Stock Market Volatility: Reading the Meter

Stock market volatility, a barometer of uncertainty or risk, measures the size and frequency of fluctuations in a broad stock market price index. Usually, volatility is gauged by the standard deviation of price changes at fixed intervals in a given period. That is, volatility is low if price changes are clustered near their mean and is high if price changes are widely dispersed. In practice, we can either (i) estimate *realized volatility* using historical price index data or (ii) derive *implied volatility* from, for example, prices of options on Standard and Poor's 100 index traded on the Chicago Board Options Exchange. Because index options were not traded until the early 1980s, and thus have a relatively short history, I illustrate here the evolution of realized stock market volatility.

The accompanying Figure plots the quarterly standard deviation of daily changes in the Standard & Poor's 500 index for the period 1950:Q1 to 2001:Q4. (Shaded bars indicate recessions dated by the National Bureau of Economic Research.) As shown, stock market volatility displays a strong countercyclical pattern—peaking just before or during recessions and falling sharply late in recessions or early in recovery periods. Moreover, recent research by Campbell et al. (2001) finds that stock market volatility has significant forecasting power for real gross domestic product (GDP) growth.[1] These results are not a surprise. When volatility increases, investors require a higher risk premium to hold stocks. As a result, stock prices fall and the cost of capital rises, which in turn reduces investment and output. The Figure also shows that volatility fluctuates greatly in the short run; in particular, it rises dramatically during financial crises such as the 1987 stock market crash and other periods of uncertainty such as the Cuban missile crisis in 1962. The movement in volatility is somewhat persistent: once volatility rises, it usually stays at high levels for a while. However, volatility shows no apparent long-run trend in the post-World War II sample; it tends to return eventually to an average level.

After declining in the early 1990s, volatility started to rise in 1996 and since then has remained at remarkably high levels by postwar standards. Although unusual, the prolonged period of high volatility appears to be the result of a string of specific events. The East Asian crisis and the Russian bond default ignited financial market turmoil in 1997 and 1998, which persisted through 1999. Stock market volatility rose again in 2000 and 2001, and stock prices fell, when analysts began to forecast an end to the long economic expansion. Given its historical pattern, volatility is likely to decline and return to its normal level when the recession comes to an end. Interestingly, stock market volatility took a large dip in the fourth quarter of 2001, which might be a sign that the economy is recovering from the recession.

—Hui Guo

[1] Campbell, John; Lettau, Martin; Malkiel, Burton and Xu, Yexiao. "Have Individual Stocks Become More Volatile? An Empirical Exploration of Idiosyncratic Risk." *Journal of Finance*, February 2001, *56*(1), pp. 1-43.
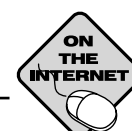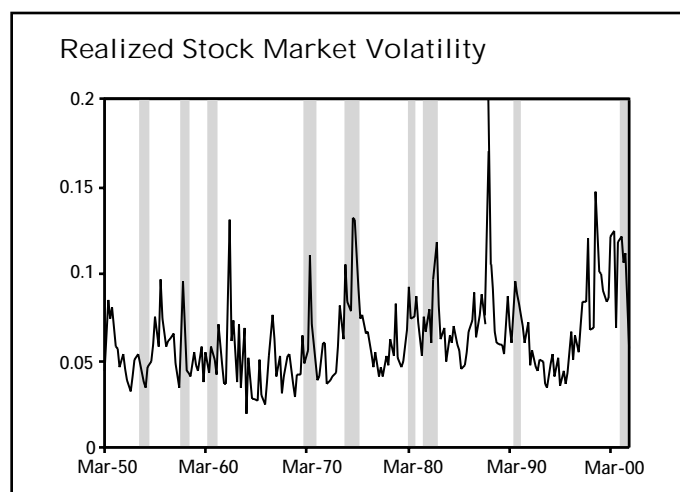

Realized Stock Market Volatility

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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: $[(x_t / x_{t-12}) - 1] \times 100$.
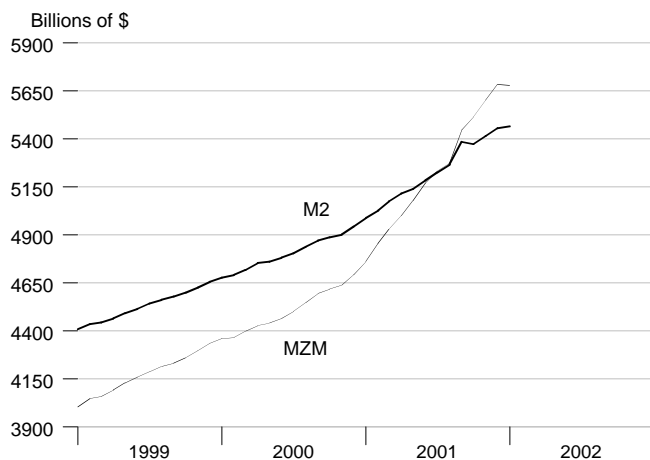
We welcome your comments addressed to:
Editor, *Monetary Trends*
Research Division
Federal Reserve Bank of St. Louis
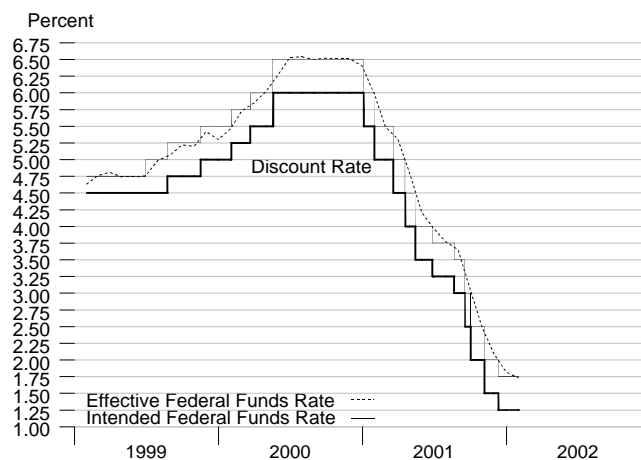P.O. Box 442
St. Louis, MO 63166
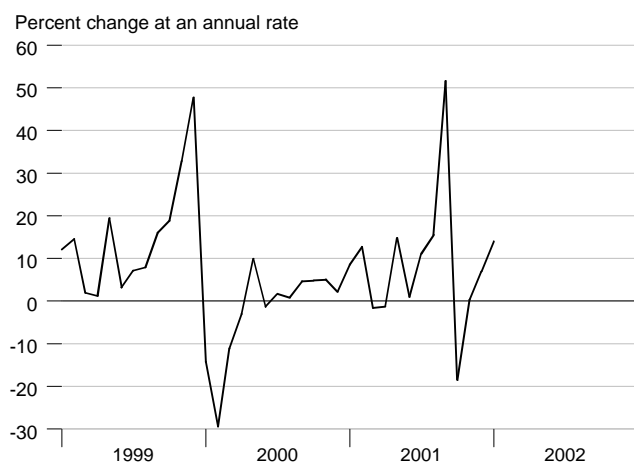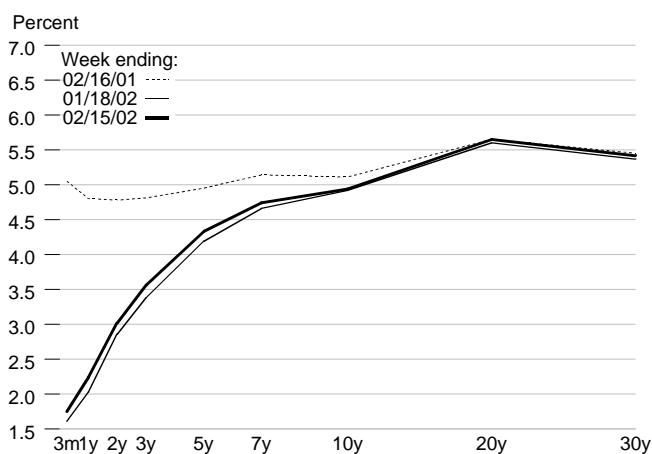
or to:
webmaster@stls.frb.org

M2 and MZM

Billions of $

Adjusted Monetary Base

Percent change at an annual rate

Total Bank Credit

Percent change at an annual rate

Reserve Market Rates

Percent

Treasury Yield Curve

Percent

Week ending:
02/16/01
01/18/02
02/15/02
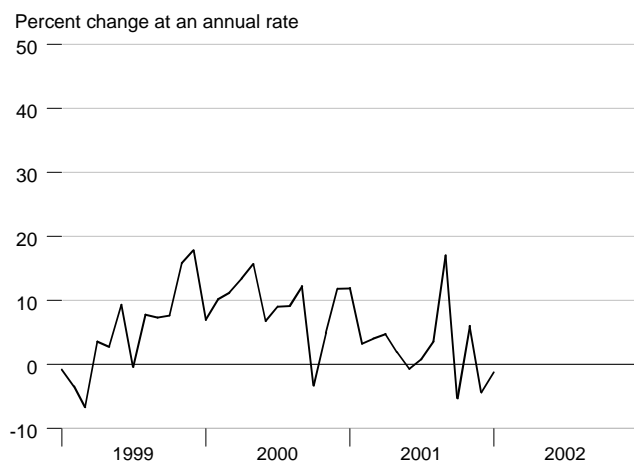
Interest Rates

	Nov 01	Dec 01	Jan 02
Federal Funds Rate	2.09	1.82	1.73
Discount Rate	1.58	1.33	1.25
Prime Rate	5.10	4.84	4.75
Conventional Mortgage Rate	6.66	7.07	7.00
Treasury Yields:			
3-month constant maturity	1.91	1.72	1.68
6-month constant maturity	1.92	1.82	1.77
1-year constant maturity	2.18	2.22	2.16
3-year constant maturity	3.22	3.62	3.56
5-year constant maturity	3.97	4.39	4.34
10-year constant maturity	4.65	5.09	5.04
30-year constant maturity	5.12	5.48	5.45

