Can Monetary Policy Affect GDP Growth?

The Fed has taken unconventional measures over the past 18 months to contain the financial crisis and limit ramifications for the broader economy. These measures have resulted in an extraordinary increase in reserve balances at commercial banks—which is a key component, along with currency, of the monetary base. Economist John Taylor of Stanford University estimates the current programs proposed by the Fed should increase reserves by about $2.285 trillion—nearly a 300-fold increase compared with the $8 billion level in early September 2008.¹

Many analysts have raised concerns that the increased reserves will ultimately increase inflation and the price level. One might also expect such an enormous increase in reserves to stimulate aggregate output, thereby mitigating the adverse effects of the financial crisis on the economy. But can such an impact be estimated quantitatively?

Historically, we can look at postwar U.S. data and see how much gross domestic product (GDP) growth can be associated with or forecasted by the growth rate of the monetary base. Note that such a statistical association is not “causal.” We merely want to see whether, historically, fast growth of the monetary base has been associated with faster growth of real output. One approach is to use an analysis that captures the impact of current and past increases of the monetary base on current GDP growth, taking into consideration the influence of the history of GDP on its own future growth. This estimation can be done at different horizons using statistical tools.

The chart shows the association of monetary base growth with GDP growth at different horizons, where the horizontal axis is the number of quarters and the vertical axis indicates the estimated impact of money base growth on output growth. The solid line is the estimation and the dashed lines are one-standard-error bands, which quantify the uncertainty of the estimation. The chart indicates that in the very short run (say at the 2-quarter horizon), money base growth is slightly negatively associated with GDP growth. However, around the typical business cycle horizon (say within the horizon of 8 to 16 quarters or 2 to 4 years), money base growth has a significant positive relation with GDP growth. In particular, at the 12-quarter horizon, for every 1 percent increase in money base growth, there is about 0.4 percent corresponding increase in GDP growth. Such a positive relation disappears again in the very long run beyond the typical business cycle, perhaps because in the long run money growth is inflationary, which leads to higher prices and lower output.

Therefore, historical data tell us that if there is any positive association between money growth and GDP growth, the impact comes about 3 years after an initial acceleration of base growth. Such a long lag suggests that an observed and expected increase in the monetary base may not have a very large effect on output growth. Of course, the big caveat is that there has never been such an extraordinary increase in base growth. Therefore, the evidence based on historical data is not conclusive, but only a rough guide.

—Yi Wen

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Conventions used in this publication:

1. Unless otherwise indicated, data are monthly.
2. Shaded areas indicate recessions, as determined by the National Bureau of Economic Research.
3. Percent change at an annual rate is the simple, not compounded, monthly percent change multiplied by 12. For example, using consecutive months, the percent change at an annual rate in \( x \) between month \( t-1 \) and the current month \( t \) is: \( \left( \frac{x_t}{x_{t-1}} - 1 \right) \times 12 \). Note that this differs from National Economic Trends. In that publication, monthly percent changes are compounded and expressed as annual growth rates.
4. The percent change from year ago refers to the percent change from the same period in the previous year. For example, the percent change from year ago in \( x \) between month \( t-12 \) and the current month \( t \) is: \( \left( \frac{x_t}{x_{t-12}} - 1 \right) \times 100 \).

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On March 23, 2006, the Board of Governors of the Federal Reserve System ceased the publication of the M3 monetary aggregate. It also ceased publishing the following components: large-denomination time deposits, RPs, and eurodollars.
M2 and MZM
Billions of dollars

Treasury Yield Curve
Percent

Adjusted Monetary Base
Percent change at an annual rate

Real Treasury Yield Curve
Percent

Reserve Market Rates
Percent

Inflation-Indexed Treasury Yield Spreads
Percent

Data available as of January 2009.
Note: Effective December 16, 2008, FOMC reports the intended Federal Funds Rate as a range.
Monetary Trends

MZM and M1
Percent change from year ago

M2
Percent change from year ago

M3*
Percent change from year ago

Monetary Services Index - M2**
Percent change from year ago

*See table of contents for changes to the series.

