Does Stock Market Volatility Forecast Returns?

When stock market risk, or volatility, increases, risk-averse investors tend to reduce their holding of equities relative to safe assets such as Treasury bills. Thus, to induce investors to hold a broadly measured stock market index, the expected excess stock market return—the difference between the return on the stock market index and a risk-free rate—has to rise. Such a positive relation between stock market volatility and returns is an important prediction of the widely accepted capital asset pricing model.

The level of volatility tends to persist over time, and, hence, we expect that past volatility should provide some indication of future stock market returns. Several studies, however, have found that volatility, by itself, explains little of the variation of stock market returns. We replicate this result in the accompanying table. Quarterly realized volatility is measured by the sum of the squared daily stock market returns in a quarter. We regress quarterly excess returns, measured by the difference between the return on the Standard & Poor's 500 index and the yield on three-month Treasury bills, on this measure of volatility. Row 1 shows that the adjusted R^2 from this regression is 0.01, indicating that volatility accounts for only about 1 percent of the variation of the one-quarter-ahead excess stock market return.

The weak estimated relationship between stock market volatility and returns may reflect the fact that other factors also affect stock prices. For example, Guo (2000) shows that, in addition to the risk premium, a liquidity premium is also an important component of excess stock market returns.[1] Intuitively, if investors have excess liquidity, they might be willing to hold stocks when expected return is low, even though expected volatility is high. However, the theory still stipulates a positive relation between stock market volatility and returns after taking into account the liquidity premium.

Although the liquidity premium is not directly observable in data, the consumption-to-wealth ratio is a suitable proxy for it. Row 2 shows that the one-quarter-lagged consumption-to-wealth ratio has predictive power for excess stock market returns.[2] Moreover, when this proxy for liquidity is included in the regression, we find that past volatility explains a significant portion of excess stock returns (row 3). Thus, theory and empirical evidence both indicate that stock market returns increase when volatility rises.

—Hui Guo

[1]Guo, Hui. "Limited Stock Market Participation and Asset Prices in a Dynamic Economy." Working Paper 2000-031B, Federal Reserve Bank of St. Louis, January 2002.

[2]This corroborates the finding in Lettau and Ludvigson: "Consumption, Aggregate Wealth, and Expected Stock Returns." *Journal of Finance*, June 2001, *56*(3), pp. 815-49.

Forecasting Excess Stock Market Returns: Regression Coefficient Estimates

	Intercept	Volatility	Consumption-to-wealth ratio	Adjusted R^2
1	−0.009	2.763		0.01
2	−0.806		1.898	0.09
3	−1.081	5.721	2.481	0.15

NOTE: The sample spans 1952:Q2 to 2002:Q3. The p value for volatility is 8.2 percent in row 1 and is less than 1.0 percent in row 3.

Table*of*Contents

Conventions used in this publication:

1. Unless otherwise indicated, data are monthly.

2. Shaded areas indicate recessions, as dated by the National Bureau of Economic Research.

3. The *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: $[(x_t / x_{t-1}) -1] \times 1200$. 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: $[(x_t / x_{t-12}) -1] \times 100$.
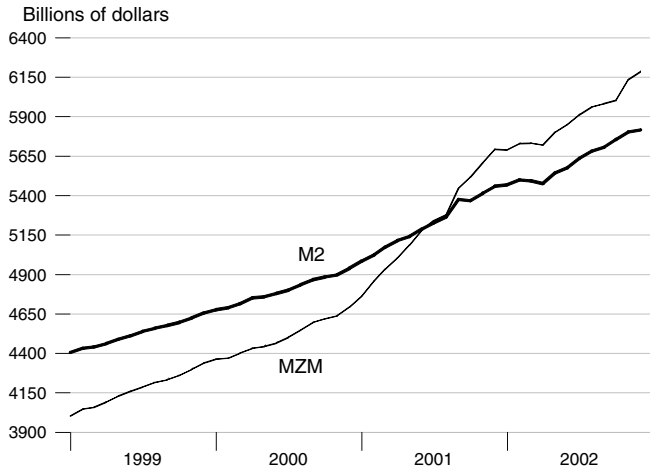
M2 and MZM

Billions of dollars

Reserve Market Rates

Percent

Adjusted Monetary Base

Percent change at an annual rate

Treasury Yield Curve

Percent

Week Ending:
01/18/02 ------
12/20/02 ——
01/17/03 ▬▬

Total Bank Credit

Percent change at an annual rate
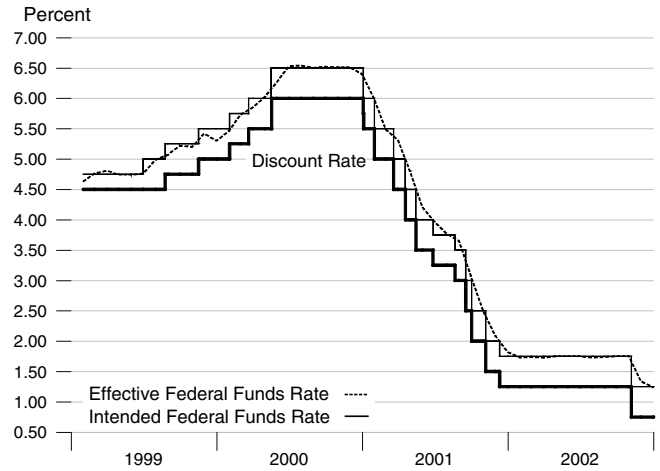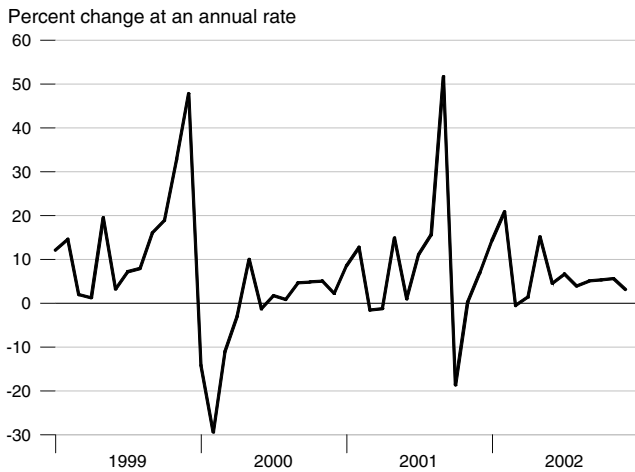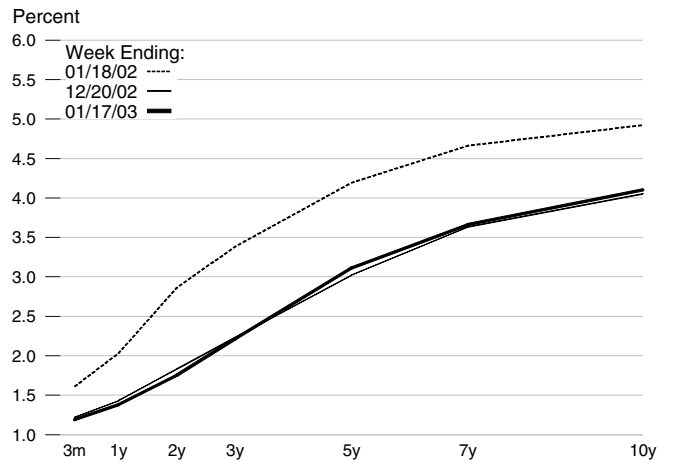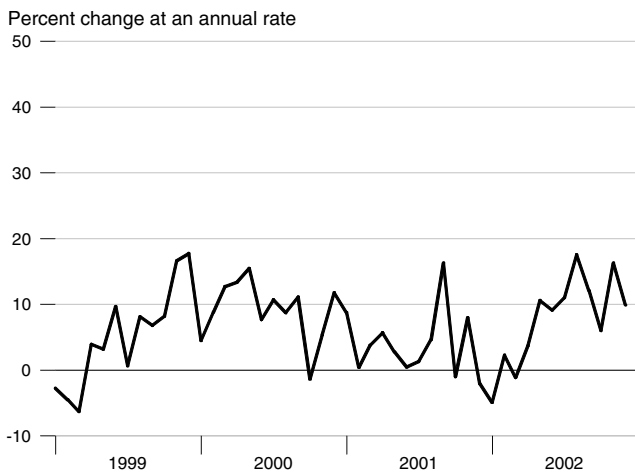
Interest Rates

|	Oct 02	Nov 02	Dec 02
Federal Funds Rate	1.75	1.34	1.24
Discount Rate	1.25	0.83	0.75
Prime Rate	4.75	4.35	4.25
Conventional Mortgage Rate	6.11	6.07	6.05
Treasury Yields:			
3-Month Constant Maturity	1.61	1.25	1.21
6-Month Constant Maturity	1.59	1.30	1.27
1-Year Constant Maturity	1.65	1.49	1.45
3-Year Constant Maturity	2.25	2.32	2.23
5-Year Constant Maturity	2.95	3.05	3.03
10-Year Constant Maturity	3.94	4.05	4.03

MZM and M1

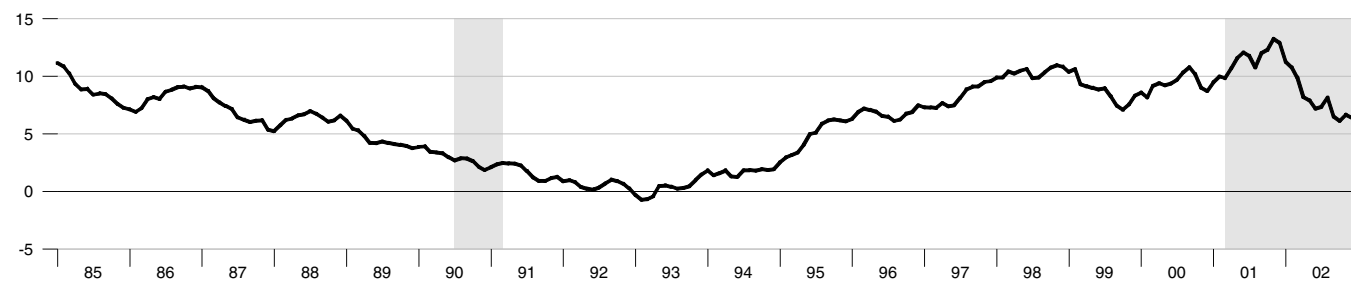Percent change from year ago

M2
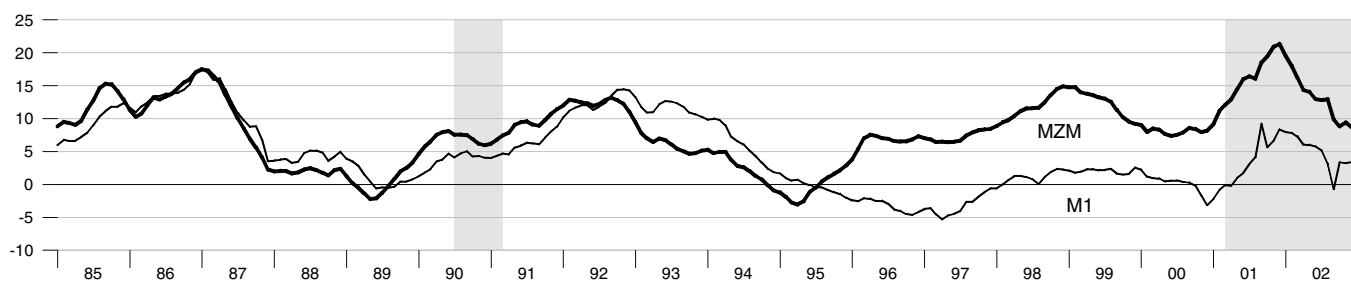
Percent change from year ago
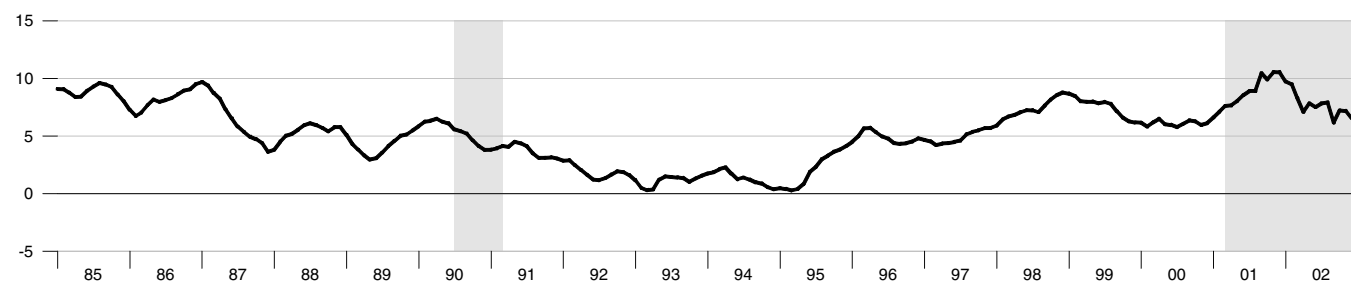
M3

