables have been omitted — for example, service exports — they are either highly correlated with the U.S.-industrial countries' merchandise export discrepancy or have a mean of zero.

CONCLUSION

U.S. merchandise exports have been underreported during 1960–86, primarily during 1975–86. This underreporting, measured by country-of-destination merchandise imports from the United States, parallels the export discrepancy documented by the U.S. Commerce Department for U.S. exports to Canada since 1970. An estimated export correction based on industrial countries' imports from the United States reduced the statistically significant U.S. balance of payments discrepancy from $9 billion to $3.2 billion for 1960–86 and from $21.6 billion to $10.9 billion for the 1975–86 subperiod. Moreover, regression tests of the industrial-country import-based adjustment explain most of the variation in SDTOT during the last 12 years. These results indicate that U.S. exports of merchandise and services have been larger than reported and, consequently, that U.S. merchandise and current account deficits have been smaller than reported since the mid-1970s.

[28]Regression tests parallel to those reported in table 4 were also run on a sample including the selected nonindustrial countries described in footnote 23. Tests of the explanatory power of the nonindustrial countries against the null specifications omitting them established that the sample of nonindustrial countries did not add explanatory power to specifications restricted to industrial countries.

[29]See also Heller (1984) and Stekler (1984).

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Appendix
Data Sources for the U.S. Export Discrepancy and the U.S. Balance of Payments Statistical Discrepancy

The bilateral import and export data were compiled from the IMF Directions of Trade Statistics tape and the U.S. balance of payments statistical discrepancy was obtained from International Financial Statistics tape.

The U.S. export discrepancy was estimated using 17 industrial countries — the 20 countries classified as industrial by the IMF less the Netherlands, Switzerland and, of course, the United States. The estimated U.S. export discrepancy for the 17-country sample of industrial countries, XDI17, was obtained as follows:

$$XDI17_t \equiv \sum_{j=1}^{17} (MUS_{tj}/1.052) - XUS_{tj},$$

where

MUS_{tj} ≡ CIF imports of country j from the United States in year t.

XUS_{tj} ≡ FAS exports of the United States to country j in year t.

The included countries in XDI17 are: Australia, Austria, Belgium-Luxembourg, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, New Zealand, Norway, Spain, Sweden and the United Kingdom.

The U.S. balance of payments statistical discrepancy, SD_t, was obtained from the IFS tape of the IMF. Since the reconciled adjustment to the bilateral U.S.-Canadian merchandise trade balance is removed from the data (1970–86), the annual U.S.-Canadian reconciliation, $RAUSCA_t$, is subtracted from the reported SD, $SDHAT_t$, to get $SDTOT_t$. That is, from identity 4,

$$SDHAT_t \equiv -[C\hat{A}B_t + K\hat{A}B_t] + RAUSCA_t,$$

so that

$$SDTOT_t \equiv SDHAT_t - RAUSCA_t.$$

$RAUSCA_t$ was obtained from U.S. Department of Commerce (1987b), table 14. Prior to 1970, $RAUSCA_t$ is zero, so $SDHAT_t$ and $SDTOT_t$ are equal.

Source Data and Constructs (billions of dollars)

Year	USCAB	SDHAT	SDTOT	XDI17	XDI17NC[1]
1960	$2.82	−$1.02	−$1.02	$0.5422	$0.5851
1961	3.82	−1.00	−1.00	1.0101	0.9723
1962	3.38	−1.11	−1.11	1.3890	1.4175
1963	4.40	−0.36	−0.36	0.1014	0.2399
1964	6.82	−0.91	−0.91	0.2590	0.3888
1965	5.41	−0.42	−0.42	0.5876	0.6523
1966	3.03	0.63	0.63	0.5828	0.6600
1967	2.59	−0.22	−0.22	0.7807	0.5358
1968	0.59	0.46	0.46	1.7465	1.4384
1969	0.42	−1.46	−1.46	2.0261	1.6202
1970	2.33	−0.17	0.43	2.3949	2.0144
1971	−1.45	−9.76	−8.86	2.7078	2.2254
1972	−5.78	−1.95	−0.95	2.8999	2.2613
1973	7.07	−2.60	−1.20	4.1984	2.7936
1974	1.92	−1.52	−0.02	5.3438	3.6280
1975	18.13	5.88	7.58	4.9660	3.6362
1976	4.17	10.53	11.93	5.6111	3.5931
1977	−14.49	−2.05	−0.05	5.8041	5.5742
1978	−15.45	12.59	15.09	7.9439	3.4205
1979	−0.97	25.45	29.85	11.5811	6.0699
1980	1.84	25.01	29.71	16.5480	10.7420
1981	6.87	19.96	24.06	12.2240	6.5639
1982	−8.64	36.12	39.22	12.9268	8.1274
1983	−46.28	11.18	13.38	12.0168	6.0545
1984	−107.09	26.81	31.41	11.1532	4.6521
1985	−116.43	17.87	23.87	13.3568	5.9909
1986	−141.46	24.06	33.66	15.4334	4.6719

[1]XDI17–XDCANADA

Cletus C. Coughlin and Thomas B. Mandelbaum

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Why Have State Per Capita Incomes Diverged Recently?

FROM the early 1930s to the late 1970s, differences in per capita income across states narrowed substantially. By 1978, for example, one measure of state per capita income inequality had fallen to less than one-third of its 1932 value. Since 1978, however, this trend toward greater income equality across states has been sharply reversed; by 1987, state per capita income inequality had risen back to its 1966 level.

Historically, disparate regional income growth has generated political pressures to alter federal policies. For example, faster income growth in the South and West relative to the Northeast and Midwest in the 1970s led to charges that these differential growth rates were due, in part, to the distribution of federal government expenditures.[1] Yet, the Sun Belt-Frost Belt controversy arose during a period in which state per capita income growth was converging. Pressures for increased federal action in the realms of farm policy, trade policy and industrial targeting are even more likely to appear because of the increasing income divergence across states in the 1980s.[2]

This study pursues two objectives. First, it identifies the specific states responsible for the increasing inequality of state per capita income. Second, it examines whether well-known descriptions of regional growth and major economic changes can explain this new phenomenon.

INCREASING INEQUALITY — WHICH STATES ARE DIVERGING?

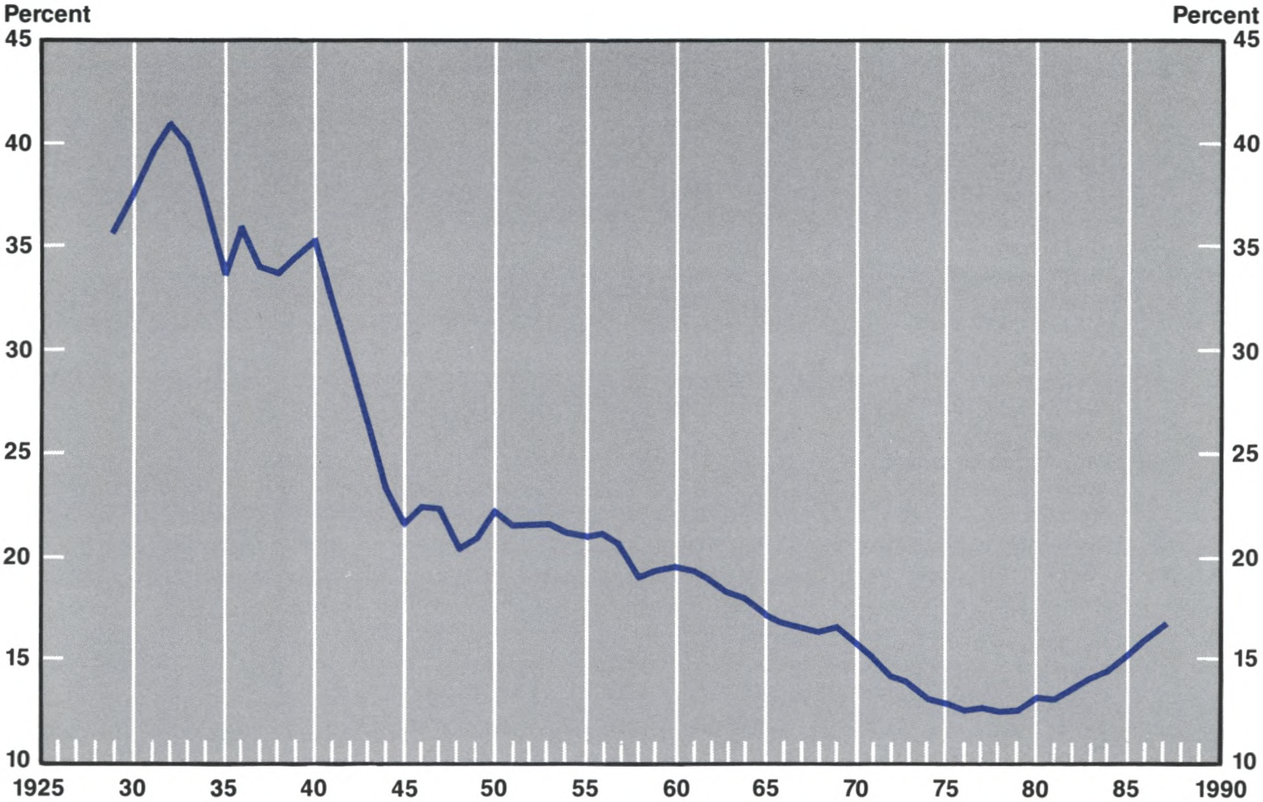
The recent sharp reversal of the 45-year trend toward lesser state per capita income inequality is shown in chart 1.[3] The measure of income inequality across states used in the chart is the annual coefficient of variation of state per capita income; its precise calculation is detailed on page 28. Income inequality across states generally declined from 1932 to 1978; since then, it has risen gradu-

[1]For example, see "The Second War Between the States" (1977) and "Federal Spending: The Northeast's Loss is the Sunbelt's Gain" (1976).

[2]Different views of the appropriate federal role can be found in Reich (1988) and Weinstein and Gross (1988).

[3]The reversal of the income inequality trend was confirmed statistically by regressing state per capita income inequality on time. To allow for the possibility of a structural break in 1978, a piecewise linear regression model was estimated. The results, based on conventional hypotheses tests, indicated a negative relationship between inequality and time until 1978 and a positive relationship thereafter.

Chart 1
Inequality of State Per Capita Income



ally, but consistently. By 1987, it had climbed back to its mid-1960s levels.[4]

Differential income growth across states has two opposing effects on state per capita income inequality measures. Income inequality is reduced when states whose per capita incomes exceed (are less than) the average for all states experience slower (faster) than average growth in income. Similarly, income inequality rises when states whose per capita incomes exceed (are less than) the average for all states experience faster (slower) than average income growth. The net effect on income inequality depends on which of these two possible growth patterns predominate. As chart 1 indicates, the former pattern predominated until the end of the 1970s, but the latter result has occurred since then.

Table 1 identifies the impact of each state on income inequality since 1978. The analysis in this table, and throughout the article, focuses on the state's *relative* per capita income — the state's per capita income expressed as a percent of the per capita income of all (continental) states. For example, if Mississippi's per capita income in 1978 was three-fourths of the average per capita income of all states for that year, its relative per capita in-

[4]Personal income consists of labor and proprietor income, dividends, interest, rent and transfer payments. Transfer payments differ from the other components in that they are not derived from current economic activity. The interstate inequality of per capita income minus transfers followed similar trends as the inequality of total per capita income; the coefficient of variation of non-transfer per capita income for the 48 states trended downward from 23.3 percent in 1946 to a minimum of 13.8 percent in 1976, then rose to 19.1 percent by 1987.

Table 1

Classification of States Based on Per Capita Income Levels and Changes

	State Per Capita Income as a Percent of State Average		Percentage Point Change 1978–87
	1978	1987	
Upwardly Divergent[1]			
Connecticut	123%	146%	23
Massachusetts	109	131	22
New Jersey	119	139	20
New Hampshire	100	119	19
New York	113	125	12
Virginia	101	113	12
Maryland	113	123	10
Rhode Island	98	107	9
Delaware	108	113	5
Florida	101	106	5
Downwardly Divergent[2]			
Idaho	93	82	−11
Montana	96	85	−11
Louisiana	88	79	−9
Utah	87	78	−9
North Dakota	99	91	−8
West Virginia	84	76	−8
Oklahoma	94	87	−7
Indiana	102	96	−6
New Mexico	87	81	−6
Texas	102	96	−6
Upwardly Convergent[3]			
Georgia	89	98	9
Maine	86	95	9
Vermont	90	98	8
North Carolina	86	91	5
Downwardly Convergent[4]			
Wyoming	117	89	−28
Nevada	124	111	−13
Oregon	107	96	−11
Iowa	107	99	−8
Michigan	113	106	−7
Washington	114	107	−7

come for 1978 would equal 75 percent. A state is judged to have had an impact on income inequality if its relative per capita income changed by 5 percentage points or more between 1978 and 1987.

The income changes of 20 states tended to increase inequality. Ten states with above-average per capita income in 1978 — Connecticut, Massachusetts, New Jersey, New Hampshire, New York, Virginia, Maryland, Rhode Island, Delaware and Florida — experienced substantially faster growth between 1978 and 1987 than the average. We call these states "upwardly divergent." There were 10 states with below-average per capita income — Idaho, Montana, Louisiana, Utah, North Dakota, West Virginia, Oklahoma, Indiana, New Mexico and Texas — that experienced substantially slower than the average growth. We call these states "downwardly divergent."

We have also identified 10 states whose income changes have tended to reduce inequality. Four of them — Georgia, Maine, Vermont and North Carolina — were states whose per capita incomes were below the average across states in 1978, but who have grown faster than this average since then. These states are called "upwardly convergent."

Table 1 cont'd.

No Substantial Change[5]			
Illinois	118	114	−4
Ohio	105	101	−4
South Dakota	91	87	−4
Kentucky	86	83	−3
Mississippi	74	71	−3
Nebraska	103	100	−3
Arkansas	81	79	−2
Wisconsin	104	102	−2
Kansas	105	104	−1
Pennsylvania	105	104	−1
Alabama	82	82	0
Colorado	109	110	1
Missouri	100	101	1
Arizona	95	97	2
California	121	123	2
South Carolina	80	82	2
Tennessee	86	88	2
Minnesota	106	110	4

[1]States with above-average per capita income in 1978 and with a 5 or more percentage-point increase in per capita income as a percent of the state average. For Rhode Island, a state with below-average per capita income in 1978 and above-average per capita income in 1987, the rise in relative income resulted in the state's income absolutely further from the average in 1987 than in 1978.

[2]States with below-average per capita income in 1978 and with a 5 or more percentage-point drop between 1978 and 1987 in state per capita income as a percent of state average. For Indiana and Texas, states with above-average income in 1978 and below-average income in 1987, the drops resulted in the states' being absolutely further from average per capita income in 1987 than in 1978.

[3]States with below-average per capita income in 1978 and with a 5 or more percentage-point increase between 1978 and 1987 in state per capita income as a percent of the state average.

[4]States with above-average per capita income in 1978 and with a 5 or more percentage-point decline between 1978 and 1987 in state per capita income as a percent of the state average. For Wyoming, Oregon and Iowa, states with above-average per capita income in 1978 and below-average per capita income in 1987, the drop resulted in per capita income closer to the state average in 1987 than in 1978.

[5]States whose absolute percentage-point change in per capita income as a percent of the states was less than 5 percent between 1978 and 1987.

Six states — Wyoming, Nevada, Oregon, Iowa, Michigan and Washington — were "downwardly convergent." These states, whose per capita incomes exceeded the average across states in 1978, but who have grown slower than this average, also contributed to reduced inequality. Of all the states, Wyoming is the hardest to categorize. Between 1978 and 1987, it experienced the largest percentage point decline in relative per capita income of the 48 states. This 28-point decline dropped Wyoming from an above-average income level in 1978 to below-average by 1987. If the analysis had focused on changes from 1984 to 1987, Wyoming would have been labeled as downwardly divergent rather than downwardly convergent.

