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**Federal Reserve Bank of St. Louis**
***Review***
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# In This Issue . . .

One of the most significant reforms in the history of the U.S. tax system begins this year — the indexation of the personal income tax authorized by Congress in 1981 to begin in 1985. In the first article in this *Review*, "Federal Income Tax Reform in 1985: Indexation," John A. Tatom explains the purpose of indexation and how the provisions of the current law will work.

Indexation, the author notes, is a scheme that avoids "bracket creep," the increase in the percent of income paid in taxes, both on average and at the margin, due to inflation. Until this year, inflation-induced increases in income that simply maintained the purchasing power of income were taxed at "bracket" or marginal tax rates that far exceeded the average tax rate paid on income.

Using the experience from 1980 to 1984, Tatom shows how inflation raised tax burdens for 1980 median-income households, as well as for households earning half and twice as much, even in the absence of real income changes. From 1980 to 1984, these increases were substantial, ranging from 20 to 60 percent for average tax rates and 12.5 to 17.0 percent for marginal tax rates. Indexation over the period would have avoided these increases.

Tatom indicates that, beginning this year, indexation will raise the bracket incomes and personal exemptions by a certain percentage that reflects past inflation. In 1985, this percentage is 4.1 percent. This change will have a relatively small impact on average tax rates in 1985 compared with 1984. Over a few years, however, such increases would compound and become quite substantial relative to the current tax burden, according to Tatom.

In the second paper in this issue, "Operating Procedures for Conducting Monetary Policy," R. Alton Gilbert describes the methods used by the Federal Reserve since 1970 for implementing monetary policy. The Federal Reserve has stated its objectives for monetary policy in terms of growth rates of monetary aggregates since 1970. Over that period, however, the Federal Reserve has used different operating procedures in pursuing its monetary objectives.

The first procedure involved targeting on the federal funds rate. The Open Market Desk supplied the amount of reserves necessary to keep the federal funds rate within ranges specified by the Federal Open Market Committee (FOMC). The second procedure involved targeting on levels of bank reserves that were estimated to be consistent with the objectives of the FOMC for the monetary aggregates. The third procedure, in effect since October 1982, involves targeting on levels of reserves borrowed by depository institutions from Federal Reserve banks. This third procedure is similar in some respects to the first procedure of targeting on the federal funds rate: under both procedures, the Federal Reserve would increase the quantity of reserves it supplies in response to an increase in the demand for reserves.

In the third paper in this issue, "The Discount Rate, Interest Rates and Foreign Exchange Rates: An Analysis with Daily Data," Dallas S. Batten and Daniel L. Thornton investigate two factors often considered important influences on the foreign exchange value of the dollar: credit market conditions across countries and the Federal Reserve's monetary policy stance. Using daily data on the ex-

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change rates of the U.S. dollar against the Canadian dollar, the French franc, the Deutsche mark, the Japanese yen and the British pound, they find that changing credit market conditions, as reflected by changing nominal interest rate differentials, have had a significant influence on daily exchange rate movements.

This impact, however, has been realized only during the period in which the inflation rate has declined. Furthermore, using discount rate changes to proxy changes in Federal Reserve policy, they find that such changes made for other than technical reasons have both a statistically and an economically significant impact on the U.S. dollar exchange rate with the five currencies examined.

# Federal Income Tax Reform in 1985: Indexation

***John A. Tatom***

*"I thought it was the most significant reform I've voted for in the 20 years I've been in Congress."*
*— The Honorable Barber Conable*[1]

AMID the current debate over taxes — whether to reform the tax system, raise taxes, or both — it is easy to lose sight of the revolutionary change in personal income taxation that began this year. As provided in the 1981 tax act, 1985 marks the first year of indexation of income tax brackets and personal exemptions.

The survival of indexation has not come easily. Many analysts and policymakers advocated its repeal from 1981 to 1984, prompting a spirited defense by its proponents.[2] So far, however, indexation has survived, and its continued existence is part of most recent proposals for tax reform.[3]

There is considerable confusion about the effects of indexation. For example, some analysts assert that indexation will reduce taxes. This is clearly not the case. Indexation, however, will *reduce the increase* in taxes that otherwise would occur; it will not lower taxes from year to year or reduce household tax burdens. Under indexation, inflation-induced increases in income will generate tax payments that rise in line with income (and inflation); it will simply prevent taxes from rising *faster* than these inflation-induced income gains, as they had in the past. The purpose of this article is to explain how the indexing provision of the 1981 tax act will work. It is also intended to clarify indexation's effects on taxes and tax burdens.

## THE INDEXATION PROVISION OF THE 1981 TAX ACT

The 1981 tax act provided for the indexing of bracket incomes and personal exemptions used in computing federal taxes beginning in 1985, based upon inflation over the previous year. The specific formula used to compute this inflation adjustment factor is the rise in the average consumer price index for all urban workers from the year ending in September two years earlier to the previous year ending in September.

For example, since prices, as measured by the average consumer price index (CPI), were 4.1 percent higher during October 1983 to September 1984 than during October 1982 to September 1983, the bracket incomes and personal exemptions for 1985 income

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[1]Hamilton (1984).

[2]For example, Feldstein (1983) responds to such attacks on indexing. He indicates that "indexing of personal income taxation is the most fundamental and far reaching aspect of Ronald Reagan's tax program."

[3]The major exception is the Bradley-Gephardt proposal, which would abolish indexation. For a discussion of recent proposals, including Bradley-Gephardt, see *Wall Street Journal* (1984) and Miller (1984). In the recent "Treasury proposal" (U.S. Department of Treasury, 1984), the indexation principle is *extended* to restructure the taxation of capital gains and the taxation of capital that otherwise arises under the corporate income tax treatment of depreciation and the tax treatment of interest receipts.

Table 1

**Federal Income Tax Schedules, Married Filing a Joint Return (1984–85)**

| 1984 | | 1985[1] | |
|---|---|---|---|
| Taxable Income | Tax[2] | Taxable Income | Tax[2] |
| $ 0 – $ 3,400 | $ 0 | $ 0 – $ 3,540 | $ 0 |
| $ 3,400 – $ 5,500 | $ 0 + 11% | $ 3,540 – $ 5,730 | $ 0 + 11% |
| $ 5,500 – $ 7,600 | $ 231 + 12 | $ 5,730 – $ 7,910 | $ 241 + 12 |
| $ 7,600 – $ 11,900 | $ 483 + 14 | $ 7,910 – $ 12,390 | $ 503 + 14 |
| $ 11,900 – $ 16,000 | $ 1,085 + 16 | $ 12,390 – $ 16,660 | $ 1,130 + 16 |
| $ 16,000 – $ 20,200 | $ 1,741 + 18 | $ 16,660 – $ 21,030 | $ 1,813 + 18 |
| $ 20,200 – $ 24,600 | $ 2,497 + 22 | $ 21,030 – $ 25,610 | $ 2,600 + 22 |
| $ 24,600 – $ 29,900 | $ 3,465 + 25 | $ 25,610 – $ 31,130 | $ 3,607 + 25 |
| $ 29,900 – $ 35,200 | $ 4,790 + 28 | $ 31,130 – $ 36,640 | $ 4,987 + 28 |
| $ 35,200 – $ 45,800 | $ 6,274 + 33 | $ 36,640 – $ 47,680 | $ 6,530 + 33 |
| $ 45,800 – $ 60,000 | $ 9,772 + 38 | $ 47,680 – $ 62,460 | $10,173 + 38 |
| $ 60,000 – $ 85,600 | $15,168 + 42 | $ 62,460 – $ 89,110 | $15,790 + 42 |
| $ 85,600 – $109,400 | $25,920 + 45 | $ 89,110 – $113,890 | $26,983 + 45 |
| $109,400 – $162,400 | $36,630 + 49 | $113,890 – $169,060 | $38,134 + 49 |
| $162,400 + | $62,600 + 50 | $169,060 + | $65,167 + 50 |

[1]The official Internal Revenue Service table may differ slightly due to rounding.

[2]The percentage at the right in this column is the marginal tax rate applied to taxable income in the range indicated.

taxation will be about 4.1 percent larger than in 1984.[4] Thus, the personal exemption will rise from $1,000 to $1,040, and the maximum taxable income that is subject to a zero marginal income tax rate for joint returns will rise from $3,400 to $3,540.

Table 1 shows the 1984 and 1985 tax schedules for married taxpayers filing joint income tax returns. The difference shows the effects of the indexation provision in the first year. Although these changes may seem trivial, over a few years indexation will have substantial effects on taxes and tax burdens.

## INDEXATION AND THE EFFECT OF INFLATION ON PERSONAL TAXES FROM 1980 TO 1984

Perhaps the simplest way to see how indexation will work in the future is to look at what would have occurred had it been adopted in the recent past. Suppose that, in 1981, Congress had adopted indexation to adjust for increases in prices beginning in 1980, instead of passing the 1981–84 personal income tax reductions and delaying indexing until 1985. What would the effect have been on taxes paid in 1984?

Consider three representative households based on the median family income of $21,023 in 1980.[5] The top panel in table 2 shows the personal income tax in 1980 for this income, one-half this income and twice this income, assuming that a joint return is filed, there are four people (exemptions) in each household, all income is adjusted gross income and there are no other deductions, credits or income adjustments.

In the middle panel of table 2, the same tax calculation is shown using the 1980 tax tables for nominal income levels that would have prevailed in 1984 if there had been no real before-tax income gain from 1980 to 1984. These incomes merely reflect the 26 percent increase in the CPI from 1980 to 1984. Taxes would have risen sharply, given the 1980 tax law and the 26 percent inflation-induced increases in nominal incomes.

[4]It is "about" 4.1 percent in 1985 or the similarly calculated inflation in the future, because the act calls for rounding the bracket incomes and personal exemptions to the nearest $10.

[5]The median measure indicates the level at which one-half of all families receive more income and one-half receive less. The average-size family in 1980 contained 3.27 members and the average number of wage earners was 1.63. See Bureau of the Census (1982).

Table 2

**An Illustration of the Effect of Indexation on Taxes from 1980 to 1984**

| | One-half 1980 median income | 1980 median income | Twice 1980 median income |
|---|---|---|---|
| **1980 Tax** | | | |
| Income | $10,512 | $21,023 | $42,046 |
| Personal Exemptions (4) | 4,000 | 4,000 | 4,000 |
| Taxable Income | $ 6,512 | $17,023 | $38,046 |
| Personal Income Tax | $ 456 | $ 2,511 | $ 9,386 |
| Marginal (Bracket) Rate | 16% | 24% | 43% |
| Average Tax Rate | 4.3% | 11.9% | 22.3% |
| **1984 Tax (no real income gain, using 1980 tax law)** | | | |
| Income | $13,245 | $26,489 | $52,978 |
| Personal Exemptions (4) | 4,000 | 4,000 | 4,000 |
| Taxable Income | $ 9,245 | $22,489 | $48,978 |
| Personal Income Tax | $ 926 | $ 3,914 | $14,277 |
| Marginal (Bracket) Rate | 18% | 28% | 49% |
| Average Tax Rate | 7.0% | 14.8% | 26.9% |
| **1984 Tax (with indexation, using 1980 tax law)** | | | |
| Income | $13,245 | $26,489 | $52,978 |
| Personal Exemptions (4) | 5,040 | 5,040 | 5,040 |
| Taxable Income | $ 8,205 | $21,449 | $47,938 |
| Personal Income Tax | $ 574 | $ 3,163 | $11,826 |
| Marginal (Bracket) Rate | 16% | 24% | 43% |
| Average Tax Rate | 4.3% | 11.9% | 22.3% |

The increases in the tax burden from 1980 to 1984 shown in the top two panels of table 2 arise solely from bracket creep. Such increases fall disproportionately on low-income families.[6] Without indexation or the other provisions of the 1981 tax act, average tax rates rise by 1984 to those shown in the middle panel. Average tax rates rise from 4.3, 11.9 and 22.3 percent to 7.0, 14.8 and 26.9 percent, respectively, for the three families shown, despite no change in real income. These rates, which represent increases in the average tax rate of 62.8, 24.4 and 20.6 percent, respectively, are due to bracket creep, that is, the taxation of purely inflation-induced income increases at marginal tax rates (bracket rates), instead of average tax rates.