Percent change from year ago

Monetary Services Index - M2

Percent change from year ago
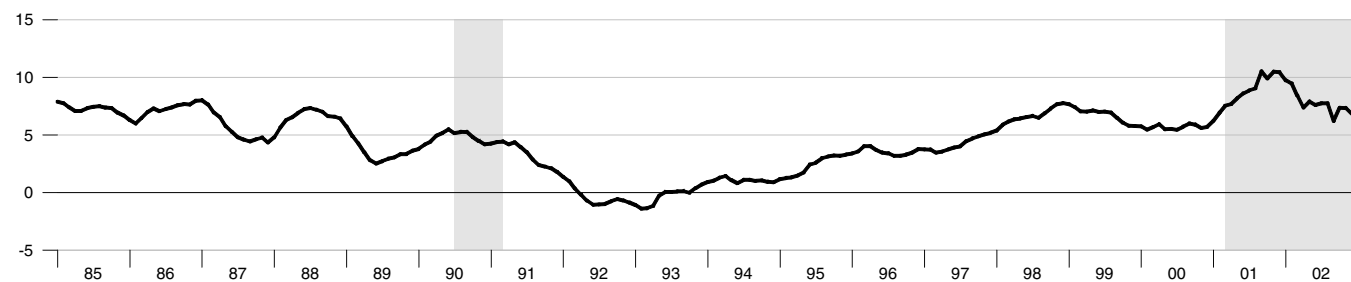
Adjusted Monetary Base

Percent change from year ago

Domestic Nonfinancial Debt

Percent change from year ago
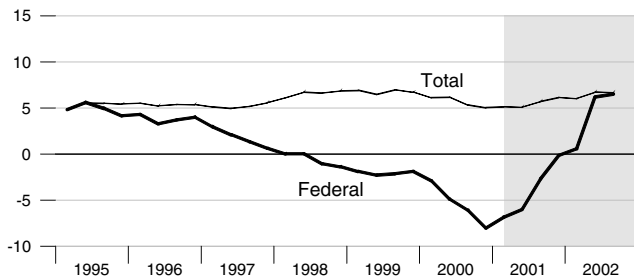
Currency Held by the Nonbank Public

Percent change from year ago
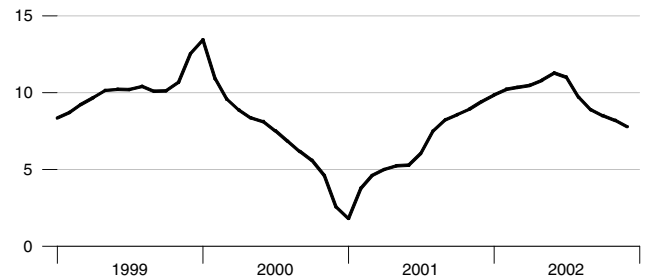
Time Deposits

Percent change from year ago
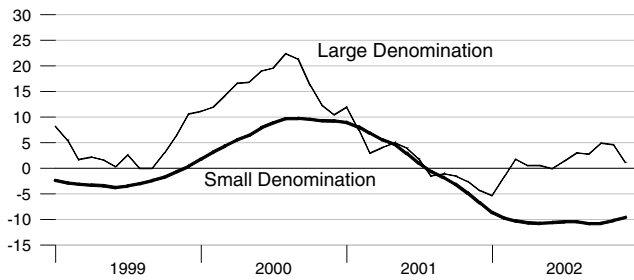
Checkable and Savings Deposits

Percent change from year ago
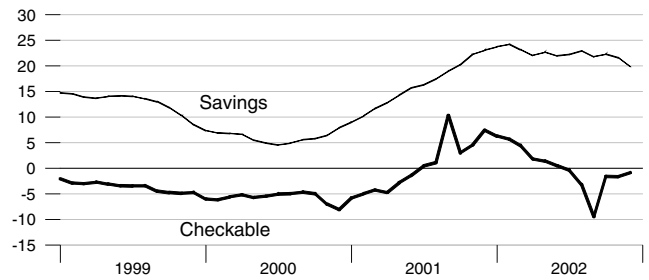
Money Market Mutual Fund Shares

Percent change from year ago
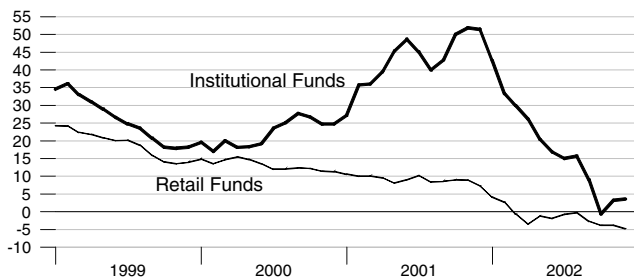
Repurchase Agreements and Eurodollars

Billions of dollars   Billions of dollars
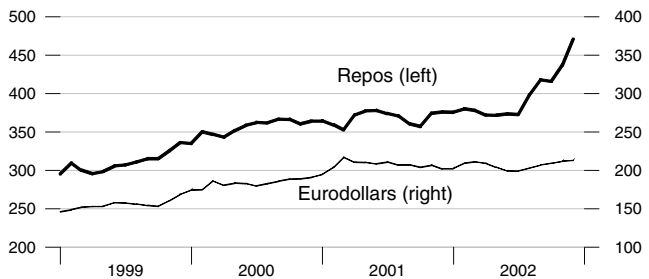
M1

Percent change at an annual rate
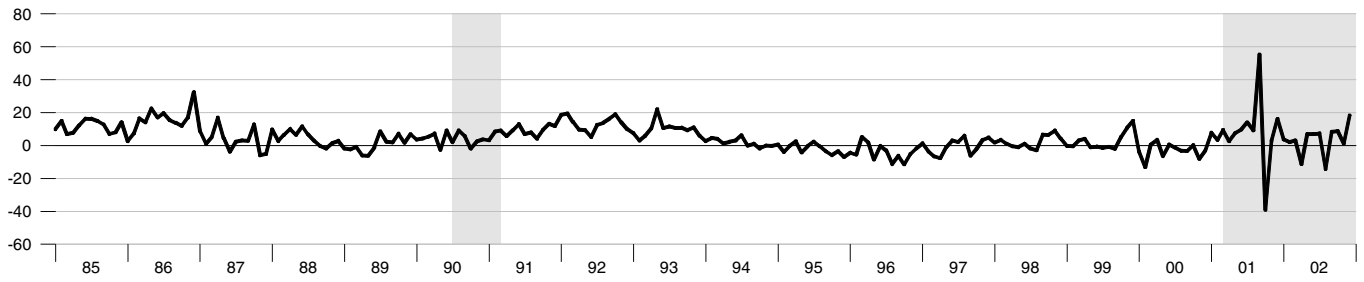
MZM

Percent change at an annual rate

M2

Percent change at an annual rate

M3
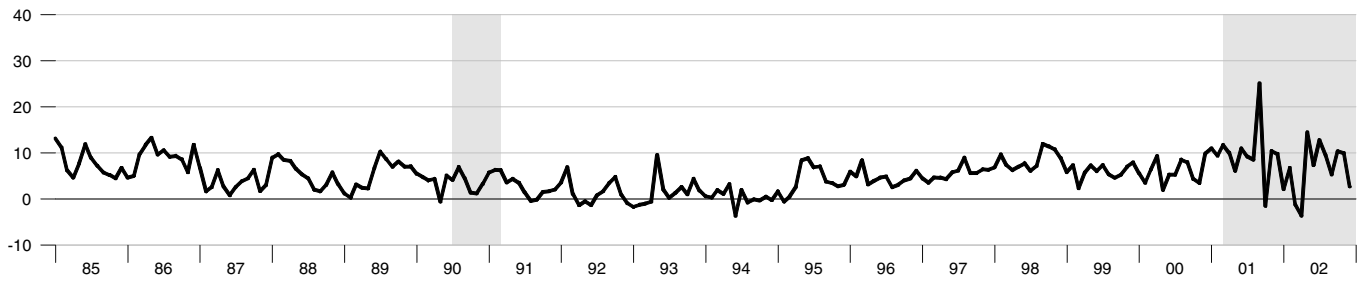
Percent change at an annual rate
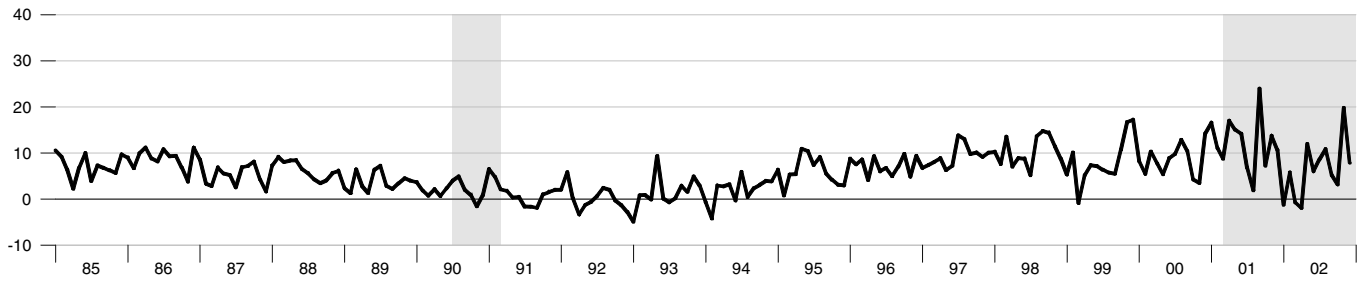
Adjusted and Required Reserves