Finally, 18 states had relative per capita incomes that changed less than 5 percentage points between 1978 and 1987. These states had little impact on the recent changes in inequality.

To provide a geographic overview of the results presented in table 1, a map is presented. As the map reveals, states experiencing relatively rapid per capita income growth are, without exception, Atlantic Coast states. Since these states tend to have per capita incomes above the average across states, their rapid growth tends to contribute to increasing inequality. On the other hand, states experiencing relatively slow per capita income growth are scattered across the remainder of the continental United States. The following analysis examines some of the popular descriptions of regional growth and some major economic changes to see if they can explain this rising inequality.

Measuring Income Inequality

The measure of income inequality used in this article is the coefficient of variation of annual state per capita incomes across the 48 continental states (INEQ).[1] The coefficient of variation is the standard deviation of a series divided by its mean. For each year, INEQ measures the degree of dispersion of state per capita incomes about the mean state per capita income (MEAN). With each state weighted equally, MEAN is calculated as follows:

$$MEAN = \sum_{i=1}^{48} SPCI_i \,/\, 48,$$

where i = subscript denoting the individual states and SPCI = state per capita income.

Thus, the INEQ is calculated as follows:

$$INEQ = [\{ \sum_{i=1}^{48} (SPCI_i - MEAN)^2 / 47 \}^{1/2}] /MEAN.$$

A larger value of INEQ indicates greater variation between state per capita incomes and, thus, greater inequality.[2] If per capita income rose (fell) in a state with below-average per capita income or declined (rose) in a high per capita income state, other things equal, INEQ would decline (increase).[3]

Unlike the standard deviation, the coefficient of variation used in computing INEQ reflects dispersion relative to the mean and can be used to compare the degree of inequality in different years with differing means. For example, if per capita income in each state doubled between 1970 and 1980, the standard deviation for 1980 would be twice that of 1970. The coefficient of variation, however, would show no change since it is standardized by the mean per capita income.

For the coefficient of variation to be an unbiased measure of inequality, the underlying data must be normally distributed.[4] Using the Shapiro-Wilk (1965) statistic, the state per capita income series was tested for normality for each year. The null hypothesis, that the state per capita income data are a random sample from a normal distribution, could not be rejected at the 5 percent level for any years in the postwar period.

[1]Data for the continental, rather than the entire, United States are used because no consistent income series is available for Hawaii or Alaska for the postwar period.

[2]Because state income data do not correct for cost-of-living differences among states, the inequality measure may not accurately reflect the real variations in per capita income levels among states. No reliable state cost-of-living data exist to make such adjustments. A related issue is interstate differences in price changes over time. If states with above-average per capita income in 1978 experienced substantially higher inflation between 1978 and 1987 than low-income states, the rise in inequality could be due to these differences with no change in the inflation-adjusted distribution of per capita income. Price deflators for individual states are unavailable; however, regional deflators show little difference in inflation between 1978 and 1987. Using a December 1977 base, the consumer price index (for all urban consumers) for November 1987 was 186.2 for the Northeast, 184.7 for the North Central Region, 185.1 for the South and 187.4 for the West.

[3]A related measure of income inequality, the standard deviation of the ratio of regional to national per capita income was used in Browne (1980) and Ray and Rittenoure (1987). The simple correlation between INEQ and the standard deviation of the ratio of state to national per capita income was 0.999 in the 1948–87 period. Williamson (1965) p. 11, also used a related inequality measure: a population-weighted coefficient of variation of per capita income; the measure is computed identically to INEQ except each region's squared deviation from the mean is multiplied by its share of the national population. For the 1946–87 period, a correlation of 0.985 was found between INEQ and a population-weighted coefficient of variation using state per capita income.

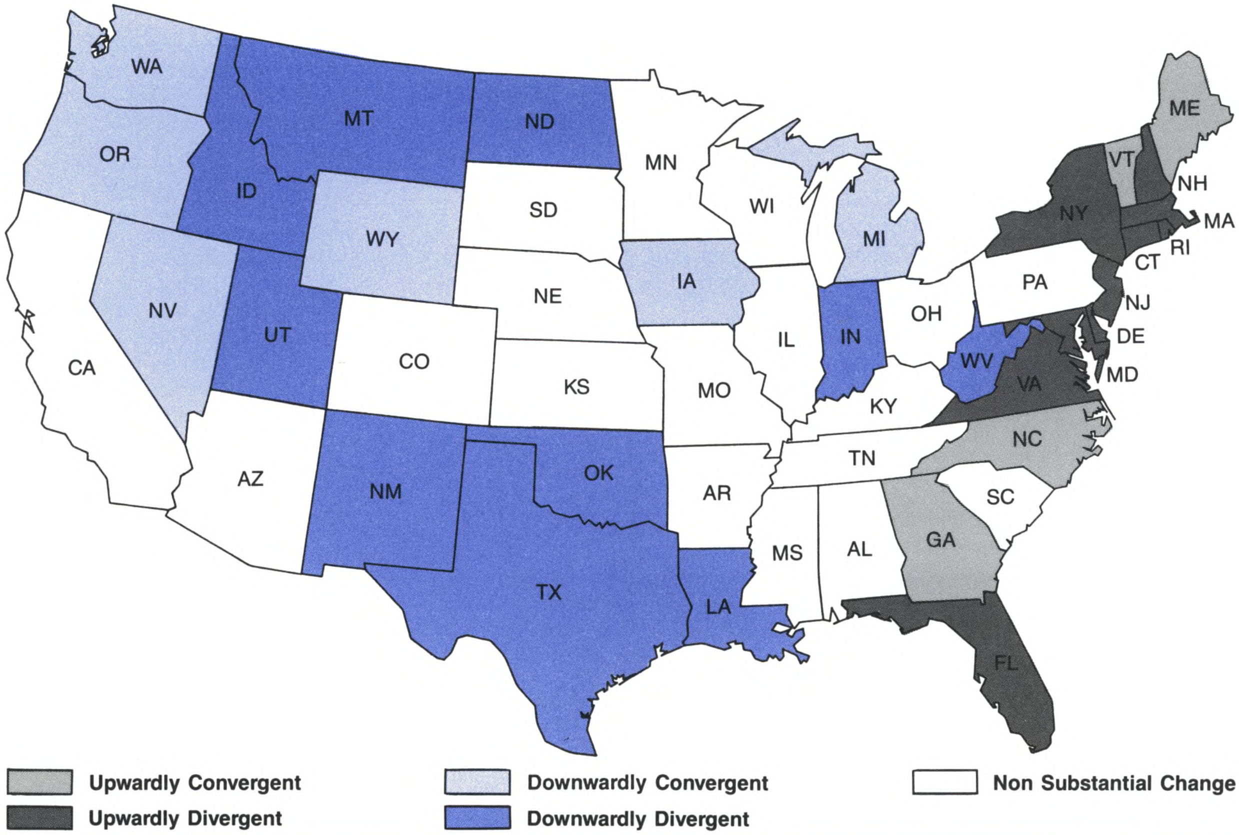
[4]See Yotopoulos and Nugent (1976), pp. 242–43.

THE SHIFT TO THE SUN BELT

The shift of industrial activity from the nation's Frost Belt to the Sun Belt contributed to the lessened inequality during the 1970s. Businesses, particularly manufacturing, migrated to the Sun Belt from the Frost Belt for various reasons, including lower wage rates.[5] Since manufacturing wages are

[5]See Crandall (1986), pp. 124–27, for a brief survey of empirical research documenting and explaining manufacturing's shift to the Sun Belt.

States Classified by 1978-87 Per Capita Income Change



well above the average wage of all industries in all regions of the nation, this shift of labor demand from higher-wage to lower-wage states produced higher relative growth in per capita income in the lower-income states and relatively lower income growth in the higher-income states.[6] For example, using one listing of Frost Belt and Sun Belt states (see table 2), the Sun Belt's share of (continental) U.S. manufacturing employment increased from 34.4 percent in 1969 to 39.0 percent in 1978, while the Frost Belt's share decreased from 51.3 percent to 46.2 percent. During the same period, average relative per capita income for the Sun Belt states increased from 91.2 percent in 1969 to 92.6 percent in 1978; in the Frost Belt states, it fell from 112.4 percent in 1969 to 106.3 percent in 1978.

This shift has continued in the last 10 years. The Sun Belt's share of manufacturing employment increased from 39.0 percent in 1978 to 43.7 percent in 1987, while the Frost Belt's share decreased from 46.2 percent to 41.1 percent. Although the shift, by itself, tends to reduce income inequality, the actual per capita incomes for the two regions have not continued to converge over this period. While the average per capita income for the Sun Belt states as a percentage of the average income for all states rose slightly from 92.6 percent to 93.1 percent between 1978 and 1987, it jumped from 106.3 percent to 111.1 percent in the Frost Belt states.

One reason why per capita incomes in the Frost Belt and the Sun Belt have stopped converging since 1978 is that the shift of manufacturing activity to the Sun Belt is less widespread than in previous decades; since 1978, manufacturing trends in many states differed sharply from that of their region. For example, the Frost Belt's share of manufacturing workers continued to decline after

[6]In 1987, for example, average weekly earnings for production workers in the nation's manufacturing sector was $406, 30 percent higher than the private-sector average.

Table 2

Impact of Sun Belt and Frost Belt States on Inequality

Sun Belt States		Frost Belt States	
Alabama	— No Substantial Change	Maine	— Upwardly Convergent
Arizona	— No Substantial Change	New Hampshire	— Upwardly Divergent
Arkansas	— No Substantial Change	Vermont	— Upwardly Convergent
Delaware	— Upwardly Divergent	Massachusetts	— Upwardly Divergent
California	— No Substantial Change	Rhode Island	— Upwardly Divergent
Florida	— Upwardly Divergent	Connecticut	— Upwardly Divergent
Georgia	— Upwardly Convergent	New York	— Upwardly Divergent
Kentucky	— No Substantial Change	New Jersey	— Upwardly Divergent
Louisiana	— Downwardly Divergent	Pennsylvania	— No Substantial Change
Maryland	— Upwardly Divergent	Ohio	— No Substantial Change
Mississippi	— No Substantial Change	Indiana	— Downwardly Divergent
New Mexico	— Downwardly Divergent	Illinois	— No Substantial Change
North Carolina	— Upwardly Convergent	Michigan	— Downwardly Convergent
Oklahoma	— Downwardly Divergent	Wisconsin	— No Substantial Change
South Carolina	— No Substantial Change		
Tennessee	— No Substantial Change		
Texas	— Downwardly Divergent		
Virginia	— Upwardly Divergent		
West Virginia	— Downwardly Divergent		

SOURCE: Weinstein, Gross and Rees (1985) and table 1.

1978, but manufacturing in most New England states grew as fast as, or faster than, the nation. Manufacturing job shares remained constant between 1978 and 1987 in Maine, Massachusetts and Connecticut, while rising in New Hampshire and Vermont. The rapid growth of high-technology manufacturing between 1978 and 1984, particularly computer- and defense-related production, was largely responsible for the rapid growth of per capita income in New England.[7] This growth contributed to the Frost Belt's relatively rapid income growth and the nation's increasing income inequality since 1978. As table 2 shows, the higher-income states of Connecticut, New Hampshire and Massachusetts are classified as upwardly divergent.

Despite a sharp loss of manufacturing jobs since 1978, New York, New Jersey and Rhode Island have had relatively rapid per capita income growth, contributing to the rising inequality. In these states, rapid income growth was fueled by the expansion of construction and services, especially health, business and financial services.[8]

At the same time, some Sun Belt states have not shared in that region's industrial expansion. Manufacturing employment from 1978 to 1987 grew substantially slower in West Virginia and Louisiana and no faster in Kentucky, Maryland, Oklahoma and Tennessee than it did in the nation. The slower growth in these states may have stemmed, in part, from their specialization in energy-related industries, an issue discussed later in this article. As table 2 indicates, Louisiana, Oklahoma and West Virginia were among the downwardly divergent Sun Belt states.

To summarize, manufacturing activity has continued to shift from the Frost Belt to the Sun Belt states in the 1980s, but not as widely as in previous decades; in fact, a number of states in both

[7]See Bradbury and Browne (1988). Manufacturing, however, was not entirely responsible for New England's per capita income growth, especially since 1985. Rapid growth of earnings in construction and in service-producing industries (especially finance, insurance, real estate, medical and business services) combined with relatively slow population growth to spur New England's expansion.

[8]U.S. Department of Commerce (1987), p. 2, and Ray and Rittenoure (1987) p. 244, briefly discuss sources of growth in Mid-Atlantic States. Gross and Weinstein (1988) argue that the rapid growth of the New England and Mid-Atlantic economies in the 1980s is at least partially due to a rise in federal spending in those regions, particularly grants-in-aid and procurement. The slower economic growth of some Sun Belt states, meanwhile, allegedly stems from a decline in the federal expenditures they receive.

"belts" have experienced manufacturing growth counter to that of their region as a whole. Thus, rather than continuing to converge as they had in the early and middle 1970s, the gap between per capita incomes in the Frost Belt and Sun Belt states has widened since 1978.

THE BI-COASTAL ECONOMY

According to a study released in 1986 by the Democratic staff of the Joint Economic Committee of the U.S. Congress, national economic growth between 1981 and 1985 was concentrated in states on the East Coast and in California.[9] The rapid expansion of these states relative to the nation's interior states led to the characterization of the United States as a bi-coastal economy, despite the absence of Oregon and Washington from the list of fast-growing states. For example, the study noted that real earnings grew at a 4 percent rate in the coastal states during the 1981–85 period, compared with a 1.4 percent rate in the non-coastal states.

Does the bi-coastal economy, which is primarily a description rather than an explanation of the pattern of growth, provide insights into the increasing inequality of state per capita income? Two questions must be answered affirmatively. First, are the bi-coastal states experiencing more rapid growth of per capita income? The answer to this question is "yes." Table 3 lists the bi-coastal states and their per capita income performance for 1978–87. Of the 16 bi-coastal states, 14 grew substantially faster in per capita income than average. California, the sole West Coast state, and South Carolina experienced no substantial change in their relative per capita income growth.

Second, did these rapidly growing states also have above-average per capita incomes? If so, the rapid growth causes their per capita income to rise further above the average, thus, increasing state income inequality. Of the 14 states with rapidly growing per capita income, 10 are classified as divergent; only four of these states are convergent. In fact, the 10 divergent states account for all the upwardly divergent states in the continental United States and the four convergent states account for all the upwardly convergent states. Thus, relatively rapid East Coast income growth was a primary influence in increasing the inequality of state per capita income.

Table 3

Impact of Bi-Coastal States on Inequality

California	— No Substantial Change
Connecticut	— Upwardly Divergent
Delaware	— Upwardly Divergent
Florida	— Upwardly Divergent
Georgia	— Upwardly Convergent
Maine	— Upwardly Convergent
Maryland	— Upwardly Divergent
Massachusetts	— Upwardly Divergent
New Hampshire	— Upwardly Divergent
New Jersey	— Upwardly Divergent
New York	— Upwardly Divergent
North Carolina	— Upwardly Convergent
Rhode Island	— Upwardly Divergent
South Carolina	— No Substantial Change
Vermont	— Upwardly Convergent
Virginia	— Upwardly Divergent

SOURCE: U.S. Congress (1986) and table 1.

While explanations for the relatively rapid growth of income in the coastal states are speculative, explanations of why income growth in interior states lagged behind are more precise.[10] Falling energy prices and the agricultural crisis are two frequently cited reasons for the below-average performance.

