Wicksell’s Natural Rate

Most central banks now implement monetary policy by setting a near-term target for an overnight interbank interest rate. In turn, policymakers face the difficult issue of how to choose, and adjust, the target rate. One widely discussed policy guide is the “natural,” or equilibrium, real rate of interest. To use this guide, one compares the level of a medium-term financial-market real interest rate—such as the yield on a 10-year Treasury inflation-indexed bond—to an estimate of the long-term “natural,” or equilibrium, rate of return on the economy’s capital stock. The idea that inflation will be approximately constant when these two rates of return are equal is an extension of an idea advanced in 1898 by the Swedish economist Knut Wicksell.¹

Wicksell, throughout his career, was an unwavering advocate of the quantity theory of money. He argued that increases in the economy’s average level of prices were due to excessive increases in the monetary base, that is, increases beyond the increase in the economy’s overall output. Precisely how this occurred, he felt, was muddled in writings of the time. With the natural rate concept, he sought to illuminate the transmission mechanism behind the quantity theory and to begin connecting the monetary base, banks’ extension of credit, aggregate demand, and inflation.

Wicksell based his theory on a comparison of the marginal product of capital with the cost of borrowing money. If the money rate of interest was below the natural rate of return on capital, entrepreneurs would borrow at the money rate to purchase capital (equipment and buildings), thereby increasing demand for all types of resources and their prices; the converse would be true if the money rate was greater than the natural rate of return on capital. (Wicksell did not distinguish real from nominal interest rates because, under the gold standard of the time, sustained inflation was unlikely. Here, all interest rates and rates of return should be interpreted as real rates.) So long as the money rate of interest persisted below the natural rate of return on capital, upward price pressures would continue. In Wicksell’s theory, price pressure could arise even if new credit were extended only against increases in production, that is, against “real bills.” Price stability would result only when the money rate of interest and the natural rate of return on capital—the marginal product of capital—were equal.

Wicksell did not complete his theory of money, output, and inflation. He did not propose a market mechanism that determined the money rate of interest. Nor did he advocate an activist policy based on the natural rate for Sweden’s central bank, the Riksbank. His work did, however, inspire later writers. John Maynard Keynes took up Wicksell’s unfinished quest for a theory connecting the price level to money and credit in his 1930 A Treatise on Money.

Implementing monetary policy by means of a natural rate framework has many uncertainties. The most relevant financial market rates for household and firm behavior likely are not the overnight rates set by central banks, but rather are intermediate-run rates of 5 to 10 years to maturity. Shocks to the economy, such as an energy or financial crisis, may cause near-term real rates of return on capital to deviate significantly from the longer-term rate of return on capital. Further, the natural rate is not observable. It varies with the economy’s underlying ability to produce, and must be estimated from empirical models often subject to substantial disagreement. Beyond differences in structure, models depend on assumed long-run projections for variables such as productivity growth, the share of national income received by capital, the aggregate savings rate from GDP, the growth of the labor force, the rate of depreciation of capital, and the variances and covariance of shocks to the economy. Agreement among economists on these issues does not seem imminent.

Ironically, Wicksell’s work laid the foundations that have led economists during the twentieth century to shift away from analysis of the quantity theory and, in some cases, to omit money entirely from their models. But, models based on the natural rate concept likely have some distance to go before they become useful guides to monetary policy.

—Richard G. Anderson


¹Wicksell introduced the natural rate in the 1898 paper, “The Influence of the Rate of Interest on Commodity Prices,” reprinted in Erik Lindahl, ed., Selected Papers on Economic Theory by Knut Wicksell (1958, pp. 67-92); it remains one of the clearest expositions. He expanded the idea in Geldzins und Guterpreise (1898), translated by R.F. Kahn as Interest and Prices (1936). The definitive biography is Torsten Gårdlund, The Life of Knut Wicksell (1958).
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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: \( [(x_t/x_{t-1})-1] \times 1200 \). 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:

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Research Division
Federal Reserve Bank of St. Louis
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St. Louis, MO 63166-0442

or to:

stlsFRED@stls.frb.org
Monetary Trends

M2 and MZM
Billions of dollars

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

Interest Rates

Federal Funds Rate  2.16  2.28  2.50
Prime Rate  5.15  5.25  5.49
Primary Credit Rate  3.15  3.25  3.49
Conventional Mortgage Rate  5.75  5.71  5.63

Treasury Yields:
3-Month Constant Maturity  2.22  2.37  2.58
6-Month Constant Maturity  2.50  2.68  2.85
1-Year Constant Maturity  2.67  2.86  3.03
3-Year Constant Maturity  3.21  3.39  3.54
5-Year Constant Maturity  3.60  3.71  3.77
10-Year Constant Maturity  4.23  4.22  4.17

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Federal Reserve Bank of St. Louis
Inflation and 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. See notes on page 19.