Billions of dollars
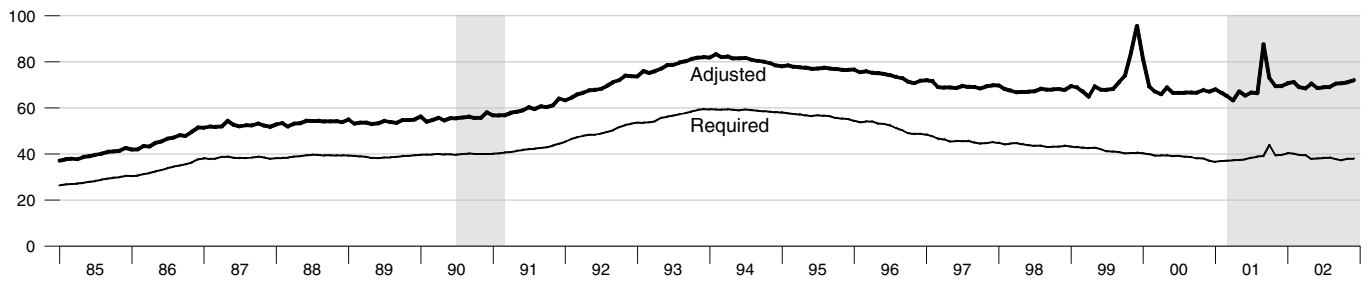
Total Borrowings, nsa

Billions of dollars
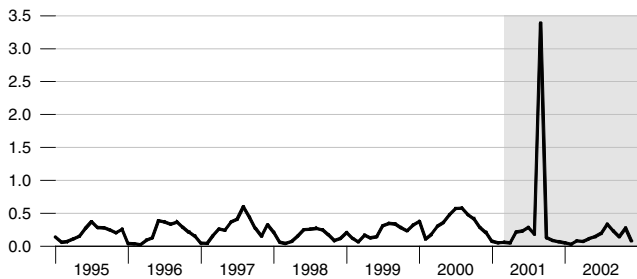
Excess Reserves plus RCB Contracts

Billions of dollars
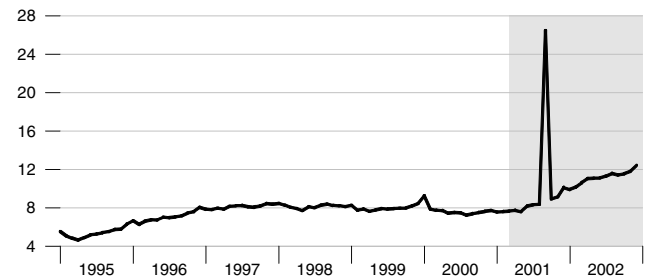
Nonfinancial Commercial Paper

Percent change from year ago
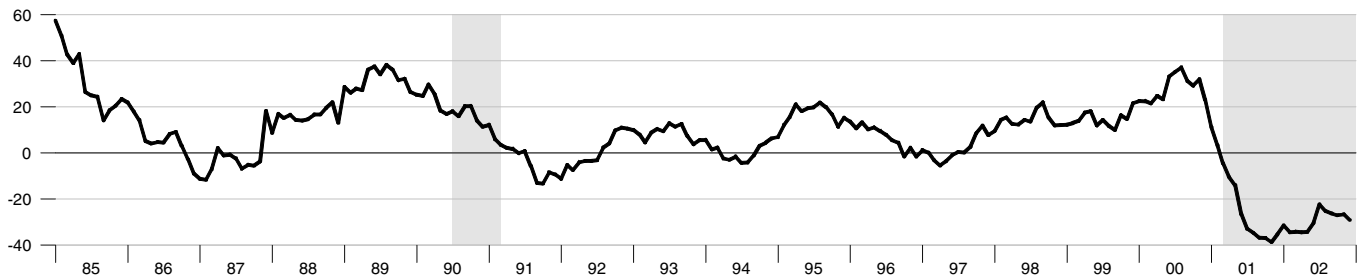
Consumer Credit

Percent change from year ago
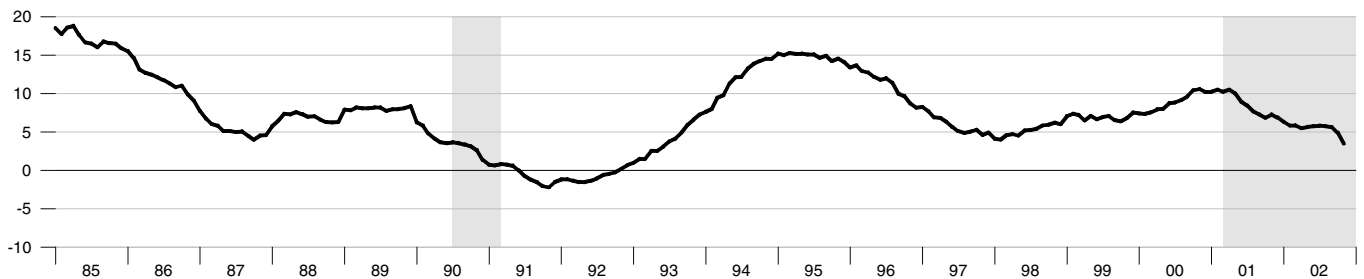
Inflation and Inflation Expectations

Percent

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. See notes on page 19.
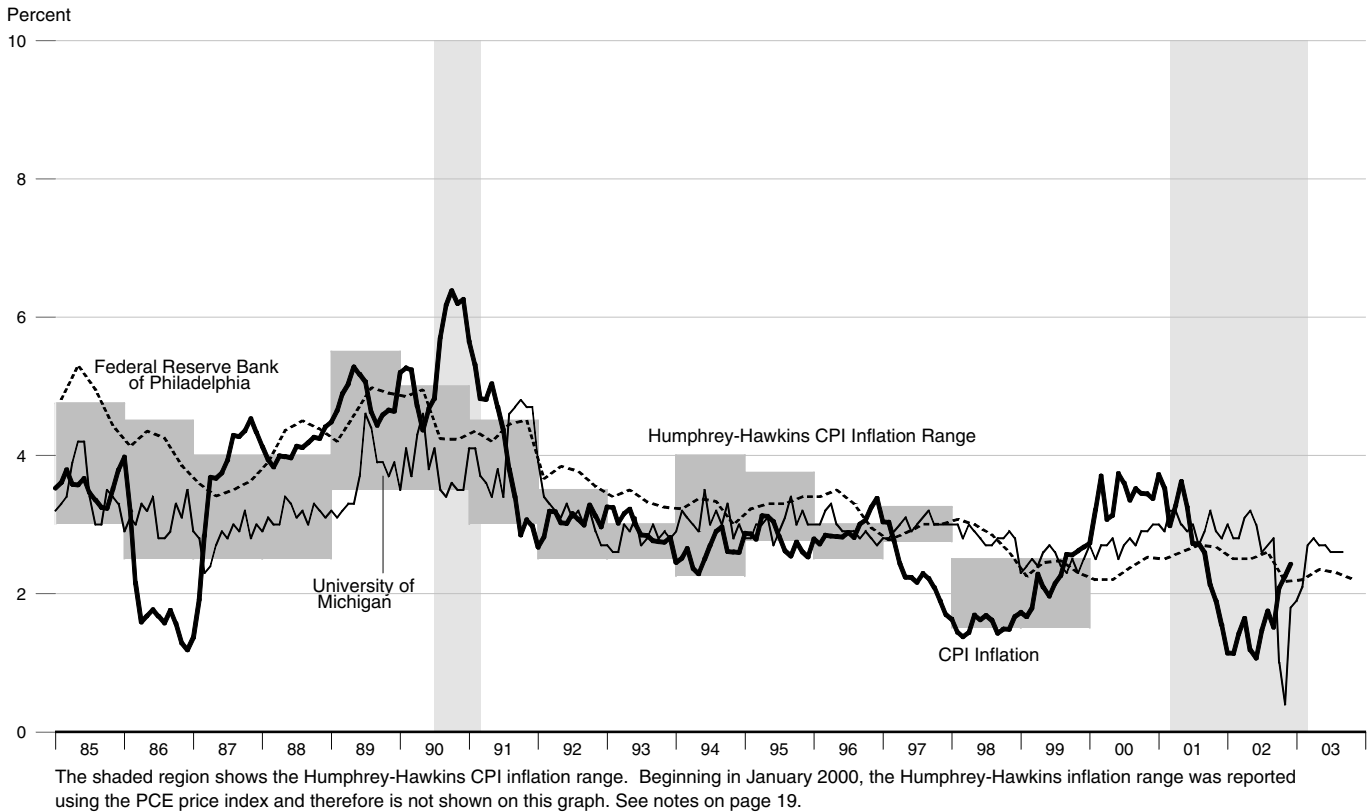
Treasury Security Yield Spreads
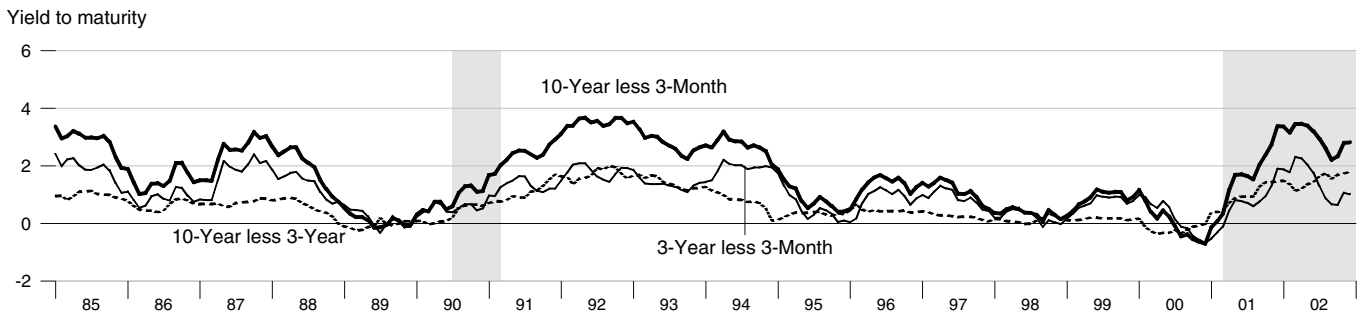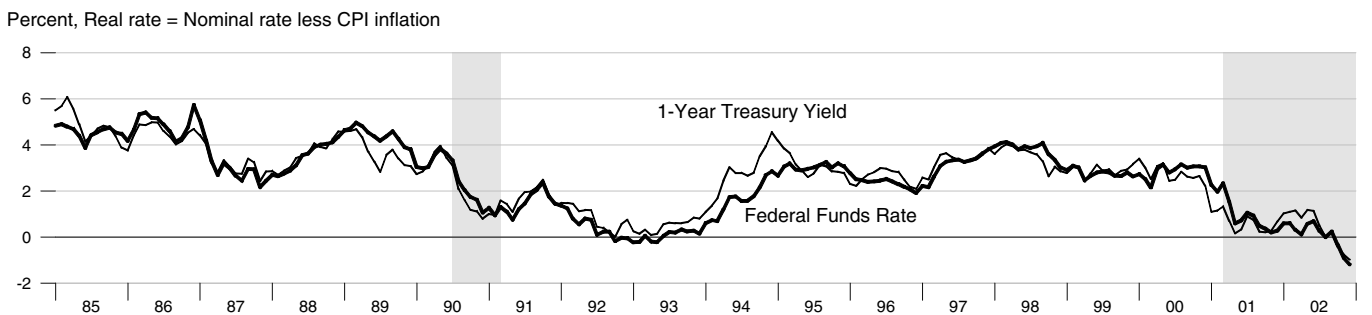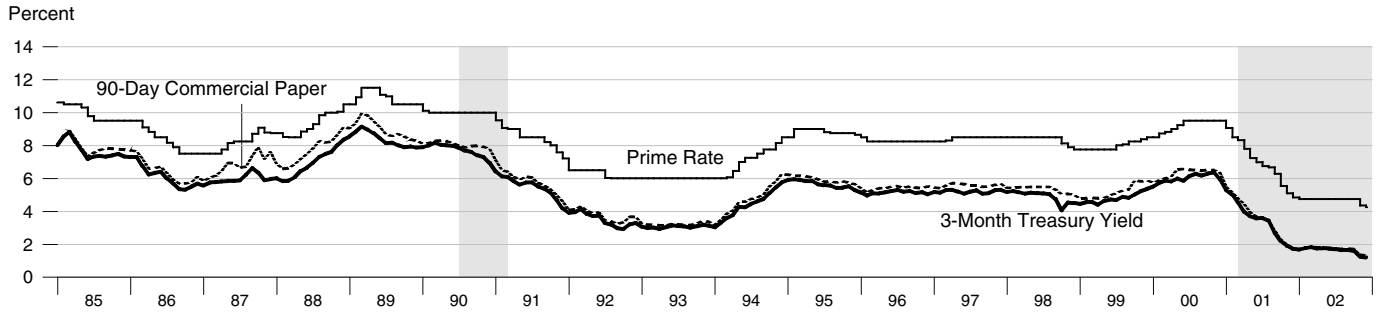
Yield to maturity