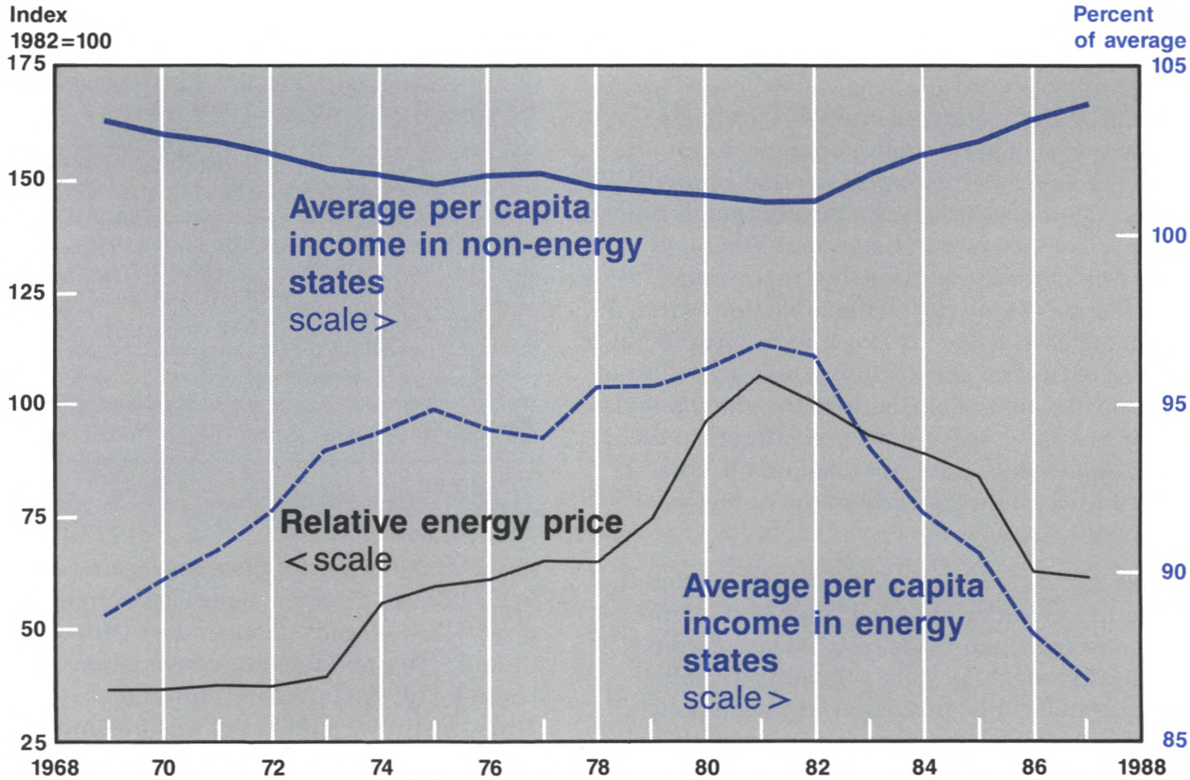
The Influence of Falling Energy Prices

The economic growth of states endowed with substantial energy resources tends to be directly related to energy prices, while the economic

[9]The study, *The Bi-Coastal Economy*, was released in July 1986 by the Joint Economic Committee of the U.S. Congress. See U.S. Congress (1986).

[10]The Joint Economic Committee study suggested a number of reasons for the uneven pattern of regional growth during the first half of the 1980s. The study suggests that "a central cause is trade and the current massive imbalance in trade that exists between the United States and its trading partners" that disproportionately affects interior states. U.S. exports of both agricultural and nonagricultural commodities had declined to some extent, according to the authors, because of increased competition from Third World nations attempting to earn foreign currency to pay interest on their loans. Also, increased competition from imported manufactured goods in domestic markets was claimed to be partially responsible for the observed pattern of regional growth. The study's final explanation relates to the strong job growth in the service industry, particularly in firms engaged in importing, advertising, financing and selling foreign-made goods. Such industries are strongly concentrated on the coasts, according to the study, and their growth helped boost the coastal states.

Chart 2
Relative Energy Prices and Relative Per Capita Income in Energy and Non-Energy States



growth of energy-poor states tends to be inversely related.[11] As chart 2 shows, energy prices relative to the general price level rose rapidly from 1973, peaked in 1981, then fell through 1987.[12] If energy-rich states are also generally lower-income states, the decline in energy prices in the 1980s has contributed to the increasing interstate inequality by slowing income growth in these states relative to those that purchase most of their energy resources from out-of-state sources.

The evidence supports this explanation. As chart 2 shows, relative per capita income in energy states generally followed the rise and fall of energy prices, while the relationship was an inverse one

[11] See Manuel (1982) and Brown and Hill (1987) for empirical studies documenting the relationship between energy prices and state economic growth. Miernyk (1977) and Manuel (1982) discuss why energy prices and state economic growth are linked. As they rise, energy costs become an increasingly important factor in determining where to locate an energy-intensive industry. Such relocation tends to shift employment opportunities from energy-poor regions to energy-producing states. Higher energy prices may also stimulate greater investment in energy production and exploration, increasing jobs in energy-producing states. Although profits from relocating manufacturing firms are likely to be distributed to owners throughout the nation, the increased employment tends to increase income in energy-producing states. In contrast, energy-poor states are burdened with higher costs for fuel and inputs in which energy costs are an important component. When energy prices fall, the advantages shift to states that heavily import oil rather than produce it.

[12] Relative energy prices in this article are indicated by the producer price index for fuels, related products and electric power divided by the GNP implicit price deflator for the private business sector. The oil embargo in 1973–74 contributed directly to the price increases for petroleum and indirectly to price increases for other energy sources as energy users searched for oil substitutes. Relaxation of price controls during the period contributed to the price increases of natural gas. The easing of energy prices in the current decade reflects a worldwide increase in global oil supplies as international oil cartels are unable to agree on production quotas. Also, heavy investment to increase energy efficiency by car makers, businesses and households has caused the quantity of energy demanded to grow substantially slower than the rest of the nation's economy, according to Schmidt (1988).

Table 4

Impact of Energy-Producing States on Inequality

Wyoming	— Downwardly Convergent
West Virginia	— Downwardly Divergent
Oklahoma	— Downwardly Divergent
Louisiana	— Downwardly Divergent
Kentucky	— No Substantial Change
Texas	— Downwardly Divergent
North Dakota	— Downwardly Divergent
New Mexico	— Downwardly Divergent
Colorado	— No Substantial Change
Montana	— Downwardly Divergent
Utah	— Downwardly Divergent

NOTE: Energy-producing states are those in which earnings from oil and gas extraction and coal mining produced at least 3 percent of the state's total earnings in 1981. States are ordered from those with the highest to the lowest percentage.

SOURCE: table 1.

for the other states.[13] Table 4 lists the 11 energy states in the continental U.S. in which earnings from oil and gas extraction and coal mining produced at least 3 percent of the state's total earnings in 1981, the year in which energy prices peaked and oil and gas extraction and coal mining provided its largest share of total U.S. earnings in the postwar period.[14] The energy states are listed in descending order according to the proportion of their earnings derived from oil and gas extractions and coal mining, ranging from Wyoming with 18.6 percent to Utah with 3.1 percent.

In 1969, before the sharp rise in energy prices, per capita income in the energy states averaged 88.7 percent of that for all 48 continental states. This proportion rose to 95.4 percent by 1978 and peaked at 96.7 percent by 1981. By 1987, after energy prices had declined substantially, the average per capita income in energy states declined to 86.8 percent of the average of all states.

Of the 11 energy states, all but Kentucky, Colorado and Wyoming were classified as downwardly divergent (see table 4).[15] In half of these eight downwardly divergent states (Oklahoma, New Mexico, Louisiana and Texas), relative per capita income rose from 1978 through the early 1980s, then fell sharply in subsequent years, following energy price trends. Wyoming also exhibited this pattern of growth: its relative per capita income grew to 121 percent of the state average by 1980, remained high in 1981, then plummeted to 89 percent by 1987. Although classified as downwardly convergent, Wyoming's per capita income fell below the national average in 1984 and, thus, has contributed to the greater inequality of state income since that year.

In the remaining downwardly divergent energy states (West Virginia, North Dakota, Utah and Montana), relative per capita income trended downward throughout the 1978–87 period. Although the fall in energy prices undoubtedly contributed to their slowing after 1981, their sluggish income growth in previous years suggests that other factors were at work as well.

The importance of the energy price decline as a contributor to increasing interstate inequality can be seen more clearly by considering the list of downwardly divergent states in table 1. Energy states account for eight of the 10 downwardly divergent states. In addition, Wyoming, has contributed to increasing inequality since 1984.

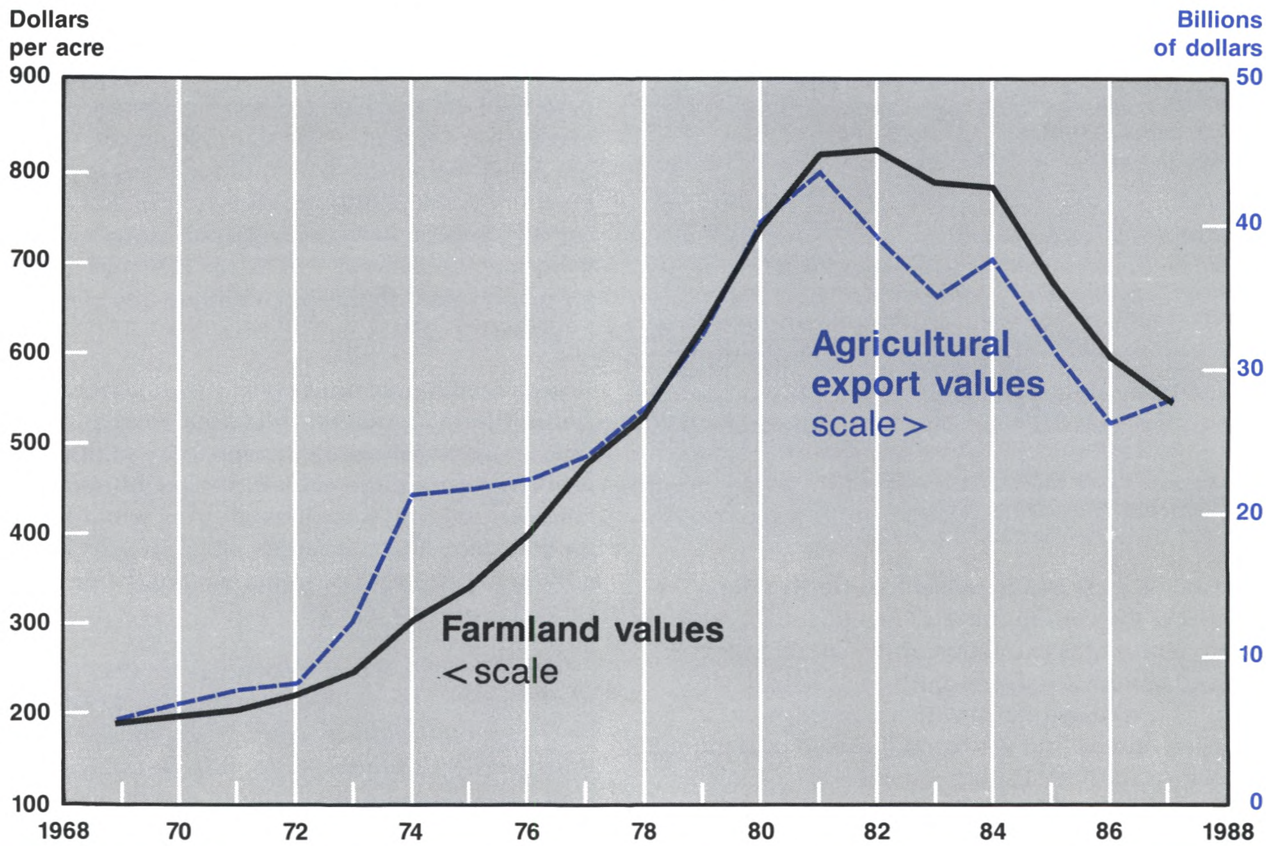
None of the states with substantial upward movement of relative per capita income were energy-rich states. Instead, these states were heavy importers of energy resources who generally benefited from the cheaper energy resources in the 1980s. Since most states with substantial post-1978 income growth had above-average per capita incomes, the fall in energy prices also tended to increase inequality by boosting their growth further above the average. Thus, the de-

[13]In the 1947–87 period, the correlation between relative energy prices and the average relative per capita income of energy states is 0.54, significantly different from zero at the 1 percent level. The correlation of relative energy prices and the relative per capita income of non-energy states, −0.54, is identical in absolute value, but negatively signed. This correlation is also significant at the 1 percent level.

[14]The validity of this classification is suggested by the substantial overlap between this list of energy states and those suggested in two previous studies. Nine of the 11 states shown in table 4 were among the 10 continental U.S. states with a ratio of energy production to energy consumption greater than unity in 1976 (Corrigan and Stanfield, 1980). Eight of the 11 states identified as energy states in our study were among the nine continental U.S. states in which oil-price declines were associated with declines in total state employment in Brown and Hill (1988).

[15]Research by Hunt (1987) suggests that Colorado's economy was not adversely affected by declining energy prices because of its diversified economic base which captured enough beneficial effects of oil price declines to offset the negative effects.

Chart 3
Economic Indicators of U.S. Agriculture



cline in energy prices was an important factor in increasing inequality in the 1980s.[16]

The Influence of the "Farm Crisis"

The first half of the 1980s has been accompanied by a widely publicized economic deterioration of the nation's agricultural sector.[17] Chart 3 shows two symptoms of the so-called farm crisis. The value of both the nation's farm exports and farmland grew rapidly during the 1970s but declined during the current decade.

A decline in the farm sector affects non-farm sectors directly linked to agriculture. These include suppliers of fertilizer and farm equipment as well as firms that transport, process and market agricultural products. Less directly, a decline in farming and agribusiness could adversely affect other sectors as well, such as those providing services to agricultural workers.

A decline in the nation's agricultural sector would most adversely affect state income in agriculture-intensive states. One measure of this intensiveness is the proportion of total state earnings accounted for by farm labor and proprietor earnings.[18] Table 5 displays the 12 states that derived at least 4 percent of their earnings from farms in 1981, the most recent peak in both agricultural exports and farmland values. North Da-

[16]Ray and Rittenoure (1987) found that declining energy prices contributed to the increasing inequality of regional per capita income in the 1980s.

[17]See Petrulis et al. (1987) for a discussion of the reasons for the farm crisis.

[18]Since the purpose of this analysis is to assess the possible effects of the farm sector downturn on state per capita personal income, farm labor and proprietor earnings (a component of personal income) is a more appropriate measure of farm income than net farm income. While real net farm income is a better measure of farm profitability, it includes corporate income, which is excluded from the personal income series.

Table 5
Impact of Farm States on Inequality

State	Classification
South Dakota	No Substantial Change
North Dakota	Downwardly Divergent
Iowa	Downwardly Convergent
Nebraska	No Substantial Change
Idaho	Downwardly Divergent
Arkansas	No Substantial Change
Montana	Downwardly Divergent
Kentucky	No Substantial Change
Minnesota	No Substantial Change
Wisconsin	No Substantial Change
Vermont	Upwardly Convergent
Kansas	No Substantial Change

NOTE: Farm states are those in which 4 percent or more of total 1981 state earnings were derived from farming. States are ordered from those with the highest to the lowest percentage.

SOURCE: table 1.

kota and South Dakota were the states most reliant on farming, with 11.9 percent and 15.1 percent of their total earnings directly derived from agriculture.

Average per capita income has declined in farm states relative to nonfarm states since 1978. Between 1978 and 1987, relative per capita income in farm states dropped from 97 percent of the average to 93 percent. During the same period, the average of relative per capita income in all other states rose from 101 percent to 102 percent.

Despite this divergence, few farm states contributed substantially to interstate income inequality. As table 5 shows, only three of the 12 farm states — Idaho, Montana and North Dakota — are classified as downwardly divergent. On the other hand, farm states account for two of the 10 convergent states. Relative per capita income also fell substantially in Iowa, a state with above-average per capita income in 1978, and per capita income rose in Vermont, a state with below-average per capita income in 1978. Little change in relative per capita income occurred in the remaining seven farm states. Overall, the impact of the farm crisis on the recent increase in inequality appears minimal.