MZM and M1

Percent change from year ago

M2
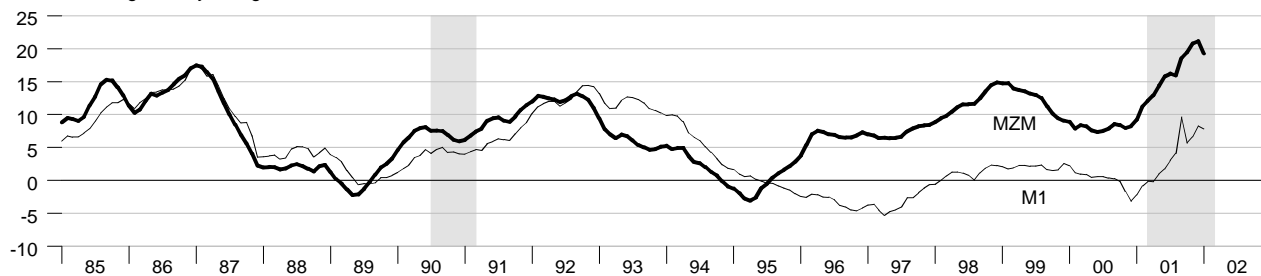
Percent change from year ago
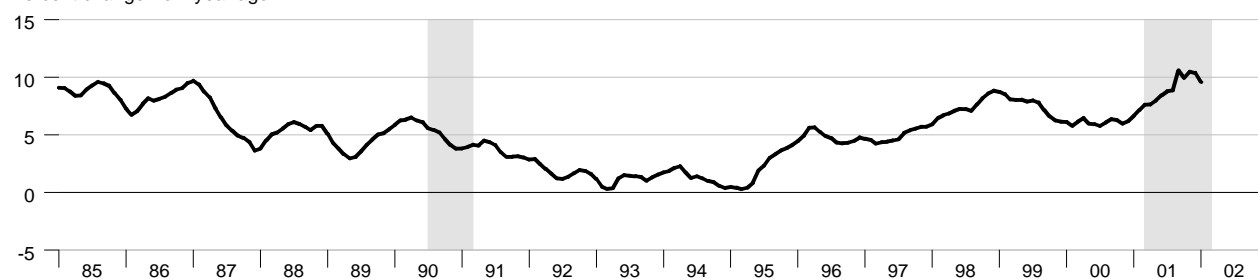
M3

Percent change from year ago
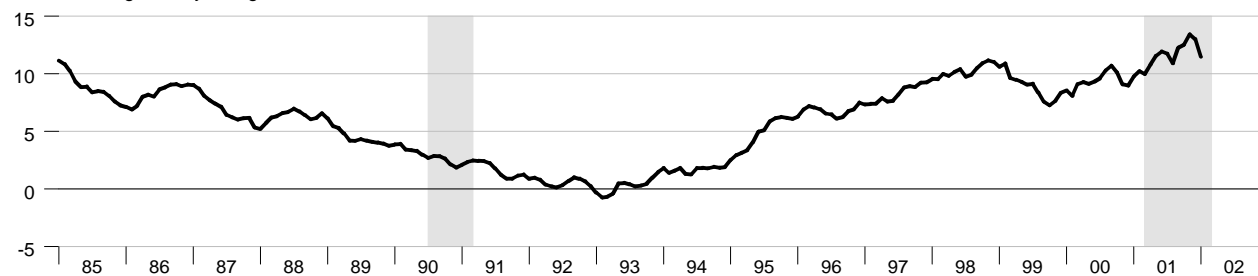
Monetary Services Index - M2

Percent change from year ago
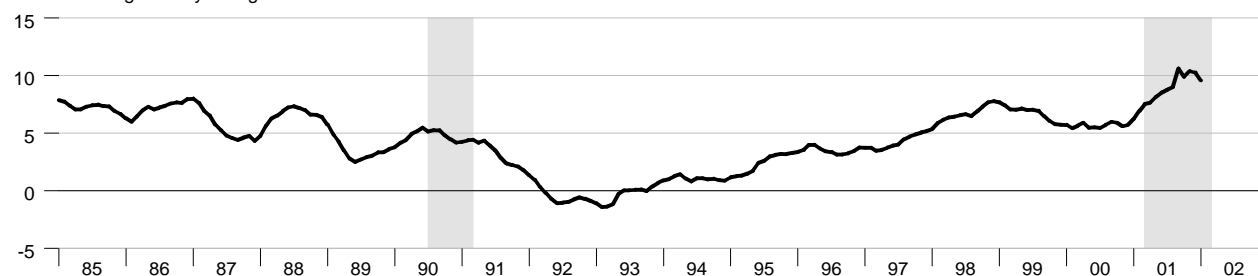
Adjusted Monetary Base

Percent change from year ago
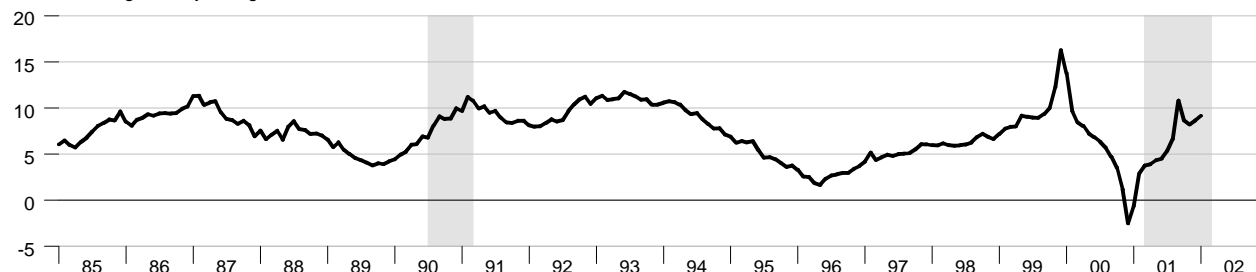
Domestic Nonfinancial Debt

Percent change from year ago
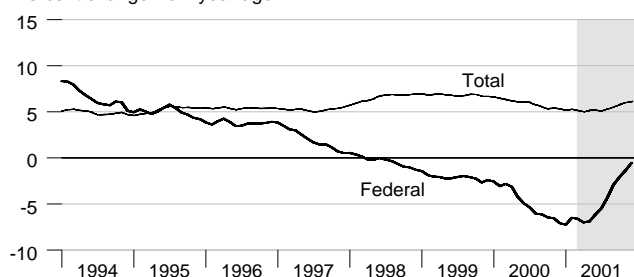
Currency Held by the Nonbank Public

Percent change from year ago
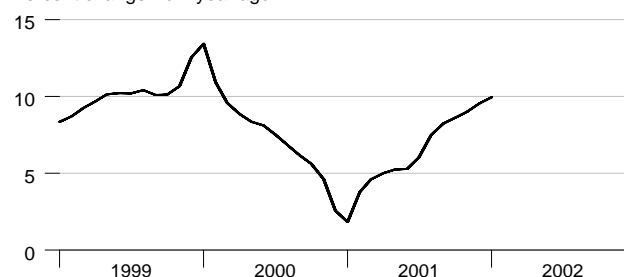
Time Deposits

Percent change from year ago
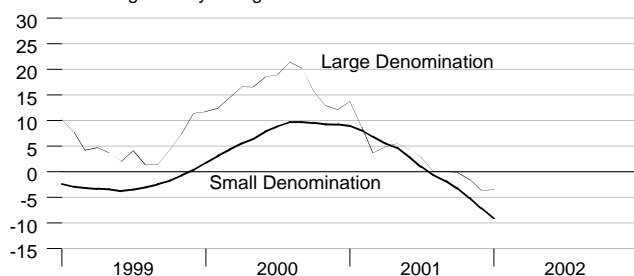
Checkable and Savings Deposits

Percent change from year ago
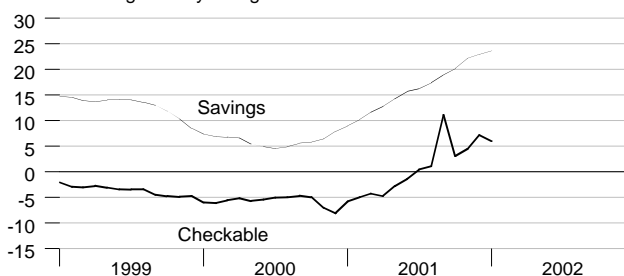
Money Market Mutual Fund Shares

Percent change from year ago
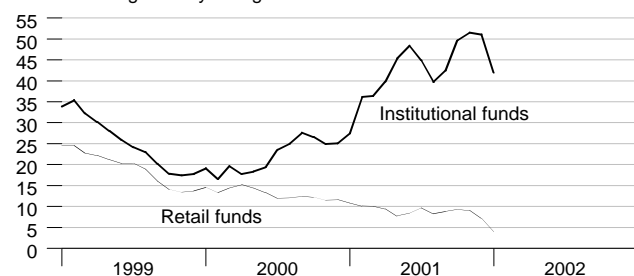
Repurchase Agreements and Eurodollars