Real Interest Rates

Percent, Real rate = Nominal rate less CPI inflation

Short-Term Interest Rates

Percent

Long-Term Interest Rates

Percent

Long-Term Interest Rates

Percent

Short-Term Interest Rates

Percent
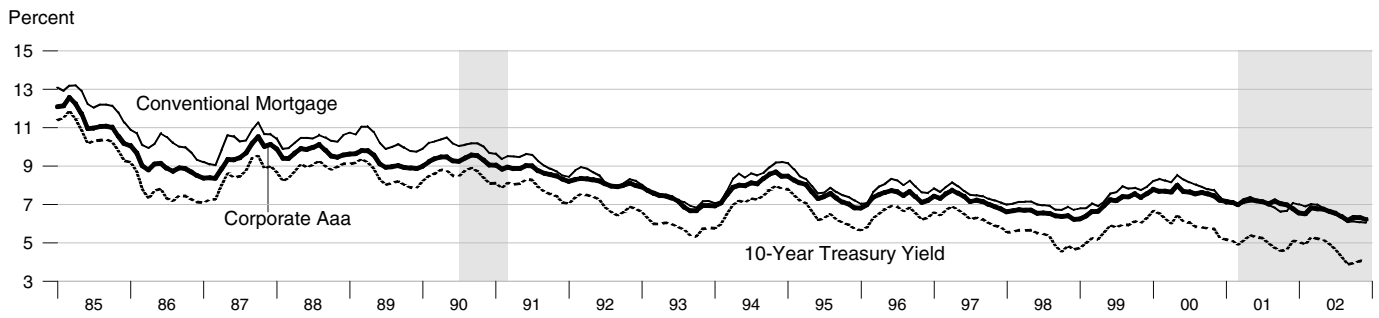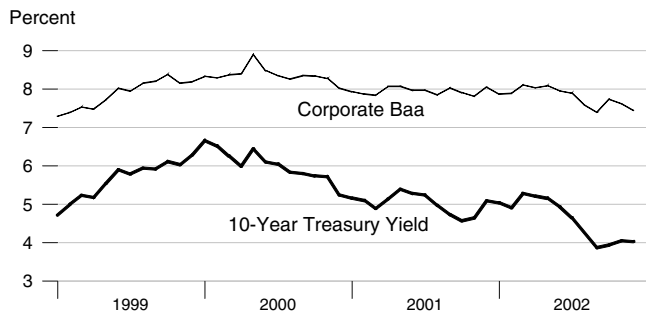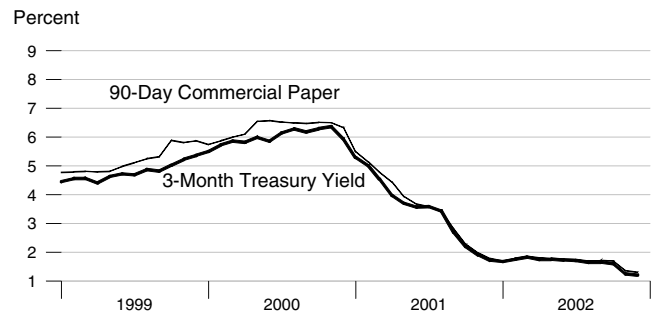
FOMC Intended Federal Funds Rate and Discount Rate

Percent

Federal Funds Rate and Inflation Targets

Percent

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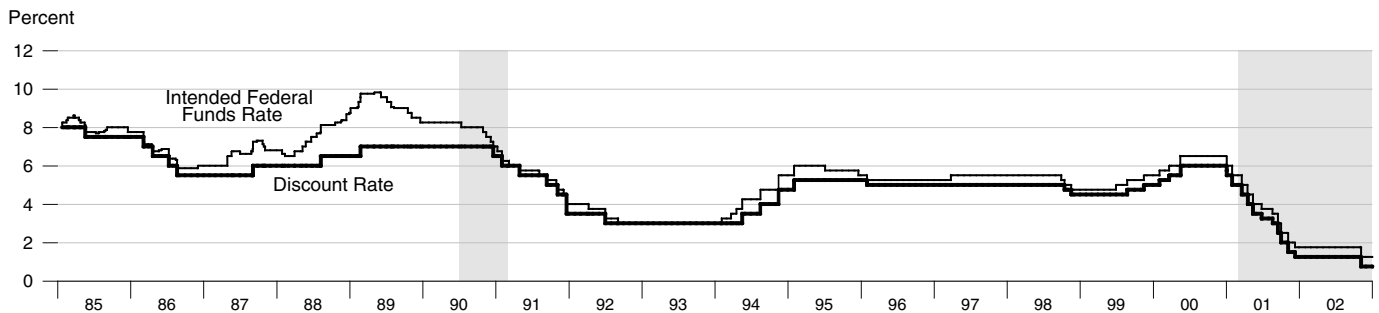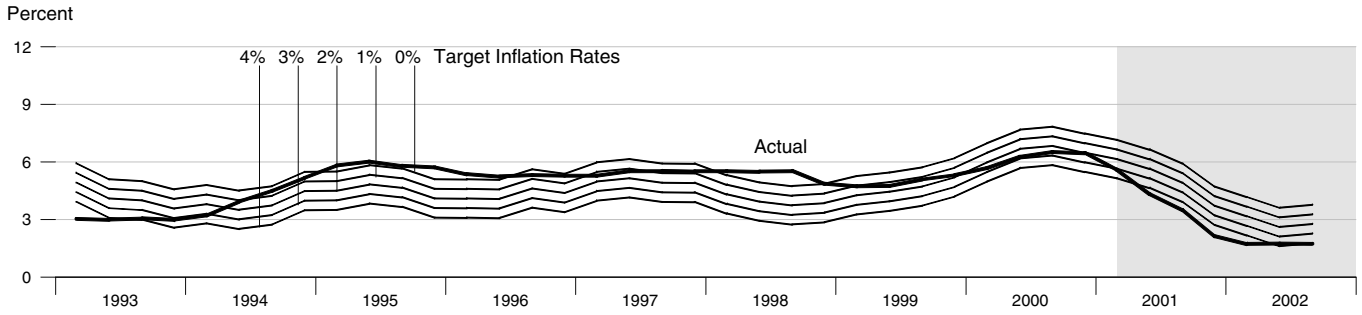
Actual

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 1996 dollars

Actual

Potential
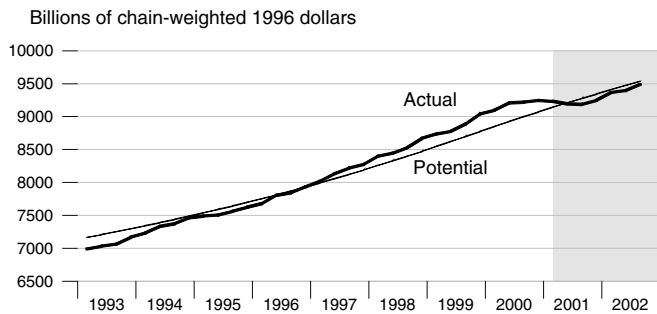
PCE Inflation and Projections

Percent change from year ago
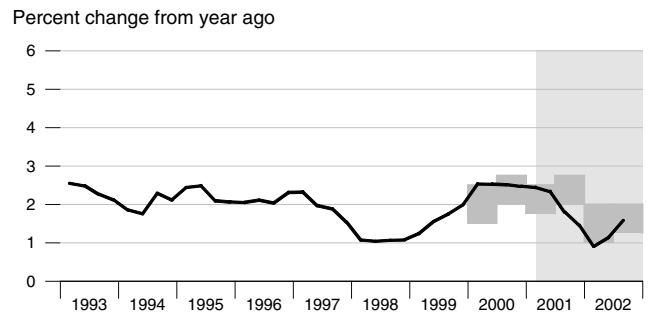
The shaded region shows the range of projections published in the
Monetary Policy Report to Congress.

Monetary Base Growth* and Inflation Targets

Percent

Actual

0% 1% 2% 3% 4% Target Inflation Rates
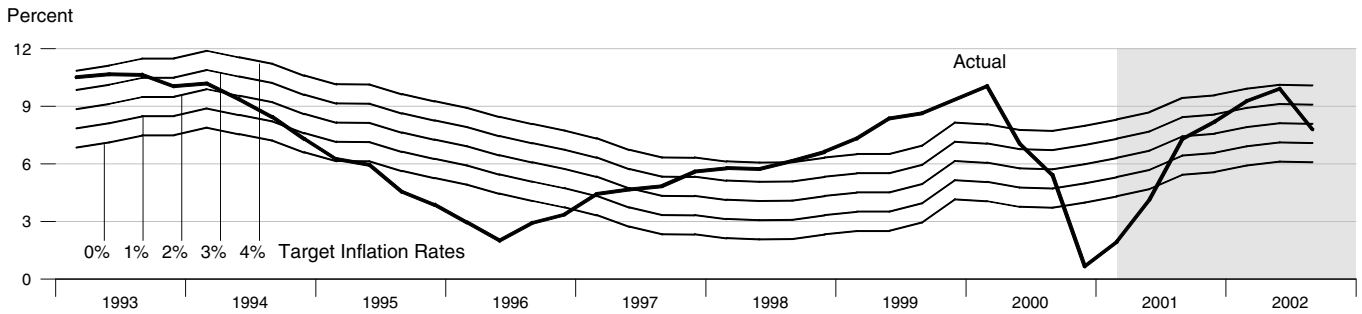
*Modified for the effects of sweeps programs on reserve demand.
Calculated base growth is based on McCallum's rule. Actual base growth is percent change from year ago. See notes on page 19.