CONCLUSION

The 45-year downward trend in inequality ended in the late 1970s. Twenty states, evenly divided between below-average and above-average per capita income states, are primarily responsible for the increasing inequality. All states with above-average per capita income and relatively rapid income growth are located on the Atlantic Coast. The states with below-average per capita income and relatively slow growth are scattered throughout the nation's interior.

The Sun Belt-Frost Belt description of regional growth has limited success in explaining this phenomenon. The shift of manufacturing activity from the Frost Belt to the Sun Belt, which contributed significantly to the narrowing of regional income differentials in the 1970s, has continued in the 1980s, but has affected fewer states. Indeed, in recent years, manufacturing has grown relatively rapidly in some New England states, while growing no faster than the national average in several Sun Belt states.

The description of the U.S. economy as a bi-coastal economy with rapidly growing coastal and slowly growing interior states provides a better insight into the location of states responsible for the rising income inequality, but not necessarily the reasons for this result. The relatively poor performance of the interior states has been attributed to various problems related to agriculture as well as to falling energy prices. The agriculture crisis has little explanatory power. Although the agricultural sector has weakened in the 1980s, farm states account for only three of the 10 downwardly divergent states.

On the other hand, declining energy prices have been a major factor in increasing interstate income inequality. Energy states account for eight of the 10 downwardly divergent states. Another energy state, Wyoming, has contributed to increasing income inequality since 1984.

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Testing the Expectations Model of the Term Structure: Some Conjectures on the Effects of Institutional Changes

THE TRADITIONAL expectations model of the term structure of interest rates attempts to explain how interest rates on a similar debt instrument are related across different maturities. It posits that, in a world without risk or one in which assets are perfect substitutes, the one-period interest rate should equal the expected return to holding an instrument of longer maturity for one period. Because the model is based on the most fundamental economic assumptions — rational behavior by individuals who act on all available information — it has held considerable appeal in applied research. Empirical tests for data across a range of countries and sample periods, however, have tended to reject this simple statement of the expectations model.[1] Moreover, expanding the basic model by adding other explanatory variables, such as a time-varying risk premium or latent information variables, still has found limited empirical success in explaining interest rate behavior.[2] Thus, a puzzle remains: why is such a basic theoretical model so frequently rejected by the data?

In this article, using short maturities in the Eurocurrency market, we isolate several institutional factors that might explain some rejections of the expectations model. Alternatively, the analysis may be viewed as an attempt to suggest specific characteristics of policy procedures that are inconsistent with the theoretical model's assumptions. Our results suggest that single-country estimates of the expectations model may omit important information because financial markets are highly integrated across countries. Moreover, it appears as if the manner in which monetary policy is conducted has effects on interest rates that contribute to rejections of the theory. In particular, the expectations model does not hold in countries where the central bank — at least periodically — follows an exchange rate rule. Accounting for relationships across markets and for the manner in which monetary policy is conducted reverses, in some cases, the negative conclusion of simple, single equation estimates of term structure relationships.

[1]For a survey of these results, see Bisignano (1987).

[2]Examples of work along these lines are Shiller, et al. (1983) and Campbell and Clarida (1987).

THE EXPECTATIONS MODEL APPLIED TO SHORT MATURITIES

The empirical version of the expectations model can be written as:

$$(1)\quad (r_{1,t+1} - r_{1,t}) = a + b({}_tF_{1,t+1} - r_{1,t}) + e_t$$

where r_{1t} is the yield on a one-period bill in period t and ${}_tF_{1,t+1}$ is the current, observed forward rate on a one-period bill, one period into the future.[3] Coefficients to be estimated are denoted a and b; e_t is an error term with zero mean and variance equal to σ^2. Thus, in equation 1, the dependent variable is the difference between actual yields on one-period bills in consecutive periods and the explanatory variable is the difference between the current forward and spot rates on one-period bills. Equation 1 predicts that the change in one-period yields should be related to the forecasted change, as represented by the forward rate − spot rate spread. The expectations hypothesis implies that, if the forward rate is an unbiased predictor of the future spot rate, the regression's slope coefficient, b, should not be significantly different from one and its intercept, a, should not be significantly different from zero.

This potentially rich area for empirical research has yielded few definitive results because tests of the expectations model inevitably have been joint tests of several maintained hypotheses. To cite just a few of the problems that arise, the model assumes a zero or constant risk premium. The problem for estimation, however, is that the risk (or, term) premium — some systematic difference between the long-term interest rate and the expected future values of short-term interest rates that reflects relative degrees of uncertainty — is unobservable. Thus, if an empirical test rejects the hypothesis a = 0 and b = 1, it is not possible to discriminate between true model rejection and the possible effects of a term premium that has been assumed, incorrectly, to be zero. In part for this reason, as will be the case below, many studies have chosen to test a weaker form of the expectations model (b = 1) and interpret the statistical significance of the regression's intercept as indicating the existence of a term premium.[4]

There are other testing problems as well. When data for longer maturities are studied, interest rate data often are estimated from a fitted yield curve rather than taken from observed market transactions. In this instance, negative results might be a rejection of the formula used to approximate unobservable interest rates rather than the expectations model. Finally, the rationality of expectations by market agents is assumed but, again, this is difficult or impossible to test directly. Although more attention has been paid in recent research to models that isolate these assumptions, it remains impossible to say whether negative results indicate a rejection of the expectations model itself or simply one (or more) of its underlying assumptions.

ESTIMATION OF THE EXPECTATIONS MODEL

As noted in the introduction, equations similar to (1) have been estimated with data for many countries and sample periods. We illustrate these results by estimating equation 1 with Harris Bank data on spot three-month deposit rates from the Eurocurrency market for the U.S., U.K., West Germany, Japan and Switzerland; six-month deposit rates also were used, as explained in footnote 3, to calculate values for the forward rate. The interest rates are calculated as simple rates. The data are Friday closing quotes for the Friday closest to the beginning of each month.[5] The sample period spans February 1981 through October 1986. Although data prior to 1981 are available, the Euroyen market was thinly traded and, in 1980, the Carter Administration adopted its Special Credit Control program. Because these factors

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[3]For one derivation of this result, see Mankiw and Miron (1986), p. 214. Strictly speaking, this specification holds up to a constant (the term premium), which we have ignored. The assumption was that, for the short maturities used in this paper, term premium effects, if any, should be negligible. Also see Bisignano (1987). Cosset (1982) found that forward rates in this market are unbiased, but not optimal, predictors of future interest rates. He also found this market to be efficient in the sense that past information on interest rates is not useful in predicting future values of interest rates.

Values for the forward rate, ${}_tF_{1,t+1}$, were calculated as twice the two-period interest rate minus the one-period rate. Because the data in the study use three-month rates to represent the theoretical "one period," the forward rate is calculated as twice the six-month (two period) rate minus the corresponding three-month rate.

[4]See, for example, Shiller, et al. (1983).

[5]First-Friday-of-month data, rather than monthly averages of daily or weekly data, were used to avoid questions about how to treat partial weeks in adjoining months, months with different numbers of weeks and the gap between three, four-week months and a thirteen week quarter. See Hakkio and Leiderman (1984) for a discussion of these measurement issues.

Table 1

Estimates of the Basic Expectations Theory Relationship (monthly data, 1981.02 – 1986.10)

Country	a	b	R^2
United States	−0.32	−0.26*	0.01
	(0.92)	(2.68)	
United Kingdom	0.00	0.90	0.09
	(0.00)	(0.31)	
Germany	−0.46	0.42*	0.08
	(3.25)	(4.13)	
Japan	−0.17	0.92	0.25
	(1.72)	(0.27)	
Switzerland	−0.23	0.04*	0.00
	(0.82)	(2.97)	

NOTE: Absolute values of t-statistics are in parentheses. t-statistics for b apply to the null hypothesis b = 1. An asterisk indicates a slope coefficient significantly different from one at the 0.05 level of significance.

could adversely affect the test results, data prior to February 1981 are not used in estimation.[6]

Finally, a comment on the initial approach to estimation is necessary. Because the data consist of observations on three-month yields sampled monthly, the changes in interest rates overlap and introduce a second order moving average process into the data. Because this property of the data will affect the estimated coefficients' standard errors, it must be considered by the estimation technique. The Hansen-Hodrick procedure we use accounts for this property by correcting the model's error term for serial correlation.[7]

BASIC RESULTS

The results from estimating equation 1 are reported in table 1. The expectations model is clearly rejected for the United States, Germany and Switzerland; their estimated slope coefficients are significantly different from one. In contrast, the results for the United Kingdom and Japan support the expectations model. Explanatory power for the equations is generally low (with the notable exception of Japan).[8] This result is typical in estimates of the expectations model, indicating that interest rate time series closely approximate a random walk. Overall, these mixed results represent the typical findings of previous empirical work on the expectations model.

The mixed results in table 1 can be interpreted in two ways. One interpretation is that the expectations model is rejected because it appears not to hold for most of the countries examined. Another interpretation is that institutional or other considerations, which the pure theory regards either as given or unimportant, may have had adverse effects on the empirical tests. Among others, important structural changes that will affect the results include the conduct of U.S. monetary policy, changes in interest rate ceilings and general financial market deregulation. Given the results shown in table 1, previous research generally has left these results unexplained or has added some *ad hoc* measure of risk to account for the possible effects of an unobservable term premium. In the sections that follow, we first revise the estimation procedure to see how this change affects the test results. We then discuss some well-defined events and changes in institutions that could affect the term structure relations and produce the results that appear to reject the model.

ONE POSSIBLE REASON FOR REJECTION OF THE EXPECTATIONS MODEL: CORRELATED ERROR TERMS

The increasing integration of world capital markets suggests that an alternative statistical approach should be used to estimate equation 1. As capital flows freely among nations, monetary policy actions (for example) undertaken in one country can be expected to affect financial variables in other countries as well. Consider, for example, a change in Bundesbank policy that affects German interest rates and then is transmitted to interest rates in the other four nations via capital flows caused by the change in German interest rates. This effect, which will appear only in the error term of the German interest rate equation when separate regressions are estimated, could be exploited as a new source of information for each regression if the country equations were estimated

[6]In fact, the U.S. results are extraordinarily sensitive to these few data points. The dramatic increase in interest rate volatility during the first and second quarters of 1980, relative to the remaining sample, would suggest this sensitivity in OLS regression estimates.

[7]For an extensive description of the econometrics used to account for the effects of the third-order serial correlation, see Hansen and Hodrick (1980) and Campbell and Clarida (1987).

[8]Durbin-Watson statistics are not reported because, as indicated in the text, the reported standard errors reflect corrections for serial correlation in the data.

Table 2

Revised Expectations Model Estimates Using Seemingly Unrelated Regressions (SUR): 1981.02 – 1986.10

Country	a	b
United States	−0.52	0.20*
	(2.26)	(2.60)
United Kingdom	0.00	0.93
	(0.02)	(0.20)
Germany	−0.47	0.45*
	(5.62)	(4.15)
Japan	−0.18	1.07
	(3.07)	(0.42)
Switzerland	−0.39	0.49*
	(2.37)	(2.21)

NOTE: Absolute values of t-statistics are in parentheses. For b, the t-statistic applies to the null hypothesis b = 1. An asterisk indicates a slope coefficient significantly different from one at the 0.05 level of significance.

F-test for null hypothesis: $b_{US} = b_{UK} = b_{GER} = b_J = b_{SW} = 1$ is 5.63 compared with a critical value of 2.21.

jointly. In other words, the error term of a single equation (which reflects "news," or unpredictable events within that country) also may contain information — due to linkages among markets — that is relevant to explaining interest rate behavior in another country. The important point is that the expectations model being tested assumes that this information is being used by the rational agents whose collective actions determine changes in interest rates. Single equation estimates, however, exclude the information implicit in these linkages because they look at data for each country in isolation.

One way to account for this missing information is to estimate equation 1, as applied to the five countries under study, as a system of seemingly unrelated regressions (SUR).[9] This procedure considers contemporaneous correlations that might exist among the error terms of the five equations and, by doing so, improves the efficiency with which the coefficients are estimated.

The SUR Results

The results from estimating the five equations by SUR are reported in table 2. That important information exists in the error terms is substantiated by the computed value of 56.34 for a likelihood ratio statistic testing whether covariances among the error terms are zero; this value is to be compared with the 5 percent critical value of 18.30. The error covariance and correlation matrices reported in table 3 indicate where the significant correlations between countries were found. Note, in particular, the high correlations between the U.S. and Germany and between Germany and Switzerland. Conjectures to explain these correlations and, possibly, model rejections are discussed later in reference to the table 4 results.

Although OLS and SUR should produce similar coefficient estimates, both the U.S. and Swiss slope coefficients reported in table 2 are markedly different from their values in table 1. In view of the low values for R^2 in both the U.S. and Swiss equations, however, these changes merely indicate that, for these data, the basic specification of the expectations model simply does not produce precise estimates of the slope coefficient. The more important point is that, after using the SUR estimator, the hypothesis that all five slope coefficients are jointly equal to one still is rejected. Finally, the Japanese intercept, which did not change numerically, now is significantly different from zero. Because the German and U.K. results are largely unaffected by the SUR estimation, however, this simple change in estimation procedure to incorporate linkages among financial markets, while indicating that significant information exists in the correlations among error terms across equations, still rejects the expectations model for most of the countries examined.

OTHER SOURCES OF EXPLOITABLE INFORMATION

Another assumption behind empirical tests of the expectations model is that the data used for estimation were generated during a period characterized by a stable economic structure. Moreover, the data should be drawn from markets in which interest rates can adjust freely. Thus, the basic model should not be estimated with data from periods associated with major policy

[9]Edwards (1982) has made the same point and reported much-improved results for a similar model applied to the exchange rate. Krol (1987) also reported substantial integration of these markets across countries. Mankiw (1986), however, finds little correlation across countries and speculates that capital controls may "prevent effective international arbitrage (p. 66)". See Zellner (1962) for details on the estimation procedure.

Table 3

Error Correlation and Covariance Matrices From The SUR Estimation

Country	United States	United Kingdom	Germany	Japan	Switzerland
		Covariance Across Models			
United States	2.49				
United Kingdom	0.43	2.03			
Germany	0.44	0.25	0.43		
Japan	0.06	0.07	0.11	0.23	
Switzerland	0.14	0.49	0.30	0.00	1.37
		Correlation Matrix			
United States	1.00				
United Kingdom	0.19	1.00			
Germany	0.43*	0.27*	1.00		
Japan	0.08	0.10	0.33*	1.00	
Switzerland	0.08	0.29*	0.38*	−0.01	1.00

5 percent significance level for correlation is 0.25.

For the null hypothesis that the off-diagonal elements of the covariance matrix are zero, the likelihood ratio statistic is 56.34 vs. a 5 percent critical value of 18.30.

Table 4

Revised Expectations Model SUR Estimates

Country	a	b	MTARGET	EMS
United States	−0.56	0.45	−0.49	—
	(2.23)	(1.08)	(0.88)	—
United Kingdom	0.00	0.94	—	—
	(0.02)	(0.19)	—	—
Germany	−0.47	0.47	—	−0.56
	(5.50)	(3.83)*	—	(0.72)
Japan	−0.18	1.07	—	—
	(3.07)	(0.42)	—	—
Switzerland	−0.40	0.58	—	−0.62
	(2.42)	(1.60)	—	(1.27)

NOTE: Absolute values of t-statistics are in parentheses. For b, t-statistic applies to the null hypothesis b = 1. An asterisk indicates a slope coefficient significantly different from one at the 0.05 level of significance.