Billions of dollars   Billions of dollars

Federal Reserve Bank of St. Louis
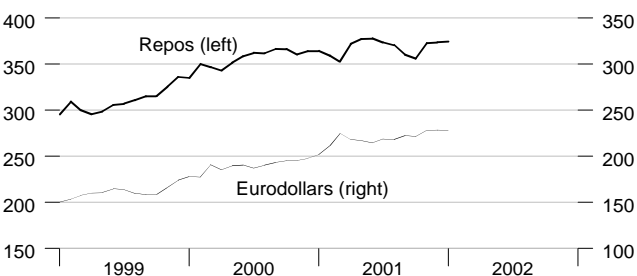
M1

Percent change at an annual rate
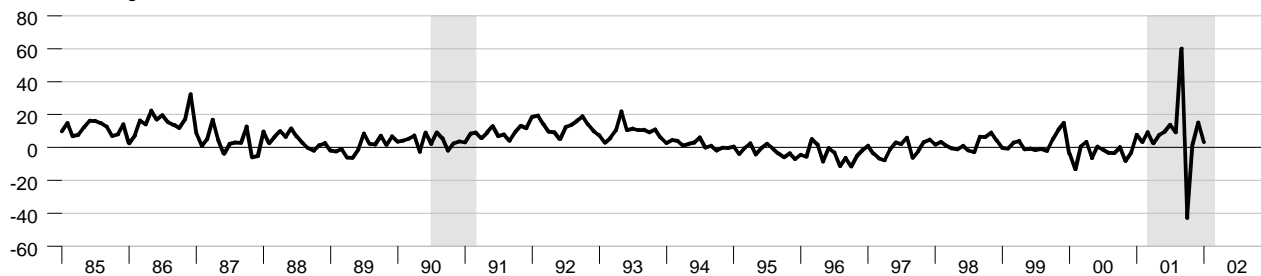
MZM

Percent change at an annual rate
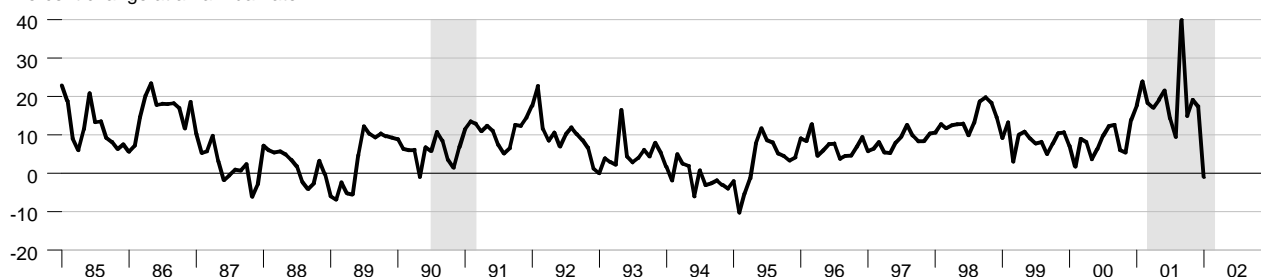
M2

Percent change at an annual rate

M3

Percent change at an annual rate

Federal Reserve Bank of St. Louis
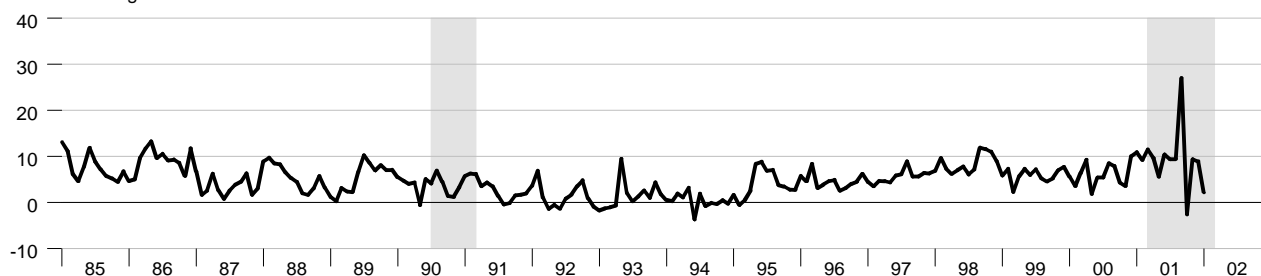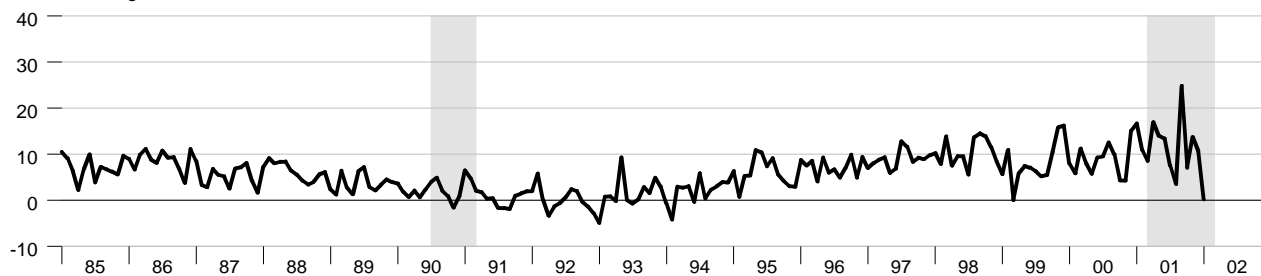
Adjusted and Required Reserves

Billions of $

Adjusted

Required
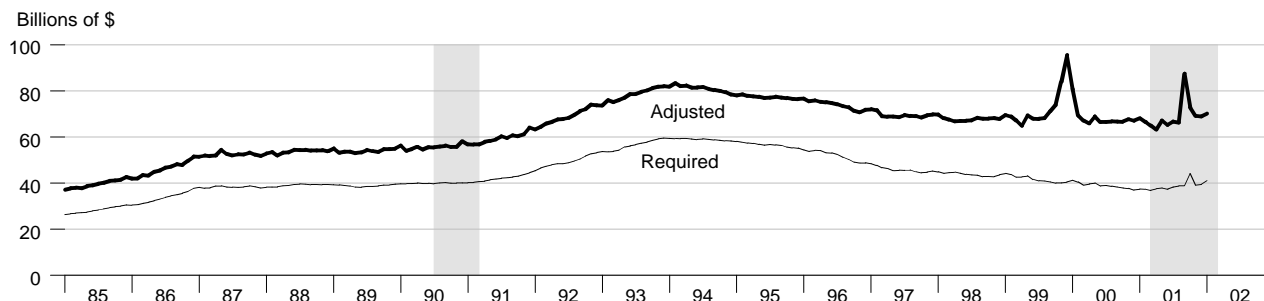
Total Borrowings, nsa

Billions of $
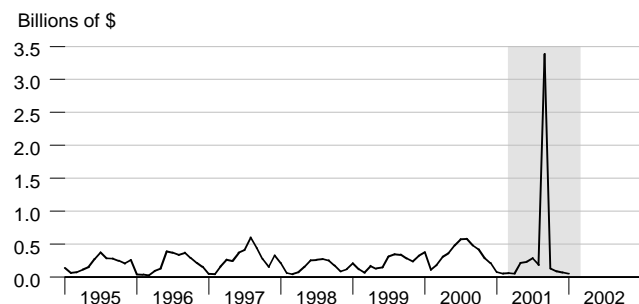
Excess Reserves plus RCB Contracts

Billions of $

Nonfinancial Commercial Paper

Percent change from year ago

Consumer Credit

Percent change from year ago

Federal Reserve Bank of St. Louis
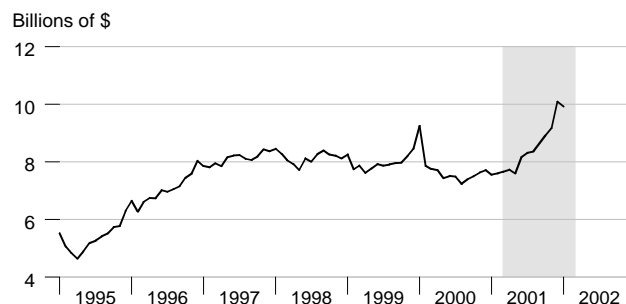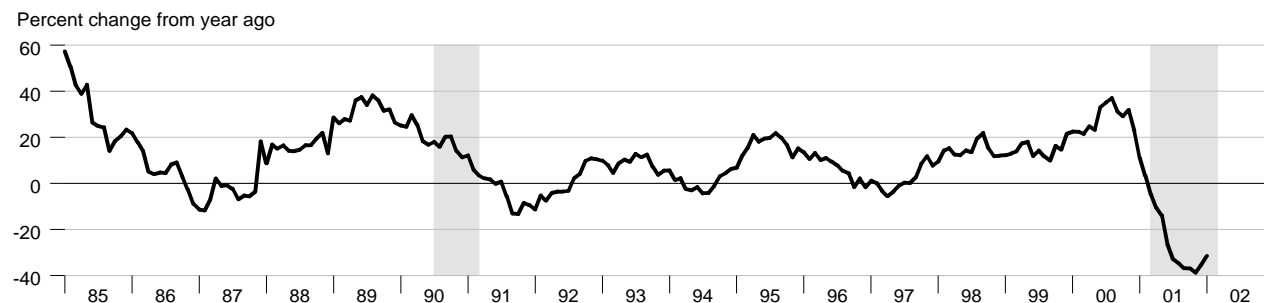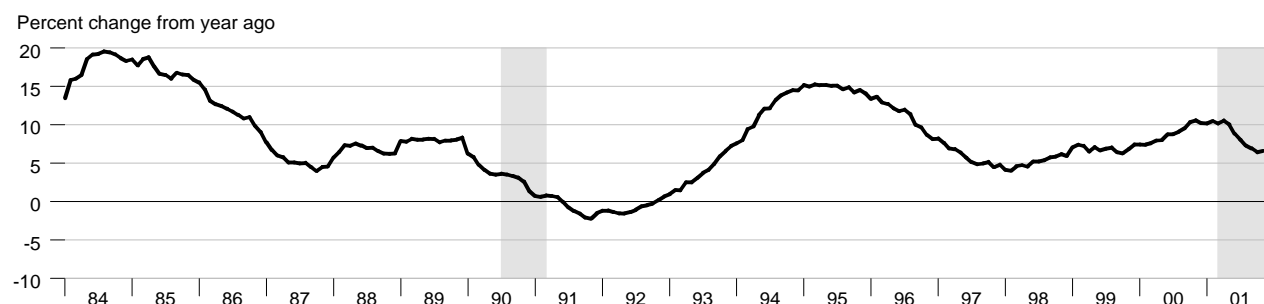
Inflation and Inflation Expectations

