FRB/US Equation Documentation

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Introduction

FRB/US is a large-scale quarterly macroeconomic model of the U.S. economy, containing roughly 400 equations and identities. However, the number of ``core" stochastic equations is much smaller -- around 40 equations. In this documentation, equations are grouped into 11 sectors, each of which is introduced by a brief discussion of its major features and concluded with a list of definitions of variables. In addition, important equations are accompanied by a small amount of explanatory text. A more complete description of the principles underlying the design of FRB/US and its system properties is available in a number of studies, including:

- Flint Brayton and Peter Tinsley, eds., A Guide to FRB/US: A Macroeconomic Model of the United States, FEDS working paper 1996-42 (October 1996).
- Flint Brayton, Andrew Levin, Ralph Tryon, and John Williams, The Evolution of Macro Models at the Federal Reserve Board, FEDS working paper 97-29 (May 1997); also published in *Carnegie Rochester Conference Series on Public Policy*, December 1997, 47, 43-81.
- Flint Brayton, Eileen Mauskopf, David Reifschneider, Peter Tinsley, and John Williams, The Role of Expectations in the FRB/US Macroeconomic Model, it Federal Reserve Bulletin, April 1997, 83 (4), 227-245.
- David Reifschneider, Robert Tetlow, and John Williams, Aggregate Disturbances, Monetary Policy, and the Macroeconomy: The FRB/US Perspective, *Federal Reserve Bulletin*, January 1999, 85 (1), 1-19.
- Flint Brayton, Morris Davis, Peter Tulip, Polynomial Adjustment Costs in FRB/US May 2000
- Michael Kiley, Business Investment in the Federal Reserve Board's U.S. Model, April 2001
- Flint Brayton, Potential Output in FRB/US, May 2002

Types of equations. Equations in FRB/US fall into four types: (1) polynomial adjustment cost specifications (PAC), (2) present value relationships (PV), (3) conventional error corrections and other types of behavioral relationships, and (4) identities.

PAC equations. Numerous references will be made to ``polynomial adjustment cost'' (or PAC) equations, a specification which is used to characterize dynamic behavior based on an explicit cost minimization framework. In this framework, agents seek to minimize the expected present value of squared deviations of current and future values of the decision variable from a target (or steady-state) path plus adjustment costs associated with squared changes in the level, the growth rate, and higher-order growth terms of the decision variable. The PAC approach is used in equations for three categories of consumption, residential construction, investment in producers' durable equipment, inventories, aggregate price and wage equations, labor hours, and dividend payments. In each of these equations, the core structure specifies that the current change in the decision variable depends on:

- the lagged deviation of the decision variable from its target;
- lagged changes in the decision variable; and
- a weighted sum of expected future changes in the target variable.

In computing the weighted sum of expected future changes in the target, the weights are a non-linear function of the adjustment cost parameters and do not sum to unity; the sum is given in each variable's definition. For a detailed discussion of the PAC approach, see Polynomial Adjustment Costs in FRB/US.

PV equations. Financial markets are assumed to be free of adjustment costs. This applies to the equations for five- and ten-year government bonds, AAA and BAA corporate bonds, and the price of equity. Long-term bond rates equal the present discounted value of expected future short-term rates, adjusted for time-varying risk/term premiums. Similarly, equity prices equal the present discounted value of future dividend payments, after adjustment for an exogenous risk premium.

Error-correction and other behavioral equations. Most of the core equations in FRB/US are specified in the PAC and PV frameworks. For the remaining core equations and other more peripheral relationships as well, conventional error-correction specifications without explicit expectations terms are used in the majority of instances. Equations of this type include export and import volumes, labor force participation, and the price of imports.

Identities. Two comments are in order concerning the numerous identities contained in FRB/US. First, the use of chain-aggregated price and quantity indexes in the National Income and Product Accounts makes the relationship between lower and higher-level aggregates quite complex. In the model, these relationships are closely approximated by identities that aggregate using Divisia indexes; chain-aggregation formulas are used only in the case of GDP and other variables that include inventory investment as a component. Second, many other types of accounting identities are simplified in order to reduce the number of variables included in the system; for these quasi-identities, exogenous multiplicative scaling variables are used to link the variable in question with its major components.

Expectations. PAC and PV equations contain explicit expectations variables. Each expectation is a weighted average of future values, with weights dictated by the structure of the optimization associated with the equation. The PAC and PV equations were estimated using a single-equation technique in which proxies for the expectations variables were constructed from forecasts of small VARs. In FRB/US simulations, two options are currently available for expectations. ``VAR'' expectations use the same VARs that were employed in estimation. In this case, each expectation can be expressed as a linear function of past and, in some cases, contemporaneous observations on the variables appearing in the VARs. The second option is expectations that are model consistent in the sense of being the same as the future simulated values of the relevant variables. In either case, the formulas for these variables are given in sector Z.

Conventions for naming variables. In addition to the use of a standard set of prefixes (such as ``E" for expenditure, ``G" for government, and ``R" for interest rate) names in FRB/US follow several other conventions. A ``Q" prefix denotes the nonstationary component of the ``target" or ``desired" level of a variable. For example, EC is consumption spending and QEC is the non-cyclical part of desired consumption. A ``Z" prefix refers to a variable that is an expectation. These variables frequently are the weighted sum of expected future changes in the target. Often, the target is split into different components with corresponding ``Z" variables representing the weighted sum of expected future changes in the components.

Equation statistics. For most equations, the equation text shows coefficients and t-statistics (in brackets) immediately before each explanatory variable. For explanatory variables that enter as distributed lags, however, the equation text gives the coefficient sum, and the individual lag coefficients and t-statistics are reported beneath the equation text. Coefficients that are constrained in estimation have ``const." in the place of a t-statistic. The constraints in PAC and PV equations typically arise from the theoretical derivation. Below the equation text and any distributed lag coefficients, standard regression statistics are shown. For PAC and PV equation, a set of diagnostic LM test statistics is also reported. The tests are based on regressions of equation residuals on the set of explanatory variables and added regressors. In the tests for serial correlation, the added regressors are lagged residuals. In the test for overidentifying restrictions, the added regressors are the VAR variables that enter the equation in restricted form through the constructed expectations variables.

Household Expenditures

The sector contains polynomial adjustment cost (PAC) equations for consumer spending on nondurable goods and services (broadly defined), expenditures on durable goods, and residential investment. The level of complexity in this sector is greater than that of other sectors because forward-looking terms are present both in the dynamic equations -- where agents calculate the present value of expected changes in the target values -- and in the equations for the target variables. As an example of the latter, target consumption depends on permanent income, with the latter equal to a weighted average of expected future income.

Desired spending on nondurable goods and services is derived from the assumption that households maximize the present value of utility associated with consumption, subject to a lifetime budget constraint. The assumption that an intertemporal budget constraint matters for current consumption introduces the need for measures of permanent income and hence forward-looking terms in the target specification. However, households are assumed to be highly risk-averse and subject to uninsurable income uncertainty, and the construction of permanent income imposes a very high discount rate on future income -- 25 percent per annum.

Owing to habit persistence and other frictions, actual spending is assumed to respond gradually to changes in target consumption: the estimated dynamic equation implies an adjustment speed of 50 percent after one year. The equation also indicates that a significant proportion (10 percent) of consumption is accounted for by liquidity-constrained households, and that spending is sensitive to cyclical changes in income risk -- an effect proxied by the expected future level of the output gap.