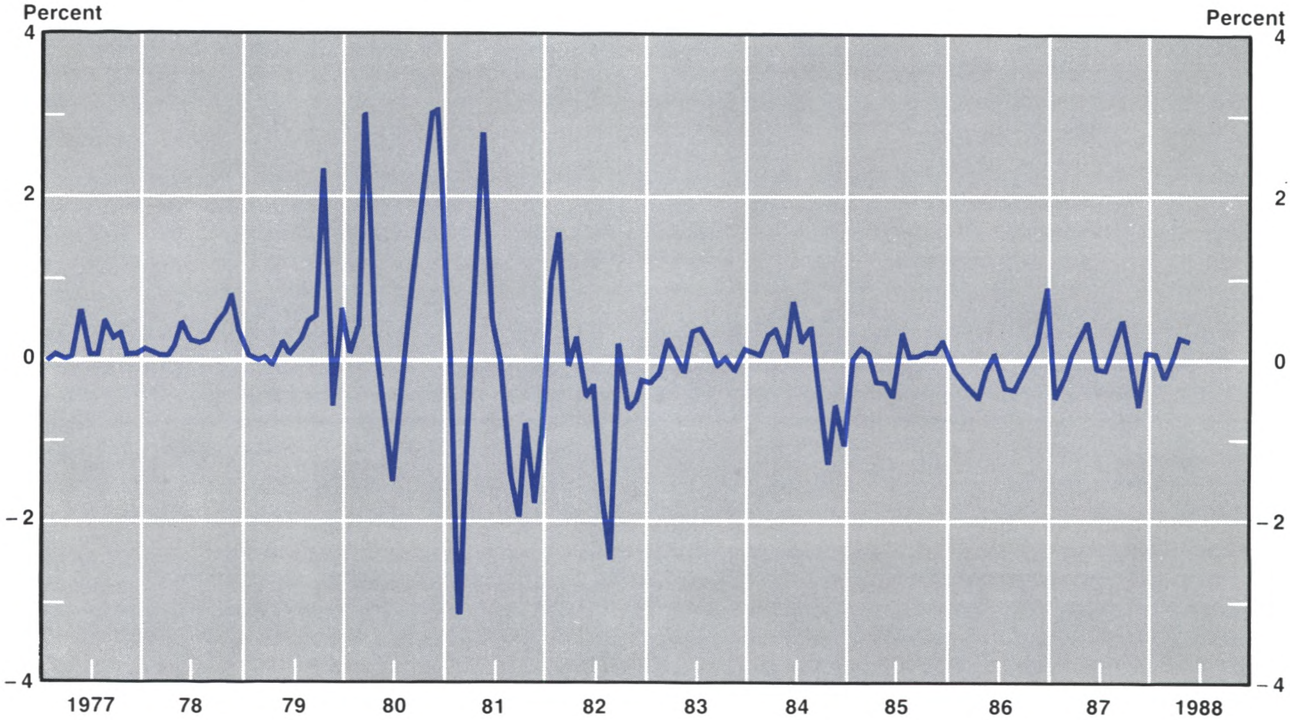
F-test for null hypothesis: $b_{US} = b_{UK} = b_{GER} = b_{J} = b_{SW} = 1$ is 3.55 versus a critical value of 2.21.

changes or impediments to market adjustments. In the case of the former, major policy changes may cause large discrete changes in expectations or changes in the variability of expectations that cannot be measured or modelled properly. Similarly, taking data from, say, a period characterized by interest rate controls would be inappropriate for testing the model because theory assumes that interest rates can adjust freely in perfectly competitive, efficient markets. In what follows below, we describe some major changes that have occurred during the period used for estimation and assess how they affect the results reported above.

Changes in U.S. Monetary Policy

Since October 1979, the Federal Reserve has used two distinct operational procedures in its conduct of monetary policy. Between October 1979 and October 1982, the Fed established a targeted path for nonborrowed reserves; this approach permitted short-term interest rates to fluc-

Chart 1
Changes in Federal Funds Rate



tuate within wider bands than had the previous procedure, which had focused on keeping the federal funds rate within a narrow range. In October 1982, the Federal Reserve announced that, due to increasing uncertainties about the definition of the M1 aggregate, it would conduct monetary policy by setting an objective for borrowed reserves; this latter strategy resulted in less variation in short-term interest rates.[10] Thus, the first part of the sample period used in the estimation is characterized by a Fed operating procedure that permitted greater variation in short-term interest rates; this period is followed by four years of data associated with a procedure that, once again, reduced the variation in short-term interest rates. The behavior of the federal funds rate, which supports this depiction of events, is shown in chart 1.

How would this switch in policy implementation affect tests of the expectations model? According to Mankiw and Miron (1986), Fed policy based on smoothing short-term interest rates can be characterized as:

$$(2)\quad E_t(\Delta r_{t+1}) = 0$$

or, the expected change in the short-rate at each moment in time is zero *even if* the Fed has been observed to change short rates in response to, say, real GNP growth or inflation rates that deviated from prior expectations. If equation 2 describes Fed policy since October 1982 (and prior to October 1979), the value of $({}_tF_{1,t+1} - r_{1,t})$ in equation 1 will *always* be zero and short-term interest rates will behave, approximately, as a random walk. In this case, the expectations model of the term structure would be incapable of explaining the behavior of short-term interest rates.

Mankiw and Miron (1986) investigated this problem using annual U.S. data from 1890–1914 and

[10]See Wallich (1984) and Gilbert (1985) for more discussion about changes in the implementation of U.S. monetary policy over time.

1915–79. They found that support for the expectations model varied with monetary regime. While the expectations model "holds" for the pre-Fed period, when there was no monetary authority to smooth interest rates, the model is rejected for the later period when the Fed's approach to policy tended to smooth fluctuations in short-term interest rates. Their results, therefore, suggest that the U.S. results reported in table 2 — and perhaps other rejections of the model using post-1979 U.S. data — could be dominated by the sub-sample associated with the post-October 1982 change in Federal Reserve operating procedures.

Effects of Exchange Rate Intervention Rules

The founding of the European Monetary System (EMS) is another important change that occurred in 1979 and is a possible source of the negative results for Germany and Switzerland. The EMS agreement established ranges for bilateral exchange rates of the member countries and called for cooperative interventions by the central banks of the countries involved when rates deviated from their specified ranges. Thus, German monetary policy since 1979 has been constrained by its participation in the exchange rate agreement and its pledge to intervene.[11] In practice, Germany has become the leader of the EMS due to the size of its economy and its low inflation rate; other EMS countries have followed its noninflationary monetary policy. Much research has shown that the EMS agreement really has behaved as if a dollar/DM objective were pursued by the German central bank.[12]

In addition, Swiss monetary policy is influenced by the DM/Swiss franc exchange rate even though Switzerland is not an EMS member.[13] Because standard models typically explain the behavior of the exchange rate as depending on the spread between foreign and domestic interest rates, attempts by the Bundesbank to influence the dollar/DM exchange rate also would create a strong link between German and Swiss interest rates.[14] Suppose, for example, that the dollar were depreciating against the DM because U.S. interest rates were falling. The Bundesbank could attempt to stop or reverse this dollar depreciation by expanding the German money stock and lowering German short-term interest rates. Such an action, however, would cause the value of the Swiss franc to rise against the DM. In the past, the Swiss National Bank has responded to this (or similar) sequence of events by following the Bundesbank with a more expansionary monetary policy and lower short-term interest rates as it attempted to re-establish some desired value for the DM/Swiss franc exchange rate. This close linkage of German and Swiss interest rates, from a Swiss objective for stability of the bilateral exchange rate, is likely to be the source of the highly correlated Swiss and German error terms reported in table 3.[15] In sum, both German and Swiss monetary policies are influenced by exchange rate considerations that could affect empirical estimates of the expectations model.

Empirical Implementation

To investigate these possibilities, the system of SUR equations reported in table 2 was re-estimated with changes in the U.S., German and Swiss regressions. For the U.S., the whole-sample slope coefficient was split to represent the two distinct periods of Federal Reserve operating procedures. A slope dummy (MTARGET) was introduced, which took a value of one between February 1981 and September 1982 and a value of zero for the remaining months. If the Mankiw-Miron hypothesis is correct, the slope coefficient for the first part of the sample (b plus MTARGET) should not be significantly different from one while the coefficient for the latter period (b alone) should be significantly different (less than) from one.[16]

Although the precise way to quantify the impact of the EMS agreement on German and Swiss financial markets is not clear, the periods when the

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[11] The history of the EMS and a discussion of how it functions can be found in Ungerer, et al. (1986).

[12] See, for example, Fels (1987) for a discussion of the EMS as a dollar/DM commitment by the Bundesbank.

[13] Because trade represents 39 percent of Swiss GDP and trade with Germany accounts for one-fifth of total trade, the Swiss franc/DM exchange rate has been particularly important to the conduct of Swiss monetary policy. The Swiss National Bank, at times, has abandoned its objectives for the growth rate of the monetary base and, instead, pursued an exchange rate objective. See Rich and Béguelin (1985).

[14] See, for example, the model presented by Dornbusch (1980).

[15] A related point that suggests this sort of influence across countries is based on results from Belongia and Ott (1988). They show that the dollar exchange rate risk premium and the amount that the exchange rate adjusts to a given domestic-foreign interest differential both vary with the choice of Federal Reserve operating procedure (interest rate vs. money stock objectives). If nothing else, their result would be suggestive of a time varying risk premium in the expectations model.

[16] An intercept dummy also was tried but it was not significant individually and had no material effects on the magnitudes or significance of other coefficients.

member countries agreed to major realignments of the official exchange rate levels and ranges are known. Other things the same, one can hypothesize that interest rates made discrete adjustments to these realignments within one month after they were announced. To test the proposition about exchange rate linkages and interest rates, a dummy variable was created to represent EMS realignments and was introduced into both the German and Swiss regressions. This variable took a value of one during the months associated with the eight EMS realignments and a value of zero during all other months.[17] As with the U.S. case, multiplying the forward rate − spot rate spread in the German and Swiss regressions by this dummy variable permits the estimation of two different values for the regressions' slope coefficients: one coefficient for "normal" periods and the sum of two coefficients for months when a realignment occurred.

In table 4, the revised SUR results are reported. The null hypothesis that all five slope coefficients are jointly equal to one is rejected, once again, at the 0.05 level of significance. The expectations model is rejected even after augmenting the information set to incorporate changes in the implementation of U.S. monetary policy and the EMS realignments.

Looking at individual country results, the table's top row, associated with the slope dummy for the period of monetary targeting in the United States, indicates that estimates of the expectations model are sensitive to changes in the Fed's operating procedure. Even though the MTARGET dummy is not significant, the model's whole-period slope coefficient increases from 0.20 to 0.45 and now is not significantly different from one.

This apparent improvement in the U.S. results, however, is in direct contrast to Mankiw and Miron's results in two respects. First, when they attempted to investigate the effects of post-1979 data on the expectations model, they reported that "we obtain standard errors so large that one can reject no interesting hypothesis" (p. 227). More important, they hypothesized that the expectations model should *not* be rejected for the period of money stock targeting, but should be rejected for the post-September 1982 period; empirically, this implies that b plus MTARGET should not be statistically different from one while b alone should be significantly different from (less than) one. In fact, the results are reversed; the expectations model is rejected for the period of money stock targeting. Thus, while the dummy variable improves the overall results and provides perhaps a stronger test of their model, the exact process at work is inconsistent with the one hypothesized, leaving an unexplained puzzle.

The revised estimates for the German and Swiss equations provide weak support for the conjecture that the intervention policies of their central banks have significant effects on tests of the expectations model. The signs on the slope dummies are negative and similar in magnitude, to the whole period slope coefficient, which indicates that the forward rate-spot rate spread has zero effect during months of EMS realignments. Moreover, the whole period Swiss slope coefficient now both is larger numerically and not significantly different from one. For Germany, however, the results are not altered when the dates of EMS realignments are considered and the data continue to reject the expectations model.

CONCLUSIONS

The expectations model of the term structure of interest rates has been applied to data for a number of countries and sample periods with generally negative results. In this article we have investigated some conditions under which the expectations model might be rejected in the context of its traditional single equation test. We found substantial correlations across the errors of the individual equations which, when exploited by using SUR estimation, improved the efficiency of estimation. We also found that, although dummy variables used to represent changes in the approach to monetary policy or EMS exchange rate targets were not significant individually, they contributed somewhat to improved overall characteristics of the equations. Although, as in previous studies, many puzzles still remain, these results suggest that tests of the expectations model should use more general models and more efficient estimation procedures than the simple OLS equation typically employed.

[17]The dates of EMS realignments were March 23 and October 5, 1981; February 22 and June 14, 1982; March 21, 1983; July 22, 1985; April 7 and August 4, 1986 and are provided in Fels, p. 217.

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The Puzzling Growth of the Monetary Aggregates in the 1980s

MODERN macroeconomic analysis assigns the key role in aggregate demand management to monetary policy. This role is carried out through changes in the monetary aggregates. Since there are several monetary aggregates — M1, M2 and M3 — considerable confusion may develop about the meaning of their behavior, particularly when they do not move in lock step with each other or with the growth of the monetary base. Such confusion is especially likely to happen when, as has happened in the 1980s, their movements are quite unusual by historical standards.

The monetary base can be thought of as the foundation on which all the monetary aggregates are built; it is also the set of monetary assets most closely related to Federal Reserve actions. Prior to the early 1980s, there was a fairly stable relationship on an annual basis between the growth rate of the monetary base and the growth rates of M1, M2 and M3. The monetary base grew about 1 percentage point faster than M1; and the other two aggregates, M2 and M3, grew about 2 or 3 percentage points faster than the monetary base. Thus, when Federal Reserve actions resulted in a 6 percent annual growth rate of the monetary base, M1 would grow at about 5 percent, M2 at 8 percent and M3 at about 9 percent.

In the 1980s, these relationships changed quite dramatically. From 1984 through 1987, the monetary base growth averaged about 6 percent to 8 percent. In sharp contrast to its previous historical relationship, M1 growth averaged 7 percent to 12 percent; in 1986 alone, M1 grew 4 percentage points faster than the base. Meanwhile, the growth rates of M2 and M3 declined relative to the growth of the base: in 1986, they fell below base growth, and in 1987, base growth exceeded the growth of M2 and M3 by more than 2 percentage points.

Major shifts in the public's holdings of monetary assets have accounted for these changed relationships. This article describes a framework that both incorporates the relative amounts of different monetary assets the public desires to hold and relates the growth of M1, M2 and M3 to the monetary base. This framework is then used to analyze the unusual movements of these aggregates during the past few years.

SOURCES AND USES OF THE MONETARY BASE

The monetary base is essentially derived from the Federal Reserve's balance sheet and can be

Table 1

Components of the Monetary Base: December 1987 (billions of dollars, not seasonally adjusted)

Sources		Uses	
Federal Reserve holdings of government securities	$227.8	Depository institution deposits at Federal Reserve banks	$ 37.7
Federal Reserve loans	0.8	Currency held by depository institutions	30.9
Float plus other Federal Reserve assets	17.3	Currency held by nonbank public	196.5
Other items[1]	19.4		
Source base	265.0	Source base	265.0
Reserve adjustment[2]	7.7	Reserve adjustment[2]	7.7
Monetary base	272.8	Monetary base	272.8

[1]Other items include: Treasury deposits at Federal Reserve Banks, special drawing rights, Treasury currency outstanding, Treasury cash holdings, foreign and other deposits with Federal Reserve Banks, service-related balances and adjustments, and other Federal Reserve liabilities and capital.

[2]Adjustment for reserve requirement ratio changes.

computed either from the sources side — the items that supply base — or from the uses side — the items that absorb base.[1] As table 1 shows, the major source of the monetary base is Federal Reserve holdings of government securities. Changes in this item reflect the Fed's open market operations; during the last 10 years, it has accounted for about 80 percent of the total change and most of the year-to-year fluctuations in the base.

When the Federal Reserve makes an open market purchase of government securities, other factors the same, more monetary base is supplied to the financial sector and the public. This increase in the base is then "used" by the public and depository institutions as additions to their holdings of currency and reserves. The increase in reserves forms the base from which to expand derivative monetary assets created by financial institutions. Because the public chooses the relative proportions of these types of assets they want to hold, it determines the relationship between the growth of the base and the resulting growth of the various monetary aggregates.