Percent

Federal Reserve Bank of Philadelphia

Humphrey-Hawkins CPI inflation range

University of Michigan

CPI inflation

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 page 19 for information.
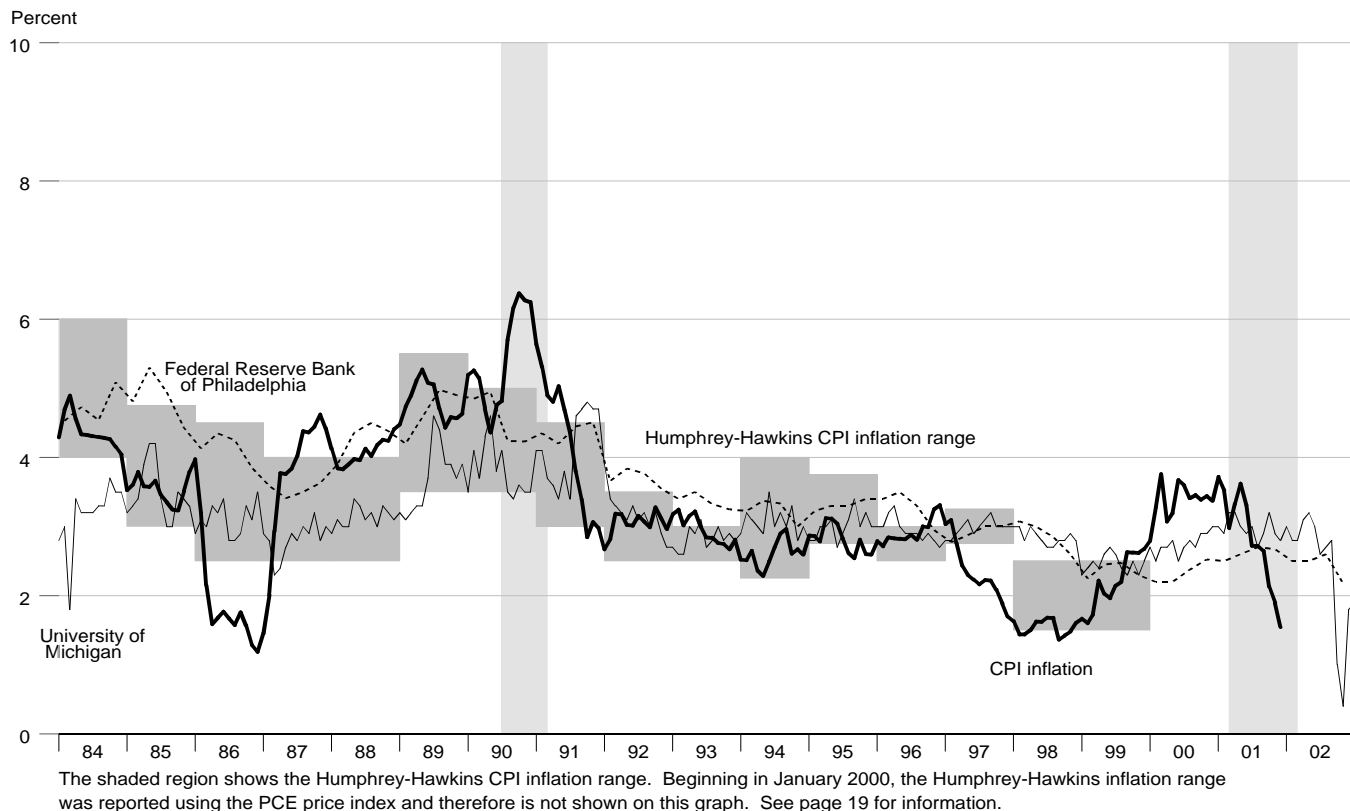
Treasury Security Yield Spreads
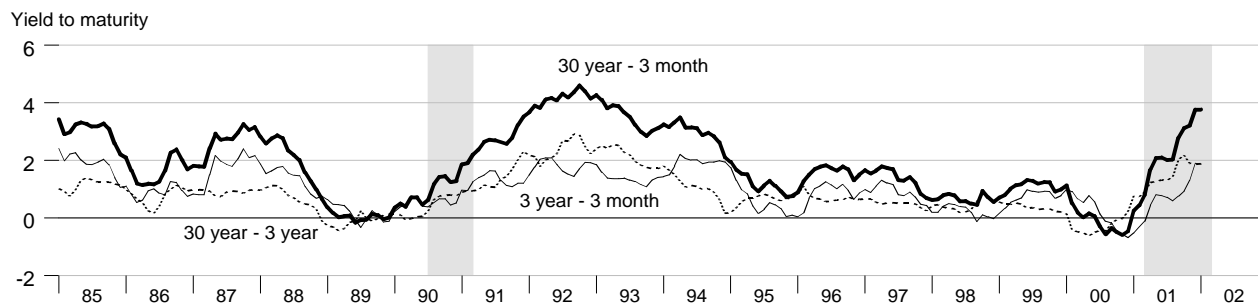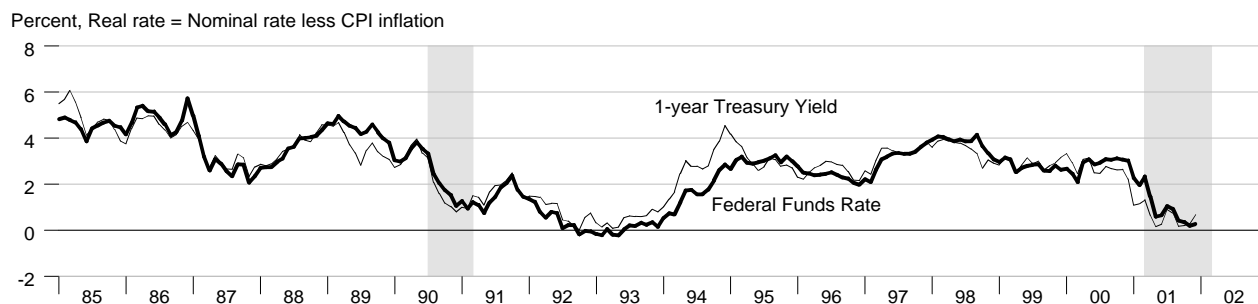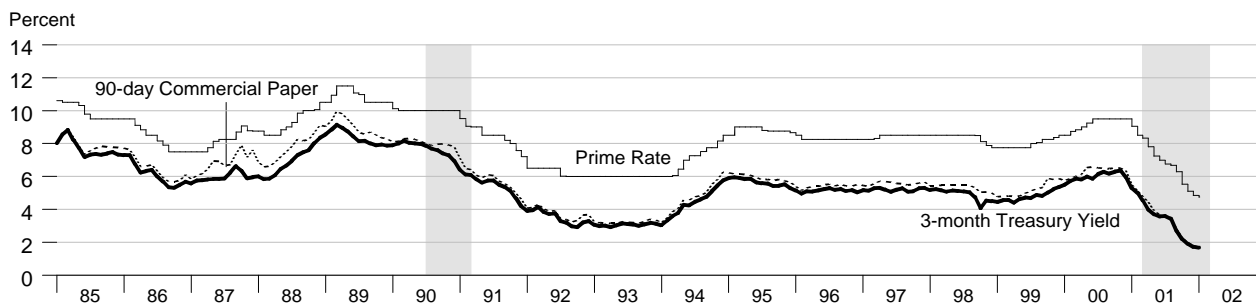
Yield to maturity

30 year - 3 month

3 year - 3 month

30 year - 3 year

Real Interest Rates

Percent, Real rate = Nominal rate less CPI inflation

1-year Treasury Yield

Federal Funds Rate

Federal Reserve Bank of St. Louis

Short Term Interest Rates

Percent

90-day Commercial Paper

Prime Rate

3-month Treasury Yield

Long Term Interest Rates

Percent

Conventional mortgage

Corporate Aaa

30-year Treasury Yield

Long Term Interest Rates

Percent

Corporate Baa

30-year Treasury Yield

10-year Treasury Yield

Short Term Interest Rates

Percent

90-day Commercial Paper

3-month Treasury Yield
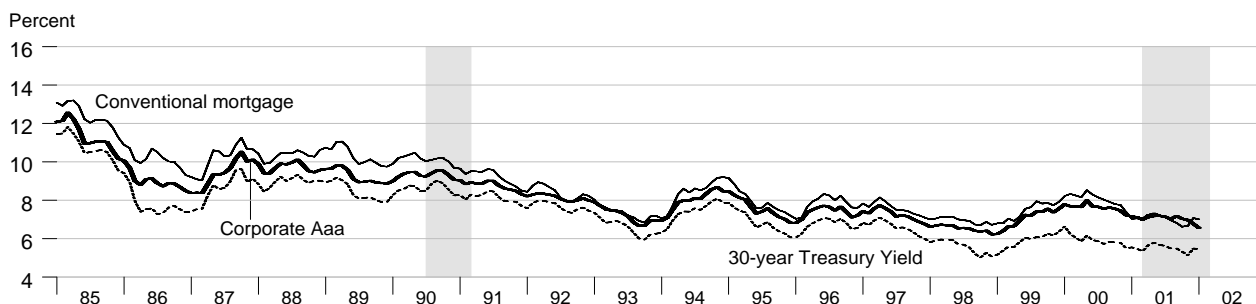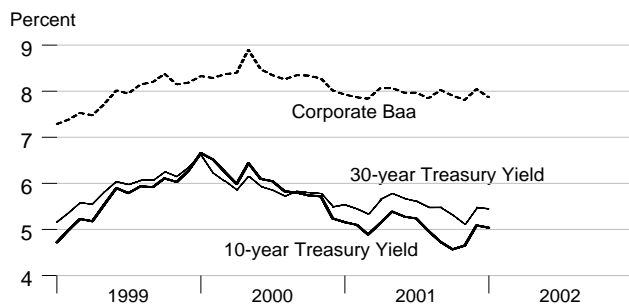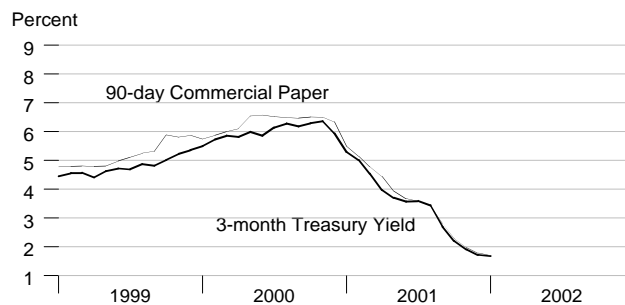
FOMC Intended Federal Funds Rate and Discount Rate

Percent

Federal Funds Rate

Discount Rate

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.
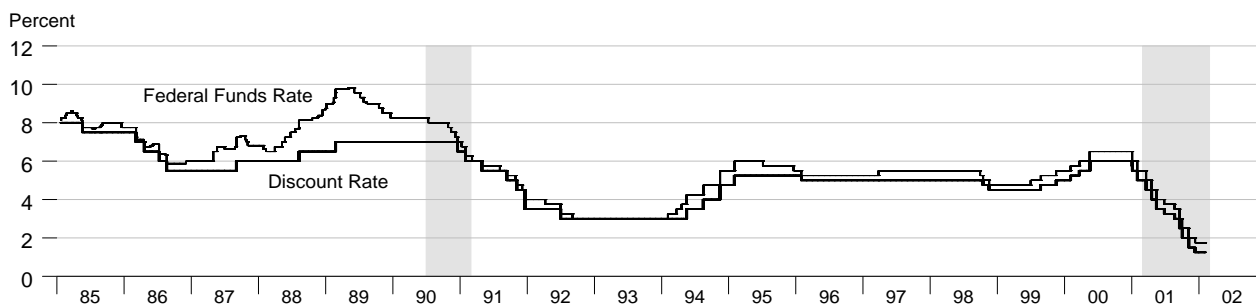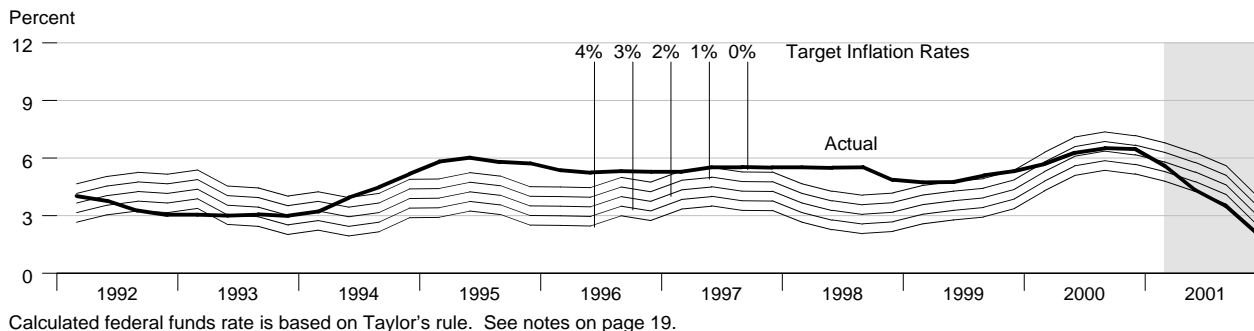
Actual and Potential Real GDP

Billions of chain-weighted 1996 dollars

Potential
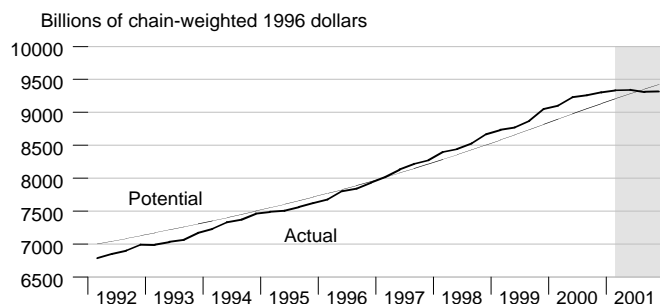
Actual

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. See page 19 for information.