Of course, since the tax burden of lower-income households is so slight relative to that at higher incomes, relative changes in real after-tax income due to bracket creep do not match the relative changes in tax burdens. The after-tax income in the top panel of table 2 of $10,056, $18,512 and $32,660, respectively, declines due to bracket creep to $9,777, $17,917 and $30,715 in 1980 prices in the middle panel. These reductions are 2.8 percent, 3.2 percent and 6.0 percent, respectively. Despite the larger relative increases in the federal income tax burden at lower incomes, the reductions in real after-tax income are largest at higher incomes because the average tax rate is typically much larger there. A given percentage increase in the tax burden, as measured by the average tax rate, reduces after-tax incomes more, the higher the initial tax rate.

[6]That inflation-induced tax increases fell most heavily on low-income groups was widely understood when the 1981 tax act was passed. The first calls for inclusion of indexation in the act came from the Black Caucus in the House of Representatives. See Bureau of National Affairs (1981). Bracket creep is explained more fully in Tatom (1984). This disproportionate effect on lower-income households occurs because at such incomes marginal tax rates exceed average tax rates by a relatively larger percentage than at higher incomes.

Table 3

**The 1984 Federal Personal Income Tax Burden With Lagged Indexation from 1979–83: No Real Income or Tax Rate Changes**

| | One-half 1980 median income | 1980 median income | Twice 1980 median income |
|---|---|---|---|
| 1984 Income | $13,245 | $26,489 | $52,978 |
| Personal Exemptions (4) | ($5,608) | ($5,608) | ($5,608) |
| Personal Income Tax | $401 | $2,849 | $10,711 |
| Marginal Tax Rate | 14.0% | 21.0% | 37.0% |
| Average Tax Rate | 3.0% | 10.8% | 20.2% |

At the bottom of table 2, the effect of indexation is shown. With indexation tied to *current* prices, the tax code would have raised the taxes shown in the top panel of table 2 by 26 percent from 1980 to 1984, simply matching the rise in prices and leaving the three groups of taxpayers shown at the top of table 2 with unchanged marginal tax rates or average tax rates (the ratio of personal income taxes to income). Such indexation would have raised the personal exemption to $1,260 from $1,000 and increased the bracket incomes (which were the same in 1980 as those shown on the left in table 1) by 26 percent.

Note that indexation does not lower tax burdens. Instead, it leaves 1984 tax burdens unchanged from 1980, since real income is unchanged. Since both the average tax rate and real income are unchanged, after-tax real incomes are the same in the bottom panel of table 2 as in 1980. Indexing ensures that the inflation-induced increase in nominal income in each case is taxed at an unchanged average tax rate, instead of being taxed at the higher marginal tax rate.

## THE 1981 INDEXATION PROVISIONS ADJUST FOR PAST CHANGES IN PRICES

Because the indexing formula under the 1981 tax act is lagged, the results shown in table 2 are only illustrative. Under lagged adjustment, tax schedules would have been adjusted to reflect the 40.2 percent price increases from 1979 to 1983 (8.8 percent annual rate of inflation) instead of the 26 percent increase from 1980 to 1984 (6 percent per year) used in table 2. The difference largely reflects the fact that, from the period October 1978 to September 1979 to the period October 1979 to September 1980, the average price level rose 13.5 percent, while from calendar year 1983 to 1984, it rose only 4.2 percent. This discrepancy would have led to indexing of 1980 income tax tables that exceeds the inflation-induced rise in incomes from 1980 to 1984.

Table 3 shows what the personal income tax burdens in 1984 would have been if the 1981 tax act indexation provision had been implemented for 1981. A comparison of these tax burdens with the 1980 tax burden on the same real income shown in table 2 indicates that the lag can have a large effect when inflation in the base-year period (1980 in this case) exceeds that in the most recent year of the calculation (1984).

Under such lagged indexation, tax burdens would have fallen from those shown at the top of table 2 for 1980 incomes. In effect, the 1984 indexation calculation in table 3 compensates for 1980 inflation, but not for 1984 inflation. Thus, tax burdens move down toward their 1979 levels on unchanged real incomes. In table 3, the lag in indexing results in average tax rates that fall from 4.3, 11.9 and 22.3 percent, respectively, to 3.0, 10.8 and 20.2 percent, respectively. The 30.2 percent decline in the average tax rate of the low-income family exceeds the 9.2 percent decline for the 1980 median-income household and the 9.4 percent decline for the high-income household, because the bracket creep from 1979 to 1980 that is being offset is largest for low-income households.

The 1979 average tax burden for the unchanged real incomes shown in the top panels of tables 2 and 3 was 1.8 percent for the low-income household, 10.6 percent for the median-income household and 19.9 percent for the high-income household. Thus, the lag in indexation does not allow the 1979 tax burdens for

these households to be restored. The marginal tax rates shown in table 3, however, are the same as in 1979 for unchanged real incomes, with one exception. At the same real income in 1979, the low-income household would have faced the same (14 percent) marginal tax rate in the tax tables, but would have qualified for an earned income credit in 1979. This credit would have reduced its average tax rate from 2.8 to 1.8 percent but boosted its marginal tax rate by 12.5 percentage points, making it 26.5 percent.

Indexation that adjusts bracket incomes and personal exemptions to current prices tends to ensure that average and marginal tax rates are unaffected by inflation. Thus, taxes rise in line with income unless real income changes. Such contemporaneous adjustment is costly to administer, however, so indexation schemes are usually tied to past price increases. Under the 1981 tax act provisions, tax tables and personal exemptions are adjusted to inflation over the year ending in the previous September. In the examples in this section, lagged indexation of 1980 tax tables nearly maintained average and marginal tax rates at their 1979 levels in 1984, because 1979–80 price increases were included in the adjustment, while 1983–84 price increases were not.

## FUTURE TAXES UNDER INDEXING

The central features of tax changes under indexation should be clear from this analysis. First, indexation ensures that purely nominal income gains are taxed at existing average tax rates rather than higher marginal tax rates. Thus, bracket creep is largely eliminated and tax burdens do not change significantly unless real income changes. Of course, federal income taxes will continue to grow faster than incomes because the tax system remains "progressive" for real income gains. As the tables throughout this article show, the tax paid per dollar of income (the average tax rate) rises as income rises in any year.

Second, due to the lag in inflation adjustment, some bracket creep can occur. If the inflation rate from 1984 to 1989, for example, raises incomes at the same percentage rate as the bracket and personal income adjustments based on 1983 to 1988 inflation, then families with unchanged real incomes from 1984 to 1989 will be subject to the same personal tax burdens (on average and at the margin) as in 1984. If the 1988–89 inflation rate exceeds the 1983–84 inflation rate, then tax burdens will rise on unchanged real incomes, even with indexing. On the other hand, if inflation from 1984 to 1989 is less than the increase in prices from 1983 to 1988, then real tax burdens will be somewhat smaller in 1989 than in 1984 for unchanged real incomes.

Before examining the impact of indexing in 1985, actual 1984 taxes must be calculated, taking the tax rate reductions in the 1981 tax act into account. At the top of table 4, the tax on the 1984 incomes incorporates these tax rate reductions based on the tax schedule on the left in table 1. Note that the 1984 taxes shown in table 4 are less than those shown in the middle panel of table 2 or (except for the low-income family) those shown in the top panel of table 2. These differences arise from the tax rate reductions of the 1981 tax act. The detrimental effect of bracket creep on low-income families is most noticeable in the top panel of table 4 because the tax burden on this group rose (compared with the top panel in table 2) despite no change in real income and about a 22 percent decline in tax bracket rates. The declines in the average tax rate from 1980 to 1984 shown for the two higher-income groups are fortuitous. Had inflation averaged about a 10 percent rate, as some analysts had predicted back in 1981, all three families would have faced larger income tax burdens in 1984 than in 1980.[7]

In the lower two panels, the 1984 incomes are increased by an assumed rise in prices from 1984 to 1985 of 4.7 percent.[8] In the middle panel of table 4, taxes are computed for 1985 income without indexation, using the 1984 tax schedule shown on the left in table 1 and the $1,000 per person personal exemption. At the bottom of table 4, the 1985 taxes use the rate schedule on the right in table 1 and the increased personal exemption level of $1,040.

The relatively small impact of indexing in 1985 *alone* is shown in table 4. Without indexation, the three families would face tax increases in 1985 of $88, $273 and $946, respectively. With indexation, taxes increase from 1984 to 1985 by $42, $159 and $572, respectively. The differences in the tax increases may not seem large in magnitude, but indexation keeps the average tax rate on the unchanged real incomes from rising.

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[7]When Social Security tax increases from 1980 to 1984 and average real income gains are taken into account, all three families in tables 2 and 3 had higher 1984 taxes than in 1980 despite the personal tax rate reductions. See Tatom (1984). The inflation rate from 1980 to 1984 expected in 1981 is that of the Congressional Budget Office (1981).

[8]The latter was found assuming a steady 5 percent annual rate of increase of the CPI from October 1984 to December 1985. The 5 percent inflation rate was chosen arbitrarily; the changes in average tax rates with or without indexation shown in table 4 are not very sensitive to the inflation assumption for 1985.

Table 4

## The Effect of Indexation in 1985 on Three Unchanged Real Incomes

| | One-half 1980 median income | 1980 median income | Twice 1980 median income |
|---|---|---|---|
| **1984 Taxes** | | | |
| 1984 Income | $13,245 | $26,489 | $52,978 |
| Personal Exemptions (4) | 4,000 | 4,000 | 4,000 |
| Tax | $ 713 | $ 3,001 | $10,980 |
| Bracket Rate | 14% | 22% | 38% |
| Average Tax Rate | 5.4% | 11.3% | 20.7% |
| **1985 Tax (4.7 percent inflation and no indexation)** | | | |
| 1985 Income | $13,868 | $27,734 | $55,468 |
| Personal Exemptions (4) | 4,000 | 4,000 | 4,000 |
| Tax | $ 801 | $ 3,274 | $11,926 |
| Bracket Rate | 14% | 22% | 38% |
| Average Tax Rate | 5.8% | 11.8% | 21.5% |
| **1985 Tax (4.7 percent inflation and the 1981 indexing provision)** | | | |
| 1985 Income | $13,868 | $27,734 | $55,468 |
| Personal Exemptions (4) | 4,160 | 4,160 | 4,160 |
| Tax | $ 755 | $ 3,160 | $11,552 |
| Bracket Rate | 14% | 22% | 38% |
| Average Tax Rate | 5.4% | 11.4% | 20.8% |

Without indexation, the tax per dollar of income would have risen 7.4 percent at the low income, 4.4 percent at the middle income and 3.9 percent at the high income. The low-income family will face the same personal income tax burden in 1985 as in 1984, according to the calculation in table 4. The middle- and upper-income examples show trivial rises in the average tax rate due to slight bracket creep because of the lag in indexation.