Treasury Security Yield Spreads

Federal Reserve Bank of Philadelphia
CPI Inflation
University of Michigan
Humphrey-Hawkins CPI Inflation Range

Real Interest Rates
Percent, Real rate = Nominal rate less CPI inflation
Monetary Trends

Short-Term Interest Rates

Percent

Long-Term Interest Rates

Percent

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

Percent
Federal Funds Rate and Inflation Targets

Percent

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

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 2000 dollars

Actual

Potential

PCE Inflation

Percent change from year ago

Monetary Base Growth* and Inflation Targets

Percent

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

Actual

*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
### Monetary Trends

**Velocity**

Nominal GDP/MZM, Nominal GDP/M2 (Ratio Scale)

- **MZM**
- **M2**

**Interest Rates**

Percent

- 3-Month T-Bill
- M2 Own
- MZM Own

**MZM Velocity and Interest Rate Spread**

Ratio Scale

- 1974Q1 to 1993Q4
- 1994Q1 to present

**M2 Velocity and Interest Rate Spread**

Ratio Scale

- 1974Q1 to 1993Q4
- 1994Q1 to present
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

Updated through 02/14/05

Research Division
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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
Recent Inflation and Long-Term Interest Rates

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<th>2004Q2</th>
<th>2004Q3</th>
<th>2004Q4</th>
<th>Nov04</th>
<th>Dec04</th>
<th>Jan05</th>
<th>Feb05</th>
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<td>4.50</td>
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Inflation and Long-Term Interest Rate Differentials

-6 0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72 75 78 81 84 87 90

Inflation differential = Foreign inflation less U.S. inflation
Long-term rate differential = Foreign rate less U.S. rate
### Money Stock

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<tr>
<th>Year</th>
<th>M1</th>
<th>MZM</th>
<th>M2</th>
<th>M3</th>
<th>Bank Credit</th>
<th>Adjusted Base</th>
<th>Reserves</th>
<th>MSI</th>
<th>M2</th>
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<td>4801.405</td>
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<td>1136.938</td>
<td>5221.308</td>
<td>5219.493</td>
<td>7643.641</td>
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<td>1192.032</td>
<td>5891.818</td>
<td>5614.811</td>
<td>8257.342</td>
<td>5597.371</td>
<td>697.072</td>
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<tr>
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<td>6322.368</td>
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### Money Stock

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<th>May</th>
<th>Jun</th>
<th>Jul</th>
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<th>Sep</th>
<th>Oct</th>
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<th>Dec</th>
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<tbody>
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*All values are given in billions of dollars.*
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<tr>
<th>Year</th>
<th>Federal Funds</th>
<th>Primary Credit Rate</th>
<th>Prime Rate</th>
<th>3-mo CD</th>
<th>3-mo Treasury Yields</th>
<th>3-yr Treasury Yields</th>
<th>10-yr Treasury Yields</th>
<th>Corporate Aaa Bonds</th>
<th>S &amp; L Aaa Bonds</th>
<th>Conventional Mortgage</th>
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<tbody>
<tr>
<td>2001</td>
<td>3.89</td>
<td>6.92</td>
<td></td>
<td>3.69</td>
<td>3.47 4.08 5.02</td>
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<tr>
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<td>1.63 3.10 4.61</td>
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**2002**
1. 1.73 4.75 1.82 1.76 3.75 5.08 6.62 5.02 6.97
2. 1.75 4.75 1.83 1.75 3.77 5.10 6.71 5.01 6.81
3. 1.74 4.75 1.76 1.67 2.62 4.26 6.35 4.72 6.29
4. 1.44 4.45 1.49 1.36 2.27 4.01 6.28 4.71 6.08

**2003**
1. 1.25 2.25 4.25 1.26 1.18 2.07 3.92 6.00 4.60 5.83
2. 1.25 2.23 4.24 1.17 1.06 1.77 3.62 5.31 4.28 5.51
3. 1.02 2.00 4.00 1.07 0.95 2.20 4.23 5.70 4.68 6.01
4. 1.00 2.00 4.00 1.10 0.93 2.38 4.29 5.66 4.52 5.92