Monetary Base Growth* and Inflation Targets
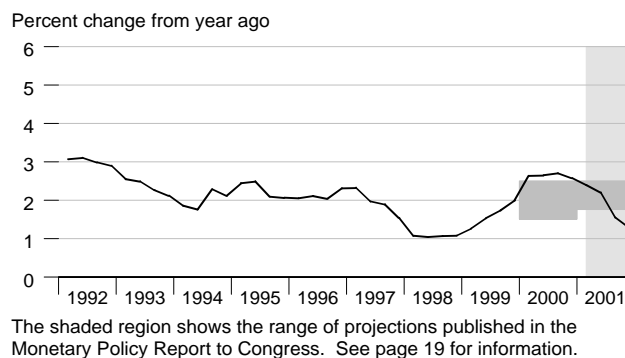
Percent

Actual

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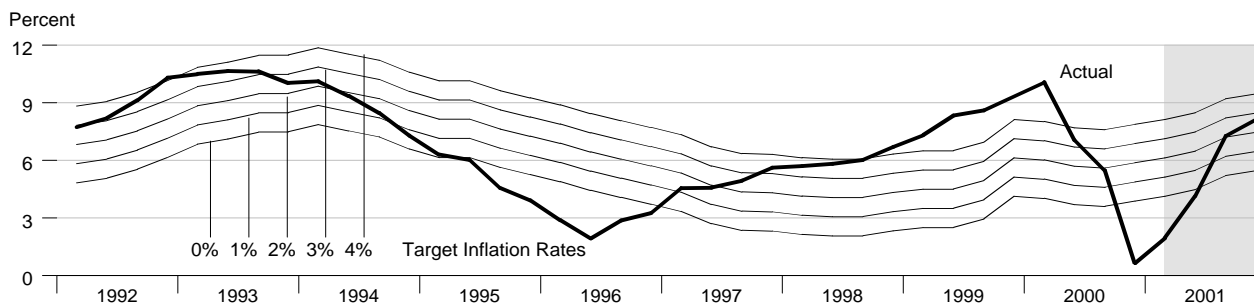
*Modified for the effects of sweeps programs on reserve demand.
Calculated base growth is based on McCallum's rule. Actual base growth is percent change from year ago. See notes on page 19.

Monetary Base Velocity Growth
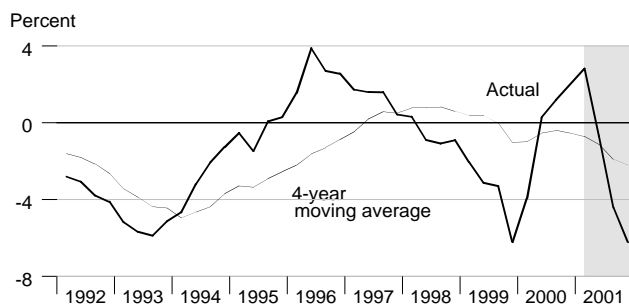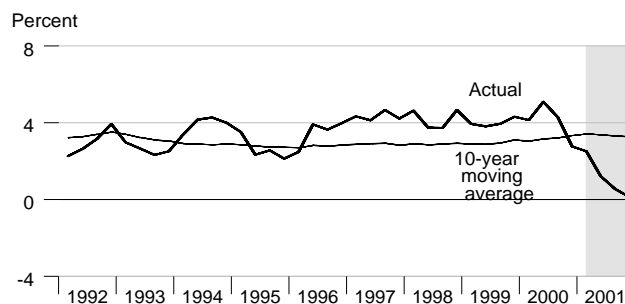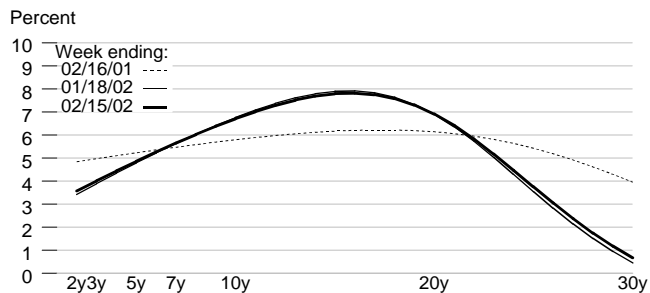
Percent

Actual

4-year moving average

Real Output Growth

Percent

Actual

10-year moving average

Implied One-Year Forward Rates

Percent

Week ending:
02/16/01
01/18/02
02/15/02

Rates on 3-Month Eurodollar Futures

Percent, daily data

Apr 2002

Feb 2002

Mar 2002

Rates on Selected Fed Funds Futures Contracts

Percent, daily data

Mar 2002

Feb 2002

Apr 2002

Implied Yields on Fed Funds Futures

Percent

12/17/2001

02/15/2002

01/14/2002

Inflation-Protected Treasury Yields

Percent, weekly data

10-year

30-year

Inflation-Protected Treasury Yield Spreads

Percent, weekly data
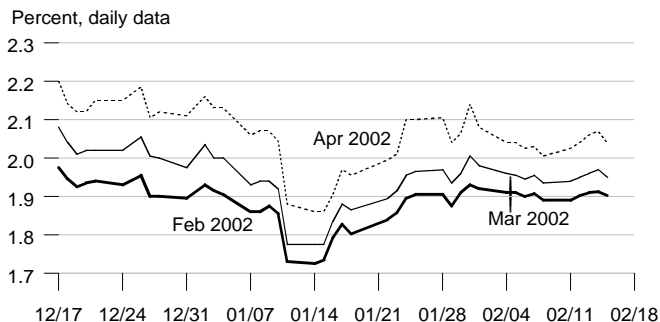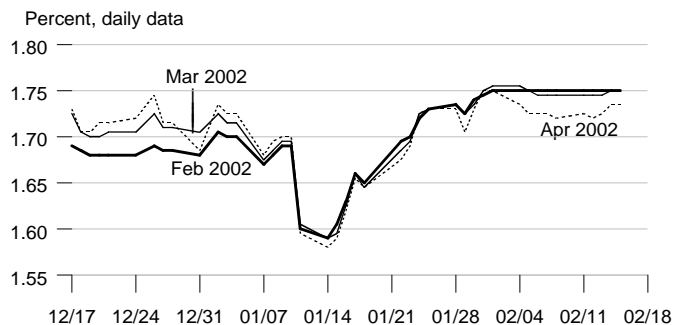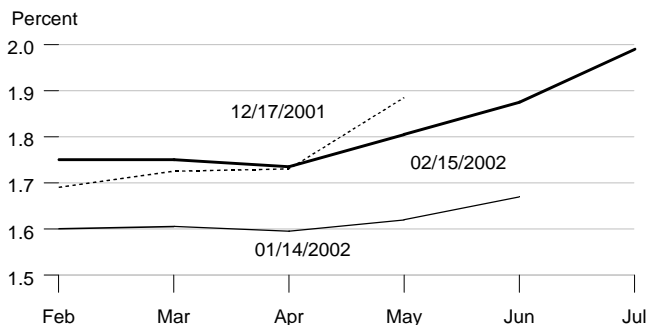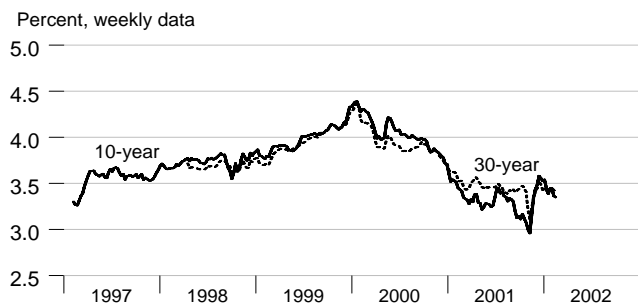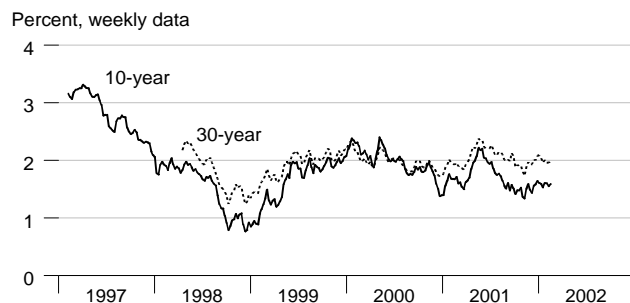
10-year

30-year

Inflation-Indexed 30-Year Bonds

Percent, weekly data

Canada

US

UK
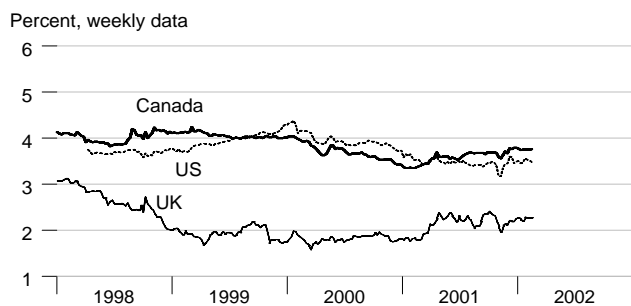
Inflation-Indexed 10-Year Bonds

Percent, weekly data

US

UK
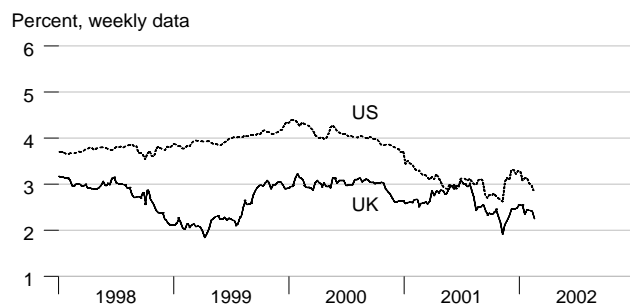
MZM Velocity and Opportunity Cost

Velocity = Nominal GDP / MZM   Opportunity Cost = 3 month T-bill rate less MZM own rate