Over a few years, however, the insulation of federal tax burdens from inflation has a substantial effect on taxes. Even the relatively low 3.9 percent per year rise in the average tax rate for the high-income family in table 4 that would have occurred without indexation in 1985 would cause taxes per dollar of income to double in about 18 years; for the 7.4 percent rate of increase shown for the low-income family in table 4, the average tax rate would double in less than 10 years. Of course, higher rates of inflation would lead to even faster growth of tax burdens than these.

Martin Feldstein, in a recent defense of indexation, showed both its importance and its expected effects by noting that the repeal of indexing would add "$17 billion in taxes in 1986, $30 billion in 1987, $44 billion in 1988 and even larger amounts in later years."[9] The 1988 tax increase is about $200 per person alive today. This is in addition to the nearly 17 percent projected increase in nominal taxes that will occur under indexation because of inflation and the larger increases in federal taxes arising from expected real income gains. Moreover, Feldstein's projections were based on an assumed inflation rate of only 4 percent. Within 10 years, even with this inflation rate, he argues that overall taxes would be 25 percent larger if indexation were repealed and the remainder of the tax law were unchanged. Such estimates are very sensitive to the inflation rate; the estimated 1988 tax increase above due to bracket creep would be nearly twice as much ($80 billion) if inflation from 1983 to 1988 ran at 6.5 percent, the rate that prevailed from 1980 to 1983. Over the period 1981 to 1983, the U.S. Commerce Department has shown that purely inflation-induced income gains raised federal tax receipts by over $120 billion.[10] Thus,

[9]Feldstein (1983).

[10]See Bureau of Economic Analysis (1984).

indexation may seem like a small technical detail when looked at from the short perspective shown in tables 1 and 4. Over a few years time, however, inflation at the recent pace, without indexation, makes a large difference in tax burdens.

## THE INCOME TAX IS NOT FULLY INDEXED

It is important to bear in mind, also, that the personal income tax was not fully indexed by the 1981 tax act. Credits, adjustments and deductions that have fixed-dollar-amount ceilings, such as the deduction for a married couple when both work, and other credits, such as that for child care, are not indexed.[11] Thus, inflation can still raise federal income tax burdens on unchanged real incomes, although to a lesser extent than in the past.[12]

For example, the federal tax credit for child and dependent care expenses is a percentage (20 to 30 percent depending on income) of such expenses up to $2,400 ($4,800 for the care of two or more persons). Although inflation will drive up incomes and child care expenses, the nominal limits on creditable child care expenses are scheduled to remain fixed. As a result, once inflation pushes such expenses to the nominal limit, the value of the credit in reducing average tax rates becomes inversely related to future inflation.

Another popular adjustment that reduces average tax burdens and that is not indexed is the individual retirement account (IRA) contribution, under which individuals can deduct up to $2,000 from taxable income. On a joint return, the maximum reduction in taxes for such a contribution is the marginal tax rate (MTR) times $4,000. Relative to income (Y), the maximum reduction in the average tax rate is MTR × ($4,000/Y). Inflation reduces the share of income that is sheltered from taxes because it boosts income (Y), without boosting the nominal ceiling. The maximum reduction in the average tax rate due to contributions to an IRA is eroded; the average tax rate for such a household with an unchanged real income will continue to rise after 1984 to reflect this reduced real benefit.

## SUMMARY AND CONCLUSION

One of the most far-reaching and revolutionary changes ever to occur in the U.S. tax system begins this year. Indexation of the personal income tax, to a great extent, will reduce bracket creep in the personal income tax. From now on, inflation-induced changes in income will not lead to the substantially faster growth in personal income taxes relative to income that took place in the past. The incidence of bracket creep on tax burdens falls disproportionately on low-income taxpayers, so they are afforded the greatest protection from this reform.

The importance of indexation is easily obscured by focusing on the relatively small changes in income and taxes that occur on a year-to-year basis. In a few years, the effect of bracket creep compounds and tax burdens rise sharply.

Contrary to widespread opinion, indexation will not reduce taxes. Instead, it preserves the characteristic of the progressive personal income tax system whereby taxes rise faster than income when real income rises. Indexation will eliminate the disproportionate growth of taxes that arises solely from nominal income gains associated with inflation. In this instance, the rise in taxes is limited to the inflation rate; thus, inflation-induced income gains are taxed at existing average tax rates, not at the higher marginal rates.

[11] Another example of a rise in the average tax rate due to fixed nominal adjustments to income or taxes is the loss in the earned income credit for the low-income family discussed above for table 3. In 1979, on the same real income as those used in tables 2 and 3, such a household faced an average tax burden that was 1 percentage point lower due to the availability of the earned income credit (1.8 percent instead of 2.8 percent). Inflation-induced bracket creep removed the availability of this credit by pushing nominal income above the $10,000 ceiling where the credit becomes unavailable. From 1979 to 1984, this accounts for most of the rise in the household's average tax rate from 1.8 percent to 3.0 percent, despite the indexation shown in table 3.

[12] In addition, interest income is overstated during periods of inflation, and the indexation of tax brackets and personal exemptions does not address this problem. Interest rates contain an inflation premium that compensates for lost purchasing power, primarily of the initial amounts loaned. These payments maintain the value of capital and hence are not income, though they are taxed as such under the federal income tax. The higher is inflation, the larger is this component of interest income and the larger are taxes on unchanged real incomes. For a discussion of this problem, see Tatom and Turley (1978).

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# Operating Procedures for Conducting Monetary Policy

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WITHIN the Federal Reserve System, the body that determines the nation's monetary policy is the Federal Open Market Committee (FOMC). The FOMC meets several times each year, specifying targets for the federal funds rate and money growth over the period until the next scheduled meeting.[1] Twice each year, in February and July, the FOMC also announces its annual objectives for growth of the monetary aggregates. The Committee began setting targets for the growth rates of the monetary aggregates in 1970, because of a growing recognition of the effects of money growth on total spending and inflation. The FOMC also gives some weight to the short-run stability of interest rates, expressed as ranges for the federal funds rate.

After the FOMC determines the objectives for monetary policy, the task of implementing the policy is delegated to the staff of the Open Market Desk at the Federal Reserve Bank of New York. The Open Market Desk does this by buying and selling federal government securities for the Federal Reserve System. It increases reserves of the banking system by buying additional government securities and decreases reserves by selling securities.

The FOMC's instructions to the Open Market Desk also include a procedure that it should use to implement monetary policy. This paper identifies three distinct procedures used by the Open Market Desk since 1970. The purpose of the paper is to describe the mechanics of these three operating procedures, identifying the steps followed by the Open Market Desk in determining the amount of reserves to supply through open market operations.

The first procedure, which was used in the 1970s, involved targeting on the federal funds rate; the Open Market Desk would supply the level of reserves necessary to keep the federal funds rate within ranges specified by the FOMC for periods between meetings. The next procedure, used during the three years ending in October 1982, involved targeting on levels of nonborrowed reserves (reserves other than those borrowed from Federal Reserve Banks); these were based on the FOMC objectives for the money stock. This procedure allowed for wider short-run fluctuations in the federal funds rate. Under the final procedure, in effect since October 1982, the objective of the Open Market Desk in each reserve maintenance period is to keep the total of reserves borrowed by depository institutions from Federal Reserve Banks near some desired level. The

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[1]The FOMC consists of the seven members of the Federal Reserve Board of Governors and five of the 12 Federal Reserve Bank presidents. The Chairman of the Board of Governors is, by tradition, chairman of the FOMC. The president of the Federal Reserve Bank of New York is a permanent member of the FOMC and, also by tradition, its vice chairman. The four remaining memberships rotate among the presidents and are held for one-year terms beginning March 1 of each year. All Federal Reserve Bank presidents attend the meetings and present their views, but only those who are members of the FOMC cast votes. The FOMC currently has eight scheduled meetings each year, but may have a conference-call meeting to reevaluate monetary policy at any time.

desired level of borrowings reflects the desired degree of reserve restraint specified by the FOMC at each meeting.

## BASIC TOOL FOR EXPOSITION: SUPPLY AND DEMAND FOR RESERVES

The mechanics of the implementation of monetary policy under the three operating procedures can be described by analyzing the market for total reserves of depository institutions. These reserves include currency that depository institutions hold in their vaults and reserve balances they hold at Federal Reserve Banks. Depository institutions hold reserves to facilitate their customers' transactions and to meet reserve requirements imposed by the Federal Reserve. The required reserves are based on the amount and composition of their deposit liabilities.

Because they earn no interest on reserves, there is an opportunity cost for depository institutions to hold them. The opportunity cost is identified in this paper as the federal funds rate, the interest rate that depository institutions charge each other for lending reserves.[2] If a depository institution must increase its reserves, it borrows at the federal funds rate; if it can reduce its reserves, it lends at the federal funds rate.

In the three figures used in this paper, the demand for reserves by depository institutions is drawn as a function of the federal funds rate. Reserve requirements on those deposits included in the money stock create a close relationship between the demand for money by the public and the demand for reserves by depository institutions. The demand for money is assumed to be a function of total spending in the economy and interest rates. Various influences can cause shifts in the demand curve for reserves. A change in total spending in the economy, which influences the demand for money, would cause the demand curve for reserves to shift. Shifts in the demand for reserves could also reflect changes in the random component of money demand, a change in the average reserve requirement on deposit liabilities included in the money stock or a change in the demand for excess reserves.

The factors that influence the supply of reserves can be analyzed by considering separately the determinants of borrowed and nonborrowed reserves. Nonborrowed reserves (NBR) are determined by the open market operations of the Open Market Desk.

The amount of reserves borrowed from Federal Reserve Banks is influenced by the spread between the federal funds rate and the discount rate, and by the conditions set by the Federal Reserve for permitting depository institutions to borrow reserves. If the discount rate is above the federal funds rate, the amount of reserves borrowed from Federal Reserve Banks tends to be relatively low and insensitive to small changes in the federal funds rate. The supply curve for reserves reflects this observation. The supply curve is drawn as a vertical line from the level of NBR (labeled N in the figures) up to the level on the vertical axis at which the federal funds rate equals the discount rate, indicated as $r_f^i = r_d$.

The shape of the supply curve in the range in which the federal funds rate exceeds the discount rate depends on the conditions under which Federal Reserve Banks permit depository institutions to borrow reserves. If the Federal Reserve did not set limits on borrowings, no institution would pay more than the discount rate to borrow reserves in the federal funds market. In that case, the relevant supply curve in the range of the horizontal axis above NBR would be horizontal at the level of the federal funds rate equal to the discount rate.

The relevant supply curve is not horizontal, however; instead, it slopes upward, like the curves in the three figures labelled $S_1$, $S_2$ and $S_3$. The shape of each supply curve reflects a method of nonprice rationing of borrowed reserves among depository institutions. These supply curves differ only by the amount of NBR; each curve reflects the same method of nonprice rationing of borrowed reserves.