THE LINK BETWEEN THE MONETARY BASE AND THE MONETARY AGGREGATES

The relationship between the monetary base and any monetary aggregate can be expressed in the following manner:

$$M = mB.$$

The monetary base (B) is related to the specified monetary aggregate (M) by a money multiplier (m). Given the monetary base, the multiplier summarizes the effect of portfolio decisions by the public and financial institutions on a monetary aggregate.

In terms of growth rates, this expression can be written:

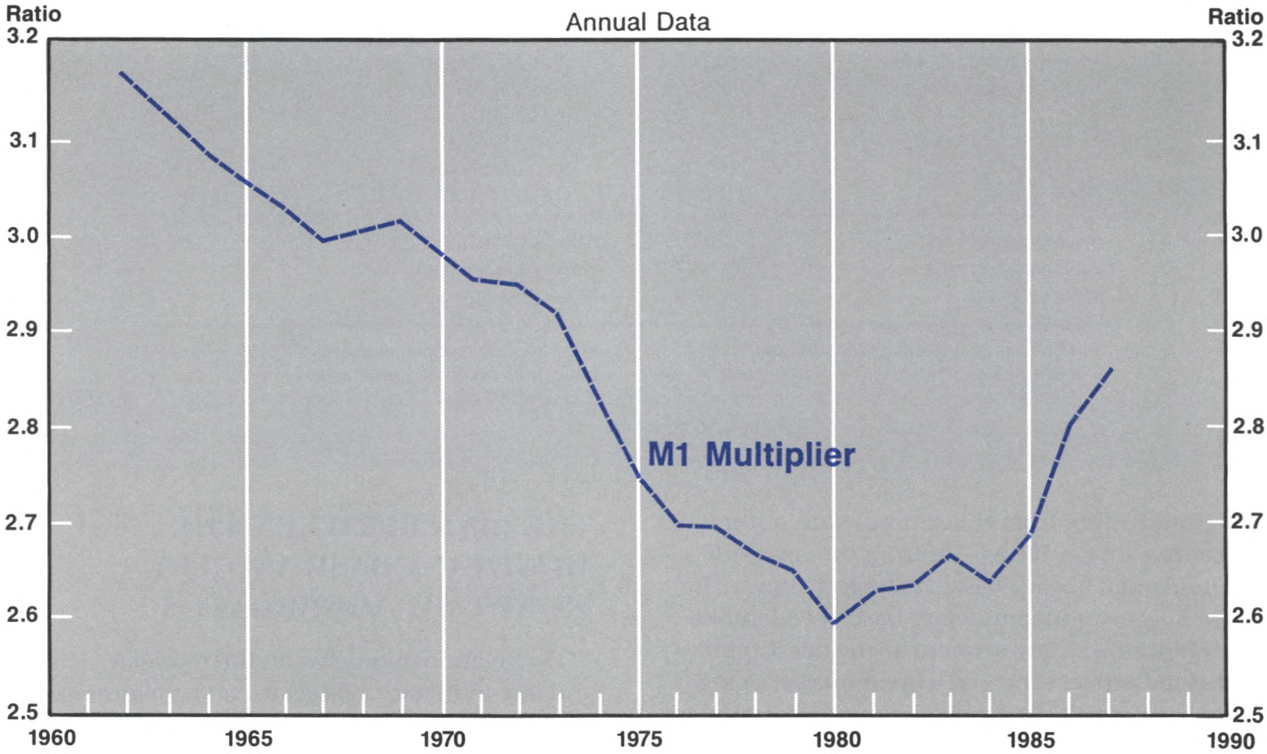
$$\dot{M} = \dot{m} + \dot{B},$$

where the dot above each item denotes its growth rate. If the money multipliers were constant over time, then the growth rates of the monetary aggregates would follow the same pattern as the growth

[1]For a discussion of the concept and derivation of the monetary base, see Burger and Balbach (1976). There are two available measures of the monetary base, one published by the Federal Reserve Board and the other by the Federal Reserve Bank of St. Louis. The Board's measure is a "uses" concept and the Federal Reserve Bank of St. Louis' is a "sources" concept. The major difference is that the St. Louis Fed treats all vault cash contemporaneously while the Board lags the vault cash component of total reserves, reflecting its treatment as total reserves. In analyzing periods of two or more quarters, the differences in results between the two base concepts is very small. For a further discussion of these measures, see Burger (1979).

The source base is usually "adjusted" to incorporate the influence of reserve requirement changes into movements in the adjusted monetary base. For a discussion of this adjustment, see Burger and Rasche (1976), Burger (1979) and, for the most recent method of calculating this adjustment, Gilbert (1987).

Chart 1
M1 Multiplier



of the monetary base, and all aggregates would grow together.

As the next section shows, however, these multipliers have not been constant. Consequently, although the growth rates of M1 and the monetary base have been highly correlated, there have still been periods such as 1974–76 and 1985–87 when they diverged substantially. The growth rates of M2 and M3 have been less closely tied to the growth of the monetary base and, although both have been highly correlated, they have frequently diverged from the growth of M1.

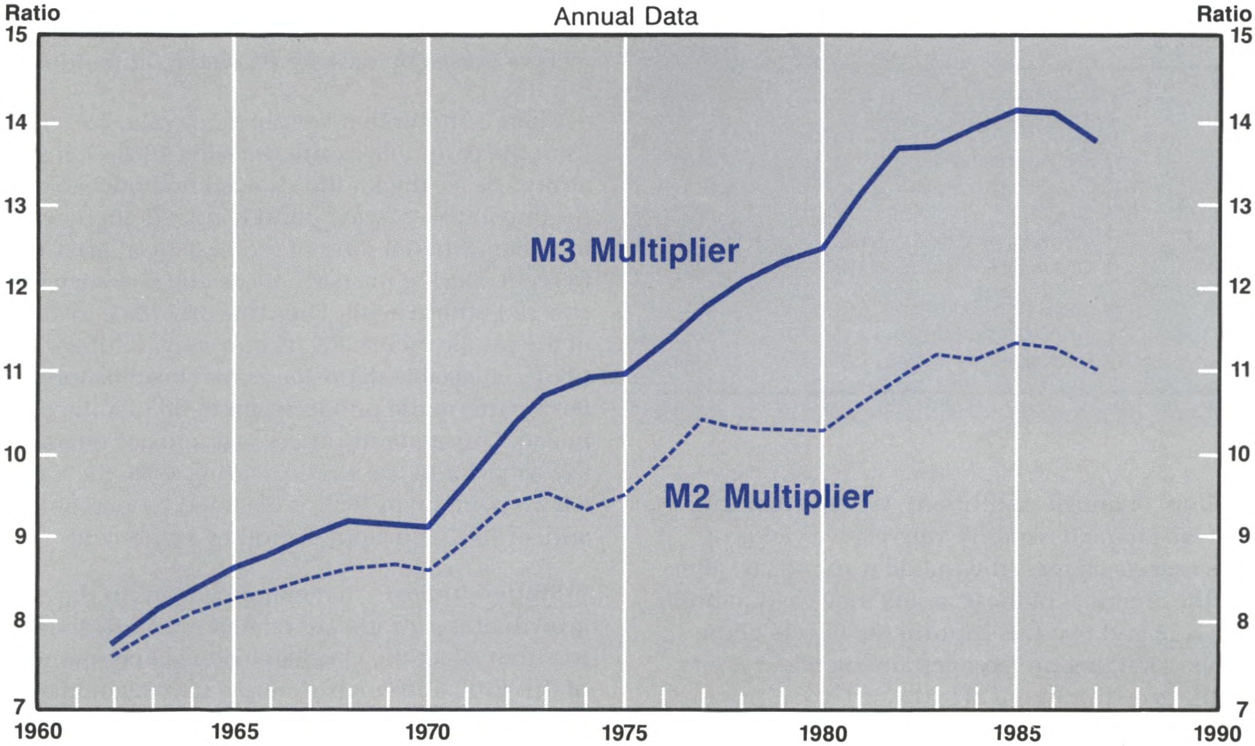
EXAMINING THE BEHAVIOR OF THE MULTIPLIERS

As chart 1 shows, from the early 1960s through the 1970s, there was a long-run downward trend in the M1 multiplier. The multiplier drifted lower from the early 1960s through 1973, declining at about a 1 percent annual rate. During the next three years, it fell faster at about a 3 percent annual rate. This was reflected in a widening spread between the growth of the monetary base and M1.

For the remainder of the 1970s, the M1 multiplier decline slowed to about its 1962–73 pace. Then, about mid-1980, the M1 multiplier flattened out and showed little growth on average until early 1985, when its behavior changed markedly. It rose at a 1.7 percent annual rate in 1985; in 1986 its growth increased to 4 percent. The M1 multiplier declined somewhat in mid-1987; however, when measured on an annual basis, it still rose another 2 percent in 1987. As chart 1 indicates, this prolonged and substantial rise was without precedent since the early 1960s.

Chart 2 shows that the M2 and M3 money multipliers have followed very different paths. They generally rose for most of the period since the early 1960s, while the M1 multiplier was falling. In the last few years, while the M1 multiplier has been rising, however, the M2 and M3 multipliers have fallen. During the period shown in chart 2, three broad growth patterns emerge in the M2 and

Chart 2
M2 and M3 Multipliers



M3 multipliers. From the early 1960s through early 1982, they increased on average at about a 2 percent rate. In early 1983, they came to a halt, and for the next two years, they showed essentially no growth. In early 1986, however, the M2 and M3 multipliers began a decline that has lasted into 1988.

A Model of the Money Multipliers

The substantial break in the usual behavior of the money multipliers in the 1980s was reflected in the unusual behavior of the monetary aggregates relative to the growth of the monetary base, and to each other. To examine why this was the case, one must develop explicit forms of the respective multipliers to analyze how the changing portfolio preferences of the public have affected them.

Given the following definitions,

m1 = M1/B,
m2 = M2/B,
m3 = M3/B,
R = reserves of depository institutions adjusted for reserve requirement changes,
C = currency held by the public,
B = monetary base = R + C,
D = checkable deposits,
k = the public's desired currency ratio = C/D,
t2 = the public's desired nontransactions balance ratio = (M2 − M1)/D,
t3 = (M3 − M2)/D, and
r = reserve ratio = R/D,

the following explicit forms of the multipliers can be derived (see appendix 1 for this derivation):

$$m1 = \frac{1+k}{r+k} \qquad m2 = \frac{1+k+t2}{r+k} \qquad m3 = \frac{1+k+t3}{r+k}$$

In this framework, a distinction can be made among three major classes of assets. As table 2 shows, M1 represents transaction balances, (M2 − M1) represents liquid savings balances, and (M3 − M2) represents managed liabilities of de-

Table 2

Components of the Monetary Aggregates: December 1987 (not seasonally adjusted)

		Monthly Average
M1	Currency	$199.4
	Total checkable deposits	560.1
M2-M1	Savings deposits	410.0
	Small time deposits	914.6
	MMDA	525.2
	Money market mutual funds	221.1
	Overnight RP and Eurodollars	78.1
M3-M2	Large time deposits	485.4
	Term RP and Eurodollars	196.3
	Institution-only MMMF	89.6

pository financial institutions. When either the specific characteristics or the relative yields of these assets change, the public responds by altering the amounts of these assets they wish to hold. The k, t2 and t3 ratios capture the effects of the public's shifting preferences among these assets on the growth rates of M1, M2 and M3. A rise in the r-ratio reflects an increase in depository institutions' desired holdings of reserves relative to deposits; hence, a rise in this ratio reduces all three multipliers.

Given this framework, we can now examine the behavior of these ratios and determine their contribution to the money multiplier movements, especially in recent years.

The Currency Ratio

A rise in the k-ratio reflects an increase in the public's desired holdings of currency relative to checkable deposits. For a given amount of monetary base, this means a reduction in the portion of base held by depository institutions (reserves) and, consequently, a reduction in checkable deposits. Therefore, a rise in the k-ratio reduces all three money multipliers.

It has been long recognized that, given the growth of the monetary base, variations in the k-ratio exert a dominant influence on movements in M1 and a strong influence on movements in other monetary aggregates.[2] As chart 3 illustrates, movements in the M1 multiplier are essentially the mirror image of movements in the k-ratio. Thus, deviations of M1 growth from base growth are predominantly due to sharp changes in the growth of the currency ratio (the quantitative effects of these changes are derived in appendix II).

Chart 3 shows that the currency ratio increased from the early 1960s until the early 1980s. On an annual basis, the k-ratio showed no noticeable decline in this 21-year period; indeed, there were few years when it did not increase by at least 1 percent. During the early 1980s, the currency ratio showed little growth. Then, in early 1985, instead of the public increasing its currency holdings relative to checkable deposits, as had been its long-term pattern, the public began to do just the opposite. Consequently, there was a major change in the behavior of the k-ratio. During 1985, the k-ratio fell 2.8 percent; in 1986, it declined 7.7 percent; and, in 1987, it dropped another 4.1 percent.

Studies indicate that major changes in the growth of the k-ratio are related primarily to factors that affect the checkable deposit component of this ratio. Although attempts have been made to trace the rise in the k-ratio in the 1970s to a sharp increase in currency demand along with the rise of the "underground economy,"[3] currency demand has been found to be stable over long periods of time.[4]

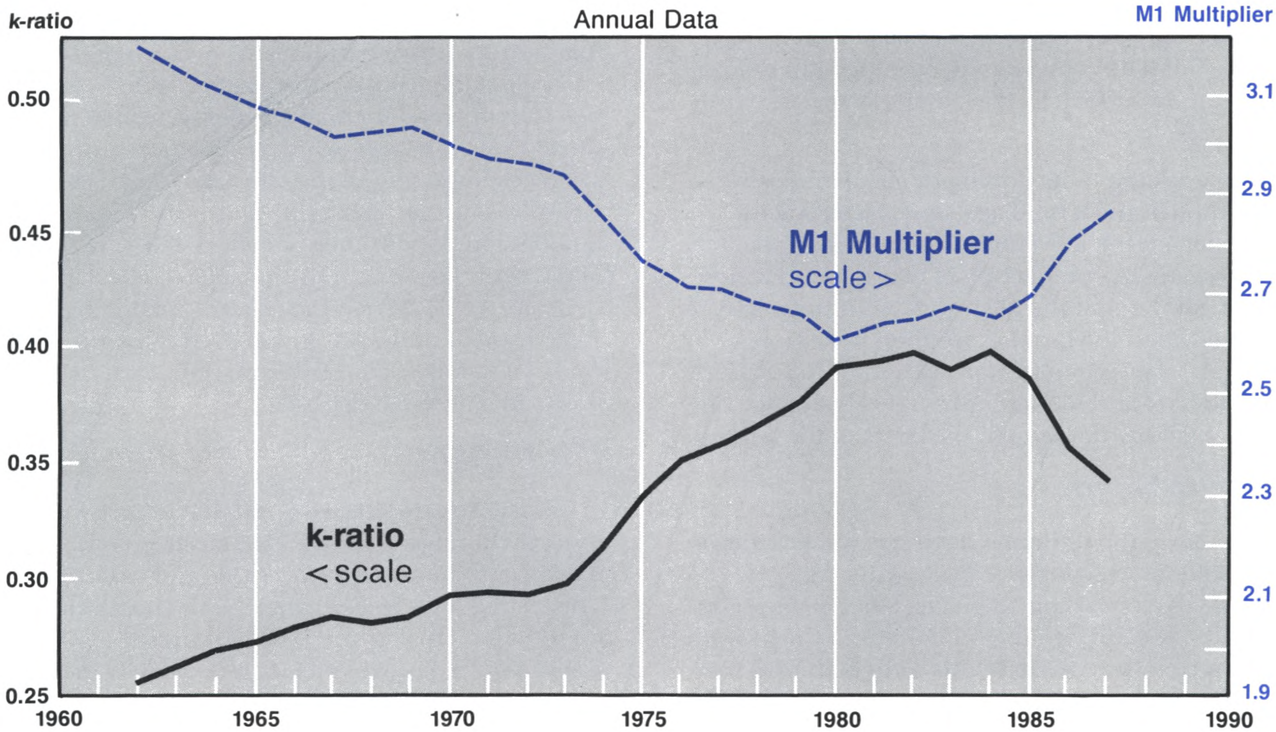
The amount of transaction balances that individuals and firms desire to hold relative to other assets is influenced by such factors as current and expected rates of inflation, relative yields on other assets and available alternative assets. In the 1970s, inflation accelerated, interest rates rose, new forms of savings accounts were offered to the public and new cash management techniques became available to business. Unlike the demand for currency, the demand for checkable deposits was substantially affected by these developments, particularly the financial innovations. For example, business holdings of transaction balances relative to financial assets declined from about 74 percent in 1970 to about 38 percent in 1981. This decline was most closely related to the rise of cash

[2]See Cagan (1958).