**We will not update the MSI series until we revise the code to accommodate the discontinuation of M3.
Adjusted and Required Reserves

Billions of dollars

Adjusted and Required Reserves

Total Borrowings, nsa

Billions of dollars

Excess Reserves plus RCB Contracts

Billions of dollars

Nonfinancial Commercial Paper

Percent change from year ago

Consumer Credit

Percent change from year ago

As of April 10, 2006, the Federal Reserve Board made major changes to its commercial paper calculations.

For more information, please refer to http://www.federalreserve.gov/releases/cp/about.htm.
CPI Inflation and 1-Year-Ahead CPI Inflation Expectations

The shaded region shows the Humphrey-Hawkins CPI inflation range. Beginning in January 2000, the Humphrey-Hawkins inflation range was reported using the PCE price index and therefore is not shown on this graph.

10-Year Ahead PCE Inflation Expectations and Realized Inflation

See the notes section for an explanation of the chart.

Treasury Security Yield Spreads

Real Interest Rates

See the notes section for an explanation of the chart.
Monetary Trends

Short-Term Interest Rates
Percent

Long-Term Interest Rates
Percent

Long-Term Interest Rates
Percent

Short-Term Interest Rates
Percent

FOMC Intended Federal Funds Rate, Discount Rate, and Primary Credit Rate
Percent


Data available as of January 2009.
Federal Funds Rate and Inflation Targets

Percent

Target Inflation Rates
- 4%
- 3%
- 2%
- 1%
- 0%

Calculated federal funds rate is based on Taylor's rule.

See notes on page 19.

Components of Taylor's Rule

Actual and Potential Real GDP

Billions of chain-weighted 2000 dollars

Potential

Actual

Components of McCallum's Rule

Monetary Base Growth* and Inflation Targets

Percent

Target Inflation Rates
- 0%
- 1%
- 2%
- 3%
- 4%

*Modified for the effects of sweeps programs on reserve demand.

Calculated base growth is based on McCallum's rule. Actual base growth is percent change from year ago.

See notes on page 19.

Monetary Base Velocity Growth

Percent

Real Output Growth

Percent

Research Division
Federal Reserve Bank of St. Louis
Monetary Trends

Gross Domestic Product
Percent change from year ago

Real Gross Domestic Product
Percent change from year ago

Gross Domestic Product Price Index
Percent change from year ago

M2
Percent change from year ago

Dashed lines indicate 10-year moving averages.
Monetary Trends

Bank Credit
Percent change from year ago

Investment Securities in Bank Credit at Commercial Banks
Percent change from year ago

Total Loans and Leases in Bank Credit at Commercial Banks
Percent change from year ago

Commercial and Industrial Loans at Commercial Banks
Percent change from year ago

Research Division
Federal Reserve Bank of St. Louis
Recent Inflation and Long-Term Interest Rates

<table>
<thead>
<tr>
<th></th>
<th>Consumer Price Inflation Rates</th>
<th>Long-Term Government Bond Rates</th>
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<tr>
<td></td>
<td>Percent change from year ago</td>
<td>Percent</td>
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<tr>
<td></td>
<td>2008Q2</td>
<td>2008Q3</td>
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<td>Japan</td>
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<td>United Kingdom</td>
<td>3.37</td>
<td>4.81</td>
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Inflation and Long-Term Interest Rate Differentials