The Federal Reserve rations borrowed reserves by setting limits on the borrowings by each depository institution. These limits are set in terms of (1) the amounts borrowed relative to the required reserves of the depository institution and (2) the frequency and duration of its borrowings. Depository institutions try to avoid exceeding these borrowing limits to ensure that they will have access to credit to cover short-term liquidity requirements. If a depository institution borrows now, it will be subjected to greater administrative pressure to limit its borrowings in the future, when

[2]Federal funds brokers facilitate the operation of the federal funds market. These brokers receive orders from depository institutions located throughout the nation to lend or borrow reserves, and the brokers match lenders and borrowers at mutually agreeable interest rates. Most of the transactions through the federal funds market involve borrowing and lending reserves for one day. The transfers of reserves to borrowers are made the same day through wire transfer systems, including the Fed Wire of the Federal Reserve System.

the attractiveness of borrowing from the discount window might be greater. Consequently, it takes an increase in the spread between the federal funds rate and the discount rate to induce depository institutions to increase their borrowings from the discount window. The slope of each supply curve reflects this relationship between borrowings and the interest rate spread.

The three figures in this paper illustrate short-run relationships between the supply and demand for reserves. In figure 1, the relevant time period is a one-week reserve maintenance period.[3] The relevant time period for figure 2 is a few weeks between FOMC meetings. For figure 3, which illustrates the current operating procedure, the time period is a two-week reserve maintenance period. Reserve maintenance periods were lengthened from one week to two weeks in February 1984, when the Federal Reserve adopted contemporaneous reserve requirements.

Given its short-run focus, this paper does not present a complete analysis of the money supply process under each operating procedure. The more limited purpose of this paper is to describe how open market operations are determined under each operating procedure for a given short time period. The following sections indicate how the short-run analysis of each operating procedure would fit into a more complete analysis of the money supply process.

## TARGETING ON THE FEDERAL FUNDS RATE: 1970 THROUGH SEPTEMBER 1979

The Federal Reserve attempted to control the money stock during the 1970s by confining the federal funds rate to relatively narrow ranges, specified at each FOMC meeting. The use of this procedure was based on the assumption of a stable demand function for money. (As indicated previously, money demand is assumed to be a function of interest rates and total spending in the economy. For the period of a few weeks between FOMC meetings, total spending is assumed to be independent of current policy actions.) The Federal Reserve attempted to control the money stock through its influence on interest rates by moving the public up or down its demand for money schedule.

### *The Statement of FOMC Objectives*

At each meeting, the FOMC stated its growth objectives for the monetary aggregates as ranges from the average of the month before the meeting to the average of the month of the next scheduled meeting. For instance, on September 18, 1979, the last meeting under this operating procedure, the FOMC's objective for M1 was an annual growth rate between 3 percent and 8 percent from August through October.

At each meeting, the FOMC directed the Open Market Desk of the Federal Reserve Bank of New York to keep the federal funds rate within a range of about 50 to 100 basis points until the next meeting, and often specified an initial level for the federal funds rate within the target range. The manager of the Open Market Desk was authorized to let the federal funds rate move toward the top or bottom of the specified range if the money stock was tending to rise above or fall below that desired by the FOMC. The Open Market Desk supplied the amounts of NBR necessary to keep the federal funds rate within the target range. Occasionally, the FOMC changed the range for the federal funds rate in conference calls held between scheduled meetings if the money stock was tending to deviate substantially from its objective.[4]

### *The Implementation of FOMC Directives*

The conduct of monetary policy under this procedure is illustrated in figure 1. At one of its scheduled meetings, the FOMC would specify an initial level for the federal funds rate for the period immediately after the meeting ($r_f^2$) and a range for the rate until the next scheduled meeting ($r_u - r_l$). The Open Market Desk then would adjust NBR to keep the federal funds rate at the initial target rate immediately after the meeting and within the target range until the next meeting.[5]

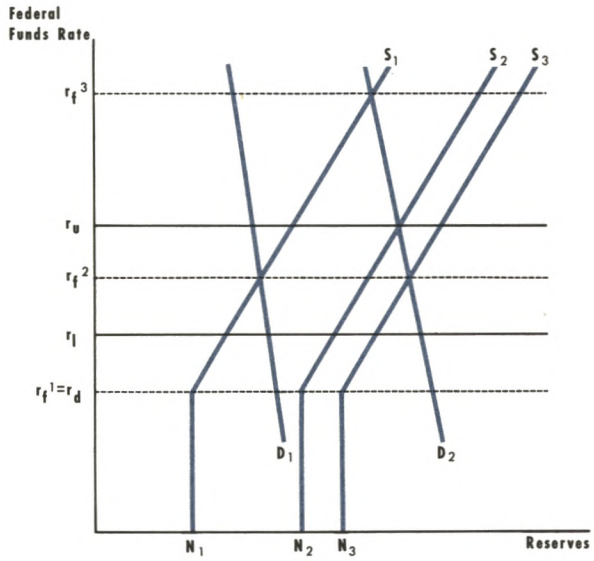
The time period for the supply and demand curves in figure 1 is one reserve maintenance week. Lagged

[3]A reserve maintenance period is a period over which daily average reserves must equal or exceed daily average required reserves to avoid a penalty for reserve deficiency.

[4]The description of the procedure of targeting on the federal funds rate is based on Lombra and Torto (1975), Holmes and Sternlight (1977), Wallich and Keir (1979) and Lindsey (1984).

[5]In examining monetary policy actions, this paper focuses exclusively on the level of NBR. Changes in NBR through open market operations are the most frequent policy actions by the Federal Reserve. By focusing on the supply of NBR, the paper abstracts from the effects of other policy actions on the supply and demand for reserves. An increase (decrease) in the discount rate would cause the upward-sloping part of the supply curve to rise (fall). Changes in the conditions for borrowing reserves would change the slope of the supply curve in the range in which the federal funds rate exceeds the discount rate. Finally, a change in the reserve requirement ratios would cause the demand curve to shift.

Figure 1
**Targeting on the Federal Funds Rate**




reserve requirements were in effect during the period in which the Open Market Desk targeted on the federal funds rate. Under lagged reserve requirements, required reserves in each maintenance week were predetermined, since they were based on deposits two weeks earlier. Consequently, the demand curves in figure 1 are drawn relatively steep.[6] With required reserves predetermined for each period, the slope of the demand curves reflects the responsiveness of the demand for excess reserves to changes in the levels of the federal funds rate.

The demand for reserves in the first week after the FOMC meeting is denoted by the curve $D_1$. The Open Market Desk would supply NBR equal to $N_1$ to keep the federal funds rate at $r_f^2$. Suppose there was a large increase in the demand for reserves in the second week, represented by the shift in the demand curve from $D_1$ to $D_2$. This increase in the demand for reserves would reflect an increase in the demand for money. To accommodate the increase in the demand for reserves, the Open Market Desk would increase NBR in order to keep the federal funds rate in the target range set by the FOMC. In figure 1, the Desk would increase the supply of NBR to $N_3$ to keep the federal funds rate at $r_f^2$.

If, however, the money stock was tending to rise above the desired range of the FOMC, the Desk might have increased NBR to only $N_2$, thus allowing the federal funds rate to rise to the top of the range ($r_u$). Any authorization for the Open Market Desk to allow an additional rise in the federal funds rate before the next scheduled FOMC meeting would require an FOMC conference call to specify a new range for the federal funds rate.

Discussions of the advantages of this operating procedure usually emphasize how the Federal Reserve could prevent transitory fluctuations in the federal funds rate, while controlling the growth rate of the money supply over a quarter of a year or longer, periods that are relevant for stabilizing economic activity. One cause of transitory fluctuations in the federal funds rate was Open Market Desk errors in measuring NBR in the current week. The Federal Reserve had to estimate several factors that influence NBR, such as balances of the U.S. Treasury at Federal Reserve Banks and Federal Reserve float. If, however, the Federal Reserve made large errors in estimating the current level of NBR, this procedure would offset those errors automatically. For instance, if actual NBR fell below Federal Reserve estimates, the federal funds rate would tend to rise above the target rate, and the Open Market Desk would respond by buying additional securities, thus increasing NBR.

Another type of transitory effect on interest rates would be a transitory shift in the demand for total reserves. The demand for total reserves may shift for various reasons. There may be random fluctuations in the demand for money, average reserve requirements or excess reserves. Under this procedure, the Open Market Desk would offset the effects of such transitory shifts in the demand for reserves by adjusting the level of NBR to keep the federal funds rate unchanged.

The effects of transitory shifts in the demand for total reserves are illustrated in figure 1. The demand for reserves is illustrated by the curve $D_1$ in the first

[6]Under lagged reserve requirements, each maintenance period covered seven days ending each Wednesday. Required reserves for each maintenance period were based on deposit liabilities in the maintenance period two weeks earlier. Under the contemporaneous reserve requirements currently in effect, each maintenance period covers 14 days ending every other Wednesday. The required reserves of each depository institution on its checkable deposits are based on its average checkable deposits over a 14-day period ending two days before the end of the current maintenance period. See Gilbert and Trebing (1982) for a description of lagged and contemporaneous reserve requirements.

week after an FOMC meeting, $D_2$ in the second week, and $D_1$ again in the third week. If the Open Market Desk kept NBR at $N_1$ throughout the three-week period, the federal funds rate would be $r_f^2$ in week 1, $r_f^3$ in week 2, and would fall back to $r_f^2$ again in week 3. The Open Market Desk would avoid these fluctuations in the federal funds rate by accommodating the random fluctuations in demand for reserves. Following this policy of accommodation, NBR would be $N_1$ in the first week, $N_3$ in the second week, and $N_1$ again in the third week.

### *The Role of the Operating Procedure in the Money Supply Process*

The position of the supply curve for reserves in a given maintenance week had little effect on the quantity of reserves supplied, because required reserves in each week were based on the deposits of two weeks earlier. The position of the supply curve did influence the level of the federal funds rate. In attempting to control the money supply, the Federal Reserve relied on the influence that changes in the federal funds rate would have on other interest rates and the influence of interest rates on the quantity of money demanded in the future. Money demand was assumed to be influenced by lagged values of interest rates. A more thorough treatment of the money supply process under this operating procedure would require an analysis of the effects of policy actions over several reserve maintenance periods. The multiperiod analysis would include changes in the FOMC's federal funds rate objectives in response to deviations of the money stock from desired levels and the lagged effects of changes in interest rates on money demand.

The major problem with this procedure was that, in attempting to stabilize the federal funds rate, the Federal Reserve could miss its targets for the money stock for periods long enough to affect total spending in the economy. A shift in the demand for reserves may have indicated that the federal funds rate must be allowed to change if the Open Market Desk is to supply the level of reserves that is consistent with FOMC objectives for the monetary aggregates. An increase in the demand for reserves may have reflected a rise in the rate of total spending in the economy, which would cause the demand for money to rise. By targeting on a fixed level of the federal funds rate in such circumstances, the Federal Reserve may conduct a procyclical monetary policy — increasing (decreasing) the level of total reserves in response to a rise (fall) in the rate of total spending.