Desired rates of investment in consumer durables and housing are derived from the specification of desired service flows from durables and housing. The desired share of these service flows in total consumption of nondurable goods and services is assumed to be inversely proportional to the ratio of the rental price of these assets to the price of aggregate consumption. The dynamic equations allow for accelerator-type behavior of investment; that is, investment may temporarily overshoot its long-run target level when determinants of the desired service flow change.

a.1 EC: Consumption, cw 2005$ (FRB/US definition)

FRB/US total consumer spending is approximated by the Divisia aggregate of expenditures on non-durable goods and non-housing services (ECO), housing services (ECH) and the service flow from durable goods (YHPCD+JKCD).

$$
\begin{aligned}
\mathbf{log(EC)} = {} & \log(EC_{t-1}) + \\
& .5 * (PCOR*PCNIA*ECO/(EC*PCNIA) \\
& + PCOR_{t-1}*PCNIA_{t-1}*ECO_{t-1}/(EC_{t-1}*PCNIA_{t-1})) \\
& * del(1:\log(ECO)) \\
& + .5 * (PCHR*PCNIA*ECH/(EC*PCNIA) \\
& + PCHR_{t-1}*PCNIA_{t-1}*ECH_{t-1}/(EC_{t-1}*PCNIA_{t-1})) \\
& * del(1:\log(ECH)) \\
& + .5 * ((PCDR*PCNIA*YHPCD+PCDR*PCNIA*JKCD)/(EC*PCNIA) \\
& + (PCDR_{t-1}*PCNIA_{t-1}*YHPCD_{t-1}+PCDR_{t-1}*PCNIA_{t-1}*JKCD_{t-1})/(EC_{t-1}*PCNIA_{t-1})) \\
& * del(1:\log(YHPCD+JKCD))
\end{aligned}
$$

a.2 QEC: Desired level of consumption (FRBUS definition), trending component

The model definition of aggregate consumption of nondurable goods and services differs from the NIPA definition by including the imputed service flow from the stock of consumer durables. Desired nondurable consumption is a function of both the level of permanent income (ZYH) and its composition. In the estimated specification, the ratio of consumption to permanent income depends on the ratios to permanent income of permanent transfer income (ZYHT), permanent property income (ZYHP), and property wealth (WPS and WPO). The estimated coefficients on these ratios measure the degree to which the propensity to spend out of these components of wealth differs from the propensity to spend out of labor income. The latter propensity is estimated to have increased slightly during the mid-1980s, as indicated by the positive coefficient on

DCON*ZYH: DCON is a dummy variable equal to 0 prior to 1986, and 1 after 1988, with a linear segment connecting these points between these two dates.

QEC = 0.762 [48.24885967798296] * ZYH
+ 0.0211 [7.496895797106838] * (DCON*(ZYH-ZYHT))
+ 0.238 * ZYHT
- 0.224 [-3.758542433501828] * ZYHP
+ 0.0317 [16.96702135542222] * (WPS+WPO)

Regression statistics

Adjusted R^2:	1.00
S.E. of regression:	0.00979125
Sum of squared residuals:	0.016777
Durbin-Watson statistic:	0.36
Sample period:	1964Q2 2008Q4
Estimation date:	August 2009
Estimation method:	Least Squares

a.3 ECD: Consumer expenditures on durable goods, cw 2005$

The growth rate of household investment in consumer durables is modeled using the PAC specification, with spending error-correcting to its long-run target. The target has two components -- an I(1) component, QECD, that is a function of overall target consumption and the cost of capital for consumer durables, and an I(0) component, ZGAPC2. ZGAPC2 is the weighted average of expected future output gaps, computed using the PAC weights implied by the estimated coefficients of the model, and is a proxy for future income uncertainty.

del(1: log(ECD)) = 0.150 [3.052871009504936] * log($QECD_{t-1}$/ECD_{t-1})
- 0.116 [-1.5245481287231] * del(1: log(ECD_{t-1}))
+ 0.000995[0.4140541498005876]
+ 1.00 * ZECD
+ 2.57 [2.838821120627385] * ZGAPC2 / 100

Regression statistics

Adjusted R^2:	0.12
S.E. of regression:	0.0294226
Sum of squared residuals:	0.151495
Durbin-Watson statistic:	1.93

Sample period:	1964Q2 2008Q4
Estimation date:	August 2009
Estimation method:	Least Squares

a.4 QECD: Target level of consumption of durable goods, trending component

The specification of the target level of spending on consumer durable goods is proportional to overall target consumption, with the proportionality factor a function of the relative rental rate on such goods. The relative rental rate is the product of two factors -- the relative purchase price of consumer durables, PCDR, and the real financial cost of capital (plus depreciation) for such goods, RCCD. The steady-state condition for the stock of consumer durables is converted to one for gross outlays by multiplying the stock condition by the sum of two factors -- the depreciation rate for durable goods, and the steady-state growth rate of the target capital stock. The latter factor equals the sum of trend output growth (HGGDPT) and the trend rate of decline in the relative price of consumer durable goods (HGPCDR, weighted by the real rental rate elasticity).

QECD = QEC
* (JRCD/4 + HGGDPT/400 - 0.643 [-61.02503445802714]*HGPCDR/400)
* exp(2.67 [65.94938715852616] - 0.643 *log(PCDR*RCCD))

Regression statistics

Adjusted R^2:	0.96
S.E. of regression:	0.0502403
Sum of squared residuals:	0.446763
Durbin-Watson statistic:	0.30
Sample period:	1964Q2 2008Q4
Estimation date:	August 2009
Estimation method:	Least Squares

a.5 EH: Residential investment expenditures, cw 2005$

The growth rate of residential investment is modeled using the general PAC specification, with spending error-correcting to its long-run target, QEH. QEH is a function of overall target consumption and the cost of capital for housing and is assumed to follow an I(1) process. Besides the standard PAC terms, the equation also includes two additional regressors -- the first and second lags of changes in the nominal mortgage rate. These terms are included to capture (approximately) the temporary effects of downpayment requirements and other borrowing constraints on housing investment when nominal interest rates change. A shift in the coefficients on these terms is allowed between 1982:Q4 and 1983:Q1 because the final repeal of Reg. Q in the early 1980s changed the sensitivity of residential construction to interest rates.

$$\mathbf{del(1 : log(EH))} = 0.0472\ [2.595364191983624] * \log(QEH_{t-1}/EH_{t-1})$$
$$+ 0.402\ [6.059707345708271] * del(1 : \log(EH_{t-1}))$$
$$+ 0.213\ [3.095858167614718] * del(1 : \log(EH_{t-2}))$$
$$+ 0.000570 [0.2172010312938585]$$
$$+ 1.00 * ZEH$$
$$- 0.0508\ [-6.606181557089804] * del(1 : RME_{t-1})$$
$$+ 0.0281\ [2.784411327453626] * D83 * del(1 : RME_{t-1})$$

Regression statistics

Adjusted R^2:	0.50
S.E. of regression:	0.0343549
Sum of squared residuals:	0.208906
Durbin-Watson statistic:	2.01
Sample period:	1964Q2 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

a.6 QEH: Target level of residential investment, trending component

The specification of the target level of residential investment is based on the assumption that the desired housing stock is proportional to overall target consumption, with the proportionality factor a function of the relative rental rate on housing. The relative rental rate is the product of two factors -- the price of new construction expressed relative to consumption prices, PHR*PXP/PCNIA, and the real financial cost of capital (plus depreciation) for housing, RCCH. The steady-state condition for the housing stock is converted to one for gross investment by multiplying the stock condition by the sum of two factors -- the depreciation rate for housing, and the steady-state growth rate of the target housing stock. The latter factor equals trend output growth (HGGDPT). (Note: unlike consumer durables, no adjustment is made to the steady-state growth of the target stock to control for trend movements in the relative price of housing construction, because the series does not show a pronounced trend.)

$$\mathbf{QEH} = QEC$$
$$* (JRH/4 + HGGDPT/400)$$
$$* \exp(2.34\ [20.65919172560213] - \log(PHR*PXP/PCNIA) - 0.298\ [-4.584965656328706]*\log(RCCH))$$

Regression statistics

Adjusted R^2:	0.26

S.E. of regression:	0.163344
Sum of squared residuals:	4.82929
Durbin-Watson statistic:	0.13
Sample period:	1964Q2 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

a.7 ECNIA: Personal consumption expenditures, cw 2005$ (NIPA definition)