**2004**
1. 1.00 2.00 4.00 1.05 0.93 2.17 4.02 5.45 4.26 5.61
2. 1.01 2.00 4.00 1.25 1.10 2.98 4.60 5.93 4.82 6.13
3. 1.43 2.42 4.42 1.70 1.51 2.92 4.30 5.64 4.54 5.89
4. 1.95 2.94 4.94 2.25 2.04 3.05 4.17 5.48 4.39 5.73

**2003 Feb**
1. 1.26 2.25 4.25 1.27 1.19 2.05 3.90 5.95 4.57 5.84
Mar 1.25 2.25 4.25 1.23 1.15 1.98 3.81 5.89 4.51 5.75

**Apr**
1. 1.26 2.25 4.25 1.24 1.15 2.06 3.96 5.74 4.60 5.81
May 1.26 2.25 4.25 1.22 1.09 1.75 3.57 5.22 4.16 5.48
Jun 1.22 2.20 4.22 1.04 0.94 1.51 3.33 4.97 4.07 5.23

**Jul**
1. 1.01 2.00 4.00 1.05 0.92 1.93 3.98 5.49 4.59 5.63
Aug 1.03 2.00 4.00 1.08 0.97 2.44 4.45 5.88 4.82 6.26
Sep 1.01 2.00 4.00 1.08 0.96 2.23 4.27 5.72 4.63 6.15

**Oct**
1. 1.01 2.00 4.00 1.10 0.94 2.26 4.29 5.70 4.64 5.95
Nov 1.00 2.00 4.00 1.11 0.95 2.45 4.30 5.65 4.50 5.93
Dec 0.98 2.00 4.00 1.10 0.91 2.44 4.27 5.62 4.41 5.88

**2004 Jan**
1. 1.00 2.00 4.00 1.06 0.90 2.27 4.15 5.54 4.42 5.74
Feb 1.01 2.00 4.00 1.05 0.94 2.25 4.08 5.50 4.26 5.64
Mar 1.00 2.00 4.00 1.05 0.95 2.00 3.83 5.33 4.11 5.45

**Apr**
1. 1.00 2.00 4.00 1.08 0.96 2.57 4.35 5.73 4.69 5.83
May 1.00 2.00 4.00 1.20 1.04 3.10 4.72 6.04 4.93 6.27
Jun 1.03 2.01 4.01 1.46 1.29 3.26 4.73 6.01 4.85 6.29

**Jul**
1. 1.26 2.25 4.25 1.57 1.36 3.05 4.50 5.82 4.71 6.06
Aug 1.43 2.43 4.43 1.68 1.50 2.88 4.28 5.65 4.52 5.87
Sep 1.61 2.58 4.58 1.86 1.68 2.83 4.13 5.46 4.40 5.75

**Oct**
1. 1.76 2.75 4.75 2.04 1.79 2.85 4.10 5.47 4.38 5.72
Nov 1.93 2.93 4.93 2.26 2.11 3.09 4.19 5.52 4.45 5.73
Dec 2.16 3.15 5.15 2.45 2.22 3.21 4.23 5.47 4.35 5.75

**2005 Jan**
1. 2.28 3.25 5.25 2.61 2.37 3.39 4.22 5.36 4.24 5.71
Feb 2.50 3.49 5.49 2.77 2.58 3.54 4.17 5.20 4.20 5.63

*All values are given as a percent at an annual rate.*
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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 (money, zero maturity): M2 minus small-denomination time deposits, plus institutional money market mutual funds (that is, those included in M3 but excluded from M2). The label MZM was coined by William Poole (1991); the aggregate itself was proposed earlier by Moltry (1988).

M2: M1 plus savings deposits (including 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 on the quantity of base money held by depositories. This series is a spliced chain index; see Anderson and Rasche (1996a,b, 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.stlouisfed.org/ms/index.html.

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.stlouisfed.org/aggreg/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 shows constant maturity yields calculated by the U.S. Treasury 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/fred2/. 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 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 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

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

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

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

to five alternative target inflation rates, \( \pi^* = 0, 1, 2, 3, 4 \) 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 \((y_t - y_{t-40})/40 \times 400\), where \( y_t \) 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/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 \( m = 1, \ldots, 10 \) years to maturity are obtained by linear interpolation between
 Monetary Trends

reported yields. These yields are smoothed by fitting the regression suggested by Nelson and Siegel (1987),
\[ R(m) = a_0 + (a_1 + a_2) (1 - e^{-m/50}) / (m/50) - a_3 \times e^{-m/50}, \]
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).

References


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