Components of McCallum's Rule

Monetary Base Velocity Growth
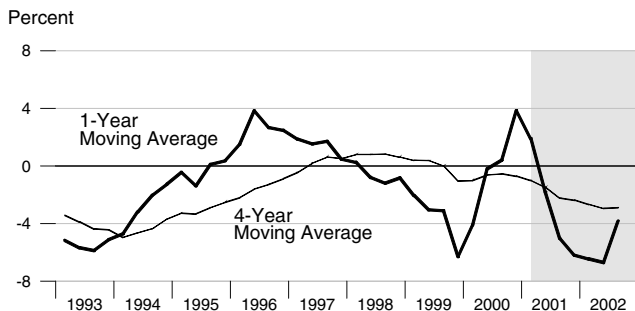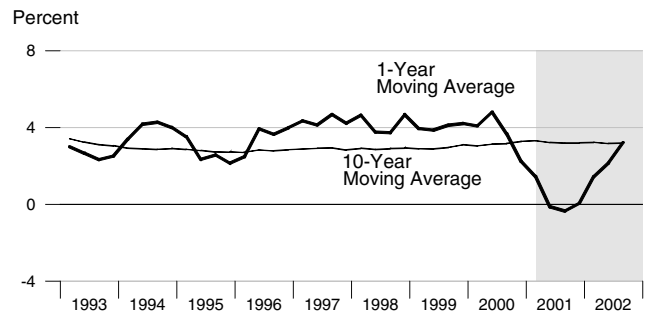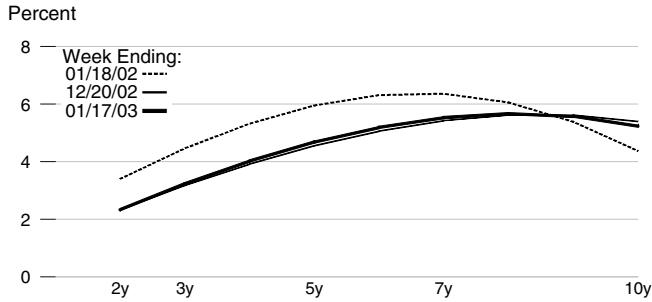
Percent

1-Year
Moving Average

4-Year
Moving Average

Real Output Growth

Percent

1-Year
Moving Average

10-Year
Moving Average

Implied One-Year Forward Rates

Percent

Rates on 3-Month Eurodollar Futures

Percent, daily data

Rates on Selected
Fed Funds Futures Contracts

Percent, daily data

Implied Yields on Fed Funds Futures

Percent

Inflation-Protected Treasury Yields

Percent, weekly data

Inflation-Protected Treasury Yield Spreads

Percent, weekly data

Inflation-Indexed 30-Year Bonds

Percent, weekly data

Inflation-Indexed 10-Year Bonds

Percent, weekly data

MZM Velocity and Opportunity Cost

Velocity = Nominal GDP / MZM

Opportunity cost

Velocity

Opportunity Cost (3-mo T-bill rate less MZM own rate)

M2 Velocity and Opportunity Cost

Velocity = Nominal GDP / M2

Opportunity cost

Velocity

Opportunity Cost (5-yr T-bond rate less M2 own rate)

Opportunity Cost (3-mo T-bill rate less M2 own rate)
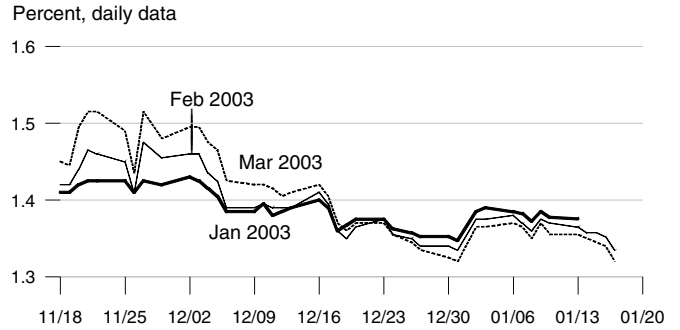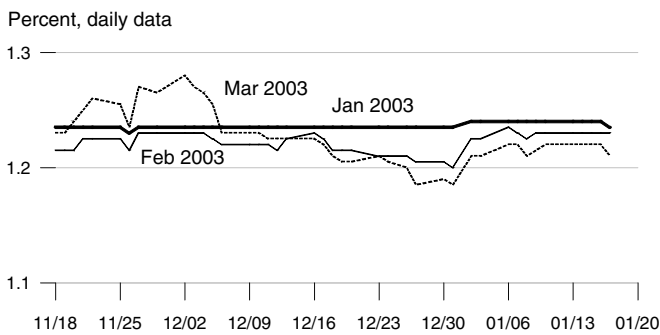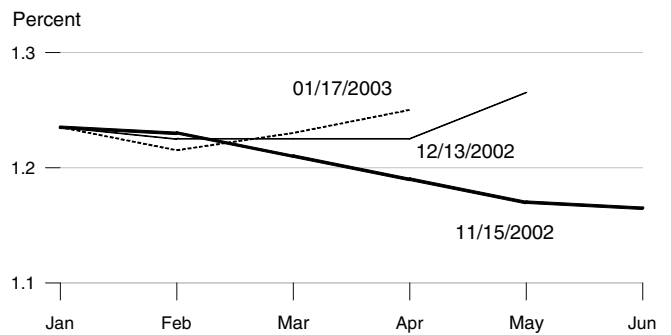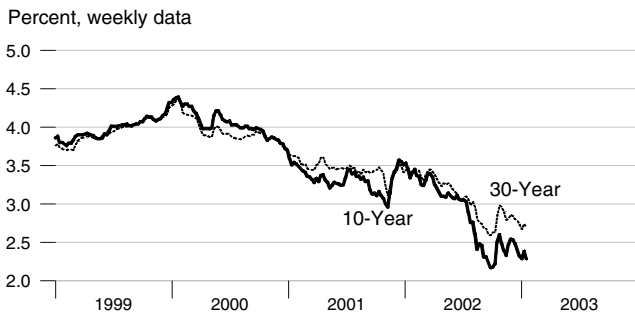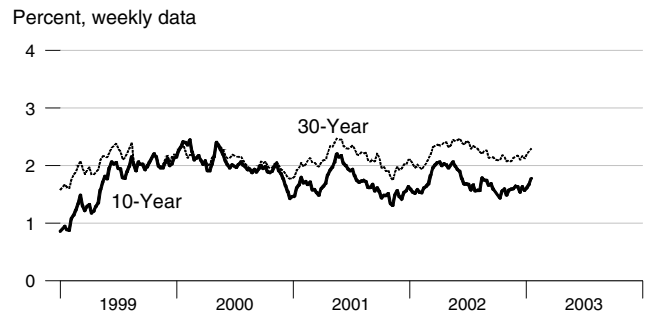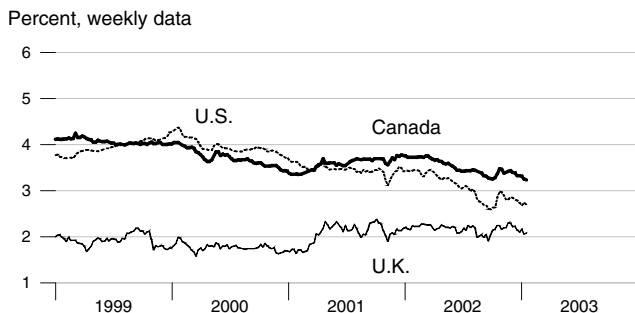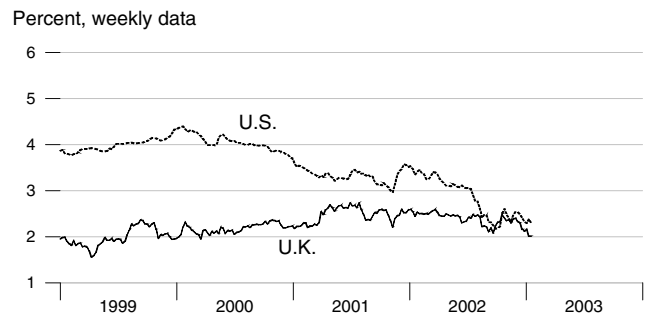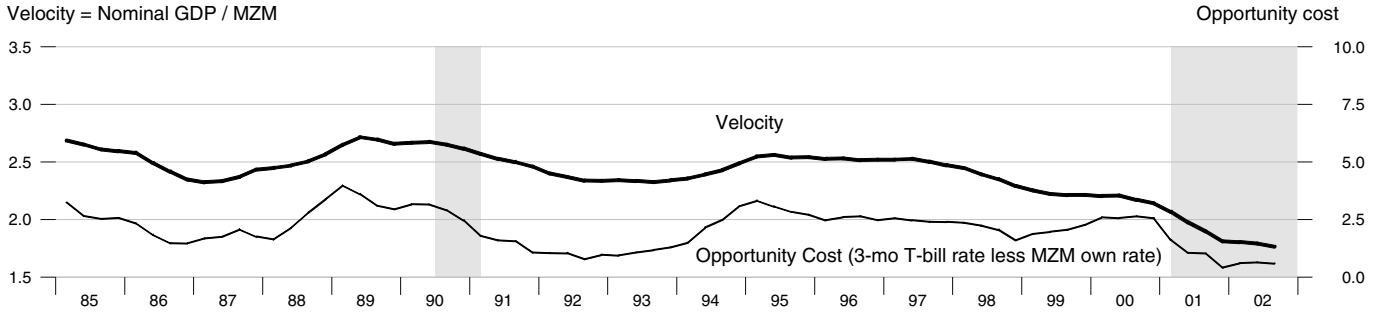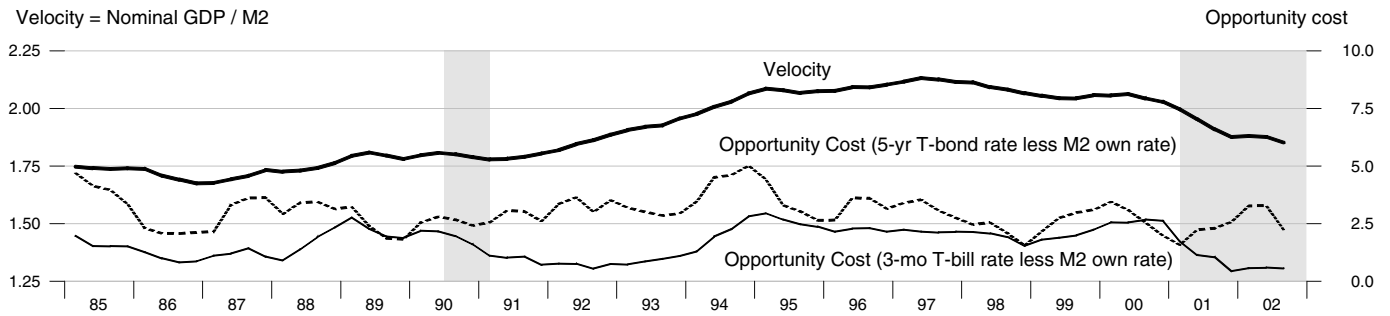
M2, MZM, and Nominal GDP