- Inflation differential = Foreign inflation less U.S. inflation
- Long-term rate differential = Foreign rate less U.S. rate
<table>
<thead>
<tr>
<th>Year</th>
<th>M1</th>
<th>MZM</th>
<th>M2</th>
<th>M3*</th>
<th>Bank Credit</th>
<th>Adjusted Monetary Base Reserves</th>
<th>MSI M2**</th>
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<tbody>
<tr>
<td>2004</td>
<td>1344.402</td>
<td>6554.572</td>
<td>6247.501</td>
<td>9234.718</td>
<td>6595.832</td>
<td>776.768</td>
<td>96.130</td>
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<td>2005</td>
<td>1371.751</td>
<td>6949.430</td>
<td>6513.905</td>
<td>9786.477</td>
<td>7247.080</td>
<td>7958.707</td>
<td>835.039</td>
</tr>
<tr>
<td>2006</td>
<td>1374.358</td>
<td>6983.573</td>
<td>6840.378</td>
<td>10270.74</td>
<td>7958.707</td>
<td>835.039</td>
<td>94.913</td>
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<tr>
<td>2007</td>
<td>1369.721</td>
<td>7615.031</td>
<td>7232.867</td>
<td>8742.712</td>
<td>6595.832</td>
<td>8742.712</td>
<td>850.579</td>
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<tr>
<td>2008</td>
<td>1374.358</td>
<td>6983.573</td>
<td>6840.378</td>
<td>10270.74</td>
<td>7958.707</td>
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<td>6840.378</td>
<td>10270.74</td>
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<td>835.039</td>
<td>94.913</td>
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<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
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<td>848.960</td>
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<tr>
<td>2009</td>
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<td>7158.243</td>
<td>8508.130</td>
<td>848.960</td>
<td>93.603</td>
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</table>

Note: All values are given in billions of dollars. *See table of contents for changes to the series.
**We will not update the MSI series until we revise the code to accommodate the discontinuation of M3.
<table>
<thead>
<tr>
<th>Year</th>
<th>Federal Funds</th>
<th>Primary Credit Rate</th>
<th>Prime Rate</th>
<th>3-mo CDs</th>
<th>3-mo</th>
<th>3-yr</th>
<th>10-yr</th>
<th>Corporate Aaa Bonds</th>
<th>Municipal Aaa Bonds</th>
<th>Conventional Mortgage</th>
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<tbody>
<tr>
<td>2004</td>
<td>1.35</td>
<td>2.34</td>
<td>4.34</td>
<td>1.56</td>
<td>1.40</td>
<td>2.78</td>
<td>4.27</td>
<td>5.63</td>
<td>4.50</td>
<td>5.84</td>
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<tr>
<td>2005</td>
<td>3.21</td>
<td>4.19</td>
<td>6.19</td>
<td>3.51</td>
<td>3.21</td>
<td>3.93</td>
<td>4.29</td>
<td>5.23</td>
<td>4.28</td>
<td>5.86</td>
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<td>2006</td>
<td>4.96</td>
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<td>4.47</td>
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<td>2.24</td>
<td>3.67</td>
<td>5.63</td>
<td>4.58</td>
<td>6.04</td>
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</tbody>
</table>

| Year | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | 2009 | Jan | Feb | Mar |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 2008 | 5.26 | 6.25 | 8.25 |     | 5.32 | 4.96 | 4.82 | 5.00 | 5.73 | 4.24 | 6.70 | 5.02 | 6.01 | 8.25 | 5.49 | 4.32 | 4.34 | 4.67 | 5.79 | 4.30 | 6.57 | 4.94 | 5.53 | 8.03 | 5.46 | 3.99 | 4.06 | 4.52 | 5.74 | 4.26 | 6.38 |
| 2009 | 0.18 | 0.50 | 3.25 |     | 1.08 | 0.22 | 1.27 | 2.74 | 5.27 | 4.64 | 5.06 | 0.19 | 0.86 | 3.61 | 1.77 | 0.03 | 1.07 | 2.42 | 5.05 | 5.17 | 5.33 | 0.16 | 0.86 | 3.61 | 1.77 | 0.03 | 1.07 | 2.42 | 5.05 | 5.17 | 5.33 |

Note: All values are given as a percent at an annual rate.
### Percent change at an annual rate

<table>
<thead>
<tr>
<th>Year</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
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<tr>
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<td>5.57</td>
<td>4.73</td>
<td>5.09</td>
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<tr>
<td>2005</td>
<td>2.03</td>
<td>4.26</td>
<td>5.97</td>
</tr>
<tr>
<td>2006</td>
<td>0.19</td>
<td>5.01</td>
<td>4.95</td>
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<tr>
<td>2007</td>
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<td>5.74</td>
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<tr>
<td>2008</td>
<td>3.93</td>
<td>6.72</td>
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<td>0.84</td>
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<td>-1.74</td>
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<td>0.00</td>
<td>8.67</td>
<td>14.24</td>
<td>-6.95</td>
<td>51.67</td>
<td>19.16</td>
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<tr>
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<td>29.63</td>
<td>26.00</td>
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</tbody>
</table>

*See table of contents for changes to the series.*
Definitions

**M1**: The sum of currency held outside the vaults of depository institutions, Federal Reserve Banks, and the U.S. Treasury; travelers checks; and demand and other checkable deposits issued by financial institutions (except demand deposits due to the Treasury and depository institutions), minus cash items in process of collection and Federal Reserve float.