Velocity
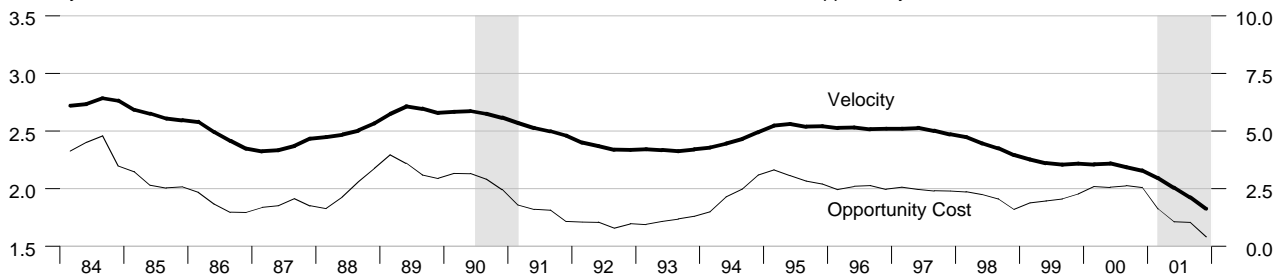
Opportunity Cost

M2 Velocity and Opportunity Cost

Velocity = Nominal GDP / M2   Opportunity Cost = Treasury rate less M2 own rate

Velocity

Opportunity Cost (5-yr T-bond)

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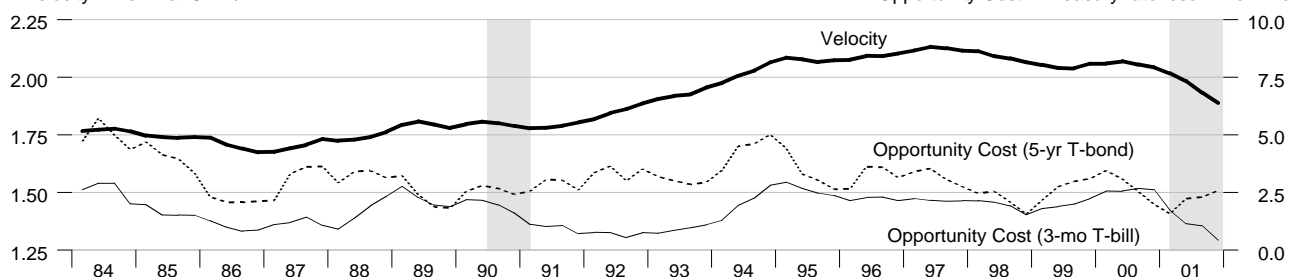
M2, MZM and Nominal GDP

Billions of $

Nominal GDP

M2

MZM

Interest Rates

Percent

5-yr bond

3-mo bill

M2 own

MZM own

Federal Reserve Bank of St. Louis
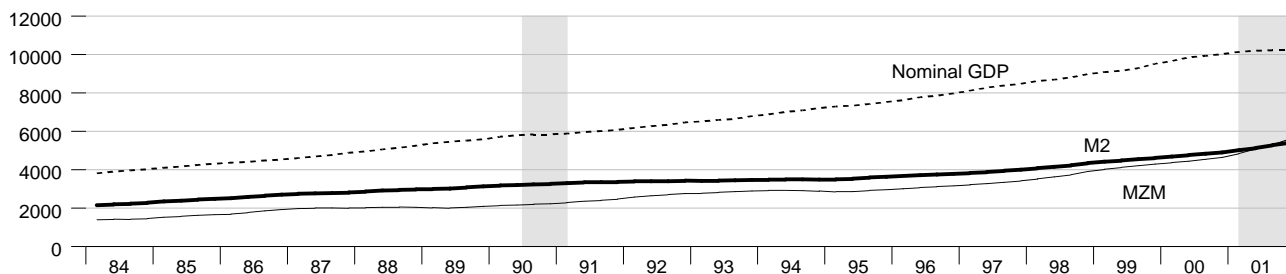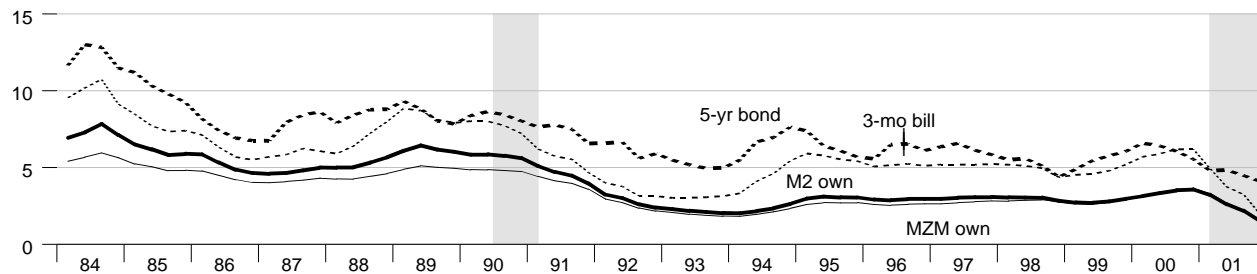
Gross Domestic Product

Percent change from year ago
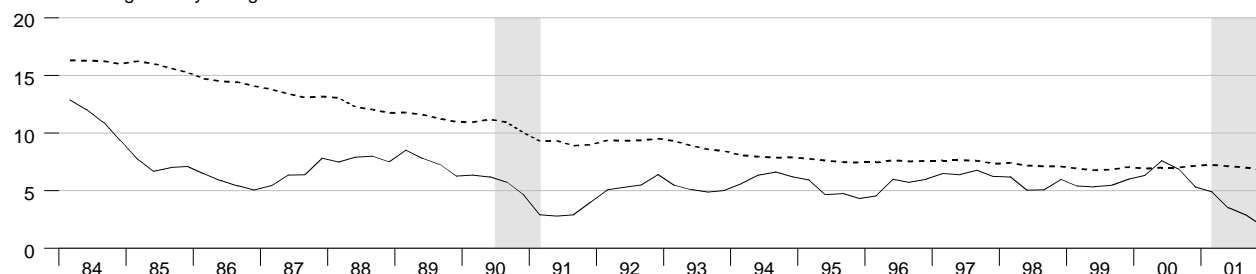
Real Gross Domestic Product

Percent change from year ago
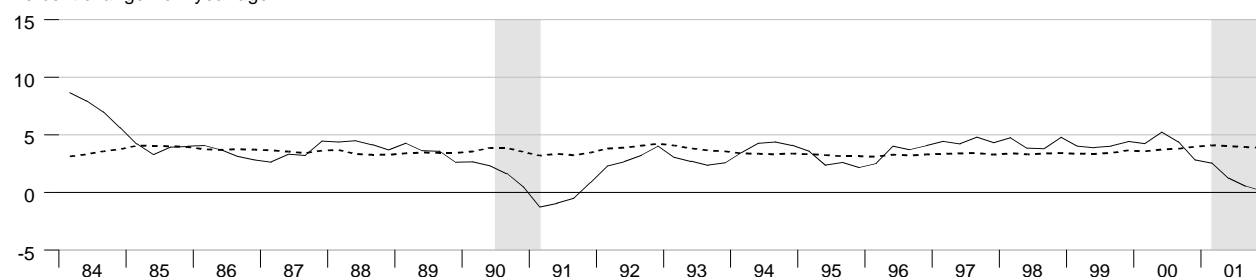
Gross Domestic Product Price Index

Percent change from year ago

M2
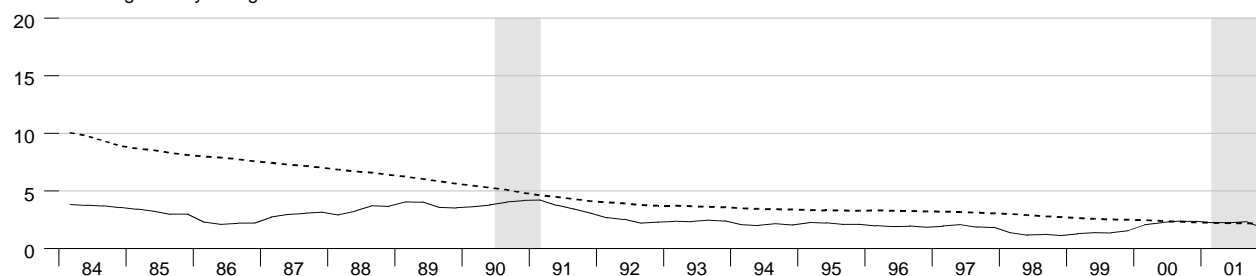
Percent change from year ago
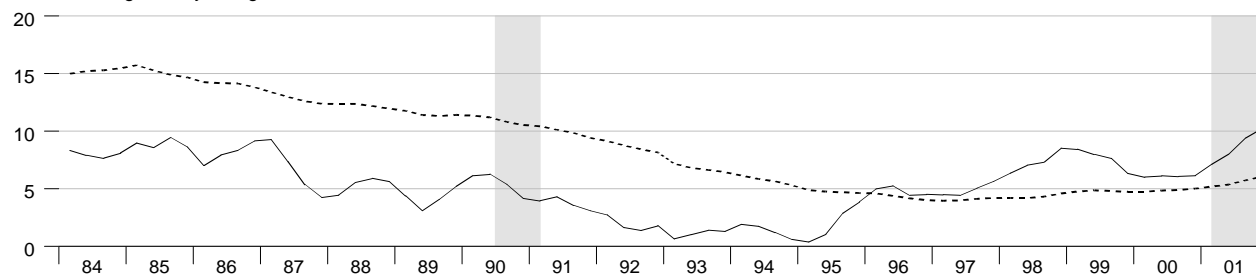
Dashed lines indicate 10-year moving averages

Federal Reserve Bank of St. Louis

Bank Credit

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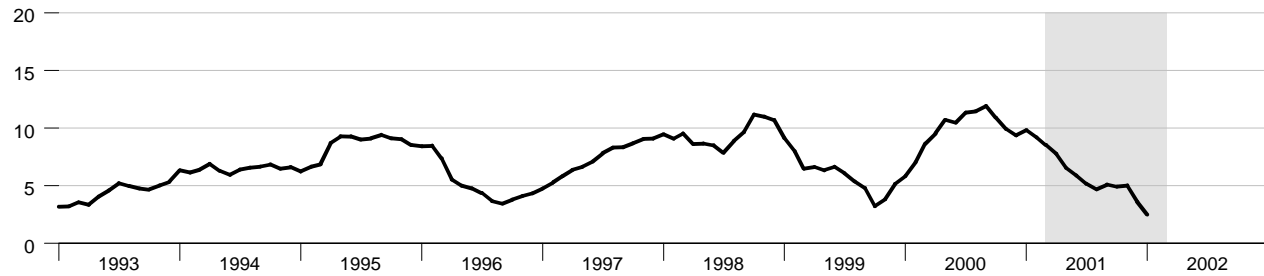
Investment Securities in Bank Credit at Commercial Banks