## TARGETING ON NONBORROWED RESERVES: OCTOBER 1979 THROUGH SEPTEMBER 1982

On October 6, 1979, the FOMC abandoned the procedure of targeting on the federal funds rate in favor of an NBR operating procedure. Most of the FOMC members concluded that the degree of monetary control under the previous procedure had become unsatisfactory. They decided to adopt, instead, a procedure in which the objective of open market operations was to supply the amount of reserves consistent with their objectives for money growth, while permitting larger fluctuations in the federal funds rate.[7]

### *The Statement of FOMC Objectives*

One of the changes adopted at the meeting on October 6, 1979, involved the way the FOMC stated its objectives for the growth of the monetary aggregates for periods between scheduled meetings. The FOMC began stating its objectives as a specific percentage growth rate for each monetary aggregate from a month before the meeting to some future month. For instance, the objective for M1 adopted on October 6, 1979, was an annual growth rate of 4.50 percent from September to December 1979.

Although the FOMC continued to specify ranges for the federal funds rate, those ranges were widened significantly. For most periods, the range was 400 basis points, compared with ranges of 50 to 100 basis points under the procedure of targeting on the federal funds rate. These wide ranges on the federal funds rate played a minor role in the implementation of monetary policy under the new NBR operating procedure. In fact, on several occasions the FOMC widened its ranges between scheduled meetings when the rate threatened to move outside the previously established limits. On other occasions, the federal funds rate was allowed to move outside its range for short periods of time.[8]

### *The Implementation of FOMC Directives*

After each FOMC meeting, the Federal Reserve staff estimated the average level of total reserves that would be necessary to support the money stock desired by the FOMC. That average level was called the total re-

[7] *Federal Reserve Bulletin* (December 1979), p. 974.

[8] See Gilbert and Trebing (1981).

serve path. Estimates of the total reserves path were based on (1) FOMC objectives for M1 and M2 and (2) estimates of the average reserve requirements on deposit liabilities in M1 and M2, currency, required reserves on liabilities of depository institutions not included in M1 or M2, and excess reserves. The staff generally re-estimated the total reserves path each week.

At each meeting, the FOMC made an assumption about the average level of borrowed reserves over the period until the next scheduled meeting. The FOMC's borrowings assumption was often near the average level of borrowings just before the meetings. The staff determined the level of NBR on which the Open Market Desk targeted open market operations (called the NBR path) by subtracting the FOMC's borrowings assumption from the total reserves path.

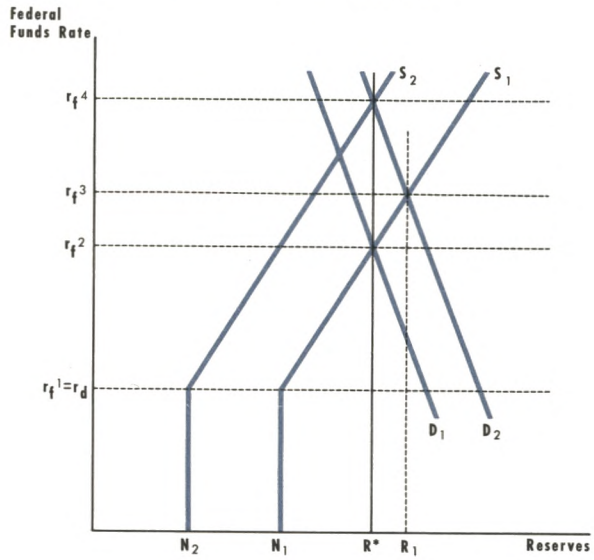
The implementation of monetary policy under this operating procedure is illustrated in figure 2. In contrast to the procedure illustrated in figure 1, the Open Market Desk would not increase the level of NBR in response to an increase in the demand for reserves; it might actually *decrease* NBR to keep total reserves near its path level.[9]

Levels of total reserves and NBR on the horizontal axis refer to average levels for the weeks between FOMC meetings. The total reserves path is illustrated as R*. The NBR path is $N_1$, since the FOMC set the borrowings assumption at R* minus $N_1$.

The demand curves for reserves represent the relationship between the federal funds rate and the average quantity of reserves demanded over a few weeks between FOMC meetings. Since the time period is a few weeks, required reserves are not predetermined but may be influenced by policy actions of the current period. A rise in the federal funds rate, for instance, might cause the quantity of money demanded to decline and, therefore, cause required reserves to decline. For these reasons, the demand curves have a flatter slope in figure 2 than in figure 1.

Total reserves would be at the path level R* if the demand curve for reserves was $D_1$. From that initial position, consider the effects of an increase in the demand for reserves, illustrated by a shift in the demand curve to $D_2$, which resulted from an increase in the demand for money. Total reserves would rise to $R_1$,

Figure 2
**Targeting on Nonborrowed Reserves**




above the total reserves path, and the federal funds rate would rise from $r_f^2$ to $r_f^3$. Without any additional policy actions, the money stock would exceed the FOMC's objectives because total reserves would be above the path level. For a given rise in the demand for reserves, however, the amount by which the money stock would exceed the FOMC objective would be smaller under this operating procedure than if the Open Market Desk had supplied the reserves necessary to keep the federal funds rate unchanged at $r_f^2$.

During some periods between FOMC meetings, the Federal Reserve adjusted the level of the NBR path or the discount rate to reduce the deviations of the money stock from desired levels.[10] The Federal Reserve took those policy actions when the deviations appeared to reflect more than a transitory movement in the money demand schedule, perhaps due to a strengthening of aggregate spending.[11]

Adjustments to the NBR path or discount rate be-

[9]Lindsey (1982, 1983, 1984) describes how the procedure of targeting on NBR worked in practice by examining the timing of money growth relative to FOMC objectives, borrowed reserves, the federal funds rate and the discount rate.

[10]The Federal Reserve Bank of New York presents a detailed description of open market operations throughout each calendar year in the spring or summer issues of its *Quarterly Review* in the following year. Those reports indicate several occasions on which the NBR target or the discount rate were changed when the staff projected that total reserves would deviate substantially from the path levels.

[11]See Lindsey (1983), p. 5.

tween FOMC meetings were based on projections of total reserves. After each FOMC meeting, the staff estimated the actual level of total reserves over the weeks until the next meeting, as well as the total reserves path, which was based on FOMC objectives for money growth. The estimates of total reserves were based on projections of the actual (in contrast to the desired) money stock, average reserve requirements and excess reserves, given the existing discount rate and NBR path. A substantial deviation between the staff estimate of actual total reserves and the total reserves path indicated that additional adjustments to the discount rate or NBR path would be necessary to keep the money stock close to the FOMC objectives.

In the situation illustrated in figure 2, the staff projects total reserves to be $R_1$, which is above the total reserves path (R*). The policy action illustrated in figure 2 is a reduction in the NBR path relative to the total reserves path (an increase in the borrowings assumption). Total reserves are constrained to be at the path level by reducing the NBR path to $N_2$, causing the federal funds rate to rise to $r_f^1$.

### *The Role of the Operating Procedure in the Money Supply Process*

By adopting the NBR targeting procedure, the FOMC changed the basic relationship on which the money supply process was based. The prior procedure of targeting on the federal funds rate relied on a stable demand function for money. The second procedure of targeting on NBR relied on a relationship between reserves and the money stock. Path levels for total reserves and NBR were re-estimated weekly to incorporate the most current information available on the relationship between reserves and the money stock.

## TARGETING ON BORROWED RESERVES: OCTOBER 1982 TO THE PRESENT[12]

### *The Statement of FOMC Objectives*

At a meeting in October 1982, the FOMC temporarily suspended its short-run objectives for M1. The event that precipitated the de-emphasis of M1 was the maturing of a large volume of all-savers certificates in October 1982, which might have had a temporary effect on money demand. Also, movements of funds into and out of M1 were about to be affected in uncertain amounts by the scheduled introduction of a couple of monthly money-market-type accounts at banks and thrift institutions. The de-emphasis of M1 continued after these events because of an observed change in the relationship between the money stock and total spending in the economy.[13]

Suspending short-run objectives for M1 made it necessary to change the operating procedure for implementing monetary policy. The procedure of targeting NBR as described previously gave considerable weight to the FOMC's objective for M1, since a large proportion of required reserves are against the deposit liabilities in M1. The total reserves path could not be estimated on the basis of the FOMC's objectives for M2 and M3 without an assumption or target for M1 over the intermeeting period. The FOMC has resumed the practice of specifying short-run objectives for M1 but has not directed the Open Market Desk to resume use of the procedure of targeting NBR.

In place of the NBR procedure, the Federal Reserve adopted a procedure for targeting on borrowed reserves. At each meeting, the FOMC states its objectives for open market operations in terms of degrees of reserve restraint. The directive from the FOMC to the Open Market Desk calls for more restraint, less restraint, or for the degree of reserve restraint to be unchanged. In some directives, the FOMC also states conditions for changing the degree of reserve restraint in the period before the next scheduled meeting, such as deviation of the rate of money growth from desired rates or developments in the economy.

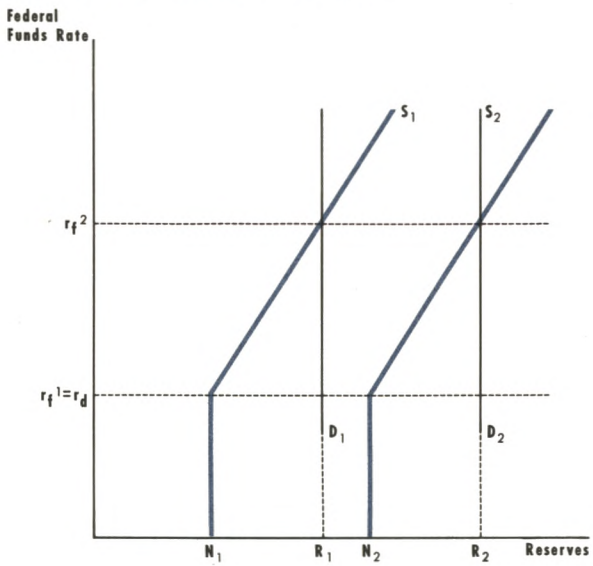
The Open Market Desk interprets the objectives of the FOMC for the degree of reserve restraint in terms of the average level of seasonal plus adjustment borrowings over the intermeeting period.[14] More restraint would imply a higher level of borrowings and less

[12]This description of the procedure of targeting on borrowed reserves is based on Wallich (1984).

[13]See Axilrod (1985), pp. 18–19.

[14]See Wallich (1984), p. 26. Adjustment borrowings are short-term loans from Federal Reserve Banks to depository institutions to aid them in adjusting their reserves to required levels. Most institutions repay their adjustment borrowings within a few days. Seasonal borrowings are longer-term loans to depository institutions that have relatively strong seasonal patterns in their loan demand or deposits. Other borrowings are called extended credit, which is made available to institutions experiencing such severe financial difficulties that they have a hard time attracting funds from other sources. The target for borrowings under the current operating procedure is in terms of the sum of seasonal plus adjustment borrowings. Extended credit is considered a relatively fixed supply of reserves, which is not as sensitive to the spread between the federal funds rate and the discount rate as seasonal and adjustment borrowings are. Extended credit is counted as part of nonborrowed reserves for purposes of implementing monetary policy under the current operating procedure.

Figure 3
**Targeting on Borrowed Reserves**




restraint a lower level of borrowings. The Open Market Desk changes its target level for borrowings between some FOMC meetings when the conditions for changing the degree of reserve restraint specified in the latest FOMC directive do occur.

## *The Implementation of FOMC Directives*

The amount of NBR supplied by the Open Market Desk under the current operating procedure depends on the target level for borrowed reserves and estimates of total reserves prepared by the Federal Reserve staff. The level of NBR to be supplied is determined by subtracting the target level for borrowed reserves from the staff estimate of total reserves.