**M2**: M1 plus savings deposits (excluding money market deposit accounts) and small-denomination (under $100,000) time deposits issued by financial institutions; and shares in retail money market mutual funds (funds with initial investments under $50,000), net of retirement accounts.

**M3**: M2 plus large-denomination ($100,000 or more) time deposits; repurchase agreements issued by depository institutions; Eurodollar deposits, specifically, dollar-denominated deposits due to nonbank U.S. addresses held at foreign offices of U.S. banks worldwide and all banking offices in Canada and the United Kingdom; and institutional money market mutual funds (funds with initial investments of $50,000 or more).

**Bank Credit**: All loans, leases, and securities held by commercial banks.

**Domestic Nonfinancial Debt**: Total credit market liabilities of the U.S. Treasury, federally sponsored agencies, state and local governments, households, and nonfinancial firms. End-of-period basis.

**Adjusted Monetary Base**: The sum of currency in circulation outside Federal Reserve Banks and the U.S. Treasury, deposits of depository financial institutions at Federal Reserve Banks, and an adjustment for the effects of changes in statutory reserve requirements on the quantity of base money held by depositories. This series is a spliced chain index; see Anderson and Rasche (1996a,b, 2001, 2003).

**Adjusted Reserves**: The sum of vault cash and Federal Reserve Bank deposits held by depository institutions and an adjustment for the effects of changes in statutory reserve requirements on the quantity of base money held by depositories. This spliced chain index is numerically larger than the Board of Governors’ measure, which excludes vault cash not used to satisfy statutory reserve requirements and Federal Reserve Bank deposits used to satisfy required clearing balance contracts; see Anderson and Rasche (1996a, 2001, 2003).

**Monetary Services Index**: An index that measures the flow of monetary services received by households and firms from their holdings of liquid assets; see Anderson, Jones, and Nesmith (1997). Indexes are shown for the assets included in M2, with additional data at research.stls.fed.us/hs/index.html.

**Note**: M1, M2, M3, Bank Credit, and Domestic Nonfinancial Debt are constructed and published by the Board of Governors of the Federal Reserve System. For details, see Statistical Supplement to the Federal Reserve Bulletin, tables 1.21 and 1.26. MZM, Adjusted Monetary Base, Adjusted Reserves, and Monetary Services Index are constructed and published by the Research Division of the Federal Reserve Bank of St. Louis.

**Notes**

Page 3: Readers are cautioned that, since early 1994, the level and growth of M1 have been depressed by retail sweep programs that reclassify transactions deposits (demand deposits and other checkable deposits) as savings deposits overnight, thereby reducing banks’ required reserves; see Anderson and Rasche (2001) and research.stls.fed.us/aggrep/swdata.html. Primary Credit Rate, Discount Rate, and Intended Federal Funds Rate shown in the chart Reserve Market Rates are plotted as of the date of the change, while the Effective Federal Funds Rate is plotted as of the end of the month. Interest rates in the table are monthly averages from the Board of Governors H.15 Statistical Release. The Treasury Yield Curve and Real Treasury Yield Curve show constant maturity yields calculated by the U.S. Treasury for securities 5, 7, 10, and 20 years to maturity. Inflation-Indexed Treasury Yield Spreads are a measure of inflation compensation at those horizons, and it is simply the nominal constant maturity yield less the real constant maturity yield. Daily data and descriptions are available at research.stls.fed.us/press2/. See also Statistical Supplement to the Federal Reserve Bulletin, table 1.35. The 30-year constant maturity series was discontinued by the Treasury as of February 18, 2002.