[3]See Gutmann (1977).

[4]See Garcia (1978) and Dotsey (1988).

Chart 3
Currency Ratio and M1 Multiplier



management techniques.[5] The major effect of these developments fell on the checkable deposit component of transaction balances, resulting in an accelerated rise in the currency ratio from 1972 through the rest of the decade.

In 1978 and 1979, small-denomination time deposits of varying maturities, with interest rates tied to Treasury certificates of comparable maturities, were authorized. In 1980, with the passage of the Depository Institutions Deregulation and Monetary Control Act, a six-year phase-out of interest rate ceilings on time deposits was established[6]; moreover, nationwide NOW accounts were authorized at the end of 1980. In 1982, new types of time deposits that paid market interest rates were introduced and the Garn-St. Germain Act was passed which authorized money market deposit accounts. By the end of 1983, almost all interest rates on time deposits were deregulated and super-NOW accounts (NOW accounts with no minimum maturity and no ceiling on yields) were permitted.

This deregulation blurred the sharp distinction between transaction and savings accounts that had existed for nearly 50 years. The Banking Act of 1933 had prohibited the payment of interest on demand deposits, making the checkable component of M1 a relatively unattractive savings vehicle, especially in times of rising interest rates. Some changes to this situation took place in the 1970s, but did not have a major effect on the unique transaction characteristics of M1. Then, in the 1980s, checkable deposits that yielded explicit interest and had many of the characteristics of savings deposits were introduced.

The yields on these new checkable deposits adjusted very sluggishly to changes in market

[5]From 1972 to 1980, the demand deposit share of liquid assets fell at about a 6 percent annual rate. The decline in households' holdings of transaction balances as a proportion of liquid assets was relatively minor. The rate of decline of neither household nor business holdings of transaction balances seems closely tied to interest rate fluctuations in the 1970s (Kopcke, 1987).

[6]See Gilbert (1986).

interest rates.[7] Consequently, as market interest rates fell sharply in the 1980s, the spread between the rates offered on checkable deposits and market interest rates on other short-term liquid assets closed rapidly. The public responded by holding more checkable deposits.[8] The demand for currency, however, was much less affected by these developments, causing the currency ratio to flatten out from 1980 to 1984, then decrease sharply in 1985.

In addition to its dominant effect on the M1 multiplier, the k-ratio also exerts a strong influence on the movements of the other monetary aggregates. A comparison of charts 2 and 3, however, shows that the M2 and M3 multipliers were rising when the k-ratio rose then flattened out in recent years when the k-ratio fell sharply. Clearly, for the M2 and M3 multipliers, the influence of other factors dominated the effect of the k-ratio.

The t2-Ratio

A rise in the t2-ratio reflects the public's desire to hold more savings-type deposits (M2 − M1) relative to checkable deposits. Since the t2-ratio enters directly into the numerator of the M2 and M3 multipliers, a rise in this ratio increases these multipliers.[9] Chart 4 shows the dominant influence of the t2-ratio on the M2 and M3 multipliers. Although the rising k-ratio exerted a negative influence on these multipliers for most of the period shown in the chart, its influence was offset by the movement of the t2-ratio. (Appendix II quantifies the influence of each of these ratios on the M2 and M3 multipliers.) The greater disparity between the mean growth rate of these multipliers and that of the base (than that between M1 and the base) during most of the 1960s and 1970s was the result of the 4 percent annual rate of growth of the t2-ratio.

The 1985–87 period stands out in contrast to previous periods. Although the t2-ratio declined, as shown in chart 4, the M2 and M3 multipliers did not decline as much as one would have expected, given the decline in the t2-ratio alone. In this period, however, the falling k-ratio, as shown in chart 3, partly offset the t2-ratio's negative effect on these multipliers.

As chart 5 shows, movements in the t2-ratio have been dominated by relative movements of savings (SVG) and small time deposits (STD). During the 1970s, the sharply rising proportion of small time deposits relative to checkable deposits (STD/D) provided the major impetus for the rise in the t2-ratio. The strong negative influence of the savings component in the late 1970s and early 1980s was further offset by a sharp rise in other liquid savings instruments such as MMDAs, MMMFs and overnight RPs relative to checkable deposits (OL/D). When the t2-ratio declined in late 1985 through mid-1987, it was predominantly because of a sharp fall in the ratio of small time deposits to checkable deposits.

The t3-Ratio

In recent years (1983–87), the spread between the growth rates of M3 and M2 has been much narrower than it was in the 1970s and early 1980s. This change can be explained by the behavior of the t3-ratio. This ratio, which captures the public's desired holdings of assets included solely in M3 compared with checkable deposits determines the spread between the M3 and M2 multipliers. Chart 6 shows that, as this ratio rose sharply from the early 1970s to the early 1980s, the spread between the M3 and M2 multipliers rose steadily. After 1982, however, as the t3-ratio fell, the spread between the M3 and M2 multipliers stabilized.

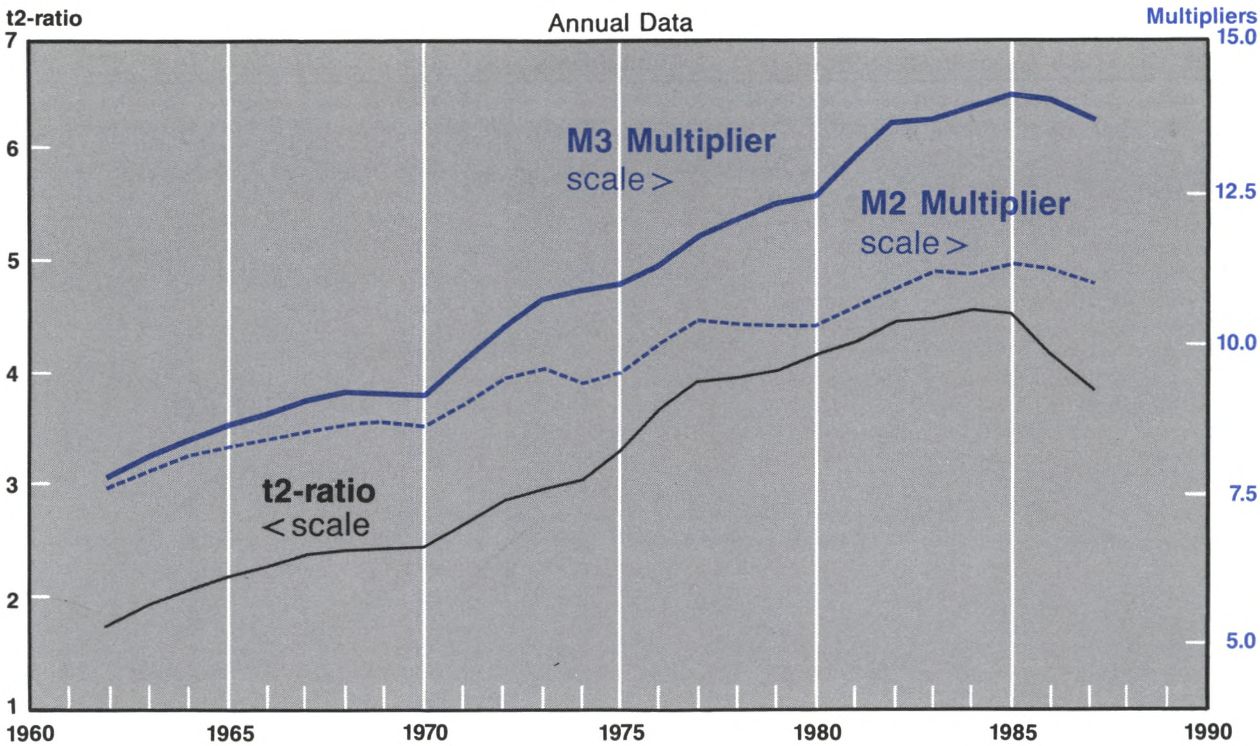
Movements of large time deposits have dominated movements of the t3-ratio. The other components of (M3 − M2) constituted no more than 20 percent of the total until 1977. Although these other managed liabilities (term RPs and Eurodollars and institution-only MMMFs) rose rapidly enough to account for 36 percent of the total by 1987, fluctuations in large time deposits continued to be the dominant cause of t3-ratio fluctuations. The sharp break in this ratio's long-run pattern that occurred in late 1984 and continued over the

[7]See Wenninger (1986) and Roth (1987).

[8]A Federal Reserve survey of changes in the use of cash and transaction accounts from 1984 to 1986 found that individuals consolidated their accounts, increased their use of checking accounts as a family savings vehicle and diminished their use as a media for transactions. The study also found that average cash balances increased with the decline in interest rates, while portfolio considerations became more important and transaction motives less important in how people managed cash and transaction accounts between 1984 and 1986 (Avery et. al., 1987).

[9]To the extent that (M2 – M1) contains reservable liabilities, an increase in time and savings deposits absorbs reserves and reduces the multipliers. In previous formulations of the multiplier, a t-ratio appears in the denominator of all the multipliers (see Burger, 1971). In the multipliers presented in this paper, this effect is not separated out in the denomination of the multipliers, but its effect is reflected in movements in the r-ratio. This influence varies between the period before 1980 and after 1980, because of the definition of adjusted reserves that appears in the r-ratio. The exact nature of this influence is shown in Gilbert (1987).

Chart 4
M2 and M3 Multipliers and t2-Ratio



next nine quarters reflected a slowing of the growth of large time deposits relative to the growth of checkable deposits. Although the growth of other managed liabilities slowed in 1985, it resumed its previous pace in 1986 and 1987.

SUMMARY

Looking at past relationships, one might be tempted to conjecture that, in the 1980s, the monetary aggregates became totally disconnected from Federal Reserve actions as summarized in the monetary base. By presenting a framework that can be used to explain the movements of the aggregates both relative to each other and relative to the growth of the monetary base, this article has shown this not to be the case. During the 1980s, new financial assets were introduced and major changes occurred in inflation, interest rates and the basic characteristics of most of the traditional monetary assets. In response to these events, the public made sizable shifts in its portfolio, which affected the various monetary aggregates in disparate ways. The framework presented in this article is one way to isolate the shifts that influenced the monetary aggregates and illustrate their effects on the growth rates of the aggregates.

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Chart 5
Components of the t2-Ratio

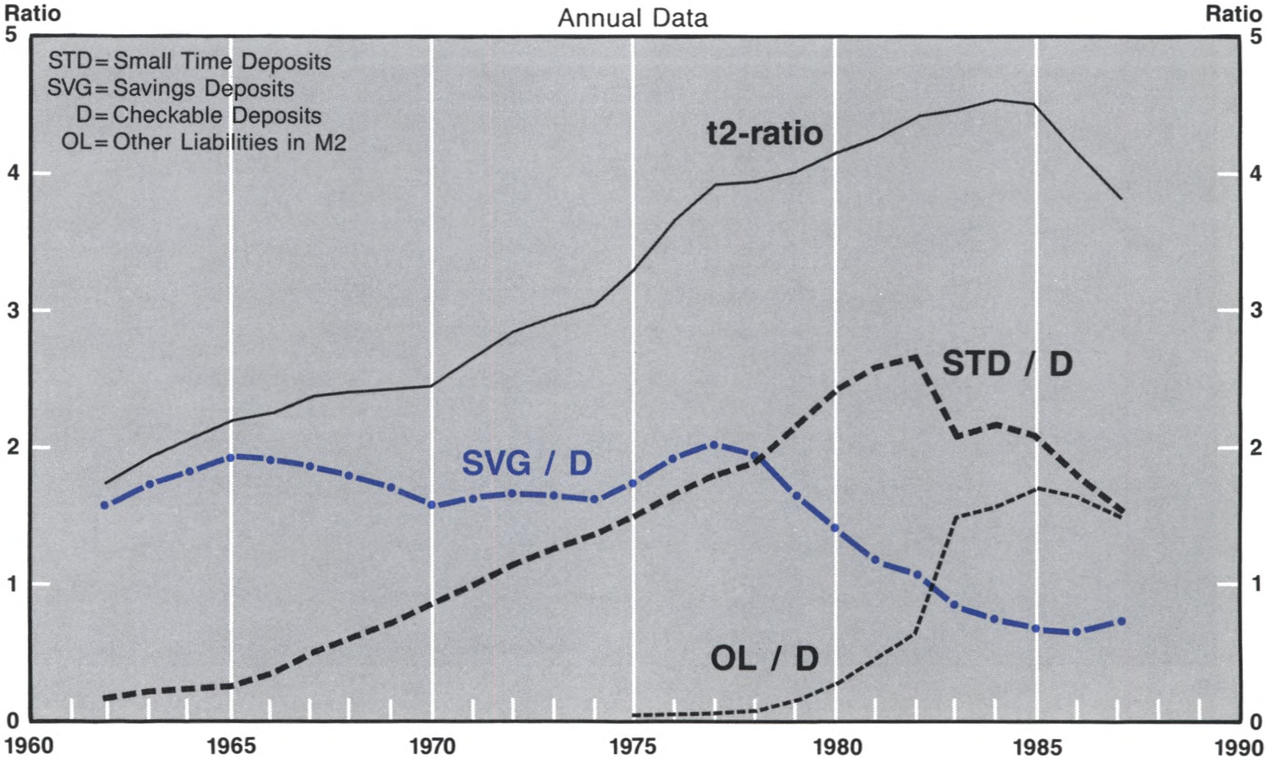

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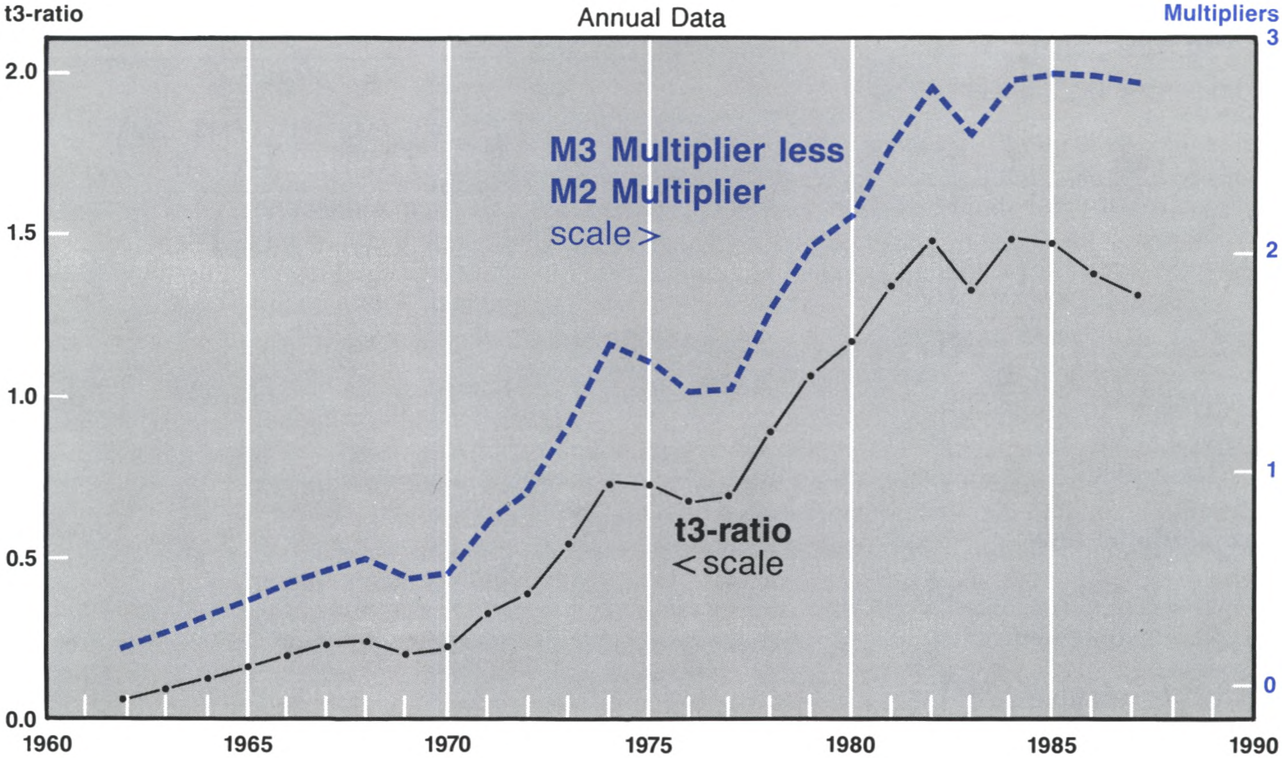
Chart 6
Spread Between M3 and M2 Multipliers and t3-Ratio