The process of estimating total reserves depends on the system of reserve accounting in effect. Under lagged reserve requirements, in effect through January 1984, required reserves for each maintenance period were known by the beginning of the period. The estimate of total reserves for each period was derived by adding an estimate of excess reserves to the known level of required reserves.

Under contemporaneous reserve requirements, the reserve accounting system currently in effect, required reserves for each maintenance period are not known until after the end of the period. The staff estimates required reserves for each maintenance period, revising the estimate several times during most periods. The target levels for NBR are adjusted by the same dollar amounts as the revisions to estimates of required reserves.

The implementation of monetary policy under the current operating procedure is illustrated in figure 3. This figure indicates that, by targeting on a given level of borrowed reserves, the Open Market Desk tends to eliminate any effect of shifts in the demand for reserves on the federal funds rate over a given reserve maintenance period.

Levels of total reserves and NBR on the horizontal axis of figure 3 refer to average levels over a two-week reserve maintenance period. The curves that represent the demand for reserves are drawn as vertical lines in figure 3; they are drawn as sloping downward to the right in figures 1 and 2. This change does not imply that the demand for reserves is less interest-elastic under the procedure of targeting on borrowed reserves. The vertical demand curves reflect the way the demand for reserves is characterized under this operating procedure, that is, as a fixed amount of reserves for each maintenance period.

Early in the maintenance period, the staff estimates total reserves at the level $R_1$. With the target level for borrowed reserves equal to $R_1$ minus $N_1$, the Open Market Desk plans to supply NBR of $N_1$, which would yield an average federal funds rate of $r_f^2$. Suppose that later in the period, the staff raises the estimate of total reserves to $R_2$. In response, the Open Market Desk raises its objective for NBR to $N_2$, to keep $R_2$ minus $N_2$ equal to the original target level of $R_1$ minus $N_1$. This response to a rise in the demand for reserves would keep the federal funds rate unchanged at $r_f^2$.

The increase in the estimate of total reserves from $R_1$ to $R_2$ may reflect a larger increase in the money stock than desired by the FOMC. If the FOMC directive calls for an increase in the degree of reserve restraint in the event of this undesired rise in the money stock, the Open Market Desk would increase its target level for borrowings. The implications of an increase in the target for borrowed reserves can be illustrated by reference to figure 3. In response to the increase in the estimate of total reserves from $R_1$ to $R_2$, the Open Market Desk increases the supply of NBR above $N_1$, but not as much as $N_2$. In that case, the federal funds rate would rise above $r_f^2$. This response to an undesired rise in the money stock is similar to the response under the procedure of targeting on the federal funds rate when the Open Market Desk allowed the federal funds rate to rise to the top of its range.

### *The Role of the Operating Procedure in the Money Supply Process*

The current operating procedure has been described by one member of the FOMC as "an indirect method of influencing the funds rate and other short-term rates which, in turn, affect the demand for money."[15] Thus, like the procedure of targeting on the federal funds rate, the current method of controlling the money stock depends upon the influence of policy actions on interest rates and the assumption of a stable relationship between interest rates and the quantity of money demanded.

The similarity of the procedures of targeting on the federal funds rate and targeting on borrowed reserves is illustrated by examining the response of the Open Market Desk in supplying NBR to a shift in the demand for reserves. In targeting on borrowed reserves, the Open Market Desk responds to shifts in the demand for reserves in a manner similar to its response under the federal funds rate targeting procedure. The similarity is illustrated by comparing the response of the supply of NBR to a shift in demand for reserves in figures 1 and 3. In both figures, the quantity of NBR supplied is increased in response to an increase in the demand for reserves, although the federal funds rate might be allowed to rise in response to an undesired rise in the money stock. Figure 2 indicates, in contrast, that under the NBR targeting procedure, the Open Market Desk keeps NBR unchanged or reduces them when there is an increase in the demand for reserves that reflects an increase in the demand for money.

## CONCLUSIONS

The Federal Reserve currently implements monetary policy by targeting open market operations on average levels of reserves borrowed from Federal Reserve Banks. This procedure, in effect since October 1982, has some features in common with the prior two procedures used for implementing monetary policy. Like the procedure of targeting on nonborrowed reserves, in effect from October 1979 until October 1982, the official range for the federal funds rate is several hundred basis points wide. Open market operations are not conducted with the objective of keeping the federal funds rate at a specific level, as they were under the procedure of targeting on the federal funds rate used for several years prior to October 1979.

The current procedure, however, has other similarities to the procedure of targeting on the federal funds rate. There is no direct relationship between the objectives of the Federal Open Market Committee for the monetary aggregates and the supply of nonborrowed reserves, as there was under the procedure of targeting on nonborrowed reserves. Under the current procedure and that of targeting on the federal funds rate, the supply of nonborrowed reserves responds to shifts in the demand for reserves within a given reserve maintenance period in such a way that these shifts have little effect on the federal funds rate. Over longer periods, however, the federal funds rate might be allowed to move in the same direction as an undesired change in the money stock under both of those procedures.

[15]Wallich (1984), p. 22.

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# The Discount Rate, Interest Rates and Foreign Exchange Rates: An Analysis with Daily Data

*Dallas S. Batten and Daniel L. Thornton*

WITH the foreign exchange value of the U.S. dollar continuing to increase rapidly, the search goes on for explanations of this unprecedented rise. Explanations of exchange rate movements frequently focus on two factors: (1) changes in credit market conditions reflected by changes in interest rate differentials across countries and (2) changes in the monetary policy stances of central banks, especially those of the Federal Reserve.

In this article, the validity of these explanations is tested. Specifically, we investigate the impact of a change in U.S. short-term interest rates relative to those in Canada, France, Germany, Japan and the United Kingdom on the bilateral foreign exchange rates between the U.S. dollar and each country's currency.

Since there has been a particular focus recently on the impact of unexpected changes in monetary policy upon exchange rates, we investigate this also.[1] Changes in the discount rate charged by the Federal Reserve on short-term loans to depository institutions are frequently considered to be an important indicator of the Fed's intentions. Moreover, discount rate changes have been shown to have a significant impact on the dollar's exchange value if these changes are unanticipated.[2] Consequently, these changes are included to proxy changes in policy by the Federal Reserve. In addition, the analysis is conducted for both before and after October 1979 to investigate the effect of the Federal Reserve's decision to place more emphasis on the growth of reserves and less on the federal funds rate in the conduct of monetary policy.

## EXCHANGE RATES: AN ASSET MARKET VIEW

The exchange rate is simply the price of one country's currency in terms of another's. It is determined in organized, efficient markets in the same manner as are the prices of other assets, such as stocks, bonds or real estate. Because these assets are durable, their current prices reflect people's perceptions of current events and expectations of future events as well. In other words, the current price of the asset reflects its expected future price. Consequently, any information that leads individuals to alter their expectations about the future price of an asset has an effect on the asset's current price.

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[1]See Cornell (1982, 1983), Engel and Frankel (1984) and Urich and Wachtel (1981).

[2]See Batten and Thornton (1984). The discount rate analysis here is an extension of the Batten-Thornton model. The distinction here is that the use of bilateral exchange rates enables the inclusion of interest rate differentials over the entire sample period.

The assets involved in the determination of exchange rates are domestic money supplies. Thus, the fundamental determinants of exchange rate movements must include, among other things, the factors that affect the demand for and the supply of domestic monies. Obviously then, the monetary policy objectives of central banks, the market's perception of the future course of policy actions, and credit market conditions across countries play integral roles in determining exchange rates.

## INTEREST RATE DIFFERENTIALS AND EXCHANGE RATE MOVEMENTS

The relationship between nominal interest rate differentials and exchange rate movements is complex and ambiguous. The decision to reallocate portfolios and the associated capital flows does not depend simply on the nominal interest differential, but on this differential adjusted for the *expected* rate of appreciation or depreciation of the foreign exchange value of the dollar.[3] In actuality, an incipient capital flow and the subsequent change in the exchange rate will occur only if the higher nominal interest rate in one country is not offset by an expectation of an equal-sized depreciation of that country's currency.[4]

The expectation of future appreciation or depreciation of a currency is linked closely to the expectation of future inflation in one country vis-a-vis that in another. If the rate of inflation in the United States is expected to exceed that in Germany by 5 percent, then, other things equal, the U.S. dollar would be expected to depreciate against the Deutsche mark (DM) by 5 percent.[5] Since nominal interest rates contain both a real return and a premium for expected inflation, this expected inflation rate differential also would be reflected by nominal interest rates in the two countries. That is, if inflation is expected to be 5 percentage points higher in the United States than in Germany, U.S. nominal interest rates would be 5 percentage points higher than those in Germany, other things equal. Consequently, a nominal interest differential in favor of the United States would be associated with a *depreciating* dollar if this interest differential was caused by an expected higher rate of inflation in the United States relative to Germany.

In this regard, a changing nominal interest differential can reflect a change in either the real interest differential or the inflation differential. If it reflects a change in the inflation differential, the nominal differential and the exchange rate will move in opposite directions as above. If it reflects a change in the real differential, just the opposite occurs. In particular, when certain events (such as changes in tax laws, asset preferences or the relative price of energy) have different impacts on nominal interest rates and inflation rates — both actual and expected — the real interest differential will change as well, and the exchange rate will change in the same direction.

## DISCOUNT RATE CHANGES AND EXCHANGE RATE MOVEMENTS

If a change in the discount rate, when announced, is to have a perceptible effect on the current exchange rate, it must (1) transmit (or be believed to transmit) some information about the policy intentions of the Federal Reserve and (2) be unanticipated.[6] If the market expects a discount rate change, this expectation will be reflected by the exchange rate immediately. If the discount rate change represents an unexpected change in current or future monetary policy, it will be assimilated by the foreign exchange rate concomitant with the announcement of the discount rate change.[7]

An unanticipated discount rate change may lead individuals to alter their expectations of the future course of monetary policy; however, there are several theories about the impact of such changes on the exchange rate.[8] The nature of the effect depends criti-

[3]See Mudd (1979b), Batten (1981), Wilby (1981) and Bergstrand (1983).

[4]In fact, if a rising (falling) interest differential is more than offset by increased expectations of exchange rate depreciation (appreciation), the spot exchange rate can actually depreciate (appreciate) even with a rising (falling) interest differential. See Mudd (1979b) and Batten (1981).

[5]For a discussion of this concept, called relative purchasing power parity, see Batten and Ott (1983).

[6]This discussion ignores the possibility of an indirect "liquidity effect," whereby an increase on the discount rate increases domestic interest rates and, hence, a decline in the foreign exchange value of the dollar. This is a possibility since Thornton (1982) has shown a temporary effect of discount rate changes on domestic interest rates.

[7]The incorporation of discount rate changes into the analysis in this manner creates an identification problem. It is impossible to determine whether it is the actual discount rate change or the announcement of new information that affects the foreign exchange value of the dollar.

[8]These have been offered as possible explanations of the potential impact of unanticipated money supply announcement on the exchange rate. See Cornell (1983).

cally on how the announcement reshapes expectations. For example, an unexpected increase in the discount rate may be interpreted as a tightening of current monetary policy and, consequently, may generate expectations that the Fed will counteract this move with a relatively looser policy in the future.[9] In this case, the market would bid down *current* real interest rates, expecting them to be realized subsequently. Consequently, the foreign exchange value of the dollar would depreciate as nominal interest rates fall in the short run, reflecting the lower *ex ante* real rates.