NIPA total consumer spending is approximated by the Divisia aggregate of expenditures on non-durable goods and non-housing services (ECO), durable goods (ECD), and housing services (ECH).

$$\mathbf{log(ECNIA)} = \log(ECNIA_{t-1}) + .5 * .01 * (PCOR*PCNIA*ECO/ECNIAN + PCOR_{t-1}*PCNIA_{t-1}*ECO_{t-1}/ECNIAN_{t-1}) * del(1:\log(ECO)) + .5 * .01 * (PCDR*PCNIA*ECD/ECNIAN + PCDR_{t-1}*PCNIA_{t-1}*ECD_{t-1}/ECNIAN_{t-1}) * del(1:\log(ECD)) + .5 * .01 * (PCHR*PCNIA*ECH/ECNIAN + PCHR_{t-1}*PCNIA_{t-1}*ECH_{t-1}/ECNIAN_{t-1}) * del(1:\log(ECH))$$

a.8 ECNIAN: Personal consumption expenditures, current $ (NIPA definition)

$$\mathbf{ECNIAN} = .01*PCNIA*ECNIA$$

a.9 EHN: Residential investment expenditures

$$\mathbf{EHN} = .01 * PHR * PXP * EH$$

a.10 JKCD: Consumption of fixed capital, consumer durables

$$\textbf{log(JKCD)} = \log(JRCD) + \log(KCD_{t-1})$$

a.11 KCD: Stock of consumer durables, cw 2005$

$$\textbf{KCD} = .25*ECD + (1\text{-}JRCD/4)*KCD_{t-1}$$

a.12 KH: Stock of residential structures, cw 2005$

$$\textbf{KH} = .25*EH + (1\text{-}JRH/4)*KH_{t-1}$$

a.13 RCCD: Cost of capital for consumer durables

The real user cost of the stock of consumer durable goods (excluding the purchase price of new goods) equals the sum of the depreciation rate (JRCD) and the real after-tax interest rate. The latter is approximated by the new auto loan rate minus expected inflation over the next five years. A MAX function is included to prevent RCCD from taking on implausible values, improving the stability of the model in stochastic simulations. Over history, RCCD has never approached this floor.

$$\textbf{RCCD} = \max(100*JRCD + RCAR - ZPI5, .01)$$

a.14 RCCH: Cost of capital for residential investment

The real user cost of housing (excluding the purchase price of new construction) equals the depreciation rate JRH, plus the real after-tax mortgage rate (1-TRFPM/100)*RME-ZPI10, plus the effective marginal property tax rate (1-TRFPM/100)*TRSPP. A MAX function is included to prevent RCCH from taking on implausible values, improving the stability of the model in stochastic simulations. Over history, RCCH has never approached this floor. Note: TRFPM is the marginal federal income tax rate for the taxpayers with household incomes that are twice the median; this group is considered the most representative of households who itemize.

$$\textbf{RCCH} = \max(100*JRH + (1-TRFPM/100)*(RME+100*TRSPP) - ZPI10, .1)$$

a.15 YHPCD: Income, household, property, imputed flow from stock of consumer durables, real

$$\textbf{log(YHPCD)} = \log(0.0537 \text{ [(const.)]}) + \log(KCD_{t-1})$$

a.16 ECO: Consumer expenditures on non-durable goods and non-housing services, cw 2005$

The rate of growth of consumer spending on non-durable goods and non-housing services is modeled using the a second-order PAC specification. Thus, actual spending growth deviates from expected future growth in target consumption by enough to close gradually any gap between the levels of actual and desired spending. Note that the target is given by the target for total FRB/US consumption (QEC), scaled by the relative price (PCOR). The nominal share of ECO in EC is subsumed in the constant term.

Aside from these standard PAC terms, the equation also includes an term that attempts to control for the effects of liquidity constraints. Specifically, the standard framework has been modified to allow for the possibility that a fixed percentage of consumption is accounted for by households whose consumption moves one-for-one with labor and transfer income. Aggregating across unconstrained and constrained households yields a functional form in which the liquidity-constrained share of total spending is approximated by the coefficient on the difference between contemporaneous income growth and expected growth in future target "other" consumption (ZECO).

$$\begin{aligned}\textbf{del(1: log(ECO))} = {} & 0.182 \text{ [6.550673056415775]} * \log((QEC_{t-1}/PCOR_{t-1})/ECO_{t-1}) \\ & + 0.204 \text{ [3.186558603644673]} * del(1{:}\log(ECO_{t-1})) \\ & - 0.0607 \text{ [-6.678970400173459]} \\ & + 1.00 * ZECO \\ & + 0.423 \text{ [4.683611858262606]} * (del(1{:}\log(YHL+YHT)) - ZECO)\end{aligned}$$

Regression statistics

Adjusted R^2:	0.40
S.E. of regression:	0.00416464
Sum of squared residuals:	0.00303524
Durbin-Watson statistic:	1.94
Sample period:	1964Q2 2008Q4
Estimation date:	August 2009

Estimation method: Least Squares

a.17 ECH: Consumer expenditures on housing services, cw 2005$

The ratio of housing services (ECH) to the housing stock (KH(-1)) is related to two lags of itself as well as a smoothed measure of the mortgage rate, RRMET.

del(1 : (ECH)/KH(-1)) = 0.00271 [2.079822781441163]
- 0.0308 [-2.166264734049899] * ECH_{t-1}/KH_{t-2}
+ 0.516 [6.930082496241925] * del(1 : ECH_{t-1}/KH_{t-2})
+ 0.00349 [2.34524052032833] * RRMET/100

Regression statistics

Durbin-Watson statistic:	1.926824806965408
Adjusted R^2:	0.3030570174892789
S.E. of regression:	0.0002342132956672768
Sum of squared residuals:	7.021551087017883e-06
Sample period:	1975Q1 2007Q4
Estimation date:	November 2008

Business Expenditures

Business investment in the FRB/US model is broken down into four categories: high-tech equipment and software (computers, software, and telecommunication equipment); other equipment; non-residential structures; and inventories.

Growth in real spending on high-tech E&S, other equipment, and nonresidential structures is modeled using a modified version of the PAC specification. As with a standard PAC equation, investment responds to the lagged gap between actual and target investment, expected future growth in target investment, and lagged growth in actual spending. We modify the standard PAC specification to allow for an ad hoc effect of output on investment. This modification improves the empirical fit of the equation, moving it toward a reduced-form accelerator specification.

For the two components of E&S spending and non-residential structures investment, target levels are defined as the rate of investment necessary to hold the capital-output ratio at its optimal level. The three individual targets are derived jointly from a nested aggregate production function. At the highest level, the production function is Cobb-Douglas with three factors of production -- quality-adjusted hours, energy, and an aggregate capital services bundle. The capital services bundle is measured as the chain-weighted aggregate of the flow of capital services from each of the four types of capital stocks. Within the capital-services bundle, the targets for the individual categories are assumed to have a unit elasticity with respect to the user cost of capital, as in a Cobb-Douglas production function. We deviate from the standard Cobb-Douglas specification, however, in allowing for the long-run capital services shares to vary over time.

In contrast to these three components of business fixed investment, growth in the stock of inventories is modeled with a simple reduced-form equation that links changes in the inventory stock to changes in final sales. Changes in sales have temporary but no permanent effects on the inventory-sales ratio. Other shocks to inventories can have a permanent effect.

b.1 EPDC: Investment in computers, software, and communication equipment, cw 2005 $

Growth in outlays for high-tech equipment and software is modeled using a standard PAC specification. In addition, an important ad hoc role was found for lagged output growth.