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Appendix I
Derivation of Multipliers

M1 multiplier (m1)

$$AMB = R + RAM + C$$

$$M1 = C + D$$

$$m1 = \frac{M1}{AMB} = \frac{C + D}{R + RAM + C}$$

$$= \frac{\left(1 + \frac{C}{D}\right)}{\left(\frac{R + RAM}{D}\right) + \left(\frac{C}{D}\right)}$$

$$m1 = \frac{1 + k}{r + k}$$

M2 multiplier (m2)

$$m2 = \frac{C + D + M2 - M1}{R + RAM + C}$$

$$= \frac{\left(1 + \frac{C}{D}\right) + \left(\frac{M2 - M1}{D}\right)}{\left(\frac{R + RAM}{D}\right) + \left(\frac{C}{D}\right)}$$

$$m2 = \frac{1 + k + t2}{r + k}$$

M3 multiplier (m3)

$$m3 = \frac{C + D + M2 - M1 + M3 - M2}{R + RAM + C}$$

$$= \frac{\left(1 + \frac{C}{D}\right) + \left(\frac{M2 - M1}{D}\right) + \left(\frac{M3 - M2}{D}\right)}{\left(\frac{R + RAM}{D}\right) + \left(\frac{C}{D}\right)}$$

$$m3 = \frac{1 + k + t2 + t3}{r + k}$$

Appendix II
Magnitude of the Influence of the Component Ratios on the Multipliers

The size of the effect that each of the ratios exerts on the growth of the money multipliers depends both on the growth rate of each ratio and the responsiveness of the multiplier to a change in the ratio. This responsiveness can be quantified by calculating the partial elasticities of each of the multipliers with respect to its component ratios, as shown below. These results show that, in this formulation, although the response of all the multipliers to a change in the r-ratio are the same, there are differences in the response of the multipliers to the other ratios.

ELASTICITIES OF THE MULTIPLIERS WITH RESPECT TO THEIR COMPONENT RATIOS

$e(m1,k) = k(r-1)/(r+k)(1+k) < 0$

$e(m2,k) = k(r-1-t2)/(r+k)(1+k+t2) < 0$

$e(m3,k) = k(r-1-t2-t3)/(r+k)(1+k+t2+t3) < 0$

$e(m2,t2) = t2/(1+k+t2) > 0$

$e(m3,t2) = t2/(1+k+t2+t3) > 0$

$e(m3,t3) = t3/(1+k+t2+t3) > 0$

$e(m1,r), e(m2,r), e(m3,r) = -r/(r+k) < 0$

Table A1 presents the computed annual averages of these elasticities. The values of these elasticities change over time as the ratios change. For example, the rise in t2-ratio has affected the relationship between the response of m2 and m3 to a change in the t2-ratio. In the early 1960s, e(m2,t2) and e(m3,t2) were both about the same. By the early 1980s, the e(m2,t2) had risen to about .76 while e(m3,t2) was still about .62. In 1985–87, these elasticities fell as the t2- and t3-ratios declined.

The magnitude of the influence of the portfolio shifts embedded in the k-, t2-, and t3-ratios on the growth of the multipliers can be isolated using the following formula:

Table A1
Elasticities of the Multipliers with Respect to Their Component Ratios

Year	e(m1,k)	e(m2,k)	e(m3,k)	e(m2,t2)	e(m3,t2)	e(m3,t3)	e(m,r)	Year
1965	−0.44	−0.57	−0.58	0.63	0.60	0.04	−0.35	1965
1966	−0.44	−0.58	−0.58	0.64	0.61	0.05	−0.34	1966
1967	−0.44	−0.58	−0.58	0.65	0.61	0.06	−0.34	1967
1968	−0.44	−0.58	−0.58	0.65	0.61	0.06	−0.34	1968
1969	−0.44	−0.59	−0.59	0.65	0.62	0.05	−0.34	1969
1970	−0.45	−0.59	−0.60	0.65	0.62	0.05	−0.33	1970
1971	−0.44	−0.59	−0.60	0.67	0.62	0.08	−0.33	1971
1972	−0.44	−0.59	−0.60	0.69	0.63	0.09	−0.33	1972
1973	−0.44	−0.60	−0.60	0.69	0.62	0.11	−0.33	1973
1974	−0.43	−0.60	−0.61	0.70	0.60	0.14	−0.33	1974
1975	−0.43	−0.61	−0.62	0.71	0.61	0.14	−0.32	1975
1976	−0.44	−0.63	−0.63	0.73	0.64	0.12	−0.30	1976
1977	−0.44	−0.64	−0.64	0.74	0.66	0.12	−0.30	1977
1978	−0.44	−0.64	−0.65	0.74	0.64	0.14	−0.29	1978
1979	−0.44	−0.65	−0.66	0.74	0.62	0.16	−0.28	1979
1980	−0.44	−0.65	−0.66	0.75	0.62	0.17	−0.28	1980
1981	−0.45	−0.66	−0.68	0.75	0.61	0.19	−0.27	1981
1982	−0.46	−0.67	−0.69	0.76	0.61	0.20	−0.26	1982
1983	−0.46	−0.68	−0.69	0.76	0.62	0.18	−0.26	1983
1984	−0.46	−0.68	−0.69	0.76	0.61	0.20	−0.26	1984
1985	−0.46	−0.68	−0.69	0.76	0.61	0.20	−0.26	1985
1986	−0.47	−0.67	−0.68	0.75	0.60	0.20	−0.27	1986
1987	−0.47	−0.66	−0.67	0.74	0.59	0.20	−0.28	1987

$$\dot{m} = e(m,k)(\dot{k}) + e(m,t2)(\dot{t}2) + e(m,t3)(\dot{t}3) + e(m,r)(\dot{r}).$$

In the above formula, e(m,__) represents the partial elasticity of the respective multiplier with respect to the specified ratio. For example, e(m1,k) would represent the partial elasticity of the M1 multiplier (m1) with respect to the k-ratio. The dots above the ratios denote growth rates. The results of this decomposition of the growth rates of the respective multipliers are shown in tables A2, A3 and A4. The results through 1984 were computed using annual growth rates of the component ratios that appear in the multipliers, and the elasticities are the ones reported in table A1. Quarterly data for I/1985–I/1988 were computed using quarterly growth rates and quarterly elasticity measures.

Over the three years ending in 1984, the k-ratio, on average, showed essentially no growth. Then, from fourth quarter 1984 to first quarter of 1986, it fell at an annual rate of about 5 percent; over the next four quarters, it fell 10 percent. This effect is shown in tables A2, A3 and A4, as the negative contributions of the k-ratio to the growth rates of the multipliers became smaller in the early 1980s and then turned into large positive effects beginning in 1985. This effect dominated the growth of m1, leading to a pronounced change in the relationship between the growth of M1 and the monetary base. From fourth quarter 1985 to first quarter 1987, the growth of M1 exceeded the growth of the monetary base by about 7 percentage points.

In the 1985–87 period, the effect of the declining k-ratio on the relationships between the growth of M2 and M3 and the growth of the monetary base was not nearly as marked as was the case with M1. Tables A3 and A4 show that the changed behavior of t2- and t3-ratios acted to offset the changed behavior of the k-ratio on these multipliers.

Since early to mid-1987, the k-, t2- and t3-ratios all have risen, resuming patterns that are more in line with their historical behavior. Since the relative growth rates of the aggregates depend on the influence of each of these ratios on the respective multipliers, the rise in the k-ratio, which has been especially strong relative to its historical pattern (from II/1987 to I/1988, the k-ratio rose at an 8 percent rate), has dominated the growth of all three multipliers, as shown in tables A2, A3 and A4. Consequently, the M1 multiplier has fallen and the growth of the monetary base has exceeded the growth of M1, as was generally the case before 1985. The multipliers associated with M2 and M3, however, have fallen since early 1987; as a result, the growth rate of the monetary base also has exceeded the growth of these aggregates. This pattern is quite different from that experienced before 1985.

Table A2

Contribution of the Component Ratios to the Growth Rate of m1

Year	EEMK	EER	MULX
1965	−0.59	−0.46	−1.02
1966	−0.94	0.07	−0.85
1967	−0.65	−0.41	−1.05
1968	0.27	−0.04	−0.26
1969	−0.48	0.75	0.30
1970	−1.43	0.37	−1.05
1971	−0.21	−0.91	−1.06
1972	0.11	−0.34	−0.20
1973	−0.67	−0.37	−1.00
1974	−2.31	−0.63	−2.90
1975	−2.68	−0.41	−2.99
1976	−2.10	0.18	−1.79
1977	−0.82	0.43	−0.31
1978	−0.93	−0.11	−1.02
1979	−1.22	0.51	−0.67
1980	−1.83	−0.16	−1.99
1981	−0.25	−1.36	1.16
1982	−0.48	0.83	0.33
1983	0.86	0.37	1.17
1984	−0.91	−0.18	−1.08
1985	−1.30	0.43	1.74
1986	3.59	0.51	4.04
1987	1.93	0.29	2.19
Quarter	**EEMK**	**EER**	**MULX**
1985.1	2.60	0.53	3.20
1985.2	1.97	0.69	2.70
1985.3	3.50	0.67	4.28
1985.4	2.55	0.03	2.48
1986.1	1.50	0.29	1.77
1986.2	5.27	0.80	6.01
1986.3	6.15	0.75	6.87
1986.4	5.93	0.72	6.49
1987.1	2.47	−0.43	2.06
1987.2	−0.46	0.22	−0.28
1987.3	−4.12	0.53	−3.48
1987.4	−3.66	0.32	−3.34
1988.1	−3.59	−0.77	−4.28

EEMK = contribution of k-ratio to growth of m1
EER = contribution of r-ratio to growth of m1
MULX = actual growth rate of m1

Table A3

Contribution of the Component Ratios to the Growth Rate of m2

Year	EEM2K	EEM2T2	EER	MUL2X
1965	−0.77	3.86	−0.46	2.59
1966	−1.24	2.15	0.07	0.98
1967	−0.86	3.00	−0.41	1.71
1968	0.36	1.13	−0.04	1.45
1969	−0.64	0.41	0.75	0.53
1970	−1.91	0.78	0.37	−0.74
1971	−0.28	5.13	−0.91	3.90
1972	0.15	4.95	−0.34	4.71
1973	−0.92	2.75	−0.37	1.45
1974	−3.20	1.94	−0.63	−1.88
1975	−3.79	5.71	−0.41	1.51
1976	−3.01	7.80	0.18	4.92
1977	−1.18	5.00	0.43	4.22
1978	−1.36	0.72	−0.11	−0.75
1979	−1.77	1.12	0.51	−0.12
1980	−2.70	2.59	−0.16	−0.26
1981	−0.37	2.06	1.36	3.07
1982	−0.71	2.76	0.83	2.87
1983	1.26	0.86	0.37	2.47
1984	−1.34	1.22	−0.18	−0.31
1985	1.89	−0.61	0.43	1.72
1986	5.12	−6.22	0.51	−0.60
1987	2.71	−5.45	0.29	−2.47
Quarter	**EEM2K**	**EEM2T2**	**EER**	**MUL2X**
1985.1	3.83	0.49	0.53	4.87
1985.2	2.89	−4.58	0.69	−0.99
1985.3	5.11	−6.32	0.67	−0.52
1985.4	3.71	−5.78	0.03	−2.05
1986.1	2.17	−3.44	0.29	−0.98
1986.2	7.56	−7.48	0.80	0.88
1986.3	8.74	−8.91	0.75	0.59
1986.4	8.34	−10.51	0.72	−1.48
1987.1	3.46	−7.57	−0.43	−4.53
1987.2	−0.64	−3.79	0.22	−4.22
1987.3	−5.80	3.75	0.53	−1.48
1987.4	−5.16	1.54	0.32	−3.29
1988.1	−5.10	−4.39	−0.77	−1.46

EEM2K = contribution of k-ratio to growth of m2
EEM2T2 = contribution of t2-ratio to growth of m2
EER = contribution of r-ratio to growth of m1
MUL2X = actual growth rate of m2

Table A4

Contribution of the Component Ratios to the Growth Rate of m3

Year	EEM3K	EEM3T2	EEM3T3	EER	MUL3X
1965	−0.77	3.69	1.10	−0.46	3.43
1966	−1.25	2.04	0.87	0.07	1.68
1967	−0.87	2.83	0.99	−0.41	2.48
1968	0.36	1.06	0.41	−0.04	1.79
1969	−0.65	0.39	−0.90	0.75	−0.47
1970	−1.92	0.74	0.43	0.37	−0.37
1971	−0.28	4.74	3.17	−0.91	6.26
1972	0.15	4.52	1.47	−0.34	5.70
1973	−0.93	2.44	3.82	−0.37	4.52
1974	−3.26	1.66	4.20	−0.63	1.57
1975	−3.85	4.93	−0.07	−0.41	0.58
1976	−3.05	6.87	−0.84	0.18	3.00
1977	−1.20	4.42	0.21	0.43	3.84
1978	−1.38	0.61	3.65	−0.11	2.42
1979	−1.81	0.94	2.86	0.51	2.34
1980	−2.75	2.14	1.66	−0.16	0.87
1981	−0.37	1.66	2.74	1.36	5.29
1982	−0.72	2.20	1.98	−0.83	4.24
1983	1.28	0.71	−2.08	0.37	0.15
1984	−1.37	0.97	2.40	−0.18	1.73
1985	1.93	−0.49	−0.20	0.43	1.68
1986	5.22	−4.97	−1.33	0.51	−0.58
1987	2.77	−4.35	−0.91	0.29	−2.22

Quarter	EEM3K	EEM3T2	EEM3T3	EER	MUL3X
1985.1	3.91	0.39	−1.89	0.53	2.94
1985.2	2.95	−3.66	−1.70	0.69	−1.71
1985.3	5.20	−5.07	−3.36	0.67	−2.55
1985.4	3.78	−4.63	−0.73	0.03	−1.56
1986.1	2.22	−2.74	1.75	0.29	1.48
1986.2	7.71	−5.97	−2.56	0.80	−0.02
1986.3	8.91	−7.13	−2.91	0.75	−0.37
1986.4	8.50	−8.44	−3.72	0.72	−2.96
1987.1	3.52	−6.08	−1.52	−0.43	−4.50
1987.2	−0.66	−3.03	1.33	0.22	−2.16
1987.3	−5.92	2.98	2.58	0.53	0.20
1987.4	−5.27	1.22	1.95	0.32	−1.78
1988.1	−5.21	3.48	0.85	−0.77	−1.64

EEM3K = contribution of k-ratio to growth of m3
EEM3T2 = contribution of t2-ratio to growth of m3
EEM3T3 = contribution of t3-ratio to growth of m3
EER = contribution of r-ratio to growth of m3
MUL3X = actual growth rate of m3

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