Page 5: Checkable Deposits is the sum of demand and other checkable deposits. Savings Deposits is the sum of money market deposit accounts and passbook and statement savings. Time Deposits have a minimum initial maturity of 7 days. Large Time Deposits are deposits of $100,000 or more. Retail and Institutional Money Market Mutual Funds are as included in M2 and the non-M2 component of M3, respectively.

Page 7: Excess Reserves plus RCB (Required Clearing Balance) Contracts equals the amount of deposits at Federal Reserve Banks held by depository institutions but not applied to satisfy statutory reserve requirements. (This measure excludes the vault cash held by depository institutions that is not applied to satisfy statutory reserve requirements.) Consumer Credit includes most short- and intermediate-term credit extended to individuals. See Statistical Supplement to the Federal Reserve Bulletin, table 1.55.

Page 8: Inflation Expectations measures include the quarterly Federal Reserve Bank of Philadelphia’s Survey of Professional Forecasters, the monthly University of Michigan Survey Research Center’s Surveys of Consumers, and the annual Federal Open Market Committee (FOMC) range as reported to the Congress in the February testimony that accompanies the Monetary Policy Report to the Congress. Beginning February 2000, the FOMC began using the personal consumption expenditures (PCE) price index to report its inflation range; the FOMC then switched to the PCE chain-type price index excluding food and energy prices (“core”) beginning July 2004. Accordingly, neither are shown on this graph. CPI Inflation is the percentage change from a year ago in the consumer price index for all urban consumers. Real Interest Rates are ex post measures, equal to nominal rates minus year-over-year CPI inflation.

From 1991 to the present the source of the long-term PCE inflation expectations data is the Federal Reserve Bank of Philadelphia’s Survey of Professional Forecasters. Prior to 1991, the data were obtained from the Board of Governors of the Federal Reserve System. Realized (actual) inflation is the annualized rate of change for the 40-quarter period that corresponds to the forecast horizon (the expectations measure). For example, in 1965:Q1, annualized PCE inflation over the next 40 quarters was expected to average 1.7 percent. In actuality, the average annualized rate of change measured 4.8 percent from 1965:Q1 to 1975:Q1. Thus, the vertical distance between the two lines in the chart at any point is the forecast error.

Page 9: FOMC Intended Federal Funds Rate is the level (or midpoint of the range, if applicable) of the federal funds rate that the staff of the FOMC expected to be consistent with the desired degree of pressure on bank reserve positions. In recent years, the FOMC has set an explicit target for the federal funds rate.

Page 10: Federal Funds Rate and Inflation Targets shows the observed federal funds rate, quarterly, and the level of the funds rate implied by applying Taylor’s (1993) equation to five alternative target inflation rates, \( \pi_t = 0, 1, 2, 3, 4 \) percent, where \( \pi_t \) is the implied federal funds rate, \( \pi_{t-1} \) is the previous period’s inflation rate (PCE) measured on a year-over-year basis, \( \gamma_t \) is the log of the previous period’s level of real gross domestic product (GDP), and \( \gamma_{t-1} \) is the log of an estimate of the previous period’s level of potential output. Potential Real GDP is as estimated by the Congressional Budget Office.

Monetary Base Growth and Inflation Targets shows the quarterly growth of the adjusted monetary base (modified to include an estimate of the effect of sweep programs) implied by applying McCallum’s (1988, 1993) equation 

\[
\Delta MB_t = \pi_t + (10\text{-year moving average growth of real GDP}) - \left( \frac{\pi_t}{4\text{-year moving average of base velocity growth}} \right)
\]

to five alternative target inflation rates, \( \pi_t = 0, 1, 2, 3, 4 \) percent, where \( \Delta MB_t \) is the implied growth rate of the adjusted monetary base. The 10-year moving average growth of real GDP for a quarter \( t \) is calculated as the average quarterly growth during the previous 40 quarters, at an annual rate, by the formula
Monetary Trends

\[(y_r - y_{t=0})/400\] times GDP, where \(y_r\) is the log of real GDP. The 4-year moving average of base velocity growth is calculated similarly. To adjust the monetary base for the effect of retail deposit sweep programs, we add to the monetary base an amount equal to 10 percent of the total amount swept, as estimated by the Federal Reserve Board staff. These estimates are imprecise, at best. Sweep program data are found at research.stlouisfed.org/agg/swdata.html.