Further discussion

del(1 : log(EPDC)) =

0.00736 [2.017643132052255]

+ 0.0894 [3.229546608611349] * log($QEPDC_{t-1}$/$EPDC_{t-1}$)

+ B2(L) {sum 0.525 } * del(1 : log(EPDC $_{t-1}$))

+ 0.667 [3.890018809493738] * ZXNFBC

+ 0.667 * ZVPDC

+ 0.333 * del(1 : log($XNFB_{t-1}$))

Distributed lag coefficients

Name	Value
$B2_0$	0.209 0.00
$B2_1$	0.316 0.00
$B2_{SUM}$	0.525

Regression statistics

Adjusted R^2:	0.39
S.E. of regression:	0.0239199

Sum of squared residuals: 0.0749529
Durbin-Watson statistic: 1.98
Sample period: 1976Q1 2009Q4
Estimation date: September 2010
Estimation method: Least Squares

b.2 QEPDC: Desired level of investment in high-tech equipment, trending comp.

The target rate of investment is defined as the rate necessary to keep the capital-output ratio at its optimal value (VPDC).

log(QEPDC) = 0.00
+ 1.00 * log(XNFB)
+ 1.00 * log(VPDC)
+ 1.00 * log(HGX/100 + JRPDC - .01*HGPDCR)

b.3 EPDCN: E&S investment in computers, software, and communication equipment, current $

EPDCN = .01*PPDCR*PXP*EPDC

b.4 EPDO: E&S investment, excluding computers, software, and communication equipment, cw 2005 $

The equation for growth in outlays on non-high-tech equipment differs from the standard PAC equation by allowing for a response lag that is one quarter longer than usual, reflecting a delivery/gestation lag in investment. As with the other components of BFI, an ad hoc role for lagged output growth is included.

Further discussion

del(1 : log(EPDO)) =
- 0.00239[-0.9391026410959405]
+ 0.129 [4.355782140873272] * log($QEPDO_{t-2}$/$EPDO_{t-2}$)
+ B2(L) {sum 0.195 } * del(1 : log(EPDO $_{t-1}$))
+ 0.179 [0.695902913057986] * $ZXNFBO_{t-1}$

$+ 0.179 * ZVPDO_{t-1}$

$+ 0.821 * (del(1 : log(XNFB_{t-1})))$

Distributed lag coefficients

Name	Value
$B2_0$	0.00489 0.00
$B2_1$	0.190 0.00
$B2_{SUM}$	0.195

Regression statistics

Adjusted R^2:	0.34
S.E. of regression:	0.026285
Sum of squared residuals:	0.10709
Durbin-Watson statistic:	2.01
Sample period:	1970Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

b.5 QEPDO: Desired level of investment in eq. excl. high-tech, trending comp.

The target rate of investment is defined as the rate necessary to keep the capital-output ratio at its optimal value (VPDO).

log(QEPDO) = 0.00

+ 1.00 * log(XNFB)

+ 1.00 * log(VPDO)

+ 1.00 * log(HGX/100 + JRPDO)

b.6 EPDON: E&S investment, excluding computers, software, and communication equipment, current $

EPDON = .01*PPDOR*PXP*EPDO

b.7 EPDN: Investment in producers' durable equipment

$$\mathbf{EPDN} = EPDCN + EPDON$$

b.8 EPD: Investment in producers' durable equipment, cw 2005$

Total outlays on equipment and software is a Divisia aggregate of its two components, high-tech and other.

$$\begin{aligned}\mathbf{log(EPD)} = {} & \log(EPD_{t-1}) \\ & + .5 * (EPDON/EPDN + EPDON_{t-1}/EPDN_{t-1}) * del(1:\log(EPDO)) \\ & + .5 * (EPDCN/EPDN + EPDCN_{t-1}/EPDN_{t-1}) * del(1:\log(EPDC))\end{aligned}$$

b.9 EPS: Investment in nonresidential structures, cw 2005$

The equation for growth in spending on non-residential structures differs from the standard PAC equation by allowing for a response lag that is one quarter longer than usual, reflecting a delivery/gestation lag in investment. In addition, an important ad hoc role was found for lagged output growth. A dummy variable for the fourth quarter of 2001 is included to account for the unprecedented fluctuation that quarter related to the destruction of the World Trade Center.

Further discussion

$$\begin{aligned}\mathbf{del(1 : log(EPS))} = {} & \\ & -0.00362 [-1.502765474708507] \\ & + 0.0477\ [3.217656625654397] * \log(QEPS_{t-2}/EPS_{t-2}) \\ & + B2(L)\ \{sum\ 0.401\} * del(1 : \log(EPS_{t-1})) \\ & + 0.502\ [2.253022607497331] * ZXNFBS_{t-1} \\ & + 0.502 * ZVPS_{t-1} \\ & + 0.498 * (del(1 : \log(XNFB_{t-1}))) \\ & - 0.0858\ [-3.26323638638053] * D01Q4\end{aligned}$$

Distributed lag coefficients

Name	Value
$B2_0$	0.226 0.00
$B2_1$	0.175 0.00

$B2_{SUM}$	0.401

Regression statistics

Adjusted R^2:	0.36
S.E. of regression:	0.0261111
Sum of squared residuals:	0.104996
Durbin-Watson statistic:	2.08
Sample period:	1970Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

b.10 QEPS: Desired level of investment in structures, trending comp.

The target rate of investment is defined as the rate necessary to keep the capital-output ratio at its optimal value (VPS).

log(QEPS) = 0.00
+ 1.00 * log(XNFB)
+ 1.00 * log(VPS)
+ 1.00 * log(HGX/100 + JRPS)

b.11 EPSN: Investment in nonresidential structures

EPSN = .01 * PPSR * PXP * EPS

b.12 KI: Stock of private inventories, cs 2005$

Changes in the real stock of business inventories follow changes in sales with a median lag of 2 quarters. Changes in sales have temporary but no permanent effects on the inventory-sales ratio. Other shocks have permanent effects. Changes in the inventory-sales ratio are partially reversed four quarters later. There is a small downward drift that is captured by the intercept.

Further discussion

$$\textbf{del(1 : log(KI))} = -0.000986_{[-2.548146848138152]} + 0.445\ [8.748468944350381] * \mathrm{del}(1 : \log(KI_{t-1})) + 0.288\ [6.143011833121311] * \mathrm{del}(1 : \log(XFS_{t-1})) + 0.267 * \mathrm{del}(1 : \log(XFS_{t-2})) - 0.138\ [-3.406145814128719] * \mathrm{del}(1 : \log(KI_{t-4}/XFS_{t-4}))$$

Regression statistics

Adjusted R^2:	0.59
S.E. of regression:	0.00507358
Sum of squared residuals:	0.00453045
Durbin-Watson statistic:	1.97
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

b.13 EI: Change in private inventories, cw 2005$

$$\textbf{EI} = 4*\mathrm{del}(1 : KI)$$

b.14 EIN: Change in business inventories, current $

$$\textbf{EIN} = .01*PXP*PKIR*EI$$

b.15 KPDC: Stock of computers, software, and communication equipment, cw 2005 $

The equation for the stock of computers differs from the standard specification in that differences in the prices of investment and capital are taken into account by measuring the contribution of investment to the increase in the capital stock in terms of the price of capital goods.

$$\textbf{KPDC} = 0.25 * EPDC * (PPDCR/PKPDCR) + (1-JRPDC/4) * KPDC_{t-1}$$

b.16 KPDO: Stock of E&S capital excluding computers, software, and communication equipment, cw 2005 $

$$\mathbf{KPDO} = 0.25 * \text{EPDO} + (1\text{-JRPDO}/4) * \text{KPDO}_{t\text{-}1}$$

b.17 KPS: Stock of nonresidential structures, cw 2005$

$$\mathbf{KPS} = 0.25 * \text{EPS} + (1\text{-JRPS}/4) * \text{KPS}_{t\text{-}1}$$

b.18 HKS: Growth rate of KS, cw 2005$ (compound annual rate)