Billions of dollars
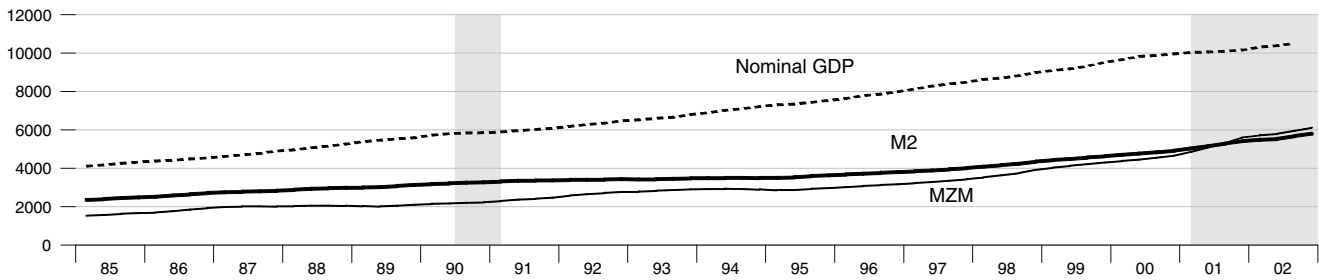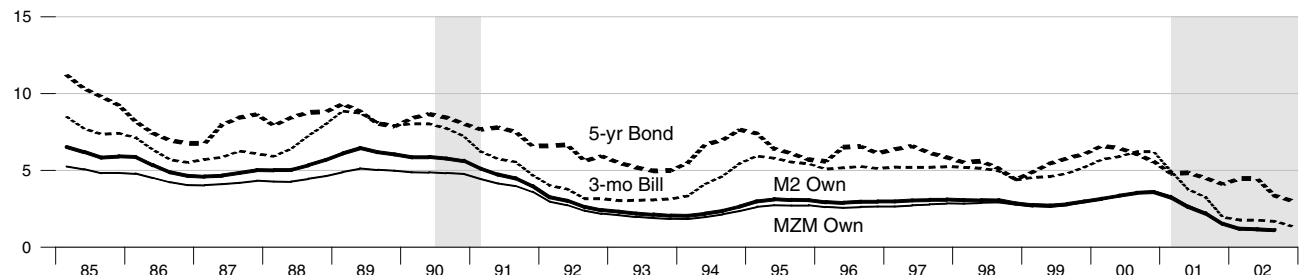
Nominal GDP

M2

MZM

Interest Rates

Percent

5-yr Bond

3-mo Bill

M2 Own

MZM Own

Gross Domestic Product

Percent change from year ago
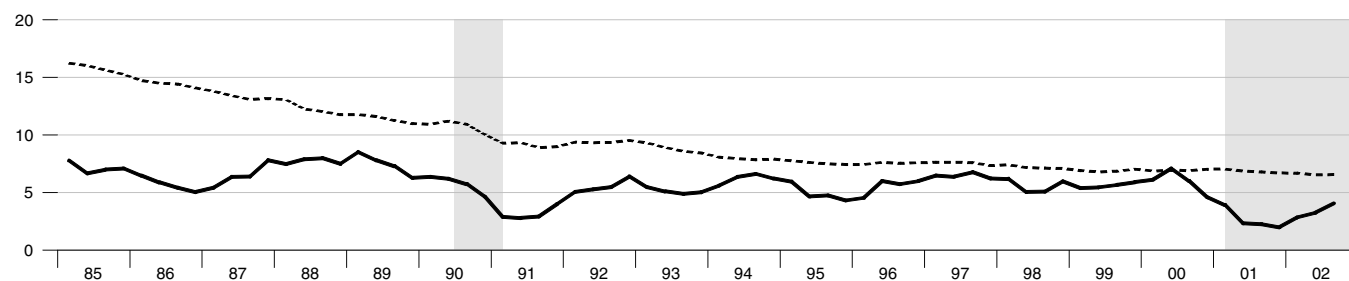
Dashed lines indicate 10-year moving averages.

Real Gross Domestic Product

Percent change from year ago
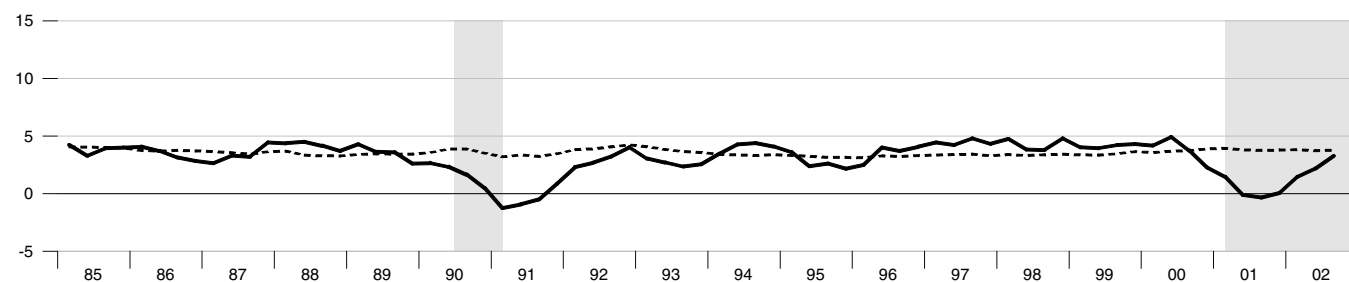
Dashed lines indicate 10-year moving averages.

Gross Domestic Product Price Index

Percent change from year ago
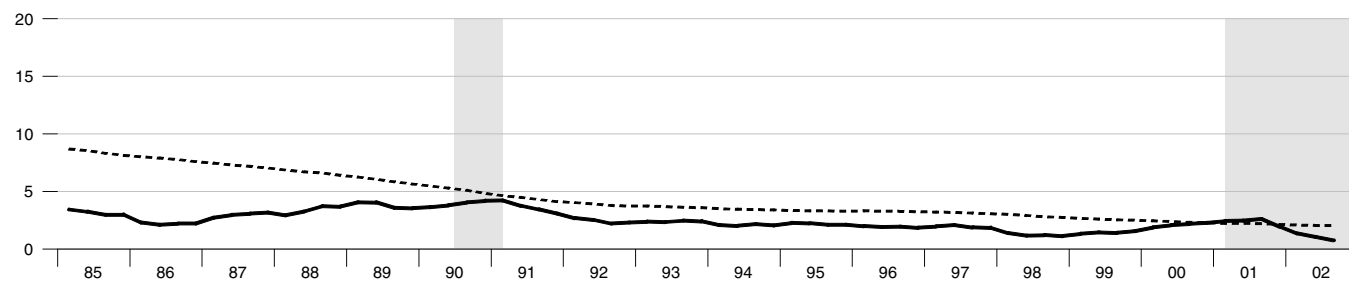
Dashed lines indicate 10-year moving averages.

M2

Percent change from year ago
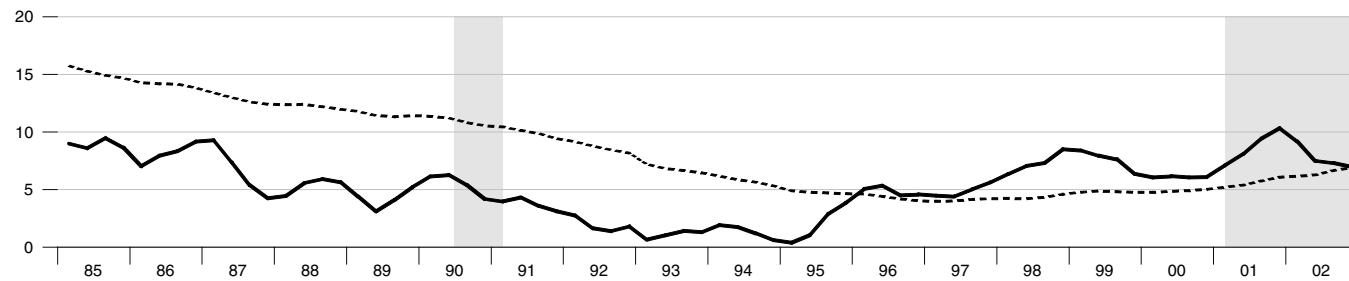
Dashed lines indicate 10-year moving averages.

Bank Credit

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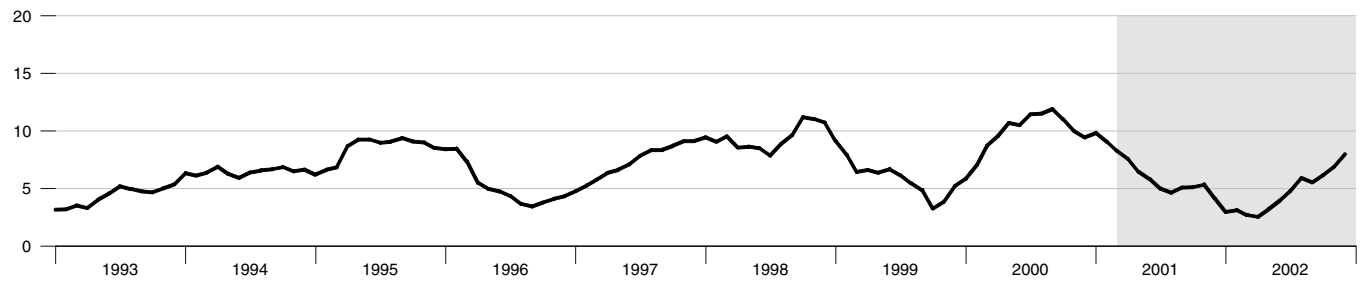
Investment Securities in Bank Credit at Commercial Banks

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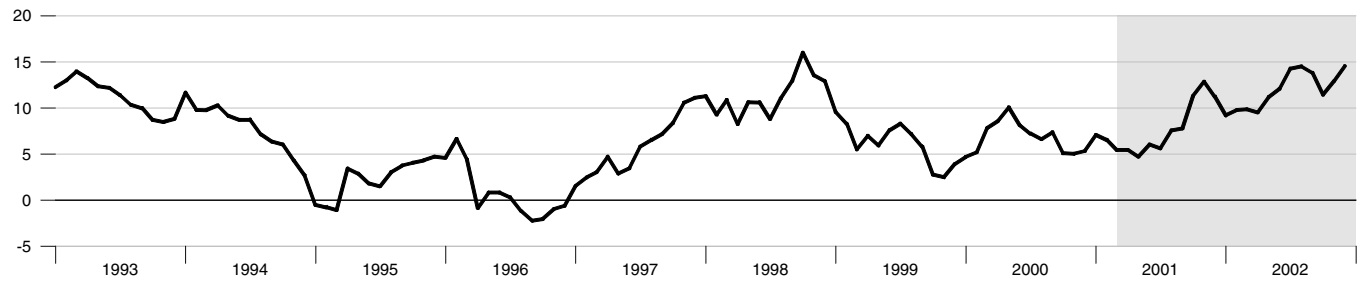
Total Loans and Leases in Bank Credit at Commercial Banks

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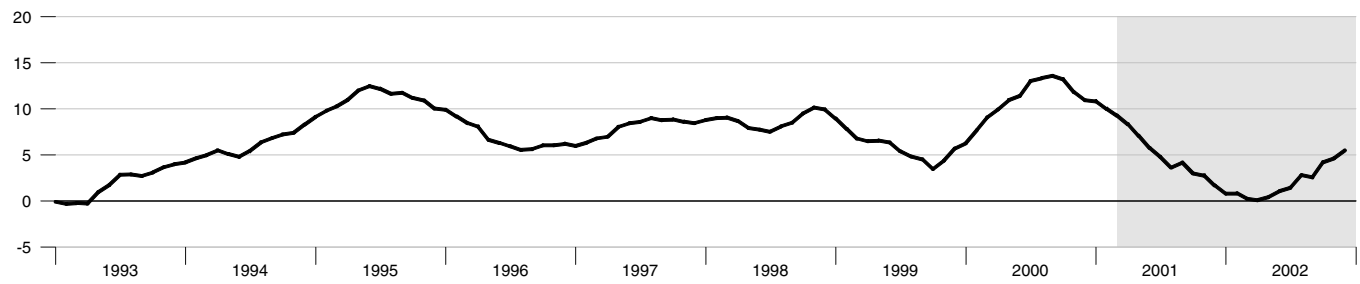
Commercial and Industrial Loans at Commercial Banks