On the other hand, this same increase may simply motivate widespread anticipation of continued monetary tightening. In this instance, individuals might expect a lower rate of U.S. inflation relative to that in the rest of the world. This will generate expectations of future appreciation of the U.S. dollar, which will be discounted into an appreciation of the current exchange rate, accompanied by lower nominal interest rates as inflation expectations fall.

This inflationary-expectations effect may not be distinguishable from an initial liquidity effect. In other words, the rise in the discount rate may cause an initial rise in U.S. real interest rates and, hence, an initial widening of the interest rate differential. Consequently, an increase in the discount rate may cause the foreign exchange value of the dollar to rise through either liquidity or inflationary-expectations effects.

## A SIMPLE MODEL OF EXCHANGE RATE MOVEMENTS

To examine the possible announcement effect of a discount rate change and the possible impact of changes in the nominal interest differential, we specify a simple model of daily exchange rate movements. In addition to these variables, the model should include numerous variables that are commonly considered to influence the dollar price of foreign currencies, such as U.S. and foreign money stocks, real incomes, expected long-term inflation rates and current account balances.[10] Unfortunately, observations on these variables are not available on a daily basis. As an alternative, we simply employ a distributed lag of past exchange rate changes.

Furthermore, only unanticipated discount rate changes should be important in an empirical model. Since the usual procedure for estimating these unexpected changes (through modeling *expected* discount rate changes) is inappropriate because of the discrete nature of these changes, actual discount rate changes are employed here. We do, however, attempt to lessen the potential bias associated with using the actual discount rate changes by (1) introducing a distributed lag of the change in the difference between the federal funds rate and the discount rate as a proxy measure of the market's anticipation of future discount rate changes and (2) employing the reasons for the change given by the Fed when the change is announced to partition the set of discount rate changes.

There is an intuitive rationale for using the distributed lag of changes in the federal funds rate/discount rate spread to measure anticipated changes in the discount rate. During approximately half of the period that we analyzed, the Fed attempted to maintain a relatively narrow spread between these rates. Thus, an atypical and prolonged widening or narrowing of this spread could have signaled that a discount rate change was imminent. Given the asset approach to exchange rate determination, such anticipated discount rate changes would then be reflected by a change in the exchange rate prior to the actual announcement of the change in the discount rate. Including a distributed lag of the federal funds rate/discount rate spread should help account for such effects.

Furthermore, when the Fed announces a discount rate change, it states the reason for the change. Consequently, discount rate changes can be partitioned into two groups according to the reason accompanying them: technical or policy-related.

Discount rate changes made solely to bring the discount rate into closer alignment with short-term market rates are merely technical adjustments and do not reflect changes in monetary policy. Using this information to partition the actual discount rate changes should lessen the potential downward bias for two reasons: First, discount rate changes made purely for technical reasons are less likely to be interpreted as indicating a change in Federal Reserve policy. Hence, it is less likely that there is an announcement effect associated with them. Second, they are more likely to be anticipated, so that any policy-related information they might contain is likely to be incorporated into the current exchange rate before the change in the discount rate. Finally, during the period analyzed, the policy-related reasons included both domestic and

[9]This so-called "policy anticipation effect" is attributed to Urich and Wachtel (1981).

[10]See, for example, Meese and Rogoff (1983).

international objectives. Consequently, the policy-motivated discount rate changes were partitioned accordingly.

### *Additional Hypotheses*

Besides the hypotheses already presented, several others of interest can be tested within this framework. First, Mudd (1979a) has proposed that the November 1, 1978 discount rate change should have had a substantially larger impact on the foreign exchange value of the dollar than others did (even those made for policy reasons) because it was accompanied by several other Fed actions that were intended to strengthen the dollar.[11] The most important of these was the stated intent of the Fed and Treasury to intervene more actively in foreign exchange markets, which was accompanied by an arrangement through which the United States floated foreign-currency-denominated debt to obtain funds to finance this intervention. To investigate this proposition, we partitioned the data by separating the discount rate change on November 1, 1978, from the others made for international reasons.

Furthermore, we investigate the possible impact of U.S. intervention in foreign exchange markets by separating discount rate changes made for international reasons during periods when the United States actively intervened from those made during the rest of the sample period. The United States has typically intervened infrequently in foreign exchange markets, leaving that activity primarily to foreign monetary authorities. With strong downward pressure on the dollar during 1978, however, the Fed and the U.S. Treasury adopted a more activist intervention policy: from November 1978 to March 1981, they intervened frequently and in large amounts. This dramatic change in policy might have altered the impact of unanticipated discount rate changes on the foreign exchange value of the dollar.

Finally, we partitioned the discount rate changes made for domestic reasons at October 6, 1979, the date the Fed changed its operating procedure for implementing domestic monetary policy. On that date, the Fed announced that it was placing greater emphasis on bank reserves and less emphasis on the federal funds rate in conducting day-to-day open market operations.[12] After this change, the spread between the federal funds and the discount rates became larger and more variable than it was before. Consequently, all discount rate changes, including those made for policy reasons, may be less predictable (and, hence, more likely to have an impact on the exchange rate) under the reserves targeting procedure than they were under the federal funds rate targeting procedure.

## EMPIRICAL RESULTS

To test the hypotheses outlined above, variants of the following equation were estimated using daily data for the period January 2, 1975, to October 31, 1984:

$$(1)\quad \Delta \ln S_t = \alpha + \sum_{i=1}^{7} \beta_i \Delta \ln S_{t-i} + \sum_{i=1}^{7} \gamma_i \Delta\,(\mathrm{FFR\text{-}DR})_{t-i}$$

$$+ \phi\, \Delta DR_t + \eta\, \Delta RDIFF_t + \varepsilon_t,$$

where

S = the U.S. dollar price of a unit of foreign currency on day t,

FFR = the U.S. federal funds rate,

DR = the U.S. discount rate, and

RDIFF = the difference between the U.S. 90-day CD rate and a comparable foreign short-term interest rate.[13]

The currencies included are those of Canada, France, Germany, Japan and the United Kingdom.[14] There were 37 changes in the discount rate during this period. Of these, 16 were made solely for technical reasons, 14 included domestic (but not international) monetary policy considerations and seven included international policy considerations.[15]

The results are reported in tables 1–5. Because the estimated coefficients of ΔDR (and its partitions) and ΔRDIFF are the focus of this analysis, only these estimates are presented. Of particular interest are the relatively low adjusted $R^2$s across the estimation for all countries. These support the basic conclusion of the asset market approach to exchange rate determination, that is, that most of the variance of exchange rate movements is attributable to unexpected events. Nonetheless, as the F-statistics demonstrate, all of the estimations are statistically significant at the 5 percent level.

[11]See Mudd (1979a) for details.

[12]See Lang (1980).

[13]The lag length chosen for each distributed lag was the longest period possible without overlapping discount rate changes. Also, a distributed lag of ΔRDIFF was included initially, but did not add to the explanatory power of the estimated equation for any currency.

[14]These countries make up the over 68 percent of the trade-weighted exchange rate.

[15]See Batten and Thornton for a more detailed discussion, a presentation of discount rate changes during this period and the reasons given for these changes.

Table 1
**Estimation of Equation 1**

| Country | Estimated Parameters ΔDR | ΔRDIFF | $\bar{R}^2$/SE | F |
|---|---|---|---|---|
| Canada | −0.00105 | −0.00081* | 0.0146 | 3.37* |
| | (1.92) | (4.40) | 0.0023 | |
| France | −0.00648* | −0.00561* | 0.0687 | 12.83* |
| | (4.65) | (11.41) | 0.0057 | |
| Germany | −0.00730* | −0.00717* | 0.0975 | 18.32* |
| | (5.43) | (14.16) | 0.0055 | |
| Japan | −0.00100 | −0.00614* | 0.0518 | 9.75* |
| | (0.72) | (10.92) | 0.0057 | |
| United | −0.00363* | −0.00279* | 0.0265 | |
| Kingdom | (2.69) | (6.96) | 0.0055 | 5.36* |

Absolute values of t-statistics in parentheses. *Statistically significant at the 5 percent level.

For each of the currencies except that of Japan, there is a statistically significant (at the 6 perent level for Canada) announcement effect associated with discount rate changes (table 1). Furthermore, when the U.S. discount rate is increased (decreased), the U.S. dollar appreciates (depreciates) against each of these currencies, a result that tends to support the inflationary expectations hypothesis.[16] A 1 percentage-point change in the discount rate (for whatever reason) motivates an exchange rate change that ranges from a low of 0.11 percentage points in Canada to a high of 0.73 percentage points in Germany, all other things constant. This result is economically, as well as statistically, significant as the average absolute daily exchange rate change during this period ranged from 0.16 percent in Canada to 0.40 percent in Germany.

Changes in the interest differential exhibited a statistically significant impact on daily exchange rate movements for every country in the sample. Moreover, in each case, an increase (decrease) in the interest differential generated an appreciation (depreciation) of the dollar exchange rate.

The magnitude of the impact, however, differed substantially across countries. For example, the U.S. dollar/Deutsche mark exchange rate was the most affected, changing by roughly 0.72 percent for each percentage-point change in the interest differential. Alternatively, the U.S. dollar/ Canadian dollar exchange rate moved only 0.08 percent for each percentage-point change in the interest differential.

When the discount rate changes are partitioned according to the reason given for the change (table 2), the results differ across countries. One common point, however, is that discount rate changes made for technical reasons never have an announcement effect for any currency. This is to be expected because these changes do not represent changes in Fed policy. Discount rate changes made for domestic reasons are statistically significant in three of the five cases: Canada, France and Germany. Changes made for international reasons are significant for each country except Canada and have an impact four to 10 times larger than those of changes made for domestic reasons. In the case of Japan, however, the effect is due solely to the discount rate change on November 1, 1978, as noted below.

## *Tests of Additional Hypotheses*

The separation of the discount rate change made on November 1, 1978, from the others made for international reasons (table 3) reveals that this was indeed an important discount rate change. Its impact was significant for every country except Canada and four to six times larger than the impact of other changes for international reasons. Moreover, the November 1,

[16]Since S is the U.S. dollar price of a unit of foreign currency, a negative sign for an estimated parameter in equation 1 indicates that an increase in that right-hand-side variable causes S to decline, or, alternatively, the foreign currency price of a U.S. dollar (1/S) to rise. So, e.g., the negative coefficient on ΔDR indicates that an increase (decrease) in the U.S. discount rate causes the foreign exchange value of the dollar to appreciate (depreciate).

Table 2

## Estimation of Equation 1 with Discount Rate Changes Partitioned by Reason

| | Estimated Parameters | | | | | |
|---|---|---|---|---|---|---|
| Country | ΔDRDOM | ΔDRINT | ΔDRTECH | ΔRDIFF | $\bar{R}^2$/SE | F |
| Canada | −0.00173* | −0.00152 | 0.00003 | −0.00080* | 0.0147 | 3.12* |
| | (2.14) | (1.17) | (0.03) | (4.35) | 0.0023 | |
| France | −0.00501* | −0.02481* | 0.00064 | −0.00556* | 0.0832 | 13.92* |
| | (2.46) | (7.63) | (0.28) | (11.37) | 0.0057 | |
| Germany | −0.00594* | −0.02585* | −0.00001 | −0.00706* | 0.1130 | 19.15* |
| | (3.03) | (8.23) | (0.00) | (14.06) | 0.0055 | |
| Japan | 0.00113 | −0.01469* | 0.00298 | −0.00606* | 0.0592 | 9.96* |
| | (0.55) | (4.52) | (1.31) | (10.81) | 0.0056 | |
| United | −0.00182 | −0.01642* | 0.00033 | −0.00275* | 0.0334 | 5.92* |
| Kingdom | (0.92) | (5.17) | (0.15) | (6.86) | 0.0055 | |

Absolute value of t-statistic in parentheses. *Statistically significant at the 5 percent level.