The growth rate of capital services is modeled as a weighted average of the growth rates of four capital stocks. The weights are measures of income shares earned by each type of capital. A residual component, which makes the equation an identity, accounts for the use of partially aggregated capital stocks rather than disaggregated capital stocks, omission of several types of capital (owner-occupied housing, land), and approximation error in the constructed income share weights.

$$\begin{aligned}\mathbf{HKS} = {} & 400 * (\text{YKPDCN} * \text{del}(1 : \log(\text{KPDC})) + \text{YKPDON} * \text{del}(1 : \log(\text{KPDO})) \\ & + \text{YKPSN} * \text{del}(1 : \log(\text{KPS})) + \text{YKIN} * \text{del}(1 : \log(\text{KI}))) / \\ & (\text{YKPDCN} + \text{YKPDON} + \text{YKPSN} + \text{YKIN}) + \text{HKSR}\end{aligned}$$

b.19 KS: Capital services, 2005 $

$$\mathbf{log(KS)} = \log(\text{KS}_{t\text{-}1}) + \text{HKS}/400$$

b.20 RPD: After-tax real financial cost of capital for producers' durable equipment

The firm's financing cost is measured as a weighted average of borrowing costs in debt and equity markets, where the weights are chosen to optimize the fit of the equation for equipment investment. The cost of debt finance is proxied by the yield on 5-year Treasury bonds plus a risk premium measured by the spread between the BAA bond rate and the yield on 10-year Treasury bonds, and allows for the tax deductibility of interest payments. The expected rate of inflation over a 5-year horizon is subtracted from the after-tax nominal yield to obtain the real after-tax rate of interest. The cost of equity finance is measured as the expected real return to equity.

RPD = 0.5*(7.2 + (1-TRFCIM)*(RG5E + RBBBE- RG10E) - ZPIB5) + 0.5*REQ

b.21 RTINV: Current dollar rent per unit of inventories

The cost, over one year, of using one unit of inventory capital is equal to the relative purchase price of new investment (PKIR*PXP/PXB) multiplied by the real rate of interest (RPD) minus the trend growth rate of the relative price of inventories (GPKIR).

$$\mathbf{RTINV} = (.01*RPD - .01*HGPKIR) * (\text{mave}(2 : PXP_t*PKIR_t))/PXNFB$$

b.22 RTPDC: Current dollar rent per unit of new computers, software, and communications equipment

The log cost, over one year, of using one unit of high-tech capital is equal to the sum of three terms: the relative purchase price of new investment (PKPDCR*PXP/PXNFB); the depreciation rate (JRPDC) plus the real rate of interest (RPD) less the trend growth rate of relative high-tech prices (GPPDCR); and the tax adjustment for depreciation, the investment tax credit, and the corporate marginal tax rate.

$$\mathbf{RTPDC} = (.01*RPD + JRPDC - .01*HGPDCR) * ((1-.01*TAPDTC-TRFCIM*(1-TAPDDP*.01*TAPDTC)*TAPDDC)/(1-TRFCIM)) * (\text{mave}(2 : PXP_t*PKPDCR_t))/PXNFB$$

b.23 RTPDO: Current dollar rent per unit of other equipment

The log cost, over one year, of using one unit of non-high-tech equipment is equal to the sum of three terms: the relative purchase price of new investment (PPDOR*PXP/PXNFB); the depreciation rate (JRPDO) plus the real rate of interest (RPD) less the trend growth rate of relative non-high-tech prices (HGPDOR); and a tax adjustment for depreciation, the investment tax credit, and the corporate marginal tax rate.

$$\textbf{RTPDO} = (.01*\text{RPD} + \text{JRPDO} - .01*\text{HGPDOR}) \\ * ((1-.01*\text{TAPDTO}-\text{TRFCIM}*(1-\text{TAPDDP}*.01*\text{TAPDTO})*\text{TAPDDO})/(1-\text{TRFCIM})) \\ * (\text{mave}(2 : \text{PXP}_t*\text{PPDOR}_t))/\text{PXNFB}$$

b.24 RTPS: Current dollar rent per unit of new nonresidential structures

The log cost, over one year, of using one unit of structures capital has three components: the relative purchase price of new investment (PPSR*PXP/PXNFB); the depreciation rate (JRPS) plus the real rate of interest (RPD) less the trend growth rate of the relative price of structures (GPPSR); and the tax adjustment for depreciation and the marginal corporate tax rate. A MAX function is included to prevent RTPS from taking on implausible values, improving the stability of the model in stochastic simulations. Over history, RTPS has never approached this floor.

$$\textbf{RTPS} = \max((.01*\text{RPD} + \text{JRPS} - .01*\text{HGPPSR}) \\ * ((1-\text{TRFCIM}*\text{TAPSDA})/(1-\text{TRFCIM})) \\ * (\text{mave}(2 : \text{PXP}_t*\text{PPSR}_t))/\text{PXNFB}, .02)$$

b.25 TAPDDC: Present value of depreciation allowances for high-tech equipment and software

The expression represents the present value of the various statutory depreciation allowances that have existed over time. The nominal rate of interest, used to compute the present value of the statutory allowance, is the after-tax cost to the firm of borrowing in debt and equity markets. The dummy variables D81, equal to 1 after 1980 and 0 before, and D87, equal to 1 after 1986, control for changes in depreciation rules: Prior to 1981, firms could elect to compute depreciation using either a straight-line or sum-of-years formula, but after that date accelerated depreciation was allowed under a 150 percent declining balance formula through 1986 and a 200 declining balance formula thereafter.

$$\textbf{TAPDDC} = .5 * \text{D2003} + .5 * \text{D2003} * (2.0 / (2.0 + .01 * \text{TAPDSC} * (\text{RPD} + \text{ZPIB5}))) \\ + .3 * \text{D2002} + .7 * \text{D2002} * (2.0 / (2.0 + .01 * \text{TAPDSC} * (\text{RPD} + \text{ZPIB5}))) \\ + (\text{D87} - \text{D2002} - \text{D2003}) * (2.0 / (2.0 + .01 * \text{TAPDSC} * (\text{RPD} + \text{ZPIB5}))) \\ + (\text{D81}-\text{D87}) * (1.5 / (1.5 + .01 * \text{TAPDSC} * (\text{RPD} + \text{ZPIB5}))) \\ + (1-\text{D81}) \\ * (((1-\text{TAPDAD})*(1-\exp(-(.01*\text{TAPDSC}*(\text{RPD}+\text{ZPIB5})))) \\ /(.01*\text{TAPDSC}*(\text{RPD}+\text{ZPIB5}))) \\ + \text{TAPDAD} *2*(1-(1-\exp(-(.01*\text{TAPDSC}*(\text{RPD}+\text{ZPIB5})))) \\ /(.01*\text{TAPDSC}*(\text{RPD}+\text{ZPIB5}))) \\ /(.01 * \text{TAPDSC} * (\text{RPD} + \text{ZPIB5})))$$

b.26 TAPDDO: Present value of depreciation allowances for non-high-tech equipment

The expression represents the present value of the various statutory depreciation allowances that have existed over time. The nominal rate of interest, used to compute the present value of the statutory allowance, is the after-tax cost to the firm of borrowing in debt and equity markets. The dummy variables D81, equal to 1 after 1980 and 0 before, and D87, equal to 1 after 1986, control for changes in depreciation rules: Prior to 1981, firms could elect to compute depreciation using either a straight-line or sum-of-years formula, but after that date accelerated depreciation was allowed under a 150 percent declining balance formula through 1986 and a 200 declining balance formula thereafter.