Page 11: **Implied One-Year Forward Rates** are calculated by this Bank from Treasury constant maturity yields. Yields to maturity, \(R(m)\), for securities with \(m = 1, \ldots, 10\) years to maturity are obtained by linear interpolation between reported yields. These yields are smoothed by fitting the regression suggested by Nelson and Siegel (1987),

\[ R(m) = a_0 + (a_1 + a_2)(1 – e^{-m/50}/(m/50) – a_3 e^{-m/50}, \]

and forward rates are calculated from these smoothed yields using equation (a) in table 13.1 of Shiller (1990),

\[ f(m) = [D(m)R(m) – D(m–1)]/ [D(m) – D(m–1)], \]

where duration is approximated as \(D(m) = (1 – e^{-R(m)/m})/R(m)\). These rates are linear approximations to the true instantaneous forward rates; see Shiller (1990). For a discussion of the use of forward rates as indicators of inflation expectations, see Sharpe (1997).

**Rates on 3-Month Eurodollar Futures and Rates on Selected Federal Funds Futures Contracts** trace through time the yield on three specific contracts. Rates on Federal Funds Futures on Selected Dates displays a single day’s snapshot of yields for contracts expiring in the months shown on the horizontal axis. **Inflation-Indexed Treasury Securities and Yield Spreads** are those plotted on page 3. **Inflation-Indexed 10-Year Government Notes** shows the yield of an inflation-indexed note that is scheduled to mature in approximately (but not greater than) 10 years. The current French note has a maturity date of 7/25/2015, the current U.K. note has a maturity date of 8/16/2013, and the current U.S. note has a maturity date of 1/15/2018. **Inflation-Indexed Treasury Yield Spreads** and **Inflation-Indexed 10-Year Government Yield Spreads** equal the difference between the yields on the most recently issued inflation-indexed securities and the unadjusted security yields of similar maturity.

Page 12: **Velocity** (for MZM and M2) equals the ratio of GDP, measured in current dollars, to the level of the monetary aggregate. **MZM** and **M2 Own Rates** are weighted averages of the rates received by households and firms on the assets included in the aggregates. Prior to 1982, the 3-month T-bill rates are secondary market yields. From 1982 forward, rates are 3-month constant maturity yields.

Page 13: **Real Gross Domestic Product** is GDP as measured in chained 2000 dollars. The **Gross Domestic Product Price Index** is the implicit price deflator for GDP, which is defined by the Bureau of Economic Analysis, U.S. Department of Commerce, as the ratio of GDP measured in current dollars, to the level of the monetary aggregate. Prior to 1982, the 3-month T-bill rates are secondary market yields. From 1982 forward, rates are 3-month constant maturity yields.

Page 14: **Investment Securities** are all securities held by commercial banks in both investment and trading accounts.

Page 15: **Inflation Rate Differentials** are the differences between the foreign consumer price inflation rates and year-over-year changes in the U.S. all-items Consumer Price Index.

Page 17: **Treasury Yields** are Treasury constant maturities as reported in the Board of Governors of the Federal Reserve System’s H.15 release.

Sources

**Agence France Trésor**: French note yields.

**Bank of Canada**: Canadian note yields.


**Bureau of Economic Analysis**: GDP.

**Bureau of Labor Statistics**: CPI.

**Chicago Board of Trade**: Federal funds futures contract.

**Chicago Mercantile Exchange**: Eurodollar futures.

**Congressional Budget Office**: Potential real GDP.

**Federal Reserve Bank of Philadelphia**: Survey of Professional Forecasters inflation expectations.

**Federal Reserve Bank of St. Louis**: Adjusted monetary base and adjusted reserves, monetary services index, MZM own rate, one-year forward rates.

**Organization for Economic Cooperation and Development**: International interest and inflation rates.

**Standard & Poor’s**: Stock price-earnings ratio, stock price composite index.

**University of Michigan Survey Research Center**: Median expected price change.

**U.S. Department of the Treasury**: U.S. security yields.

References


Note: *Available on the Internet at research.stlouisfed.org/publications/review.