Percent change from year ago
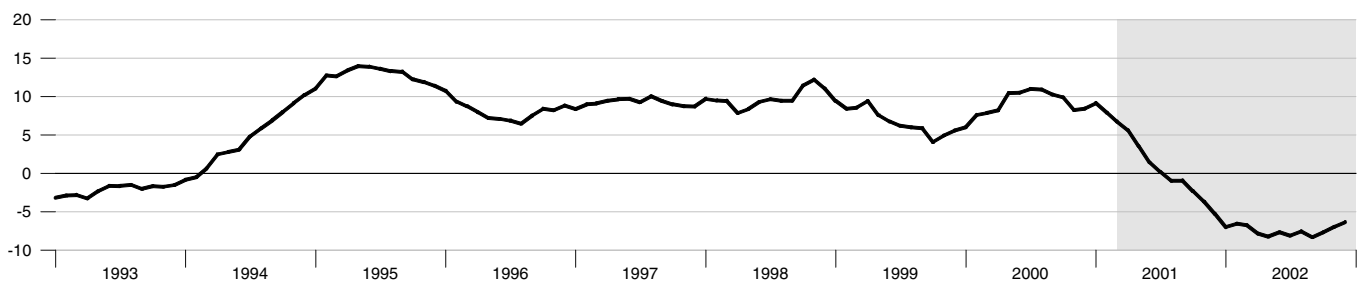
Standard & Poor's 500
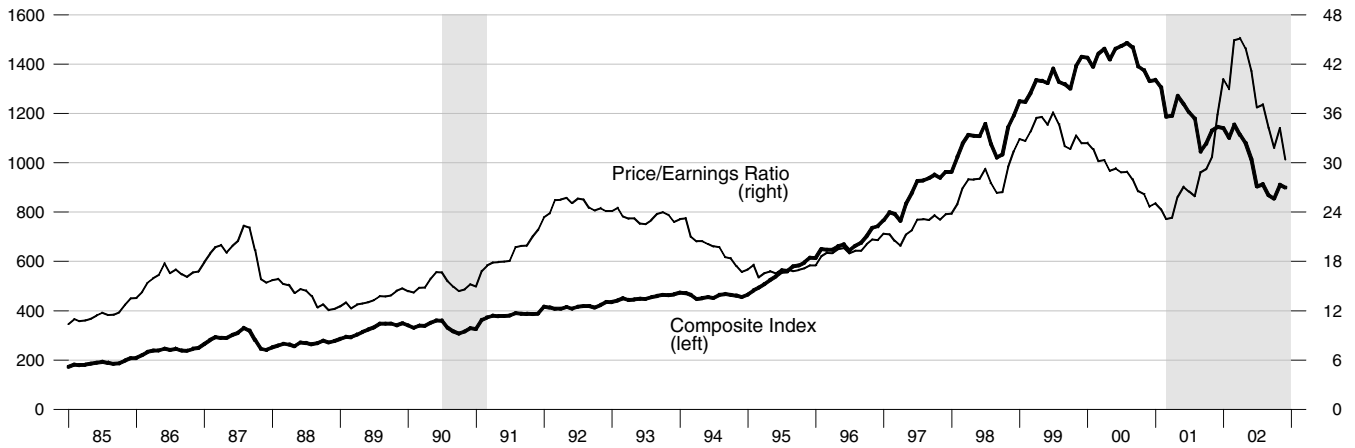
Recent Inflation and Long-Term Interest Rates

	Consumer Price Inflation Rates				Long-Term Government Bond Rates			
	Percent change from year ago				Percent			
	2002Q1	2002Q2	2002Q3	2002Q4	Sep02	Oct02	Nov02	Dec02
United States	1.25	1.30	1.58	2.25	3.87	3.94	4.05	4.03
Canada	1.53	1.33	2.33	.	5.35	5.57	5.56	5.46
France	2.13	1.63	1.75	.	4.89	5.14	4.80	.
Germany	1.90	1.16	1.03	.	4.38	4.46	4.48	4.33
Italy	2.41	2.27	2.41	2.77	4.62	4.76	4.74	4.55
Japan	-1.40	-0.90	-0.80	.	1.01	0.97	0.86	0.84
United Kingdom	1.21	1.23	1.53	.	4.49	4.61	4.64	.

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
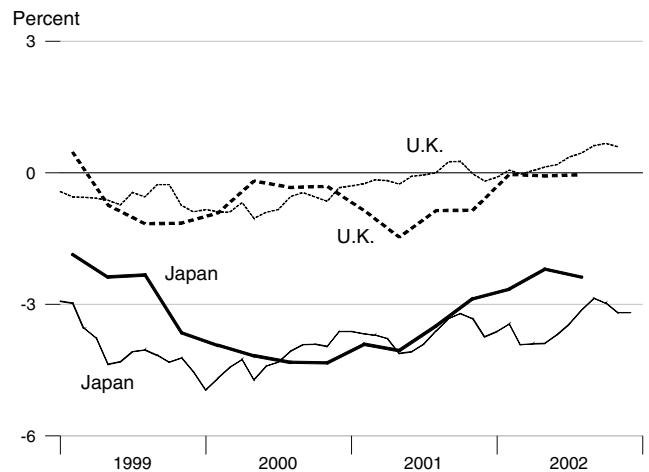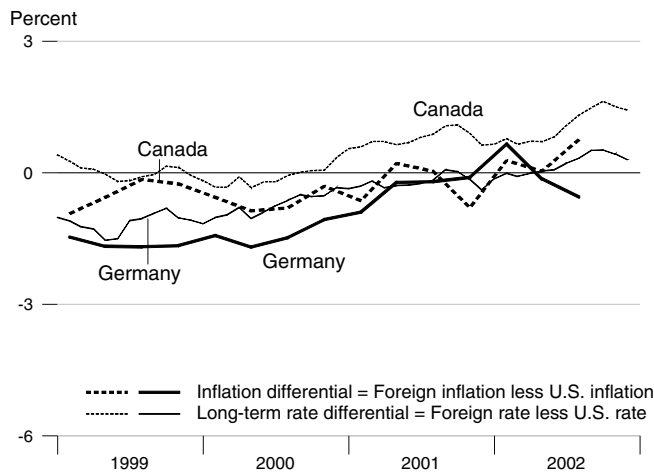
		Money Stock			Bank	Adjusted		
	M1	**MZM**	**M2**	**M3**	**Credit**	**Monetary Base**	**Reserves**	**MSI M2**
1998	1079.990	3707.949	4206.682	5747.659	4329.574	508.942	67.808	241.522
1999	1101.865	4167.952	4524.100	6248.388	4587.384	557.865	72.360	257.840
2000	1104.050	4505.592	4799.395	6834.678	5037.375	590.821	68.319	272.476
2001	1137.006	5216.325	5218.939	7613.913	5355.616	623.788	68.983	296.210
2002	1191.449	5891.108	5620.749	8221.287	5605.592	678.858	70.073	319.248
2000 1	1112.680	4377.898	4693.258	6622.972	4840.795	593.102	72.390	266.760
2	1108.118	4446.691	4763.138	6750.256	4994.223	586.045	67.097	270.320
3	1102.128	4548.194	4834.026	6917.742	5122.034	589.054	66.636	274.443
4	1093.272	4649.584	4907.157	7047.741	5192.450	595.084	67.151	278.380
2001 1	1100.701	4849.804	5026.140	7269.589	5278.910	604.848	66.577	285.123
2	1117.308	5089.141	5147.313	7521.986	5324.460	610.939	65.235	292.337
3	1161.975	5320.842	5288.672	7713.919	5373.771	633.771	73.522	300.420
4	1168.041	5605.512	5413.629	7950.155	5445.324	645.595	70.596	306.960
2002 1	1185.177	5716.295	5486.663	8042.526	5433.793	663.335	70.297	311.340
2	1183.408	5789.876	5531.749	8105.467	5496.688	674.121	69.186	314.597
3	1190.606	5951.054	5673.757	8278.442	5664.837	684.786	69.477	322.103
4	1206.606	6107.207	5790.826	8458.713	5827.051	693.191	71.332	328.953
2000 Dec	1088.856	4691.531	4938.578	7109.896	5233.975	596.639	67.078	280.000
2001 Jan	1095.844	4760.944	4983.719	7207.843	5272.146	600.886	68.095	282.510
Feb	1098.903	4856.693	5022.834	7273.953	5273.998	607.234	66.556	284.990
Mar	1107.357	4931.776	5071.867	7326.972	5290.585	606.425	65.080	287.870
Apr	1109.741	5003.402	5114.271	7430.463	5315.552	605.800	63.239	290.330
May	1116.615	5085.158	5140.390	7523.442	5327.860	613.259	67.119	292.070
Jun	1125.568	5178.862	5187.277	7612.054	5329.967	613.759	65.346	294.610
Jul	1138.605	5239.737	5227.145	7655.010	5335.825	619.440	66.654	296.780
Aug	1147.292	5277.691	5264.439	7666.959	5356.477	627.455	66.379	299.240
Sep	1200.028	5445.098	5374.433	7819.789	5429.010	654.419	87.534	305.240
Oct	1161.017	5516.976	5367.913	7866.927	5424.577	644.250	72.956	304.640
Nov	1163.788	5607.837	5414.415	7956.546	5460.418	644.417	69.378	307.050
Dec	1179.319	5691.722	5458.559	8026.992	5450.976	648.117	69.455	309.190
2002 Jan	1182.898	5688.596	5468.218	8018.794	5428.705	655.869	70.666	310.010
Feb	1184.828	5728.762	5498.785	8056.964	5438.851	667.217	71.245	311.920
Mar	1187.805	5731.527	5492.986	8051.820	5433.823	666.918	68.980	312.090
Apr	1176.661	5720.255	5476.495	8038.740	5450.728	667.691	68.480	311.740
May	1183.359	5799.832	5542.408	8118.506	5498.744	676.061	70.546	315.100
Jun	1190.204	5849.542	5576.345	8159.156	5540.593	678.610	68.531	316.950
Jul	1197.406	5910.688	5635.524	8217.309	5591.363	682.348	68.943	319.730
Aug	1183.183	5960.845	5680.282	8291.293	5673.026	684.570	69.021	322.390
Sep	1191.228	5981.628	5705.465	8326.725	5730.122	687.439	70.468	324.190
Oct	1199.762	6003.513	5754.622	8348.667	5758.963	690.454	70.715	326.980
Nov	1200.952	6133.746	5802.346	8485.952	5836.946	693.661	71.246	329.550
Dec	1219.105	6184.363	5815.510	8541.521	5885.244	695.459	72.036	330.330

*All values are given in billions of dollars.