ΔDRDOM = discount rate changes for domestic reasons
ΔDRINT = discount rate changes for international reasons
ΔDRTECH = discount rate changes for technical reasons

Table 3

## Estimation of Partitioned Equation 1 with Emphasis on November 1, 1978

| | Estimated Parameters | | | | | | |
|---|---|---|---|---|---|---|---|
| Country | ΔDRDOM | ΔDRNOV78 | ΔDROINT | ΔDRTECH | ΔRDIFF | $\bar{R}^2$/SE | F |
| Canada | −0.00173* | 0.00095 | −0.00270 | 0.00003 | −0.00081* | 0.0150 | 3.05* |
| | (2.13) | (0.42) | (1.71) | (0.03) | (4.39) | 0.0023 | |
| France | −0.00506* | −0.05035* | −0.01249* | 0.00065 | −0.00554* | 0.0935 | 14.92* |
| | (2.49) | (8.88) | (3.17) | (0.29) | (11.40) | 0.0056 | |
| Germany | −0.00602* | −0.05658* | −0.01095* | 0.00004 | −0.00708* | 0.1288 | 20.94* |
| | (3.10) | (10.37) | (2.89) | (0.02) | (14.23) | 0.0054 | |
| Japan | 0.00112 | −0.03361* | −0.00552 | 0.00303 | −0.00610* | 0.0649 | 10.37* |
| | (0.55) | (5.95) | (1.40) | (1.34) | (10.91) | 0.0056 | |
| United | −0.00184 | −0.03141* | −0.00915* | 0.00037 | −0.00275* | 0.0371 | 6.20* |
| Kingdom | (0.93) | (5.66) | (2.37) | (0.17) | (6.89) | 0.0055 | |

Absolute value of t-statistics in parentheses. *Statistically significant at the 5 percent level.

ΔDRDOM = discount rate changes for domestic reasons
ΔDRNOV78 = discount rate change on November 1, 1978
ΔDROINT = discount rate changes for international reasons other than on November 1, 1978
ΔDRTECH = discount rate changes for technical reasons

1978 change was the *only* discount rate change during the period to have any impact on the dollar/yen exchange rate. This impact was extremely large, with a 1 percentage-point change in the discount rate leading to a 3.36 percent change in the dollar/yen rate, all other things constant, compared with the average absolute change in the dollar/yen rate during this period of only 0.38 percent. Finally, for the three currencies for which international changes other than that on November 1, 1978, had a statistically significant effect (those of France, Germany and the United Kingdom), this impact was significant only during the period in which the Fed was actively intervening in foreign exchange markets (table 4).

Table 4

**Estimation of Partitioned Equation 1 with Emphasis on Intervention**

| | Estimated Parameters | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Country | ΔDRDOM | ΔDRNOV78 | ΔDROINV | ΔDRONINV | ΔDRTECH | ΔRDIFF | $\bar{R}^2$/SE | F |
| Canada | −0.00173* | 0.00095 | −0.00280 | −0.00255 | 0.00003 | −0.00081* | 0.0146 | 2.90* |
| | (2.13) | (0.42) | (1.38) | (1.01) | (0.03) | (4.38) | 0.0023 | |
| France | −0.00505* | −0.05036* | −0.01621* | −0.00669 | 0.00064 | −0.00554* | 0.0937 | 14.25* |
| | (2.49) | (8.89) | (3.21) | (1.06) | (0.29) | (11.40) | 0.0056 | |
| Germany | −0.00603* | −0.05665* | −0.01588* | −0.00323 | 0.00003 | −0.00707* | 0.1293 | 20.04* |
| | (3.10) | (10.38) | (3.27) | (0.53) | (0.01) | (14.20) | 0.0054 | |
| Japan | 0.00112 | −0.03361* | −0.00478 | −0.00666 | 0.00303 | −0.00610* | 0.0646 | 9.85* |
| | (0.55) | (5.95) | (0.95) | (1.06) | (1.34) | (10.90) | 0.0056 | |
| United | −0.00184 | −0.03141* | −0.01025* | −0.00742 | 0.00037 | −0.00275* | 0.0368 | 5.90* |
| Kingdom | (0.93) | (5.66) | (2.07) | (1.20) | (0.17) | (6.89) | 0.0055 | |

Absolute values of t-statistics in parentheses. *Statistically significant at the 5 percent level.

ΔDRDOM = discount rate changes for domestic reasons.
ΔDRINT = discount rate changes for international reasons.
ΔDRTECH = discount rate changes for technical reasons.
ΔDRNOV78 = discount rate change on November 1, 1978.
ΔDROINV = discount rate changes for international reasons other than on November 1, 1978, during period of active intervention.
ΔDRONINV = discount rate changes for international reasons during period of inactive intervention.

## *The October 1979 Change in Federal Reserve Policy*

The possible impact of the change in Federal Reserve policy procedure in October 1979 is examined in table 5. This examination was implemented by partitioning ΔDRDOM and ΔRDIFF at October 6, 1979, in the variant of equation 1 where discount rate changes are partitioned by reason.[17] The results for ΔDRTECH and ΔDRINT are consistent with those in table 2. Specifically, discount rate changes made for technical reasons had no significant announcement effect, while those made for international reasons did for all currencies except the Canadian dollar. Furthermore, for the currencies for which discount rate changes made for domestic reasons have significant announcement effects over the entire period (Canadian dollar, French franc and Deutsche mark), these effects were significant only after October 1979.

Only three of the 14 changes on the discount rate for domestic policy reasons occurred during the pre-October 1979 period. Nonetheless, these pre-October 1979 changes did not have a significant effect on the foreign exchange value of the dollar for any country. While this result is based on relatively few discount rate changes, it does suggest either that discount rate changes were more readily anticipated or that even unanticipated changes contained little useful information when the Federal Reserve's primary policy objective was to smooth or stabilize short-term interest rates.

An interesting result emerging from this partitioning is that changes in the interest differential were not statistically significant before October 6, but were highly significant afterward. (This effect, however, was significant at the 10 percent level in the earlier period for the dollar/DM rate. But even in this case, the impact is four times larger after October 6, 1979, than it was before.) A possible explanation for this is that the period between January 1, 1975, and October 6, 1979, was one in which both the rate of U.S. money growth and the rate of U.S. inflation accelerated dramatically relative to those in the rest of the world. Consequently, changes in the U.S. nominal interest differential primarily may have been reflecting changing inflationary expectations; thus, these changes had no statistically significant impact on the foreign exchange value of the dollar.

[17]Since only the discount rate and interest rate differential variables are of interest, the parameters in the other variables were assumed to be the same over both periods.

Table 5

**Estimation of Partitioned Equation 1 with ΔDRDOM and ΔRDIFF Partitioned at October 6, 1979**

| | Estimated Parameters for | | | | |
|---|---|---|---|---|---|
| **Variable** | **Canada** | **France** | **Germany** | **Japan** | **U.K.** |
| ΔDRDOM1 | 0.00020 | −0.00393 | −0.00845 | 0.00168 | −0.00343 |
| | (0.08) | (0.60) | (1.33) | (0.26) | (0.54) |
| ΔDRDOM2 | −0.00189* | −0.00447* | −0.00535* | 0.00149 | −0.00080 |
| | (2.22) | (2.10) | (2.60) | (0.69) | (0.39) |
| ΔDRINT | −0.00158 | −0.02647* | −0.02690* | −0.01620* | −0.01672* |
| | (1.22) | (8.18) | (8.56) | (4.97) | (5.30) |
| ΔDRTECH | 0.00001 | 0.00087 | 0.00001 | 0.00306 | 0.00065 |
| | (0.01) | (0.39) | (0.01) | (1.35) | (0.30) |
| ΔRDIFF1 | −0.00019 | 0.00098 | −0.00219 | −0.00122 | 0.00050 |
| | (0.52) | (0.91) | (1.71) | (0.89) | (0.73) |
| ΔRDIFF2 | −0.00099* | −0.00722* | −0.00792* | −0.00699* | −0.00438* |
| | (4.72) | (13.29) | (14.61) | (11.47) | (9.00) |
| $\bar{R}^2$ | 0.0155 | 0.0989 | 0.1183 | 0.0639 | 0.0453 |
| SE | 0.0023 | 0.0056 | 0.0054 | 0.0056 | 0.0055 |
| F | 3.02* | 15.08* | 18.20* | 9.75* | 7.09* |

Absolute values of t-statistics in parentheses. *Statistically significant at the 5 percent level.
ΔDRDOM1, ΔRDIFF1 = ΔDRDOM and ΔRDIFF, respectively, before 10/6/79 and zero afterwards.
ΔDRDOM2, ΔRDIFF2 = ΔDRDOM and ΔRDIFF, respectively, after 10/6/79 and zero before.

On October 6, 1979, the Fed announced that it was placing increased emphasis on reserve aggregate control. Since that time the inflation rate has declined dramatically. Within this environment, changes in the nominal interest differential, in the short run, have meant concomitant changes in the real interest differential and, hence, these changes had a positive impact on the foreign exchange value of the dollar.[18]

## SUMMARY AND CONCLUSIONS

The purpose of this article has been to test for the effects of changes in short-term interest differentials and unanticipated changes in U.S. monetary policy on the foreign exchange value of the dollar. Using changes in the discount rate as a proxy for unanticipated changes in U.S. monetary policy, we find that, in general, both of these factors have a significant impact on daily movements of the bilateral exchange rate between the U.S. dollar and the Canadian dollar, French franc, Deutsche mark, Japanese yen and British pound.

The evidence suggests that discount rate changes made for other than technical reasons have not been fully anticipated and, consequently, have had both a statistically and an economically significant impact on the U.S. dollar exchange rate with the five currencies examined. Furthermore, changes in interest rate differentials motivate exchange rate movements only if

[18]This conjecture is corroborated by chart 3 in Batten and Ott. In particular, using observed inflation rates to calculate real interest rates, real interest differentials and nominal interest differentials actually moved in opposite directions during most of the earlier period, but moved *together* during the later period. Furthermore, it does not appear that this result is due to just a procedural change, such as the change to reserves targeting. In October 1982, the Fed dropped M1 as an explicit intermediate target and adopted a very different operating procedure which is similar to targeting on the federal funds rate over short periods of time (see Gilbert (1985) for details). When the data are partitioned to reflect this change, the coefficients of ΔRDIFF remain negative and statistically significant in the post-October 1982 period.

they are not neutralized by offsetting changes in expected exchange rate movements. It appears that this was the case only during the period when the Federal Reserve followed a decidedly disinflationary policy.

The reader is cautioned, however, that the majority of daily exchange rate movements are explained by events *other* than previous exchange rate movements, discount rate changes and interest differential changes. The simple model estimated here never explained more than 15 percent of the variance of daily changes in these five exchange rates.

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