TAPDDO = .5 * D2003 + .5 * D2003 * (2.0 / (2.0 + .01 * TAPDSO * (RPD + ZPIB5)))
+ .3 * D2002 + .7 * D2002 * (2.0 / (2.0 + .01 * TAPDSO * (RPD + ZPIB5)))
+ (D87 - D2002 - D2003) * (2.0 / (2.0 + .01 * TAPDSO * (RPD + ZPIB5)))
+ (D81-D87) * (1.5 / (1.5 + .01 * TAPDSO * (RPD + ZPIB5)))
+ (1-D81)
* (((1-TAPDAD)*(1-exp(-(.01*TAPDSO*(RPD+ZPIB5))))
/(.01*TAPDSO*(RPD+ZPIB5)))
+ TAPDAD *2*(1-(1-exp(-(.01*TAPDSO*(RPD+ZPIB5))))
/(.01*TAPDSO*(RPD+ZPIB5)))
/(.01 * TAPDSO * (RPD + ZPIB5)))

b.27 TAPSDA: Present value of depreciation allowances for nonresidential structures

The expression represents the present value of the various statutory depreciation allowances that have existed over time. The nominal rate of interest, used to compute the present value of the statutory allowance, is the after-tax cost to the firm of borrowing in debt and equity markets.

TAPSDA = (1-TAPSAD)*(1-EXP(-0.01*(RPD+ZPIB5)*TAPSSL))/
(0.01*(RPD+ZPIB5)*TAPSSL) +
TAPSAD*(1-D69) * 2 *
(1 - (1-EXP(-0.01*(RPD+ZPIB5)*TAPSSL))/
(0.01*(RPD+ZPIB5)*TAPSSL)) / (0.01*(RPD+ZPIB5)*TAPSSL)
+ TAPSAD*(D69-D81) *((1.5 /
(1.5 + .01 * TAPSSL * (RPD + ZPIB5))) *
(1 - exp(-0.5-0.33*(0.01*(RPD+ZPIB5)*TAPSSL))) +
(exp(-0.5)/(0.67*(0.01*(RPD+ZPIB5)*TAPSSL)))*
(exp(-0.33*(0.01*(RPD+ZPIB5)*TAPSSL)) -
exp(-(0.01*(RPD+ZPIB5)*TAPSSL))))

+ TAPSAD * (D81-D86) *((1.75 /
(1.75 + .01 * TAPSSL * (RPD + ZPIB5))) *
(1 - exp(-0.75-0.428*(0.01*(RPD+ZPIB5)*TAPSSL))) +
(exp(-0.75)/(0.572*(0.01*(RPD+ZPIB5)*TAPSSL)))*
(exp(-0.428*(0.01*(RPD+ZPIB5)*TAPSSL)) -
exp(-(0.01*(RPD+ZPIB5)*TAPSSL))))
+ TAPSAD * D86 * (1-EXP(-0.01*(RPD+ZPIB5)*TAPSSL))/
(0.01*(RPD+ZPIB5)*TAPSSL)

b.28 VPDC: Desired hi-tech equipment-output ratio

The desired equipment-output ratio is inversely related to the user cost of capital, implying an elasiticity of substitution of one. The multiplicative factor UVPDC has the interpretation of the equilibrium income share of high-tech equipment and software. Over history, UVPDO is estimated with an HP filter, and is thus time-varying. It is assumed to be exogenous in simulation. Finally, owing to the interaction between rapid prices declines and differences in weighting between equipment and capital stocks, there are important differences in the trends in the price indexes for equipment (PPDCR) and the capital stock (PKPDCR).

VPDC = UVPDC*(PKPDCR/PPDCR)/RTPDC

b.29 VPDO: Desired ex. hi-tech equipment-output ratio

The desired equipment-output ratio is inversely related to the user cost of capital, implying an elasiticity of substitution of one. The multiplicative factor UVPDO has the interpretation of the equilibrium income share of non-high-tech equipment. Over history, UVPDO is estimated with an HP filter, and is thus time-varying. It is assumed to be exogenous in simulation.

VPDO = UVPDO/RTPDO

b.30 VPS: Desired structures-output ratio

The desired structures-output ratio is inversely related to the user cost of capital, implying an elasiticity of substitution of one. The multiplicative factor UVPS has the interpretation of the equilibrium income share for nonresidential structures. Over history, UVPS is estimated with an HP filter, and is thus time-varying. It is assumed to be exogenous in simulation.

$$\textbf{VPS} = UVPS/RTPS$$

b.31 HGVPDC: trend growth rate of VPDC

The trend growth rate of the capital-output ratio is estimated using a one-sided H-P filter (lambda = 6400) for the level of the capital-output ratio. Going forward, it is a geometrically weighted moving average of past growth rates.

$$\textbf{HGVPDC} = 0.970 * HGVPDC_{t-1} + 0.0300 * \log(VPDC/VPDC_{t-1})$$

b.32 HGVPDO: trend growth rate of VPDO

The trend growth rate of the capital-output ratio is estimated using a one-sided H-P filter (lambda = 6400) for the level of the capital-output ratio. Going forward, it is a geometrically weighted moving average of past growth rates.

$$\textbf{HGVPDO} = 0.970 * HGVPDO_{t-1} + 0.0300 * \log(VPDO/VPDO_{t-1})$$

b.33 HGVPS: trend growth rate of VPS

The trend growth rate of the capital-output ratio is estimated using a one-sided H-P filter (lambda = 6400) for the level of the capital-output ratio. Going forward, it is a geometrically weighted moving average of past growth rates.

$$\textbf{HGVPS} = 0.970 * HGVPS_{t-1} + 0.0300 * \log(VPS/VPS_{t-1})$$

Foreign Trade

The core of the foreign trade sector is a pair of behavioral equations for the volume of exports and nonoil imports. In addition, there is an equation determining domestic crude energy consumption (and thus the volume of oil imports), as well as a variety of identities and quasi-identities for aggregate real and nominal exports and imports, U.S. net foreign investment income, the current account balance, and the net foreign asset position of the United States.

c.1 EX: Exports of goods and services, cw 2005 $

The growth of exports is modeled in an error-correction format. In the long run, the volume of exports depends on foreign output (FGDP), export prices relative to foreign prices (PXR*PXP*FPX/FPC), and a time trend. The long-run income elasticity of exports is constrained to equal unity so that the model is stable along its steady-state growth path. The short-run income elasticity is almost 3. The long-run price elasticity of demand is -0.9. The effect of large dock strikes in the 1960s and 1970s is removed by dummying out affected quarters.

Further discussion

$$
\begin{aligned}
\mathbf{del(1 : log(EX))} = & -0.103\ [-5.890604606936495] * (\log(EX_{t-1}) - \log(FGDP_{t-1}) \\
& + 0.940309*\log(PXR_{t-1}*PXP_{t-1}*FPX_{t-1}/FPC_{t-1})) \\
& + 0.000106[3.451083055287866] * T47 \\
& + 0.678\ [5.654953501331531] \\
& + 2.46\ [9.481397997581104]*((\log(FGDP)-\log(FGDP_{t-2}))/2) \\
& + 0.597\ [1.810980004377249]*((\log(FGDP_{t-2})-\log(FGDP_{t-6}))/4) \\
& + 1.01\ [20.00927355425925]*DDOCKX
\end{aligned}
$$

Regression statistics

Adjusted R^2:	0.77
S.E. of regression:	0.0176516
Sum of squared residuals:	0.0542148
Durbin-Watson statistic:	2.34
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

c.2 EXN: Exports of goods and services, current $

EXN = .01*PXP*PXR*EX

c.3 EMO: Imports of goods and services ex. petroleum, cw 2005$

The growth of non-oil imports (EMO) is modeled in an error-correction format. In the long run, the volume of imports depends on the level of domestic absorption, relative non-oil import prices, the output gap, and a time trend. The long-run income elasticity of non-oil imports is constrained to equal unity so that the model is stable along its steady-state growth path. The inclusion of the level of the output gap means the medium-run income elasticity (holding potential output constant) is 2.2 (=.289/.245 + 1). The long-run elasticity with respect to exchange rate changes, is the sum of the price elasticity of demand, -0.6 (= -.156/.245), and the price elasticity of supply , 0.3 (= .082/.245), the latter being important when pass-through is low. Short-run import growth is a function of the lagged difference between actual and steady-state non-oil imports, the change in the output gap and dock strikes. The effect of large dock strikes in the 1960s and 1970s is removed by including a dummy constructed by Peter Isard (IFDP No. 60, 1975)