		Federal Funds	Discount Rate	Prime Rate	3-mo CDs	Treasury Yields			Corporate Aaa Bonds	S & L Aaa Bonds	Conventional Mortgage
						3-mo	3-yr	10-yr			
	1998	5.35	4.92	8.35	5.47	4.91	5.14	5.26	6.53	4.93	6.94
	1999	4.97	4.62	7.99	5.33	4.78	5.49	5.64	7.04	5.28	7.43
	2000	6.24	5.73	9.23	6.46	6.00	6.22	6.03	7.62	5.58	8.06
	2001	3.89	3.41	6.92	3.69	3.47	4.08	5.02	7.08	4.99	6.97
	2002	1.67	1.17	4.68	1.73	1.63	3.10	4.61	6.49	4.87	6.54
2000	1	5.68	5.19	8.69	6.03	5.70	6.56	6.48	7.71	5.82	8.26
	2	6.27	5.74	9.25	6.57	5.89	6.52	6.18	7.77	5.72	8.32
	3	6.52	6.00	9.50	6.63	6.20	6.16	5.89	7.61	5.45	8.03
	4	6.47	6.00	9.50	6.59	6.20	5.63	5.57	7.40	5.32	7.64
2001	1	5.59	5.11	8.62	5.26	4.95	4.64	5.05	7.08	5.03	7.01
	2	4.33	3.83	7.34	4.10	3.75	4.43	5.27	7.22	5.11	7.13
	3	3.50	3.06	6.57	3.34	3.24	3.93	4.98	7.11	4.87	6.97
	4	2.13	1.64	5.16	2.06	1.94	3.33	4.77	6.92	4.97	6.78
2002	1	1.73	1.25	4.75	1.82	1.76	3.75	5.08	6.62	5.02	6.97
	2	1.75	1.25	4.75	1.83	1.75	3.77	5.10	6.71	5.01	6.81
	3	1.74	1.25	4.75	1.76	1.67	2.62	4.26	6.35	4.72	6.29
	4	1.44	0.94	4.45	1.49	1.36	2.27	4.01	6.28	4.71	6.08
2000	Dec	6.40	6.00	9.50	6.45	5.94	5.26	5.24	7.21	5.11	7.38
2001	Jan	5.98	5.52	9.05	5.62	5.29	4.77	5.16	7.15	4.99	7.03
	Feb	5.49	5.00	8.50	5.26	5.01	4.71	5.10	7.10	5.09	7.05
	Mar	5.31	4.81	8.32	4.89	4.54	4.43	4.89	6.98	5.00	6.95
	Apr	4.80	4.28	7.80	4.53	3.97	4.42	5.14	7.20	5.14	7.08
	May	4.21	3.73	7.24	4.02	3.70	4.51	5.39	7.29	5.15	7.15
	Jun	3.97	3.47	6.98	3.74	3.57	4.35	5.28	7.18	5.03	7.16
	Jul	3.77	3.25	6.75	3.66	3.59	4.31	5.24	7.13	4.79	7.13
	Aug	3.65	3.16	6.67	3.48	3.44	4.04	4.97	7.02	4.89	6.95
	Sep	3.07	2.77	6.28	2.87	2.69	3.45	4.73	7.17	4.93	6.82
	Oct	2.49	2.02	5.53	2.31	2.20	3.14	4.57	7.03	4.89	6.62
	Nov	2.09	1.58	5.10	2.03	1.91	3.22	4.65	6.97	4.85	6.66
	Dec	1.82	1.33	4.84	1.83	1.72	3.62	5.09	6.77	5.18	7.07
2002	Jan	1.73	1.25	4.75	1.74	1.68	3.56	5.04	6.55	5.05	7.00
	Feb	1.74	1.25	4.75	1.82	1.76	3.55	4.91	6.51	4.93	6.89
	Mar	1.73	1.25	4.75	1.91	1.83	4.14	5.28	6.81	5.09	7.01
	Apr	1.75	1.25	4.75	1.87	1.75	4.01	5.21	6.76	5.09	6.99
	May	1.75	1.25	4.75	1.82	1.76	3.80	5.16	6.75	5.03	6.81
	Jun	1.75	1.25	4.75	1.81	1.73	3.49	4.93	6.63	4.92	6.65
	Jul	1.73	1.25	4.75	1.79	1.71	3.01	4.65	6.53	4.81	6.49
	Aug	1.74	1.25	4.75	1.73	1.65	2.52	4.26	6.37	4.78	6.29
	Sep	1.75	1.25	4.75	1.76	1.66	2.32	3.87	6.15	4.58	6.09
	Oct	1.75	1.25	4.75	1.73	1.61	2.25	3.94	6.32	4.66	6.11
	Nov	1.34	0.83	4.35	1.39	1.25	2.32	4.05	6.31	4.77	6.07
	Dec	1.24	0.75	4.25	1.34	1.21	2.23	4.03	6.21	4.70	6.05

*All values are given as a percent at an annual rate.

		M1	MZM	M2	M3
Percent change at an annual rate					
	1998	1.00	11.68	7.30	10.35
	1999	2.03	12.41	7.55	8.71
	2000	0.20	8.10	6.09	9.38
	2001	2.99	15.77	8.74	11.40
	2002	4.79	12.94	7.70	7.98
2000	1	0.29	7.40	5.92	10.82
	2	-1.64	6.29	5.96	7.69
	3	-2.16	9.13	5.95	9.92
	4	-3.21	8.92	6.05	7.52
2001	1	2.72	17.22	9.70	12.59
	2	6.03	19.74	9.64	13.89
	3	15.99	18.21	10.99	10.21
	4	2.09	21.40	9.45	12.25
2002	1	5.87	7.91	5.40	4.65
	2	-0.60	5.15	3.29	3.13
	3	2.43	11.14	10.27	8.54
	4	5.38	10.50	8.25	8.71
2000	Dec	-3.15	13.67	9.82	14.19
2001	Jan	7.70	17.75	10.97	16.53
	Feb	3.35	24.13	9.42	11.01
	Mar	9.23	18.55	11.71	8.75
	Apr	2.58	17.43	10.03	16.95
	May	7.43	19.61	6.13	15.02
	Jun	9.62	22.11	10.95	14.13
	Jul	13.90	14.11	9.22	6.77
	Aug	9.16	8.69	8.56	1.87
	Sep	55.16	38.06	25.07	23.92
	Oct	-39.01	15.84	-1.46	7.23
	Nov	2.86	19.76	10.40	13.67
	Dec	16.01	17.95	9.78	10.62
2002	Jan	3.64	-0.66	2.12	-1.23
	Feb	1.96	8.47	6.71	5.71
	Mar	3.02	0.58	-1.27	-0.77
	Apr	-11.26	-2.36	-3.60	-1.95
	May	6.83	16.69	14.44	11.91
	Jun	6.94	10.29	7.35	6.01
	Jul	7.26	12.54	12.74	8.55
	Aug	-14.25	10.18	9.53	10.80
	Sep	8.16	4.18	5.32	5.13
	Oct	8.60	4.39	10.34	3.16
	Nov	1.19	26.03	9.95	19.73
	Dec	18.14	9.90	2.72	7.86

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.

MZM: M2 minus small-denomination time deposits, plus institutional money market mutual funds. The label MZM was coined by William Poole (1991) for this aggregate, proposed earlier by Motley (1988).

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

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 series, a 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) and research.stlouisfed.org/aggreg/newbase.html.

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; additional data are available at research.stlouisfed.org/msi/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 *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: **MZM**, or "Money, Zero Maturity," includes the zero maturity, or immediately available, components of M3. MZM equals M2 minus small-denomination time deposits, plus institutional money market mutual funds (that is, the money market mutual funds included in M3 but excluded from M2). 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.stlouisfed.org/aggreg/swdata.html. For analytical purposes,

MZM largely replaces M1. The **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** shows constant maturity yields calculated by the U.S. Treasury Department for securities with 3 months and 1, 2, 3, 5, 7, and 10 years to maturity. Daily data and descriptions are available at research.stlouisfed.org/fred/data/wkly.html. See also *Federal Reserve Bulletin*, table 1.35. The 30-year constant maturity series was discontinued by the Treasury Department 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 *Federal Reserve Bulletin*, table 1.55.

Page 8: **Inflation Expectations** measures include the quarterly Federal Reserve Bank of Philadelphia *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 Humphrey-Hawkins Act testimony each year. Beginning February 2000, the FOMC began using the personal consumption expenditures (PCE) price index to report its inflation range and therefore is not 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 CPI inflation.

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

$$f_t^* = 2.5 + \pi_{t-1} + (\pi_{t-1} - \pi^*)/2 + 100 \times (y_{t-1} - y_{t-1}^P)/2$$

to five alternative target inflation rates, $\pi^* = 0, 1, 2, 3, 4$ percent, where f_t^* is the implied federal funds rate, π_{t-1} is the previous period's inflation rate (PCE) measured on a year-over-year basis, y_{t-1} is the log of the previous period's level of real gross domestic product (GDP), and y_{t-1}^P 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

$$\Delta MB_t^* = \pi^* + (\text{10-year moving average growth of real GDP})$$
$$- (\text{4-year moving average of base velocity growth})$$

to five alternative target inflation rates, $\pi^* = 0, 1, 2, 3, 4$ percent, where ΔMB_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 $((y_t - y_{t-40})/40) \times 4 \times 100$, where y_t is the log of real GDP. The four-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 available at research.stlouisfed.org/aggreg/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 $m = 1,...,$ 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),

$$R(m) = a_0 + (a_1 + a_2)(1 - e^{-m/50})/(m/50) - a_2 \times e^{-m/50},$$

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 $D(m) = (1 - e^{-R(m) \times m})/R(m)$. 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 Fed Funds Futures Contracts** each trace through time the yield on three specific contracts. **Implied Yields on Fed Funds Futures** displays a single day's snapshot of yields for contracts expiring in the months shown on the horizontal axis. **Inflation-Protected Treasury Yields** are yields on the most recently issued inflation-protected securities of 10- and 30-year original maturities. **Inflation-Protected Treasury Yield Spreads** equal, for 10- and 30-year maturities, the difference between the yields on the most recently issued inflation-protected securities and the unadjusted bond yields of similar maturity. **Inflation-Indexed 30-Year Bonds** shows the yield of an inflation-indexed bond that is scheduled to mature in approximately (but not greater than) 30 years. The current bond for Canada has a maturity date of 12/01/2031, the current U.K. bond has a maturity date of 7/22/2030, and the current U.S. bond has a maturity date of 4/15/2032. **Inflation-Indexed 10-Year Bonds** shows the yield of an inflation-indexed bond that is scheduled to mature in approximately (but not greater than) 10 years. The current U.K. bond has a maturity date of 8/23/2011 and the current U.S. bond has a maturity date of 7/15/2012.

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. Two alternative opportunity costs are shown, one relative to the 3-month Treasury constant maturity yield, the other to the 5-year constant maturity yield.

Page 13: **Real Gross Domestic Product** is GDP as measured in chained 1996 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 GDP measured in chained 1996 dollars.

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

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

Bank of Canada
Canadian inflation-linked bond yields and long-term interest rates.

Bank of England
U.K. inflation-linked bond yields.

Board of Governors of the Federal Reserve System
Monetary aggregates and components: H.6 release. Bank credit and components: H.8 release. Consumer credit: G.19 release. Required reserves, excess reserves, clearing balance contracts, and discount window borrowing: H.4.1 and H.3 releases. Interest rates: H.15 release. Nonfinancial commercial paper: Board of Governors website. Nonfinancial debt: Z.1 release. M2 own rate.

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 & Poors Inc.
Stock price-earnings ratio, stock price composite index.

University of Michigan Survey Research Center
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U.S. Department of the Treasury
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Note: Articles from this Bank's *Review* are available on the Internet at research.stlouisfed.org/publications/review/.