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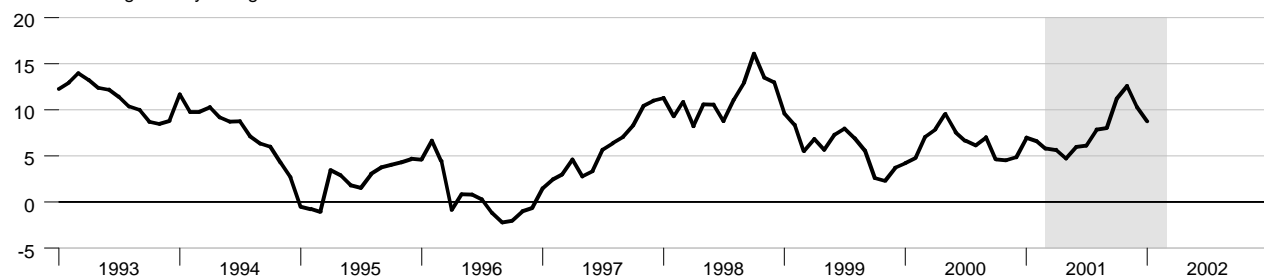
Total Loans and Leases in Bank Credit at Commercial Banks

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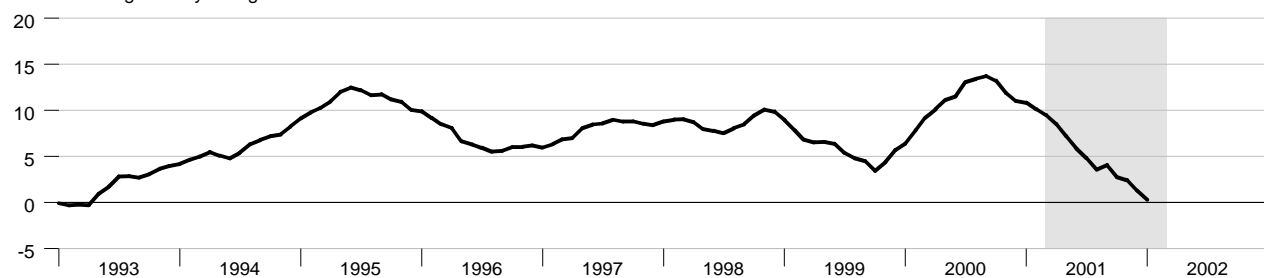
Commercial and Industrial Loans at Commercial Banks

Percent change from year ago

Federal Reserve Bank of St. Louis
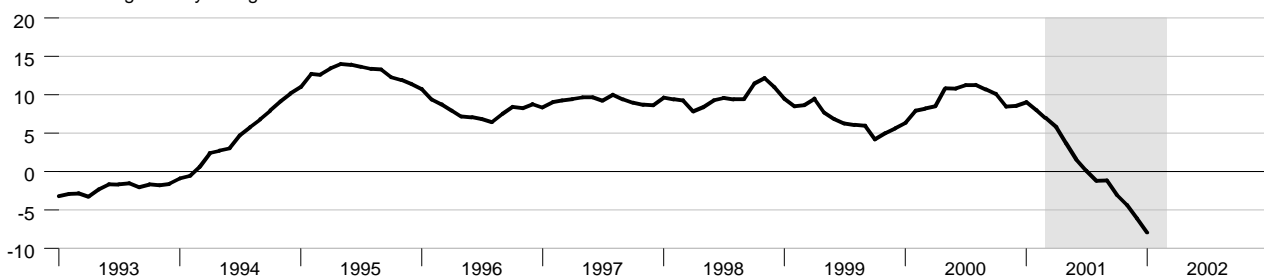
Standard and Poor's 500
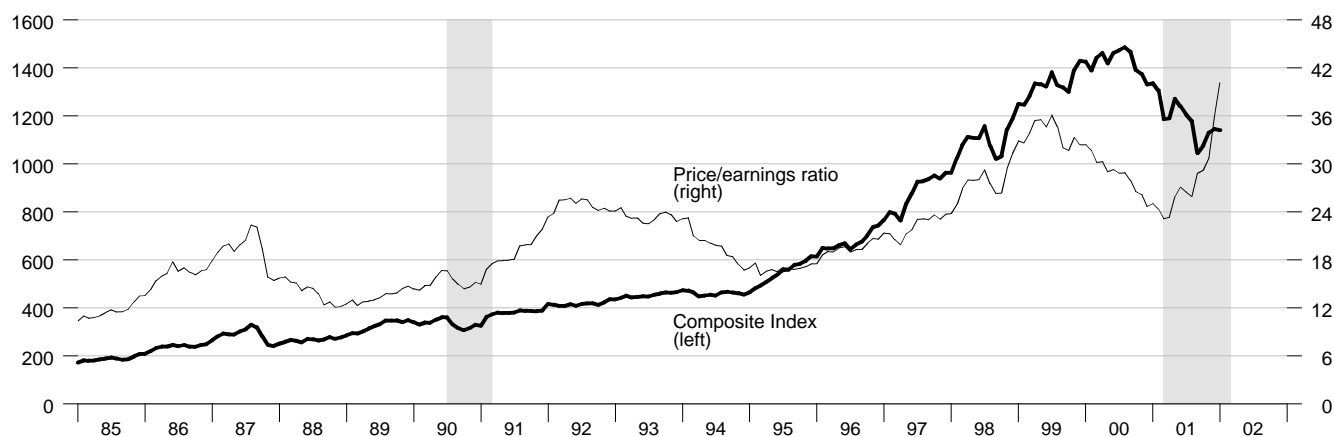
Inflation and Long-Term Interest Rates

	Trend in Consumer Price Inflation Rates Percent change from year ago				Recent Long-Term Government Bond Rates Percent			
	2001Q1	2001Q2	2001Q3	2001Q4	Oct01	Nov01	Dec01	Jan02
United States	3.41	3.44	2.72	1.84	4.57	4.65	5.09	5.04
Canada	2.77	3.60	2.69	1.10	5.66	5.55	5.72	5.69
France	1.29	2.02	1.79	1.43	5.04	5.07	5.35	.
Germany	2.52	3.16	2.46	1.79	4.60	4.45	4.74	4.86
Italy	2.89	3.05	2.80	2.40	4.96	4.80	5.05	5.13
Japan	-0.50	-0.67	-0.84	-0.98	1.36	1.33	1.35	1.42
United Kingdom	2.55	1.91	1.80	1.04	4.82	4.63	4.90	.

Inflation and Long-Term Interest Rates Differentials
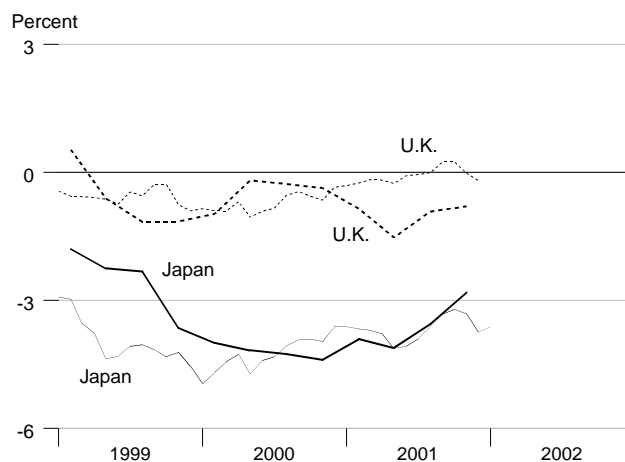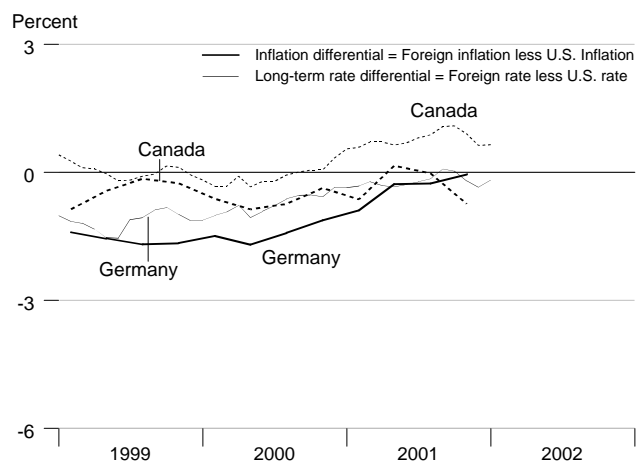
		Money Stock			**Bank**			
		M1	**MZM**	**M2**	**M3**	**Credit**	**Monetary Base** **Reserves**		**MSI M2**
	1997	1069.292	3320.459	3920.390	5208.489	3955.432	478.708	69.523	226.529
	1998	1079.990	3708.388	4207.518	5742.136	4328.519	508.942	67.808	241.572
	1999	1101.817	4166.856	4526.221	6254.214	4584.726	557.865	72.360	257.918
	2000	1104.050	4503.203	4801.384	6840.053	5032.344	590.821	68.327	272.555
	2001	1137.393	5211.340	5219.961	7629.643	5349.243	623.818	68.871	296.231
1999	1	1096.680	4035.759	4428.580	6098.490	4519.061	536.334	68.521	252.663
	2	1100.996	4125.807	4489.937	6184.933	4529.810	545.912	67.392	255.980
	3	1097.705	4210.251	4560.118	6282.411	4584.090	557.969	69.050	259.677
	4	1111.889	4295.608	4626.249	6451.023	4705.945	591.246	84.477	263.353
2000	1	1112.681	4373.872	4694.537	6622.059	4842.688	593.102	72.390	266.813
	2	1108.120	4443.913	4764.474	6757.110	4993.341	586.045	67.097	270.373
	3	1102.127	4546.647	4836.381	6923.772	5114.541	589.054	66.670	274.537
	4	1093.271	4648.382	4910.146	7057.271	5178.805	595.084	67.151	278.497
2001	1	1100.720	4847.897	5029.029	7284.092	5286.916	604.848	66.543	285.237
	2	1117.333	5082.032	5145.701	7529.852	5328.934	610.939	65.201	292.307
	3	1163.441	5315.976	5291.148	7730.432	5368.938	633.770	73.453	300.527
	4	1168.077	5599.454	5413.965	7974.194	5412.184	645.714	70.288	306.853
2000	Jan	1120.728	4358.876	4676.837	6580.014	4800.522	604.796	80.824	266.030
	Feb	1108.416	4365.155	4690.858	6612.173	4841.164	589.984	69.258	266.610
	Mar	1108.899	4397.584	4715.916	6673.991	4886.377	584.525	67.089	267.800
	Apr	1111.966	4427.235	4752.359	6718.184	4940.925	583.053	65.913	269.700
	May	1105.978	4440.562	4759.780	6750.462	5005.419	587.863	68.889	270.050
	Jun	1106.417	4463.943	4781.282	6802.684	5033.680	587.220	66.490	271.370
	Jul	1105.152	4500.185	4802.979	6856.881	5071.465	588.032	66.555	272.740
	Aug	1102.141	4546.067	4837.064	6928.472	5110.092	588.436	66.765	274.550
	Sep	1099.087	4593.688	4869.100	6985.962	5162.066	590.694	66.689	276.320
	Oct	1099.232	4616.667	4886.714	7011.150	5147.827	593.064	66.688	277.290
	Nov	1091.724	4637.370	4901.372	7036.132	5168.846	595.549	67.686	278.050
	Dec	1088.856	4691.109	4942.352	7124.530	5219.742	596.639	67.078	280.150
2001	Jan	1095.851	4760.179	4987.314	7223.352	5271.562	600.886	68.095	282.640
	Feb	1098.923	4854.807	5025.795	7288.480	5285.740	607.234	66.556	285.110
	Mar	1107.386	4928.705	5073.978	7340.445	5303.446	606.425	64.979	287.960
	Apr	1109.778	4998.740	5114.874	7443.986	5324.372	605.800	63.239	290.370
	May	1116.673	5078.231	5138.822	7530.693	5332.757	613.259	67.119	292.050
	Jun	1125.547	5169.125	5183.408	7614.878	5329.674	613.759	65.246	294.500
	Jul	1138.463	5230.217	5224.115	7662.382	5333.090	619.439	66.654	296.680
	Aug	1147.233	5271.385	5265.413	7685.011	5348.941	627.454	66.276	299.270
	Sep	1204.628	5446.325	5383.917	7843.903	5424.784	654.416	87.430	305.630
	Oct	1161.690	5514.012	5372.524	7890.258	5400.811	644.340	72.843	304.740
	Nov	1163.939	5601.635	5414.529	7980.394	5427.770	644.535	69.095	306.910
	Dec	1178.603	5682.714	5454.843	8051.930	5407.971	648.267	68.925	308.910
2002	Jan	1181.809	5677.960	5464.942	8053.362	5402.277	655.820	70.137	309.740