Further discussion

del(1 : log(EMO)) = -0.180 [-3.991561571917959]*(log(EMO$_{t-1}$) - log(XGDE$_{t-1}$))
- 0.110 [-4.003631565147956]*log(PMO$_{t-1}$/PGDP$_{t-1}$)
+ 0.0847 [2.925956027916481]*(log((PMO$_{t-1}$*FPXM$_{t-1}$)/FPCM$_{t-1}$))
+ 0.00187 [3.954936723516476]*T47
- 1.18 [-3.927043344681194]
+ 1.63 [8.352872718645394]*((XGAP2-XGAP2$_{t-1}$)/100)
+ 1.39 [7.13203170765431]*((XGAP2$_{t-1}$-XGAP2$_{t-2}$)/100)
+ 0.347 [2.882147519889398]*(XGAP2$_{t-2}$/100)
+ 0.720 [8.596055129416435]*del(1:log(DDOCKM))
+ 0.313 [2.27709164039414]*log(DDOCKM$_{t-1}$)

Regression statistics

Adjusted R^2:	0.66
S.E. of regression:	0.021113
Sum of squared residuals:	0.0757788
Durbin-Watson statistic:	1.74
Sample period:	1965Q1 2009Q4

Estimation date:	September 2010
Estimation method:	Least Squares

c.4 EMON: Imports of goods and services ex. petroleum

EMON = .01 * PMO * EMO

c.5 CENG: Consumption of crude energy (oil, coal, natural gas), 2005 $

Real growth in economy-wide consumption of crude energy (oil, natural gas, and coal) is determined in an error-correction format, in which the long-run level of consumption is proportional to aggregate gross output (XG) and the trend optimal energy-output ratio (VEOA). In the short run, energy consumption growth is also affected by lagged growth, growth in the optimal energy-output ratio, growth in spot energy prices relative to trend (VEO/VEOA), and growth in gross output.

del(1 : log(CENG)) =

-0.0268 [-0.7977064378679613] * $(\log(CENG_{t-1})-\log(XG_{t-1}*VEOA_{t-1}))$

$- 0.0948$ [-0.8219483097785871]

$+ B1(L)$ {sum 1.48 } * $del(1 : \log(XG_{t}))$

$+ 0.352$ [0.8426406766512768] * $del(1 : \log(VEOA))$

$+ B3(L)$ {sum -0.484 } * $del(1 : \log(CENG_{t-1}))$

Distributed lag coefficients

Name	Value
$B1_0$	0.498 0.00
$B1_1$	0.986 0.00
$B1_{SUM}$	1.48
$B3_0$	-0.336 0.00
$B3_1$	-0.148 0.00
$B3_{SUM}$	-0.484

Regression statistics

Adjusted R^2:	0.21
S.E. of regression:	0.0261803

Sum of squared residuals:	0.119261
Durbin-Watson statistic:	2.04
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

c.6 EMP: Petroleum imports, cw 2005$

EMP equals the difference between domestic energy consumption and production multiplied by an exogenous conversion factor.

$$\mathbf{EMP} = UEMP*(CENG-XENG)$$

c.7 EMPN: Petroleum imports, current $

$$\mathbf{EMPN} = .01*PMP*EMP$$

c.8 EMN: Imports of goods and services, current $

$$\mathbf{EMN} = EMON + EMPN$$

c.9 EM: Imports of goods and services, cw 2005$

Total export volumes are approximated by the Divisia aggregate of oil and non-oil imports.

$$\begin{aligned}\mathbf{log(EM)} = & \log(EM_{t-1}) \\ & + .5 * (EMON/EMN + EMON_{t-1}/EMN_{t-1}) * del(1:log(EMO)) \\ & + .5 * (EMPN/EMN + EMPN_{t-1}/EMN_{t-1}) * del(1:log(EMP))\end{aligned}$$

c.10 FCBN: US current account balance, current $

The current account balance is equal to net exports (EXN - EMN) plus net foreign investment income (FYNIN), plus a discrepancy (FCBRN).

FCBN = EXN - EMN + FYNIN + FCBRN

c.11 FCBRN: US current account balance residual, current $

The discrepancy in the current account balance is assumed to be proportional to nominal potential output.

FCBRN = UFCBR*PXG*XGPOT/100

c.12 FNFIN: Net foreign investment

FNFIN = FCBN + FNFIRN

c.13 FNFIRN: Discrepancy between net foreign investment and current account balance

FNFIRN = UFNFIR * (.01 * PXG * XGPOT)

c.14 FNIN: Net stock of claims of US residents on the rest of the world, current $

The change in the net foreign investment position is equal to the current account balance expressed at a quarterly rate.

$$\mathbf{del(1 : FNIN)} = .25 * FCBN + .54 * (del(1: \log(FPC)) * FNICN_{t-1}) - .32 * (del(1: \log(PGDP)) * FNILN_{t-1})$$

$$- .67 * (\mathrm{del}(1: \log(FPX)) * FNICN_{t-1})$$
$$+ .06 * (\mathrm{del}(1: \log(FPX)) * FNILN_{t-1})$$
$$+ FNIRN$$

c.15 FTCIN: Corporate taxes paid to rest of world, current $

Corporate taxes paid to the rest of the world are assumed to be proportional to nominal GDP.

$$\mathbf{FTCIN} = UFTCIN * YNICPN$$

c.16 FYNIN: Net investment income received from the rest of the world, current $

$$\mathbf{FYNIN} = FYNICN - FYNILN$$

c.17 HGEMP: Petroleum imports, cw 2005$, trend growth rate

$$\mathbf{HGEMP} = 0.900 * HGEMP_{t-1}$$
$$+ 0.100 * 400 * \log(EMP/EMP_{t-1})$$

c.18 FNICN: Gross stock of claims of US residents on the rest of the world, current $

$$\mathbf{del(1{:}FNICN)/XGDPTN} = .54 * \mathrm{del}(1: \log(FPC))*FNICN_{t-1}/XGDPTN$$
$$- .67 * \mathrm{del}(1: \log(FPX))*FNICN_{t-1}/XGDPTN$$
$$+ RFNICT$$

c.19 FNILN: Gross stock of liabilities of US residents to the rest of the world, current $

$$\textbf{FNILN} = \text{FNICN} - \text{FNIN}$$

c.20 FYNICN: Gross investment income received from the rest of the world, current $

$$\textbf{FYNICN} = .01*\text{RFYNIC}*\text{FNICN}_{t-1}$$

c.21 FYNILN: Gross investment income paid to the rest of the world, current $

$$\textbf{FYNILN} = .01*\text{RFYNIL}*\text{FNILN}_{t-1}$$

c.22 RFYNIC: Average yield earned on gross claims of US residents on the rest of the world

$$\begin{aligned}\textbf{del(1 : RFYNIC)} = {} & 0.261 \; [3.691211818521129] \\ & - 0.148 \; [-3.828745012838288] * (\text{RFYNIC}_{t-1}-\text{RFYNIL}_{t-1}) \\ & + 0.146 \; [2.217149444859147] * \text{del}(1 : \text{RFYNIC}_{t-1}) \\ & + 0.649 \; [8.722848948396303] * \text{del}(1 : \text{RFYNIL})\end{aligned}$$