*All values are given in billions of dollars

Federal Reserve Bank of St. Louis

		Federal Funds	Discount Rate	Prime Rate	3-mo CDs	Treasury Yields			Corporate Aaa Bonds	S & L Aaa Bonds	Conventional Mortgage
						3 mo	3 yr	30 yr			
	1997	5.46	5.00	8.44	5.62	5.20	6.10	6.61	7.26	5.32	7.60
	1998	5.35	4.92	8.35	5.47	4.91	5.14	5.58	6.53	4.93	6.94
	1999	4.97	4.62	7.99	5.33	4.78	5.49	5.87	7.04	5.28	7.43
	2000	6.24	5.73	9.23	6.46	6.00	6.22	5.94	7.62	5.58	8.06
	2001	3.89	3.41	6.92	3.69	3.47	4.08	5.49	7.08	4.99	6.97
1999	1	4.73	4.50	7.75	4.90	4.53	4.87	5.37	6.42	4.87	6.88
	2	4.75	4.50	7.75	4.98	4.59	5.35	5.80	6.93	5.05	7.20
	3	5.09	4.60	8.10	5.38	4.79	5.71	6.04	7.33	5.42	7.80
	4	5.31	4.87	8.37	6.06	5.20	6.00	6.25	7.49	5.79	7.83
2000	1	5.68	5.19	8.69	6.03	5.70	6.56	6.30	7.71	5.82	8.26
	2	6.27	5.74	9.25	6.57	5.89	6.52	5.98	7.77	5.72	8.32
	3	6.52	6.00	9.50	6.63	6.20	6.16	5.80	7.61	5.45	8.03
	4	6.47	6.00	9.50	6.59	6.20	5.63	5.69	7.40	5.32	7.64
2001	1	5.59	5.11	8.62	5.26	4.95	4.64	5.44	7.08	5.03	7.01
	2	4.33	3.83	7.34	4.10	3.75	4.43	5.70	7.22	5.11	7.13
	3	3.50	3.06	6.57	3.34	3.24	3.93	5.52	7.11	4.87	6.97
	4	2.13	1.64	5.16	2.06	1.94	3.33	5.31	6.92	4.97	6.78
2000	Jan	5.46	5.00	8.50	5.95	5.50	6.49	6.63	7.78	5.91	8.21
	Feb	5.73	5.24	8.73	6.01	5.73	6.65	6.23	7.68	5.88	8.33
	Mar	5.85	5.34	8.83	6.14	5.86	6.53	6.05	7.68	5.68	8.24
	Apr	6.02	5.50	9.00	6.28	5.82	6.36	5.85	7.64	5.60	8.15
	May	6.27	5.71	9.24	6.71	5.99	6.77	6.15	7.99	5.87	8.52
	Jun	6.53	6.00	9.50	6.73	5.86	6.43	5.93	7.67	5.69	8.29
	Jul	6.54	6.00	9.50	6.67	6.14	6.28	5.85	7.65	5.53	8.15
	Aug	6.50	6.00	9.50	6.61	6.28	6.17	5.72	7.55	5.43	8.03
	Sep	6.52	6.00	9.50	6.60	6.18	6.02	5.83	7.62	5.40	7.91
	Oct	6.51	6.00	9.50	6.67	6.29	5.85	5.80	7.55	5.46	7.80
	Nov	6.51	6.00	9.50	6.65	6.36	5.79	5.78	7.45	5.38	7.75
	Dec	6.40	6.00	9.50	6.45	5.94	5.26	5.49	7.21	5.11	7.38
2001	Jan	5.98	5.52	9.05	5.62	5.29	4.77	5.54	7.15	4.99	7.03
	Feb	5.49	5.00	8.50	5.26	5.01	4.71	5.45	7.10	5.09	7.05
	Mar	5.31	4.81	8.32	4.89	4.54	4.43	5.34	6.98	5.00	6.95
	Apr	4.80	4.28	7.80	4.53	3.97	4.42	5.65	7.20	5.14	7.08
	May	4.21	3.73	7.24	4.02	3.70	4.51	5.78	7.29	5.15	7.15
	Jun	3.97	3.47	6.98	3.74	3.57	4.35	5.67	7.18	5.03	7.16
	Jul	3.77	3.25	6.75	3.66	3.59	4.31	5.61	7.13	4.79	7.13
	Aug	3.65	3.16	6.67	3.48	3.44	4.04	5.48	7.02	4.89	6.95
	Sep	3.07	2.77	6.28	2.87	2.69	3.45	5.48	7.17	4.93	6.82
	Oct	2.49	2.02	5.53	2.31	2.20	3.14	5.32	7.03	4.89	6.62
	Nov	2.09	1.58	5.10	2.03	1.91	3.22	5.12	6.97	4.85	6.66
	Dec	1.82	1.33	4.84	1.83	1.72	3.62	5.48	6.77	5.18	7.07
2002	Jan	1.73	1.25	4.75	1.74	1.68	3.56	5.45	6.55	5.05	7.00

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

Federal Reserve Bank of St. Louis

		M1	MZM	M2	M3
Percent change from previous period					
	1997	-3.31	7.23	4.90	8.23
	1998	1.00	11.68	7.32	10.25
	1999	2.02	12.36	7.57	8.92
	2000	0.20	8.07	6.08	9.37
	2001	3.02	15.73	8.72	11.54
1999	1	0.50	2.92	1.77	1.87
	2	0.39	2.23	1.39	1.42
	3	-0.30	2.05	1.56	1.58
	4	1.29	2.03	1.45	2.68
2000	1	0.07	1.82	1.48	2.65
	2	-0.41	1.60	1.49	2.04
	3	-0.54	2.31	1.51	2.47
	4	-0.80	2.24	1.53	1.93
2001	1	0.68	4.29	2.42	3.21
	2	1.51	4.83	2.32	3.37
	3	4.13	4.60	2.83	2.66
	4	0.40	5.33	2.32	3.15
2000	Jan	-0.32	0.59	0.47	0.66
	Feb	-1.10	0.14	0.30	0.49
	Mar	0.04	0.74	0.53	0.93
	Apr	0.28	0.67	0.77	0.66
	May	-0.54	0.30	0.16	0.48
	Jun	0.04	0.53	0.45	0.77
	Jul	-0.11	0.81	0.45	0.80
	Aug	-0.27	1.02	0.71	1.04
	Sep	-0.28	1.05	0.66	0.83
	Oct	0.01	0.50	0.36	0.36
	Nov	-0.68	0.45	0.30	0.36
	Dec	-0.26	1.16	0.84	1.26
2001	Jan	0.64	1.47	0.91	1.39
	Feb	0.28	1.99	0.77	0.90
	Mar	0.77	1.52	0.96	0.71
	Apr	0.22	1.42	0.81	1.41
	May	0.62	1.59	0.47	1.16
	Jun	0.79	1.79	0.87	1.12
	Jul	1.15	1.18	0.79	0.62
	Aug	0.77	0.79	0.79	0.30
	Sep	5.00	3.32	2.25	2.07
	Oct	-3.56	1.24	-0.21	0.59
	Nov	0.19	1.59	0.78	1.14
	Dec	1.26	1.45	0.74	0.90
2002	Jan	0.27	-0.08	0.19	0.02

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 firms (except depository institutions and money market mutual funds).

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 www.stls.frb.org/research/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 www.stls.frb.org/research/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

www.stls.frb.org/research/swdata.html. For analytical purposes, MZM largely replaces M1. The **Discount Rate** and **Expected 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, 10, 20, and 30 years to maturity. Daily data and descriptions are available at www.stls.frb.org/fred/data/wkly.html. See also *Federal Reserve Bulletin,* table 1.35.

Page 5: **Total Checkable Deposits** is the sum of demand and other checkable deposits. **Total 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 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 CPI for all urban consumers. **Real Interest Rates** are ex post measures, equal to nominal rates minus CPI inflation.

Page 9: **FOMC Expected Federal Funds Rate** is the level (or midpoint of the range, if applicable) of the federal funds rate that the staff of the Federal Open Market Committee expected to be consistent with the desired degree of pressure on bank reserve positions.

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 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 www.stls.frb.org/research/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 $m = 1,..., 30$ 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 maturity. **Inflation-Protected Treasury Yield Spreads** equal the differences between the Treasury constant maturity yields and yields on the most recently issued inflation-protected securities of similar original maturity. **Inflation-Indexed Bonds** are, for Canada, the 31-year bond with a maturity date of 12/01/2026; for the U.K., the 37.5-year bond with a maturity date of 07/17/2024 and the 12.1-year bond with a maturity date of 10/21/2004; and, for the U.S., the 30-year bond with a maturity date of 04/15/2028 and the 10-year bond with a maturity date of 01/15/2007.

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.

Sources

Bank of Canada
Canadian inflation-linked bond yields.

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

Board of Governors of the Federal Reserve System
Monetary aggregates and components, nonfinancial debt: 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 web site. M2 own rate.

Bureau of Economic Analysis
Gross domestic product.

Bureau of Labor Statistics
Consumer price index.

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

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

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

University of Michigan Survey Research Center
Median expected price change.

Congressional Budget Office
Potential real GDP.

Dow Jones and Co. (Wall Street Journal)
Federal funds futures contracts, Eurodollar futures.

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