Regression statistics

Adjusted R^2:	0.39
S.E. of regression:	0.313226
Sum of squared residuals:	15.3052
Durbin-Watson statistic:	2.26
Sample period:	1970Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

c.23 RFYNIL: Average yield earned on liabilities of US residents on the rest of the world

$$
\begin{aligned}
\textbf{del(1 : RFYNIL)} = {} & 0.197\ [2.365772926116853] \\
& - 0.248\ [-5.756860517335384] * RFYNIL_{t-1} \\
& + 0.0825\ [3.415210906800147] * RG10_{t-1} \\
& + 0.0937\ [4.454093946873924] * RTB_{t-1} \\
& + 0.0363\ [3.255092737065924] * REQP_{t-1} \\
& + 0.145\ [2.646127198672133] * del(1 : RFYNIL_{t-1}) \\
& + 0.0861\ [1.549857878558029] * del(1 : RG10) \\
& + 0.259\ [8.606308927715266] * del(1 : RTB) \\
& + 0.00571\ [0.2301919911889315] * del(1 : REQP)
\end{aligned}
$$

Regression statistics

Adjusted R^2:	0.59
S.E. of regression:	0.227193
Sum of squared residuals:	7.79413
Durbin-Watson statistic:	2.30
Sample period:	1970Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

c.24 FNIRN: Net stock of claims of US residents on the rest of the world, residual

FNIRN = UFNIR * XGDPN

Aggregate Output Identities

This sector contains aggregate identities determining the level of various measures of real aggregate output and demand. Some of these aggregates, such as GDP and final sales, are built up from component expenditure categories that are determined in other sectors of the model. Other aggregates, such as government output, are linked by exogenous conversion ratios to a related indicator (e.g., government employment). In either case, historical data for the various aggregates are typically based on series published by the Commerce Department. However, two measures -- output of the nonfarm business sector (less housing and energy and net of indirect business taxes), and final sales excluding government compensation, imports and indirect business taxes -- are special FRB/US constructs. The former is the measure of output used in the model's aggregate production function, while the latter is used to define the main price variable in the determination of wages and prices.

In addition to these measures of aggregate output and demand, the sector also contains a set of equations determining the level of potential output -- that is, the level of production consistent with full employment in the labor market and labor productivity at its trend. Two related measures of potential output are used in the model. The first (XGPOT) refers to the maximum sustainable level of production in the adjusted nonfarm business sector; the second is XGDPT, which denotes the level of potential GDP.

d.1 XFS: Final sales of gross domestic product, cw 2005$

The real final sales category of GDP is approximated by the Divisia aggregate of its components.

$$
\begin{aligned}
\mathbf{log(XFS)} = {} & \log(XFS_{t-1}) \\
& + .5*(\ (ECNIAN/XFSN + ECNIAN_{t-1}/XFSN_{t-1}) * del(1{:}\log(ECNIA)) \\
& + (EHN/XFSN + EHN_{t-1}/XFSN_{t-1}) * del(1{:}\log(EH)) \\
& + (EPDCN/XFSN + EPDCN_{t-1}/XFSN_{t-1}) * del(1{:}\log(EPDC)) \\
& + (EPDON/XFSN + EPDON_{t-1}/XFSN_{t-1}) * del(1{:}\log(EPDO)) \\
& + (EPSN/XFSN + EPSN_{t-1}/XFSN_{t-1}) * del(1{:}\log(EPS)) \\
& + (EGFON/XFSN + EGFON_{t-1}/XFSN_{t-1}) * del(1{:}\log(EGFO)) \\
& + (EGFIN/XFSN + EGFIN_{t-1}/XFSN_{t-1}) * del(1{:}\log(EGFI)) \\
& + (EGFLN/XFSN + EGFLN_{t-1}/XFSN_{t-1}) * del(1{:}\log(EGFL)) \\
& + (EGSON/XFSN + EGSON_{t-1}/XFSN_{t-1}) * del(1{:}\log(EGSO)) \\
& + (EGSIN/XFSN + EGSIN_{t-1}/XFSN_{t-1}) * del(1{:}\log(EGSI)) \\
& + (EGSLN/XFSN + EGSLN_{t-1}/XFSN_{t-1}) * del(1{:}\log(EGSL)) \\
& + (EXN/XFSN + EXN_{t-1}/XFSN_{t-1}) * del(1{:}\log(EX)) \\
& - (EMON/XFSN + EMON_{t-1}/XFSN_{t-1}) * del(1{:}\log(EMO)) \\
& - (EMPN/XFSN + EMPN_{t-1}/XFSN_{t-1}) * del(1{:}\log(EMP)))
\end{aligned}
$$

d.2 XGDP: GDP, cw 2005$

Real gross domestic output (XGDP) is the chain-weighted aggregate of final sales and inventory investment.

$$\mathbf{XGDP} = XGDP_{t-1} * SQRT(

$$((XFSN_{t-1}/XGDPN_{t-1}) * (XFS/XFS_{t-1})$$
$$+ (.01 * EI_{t-1}*PKIR_{t-1}*PXP_{t-1} / XGDPN_{t-1}) * (EI/EI_{t-1}))$$
$$* 1/$$
$$((XFSN/XGDPN) * (XFS_{t-1}/XFS)$$
$$+ (.01 * EI*PKIR*PXP / XGDPN) * (EI_{t-1}/EI)))$$

d.3 HGGDP: Growth rate of GDP, cw 2005$ (compound annual rate)

$$\mathbf{HGGDP =} 400*del(1 : log(XGDP))$$

d.4 XNFB: BLS NFB output, 2005$

The nominal ratio of nonfarm business output to nominal GDP is 0.761 over the 1965-2007 period. Imposing the coefficient on log(XGDP) to be the inverse of this quantity ensures that the GDP gap -- XGAP2 -- bears the appropriate cyclical relationship with the private-sector output gap, XGAP. The relationship also includes a trend component, UXNFBT. UXNFBT is estimated with the Kalman filter as part of the estimation of the XNFB equation. The trend is assumed to follow a random walk with drift, with the drift component following an AR(1) process; it is not shocked in stochastic simulation. After accounting for the trend, there is an additional component, which follows an AR(1) process.

$$\mathbf{log(XNFB) =} 1.31 * log(XGDP) + log(UXNFBT)$$
$$+ 0.879 * (log(XNFB_{t-1}) - 1.31 * log(XGDP_{t-1})$$
$$- log(UXNFBT_{t-1}))$$

Regression statistics

Sample period: 1960Q1 2009Q4
Estimation date: August 2010
Estimation method: Maximum likelihood (Marquardt)

d.5 HUXNFB: Drift term in UXNFBT

The trend component of the multiplicative factor in the XNFB equation is estimated with the Kalman filter. The trend component is assumed to follow a random walk with drift, with the drift component following an

AR(1) process. This equation is not shocked in stochastic simulation.

$$\textbf{HUXNFB} = -0.0332 \; [7.93] + 0.950 * HUXNFB_{t-1}$$

Regression statistics

Standard deviation of drift shock = 0.04 :	
Sample period:	1960:1 - 2009:4
Estimation date:	August 2010

d.6 UXNFBT: Multiplicative factor in XNFB equation (Kalman filter)

The trend component of the multiplicative factor in the XNFB equation is estimated with the Kalman filter. The trend component is assumed to follow a random walk with drift, with the drift component following an AR(1) process. This equation is not shocked in stochastic simulation.

$$\textbf{log(UXNFBT)} = 0.00 + \log(UXNFBT_{t-1}) + .0025 * HUXNFB$$

Regression statistics

Standard deviation of level shock = 0.0015 :	
Standard deviation of drift shock = 0.04 :	
Sample period:	1960:Q1 - 2009:Q4
Estimation date:	August 2010

d.7 XENG: Crude energy production, cw 2005$

Output of fossil energy is linked to aggregate potential output (XGPOT) via an exogenous conversion ratio (UXENG).

$$\textbf{XENG} = UXENG * XGPOT$$

d.8 XG: Output of nonfarm, nonhousing business sector plus oil imports (net of IBT)

Gross output of the adjusted non-farm non-energy business sector is an aggregate of nonfarm business output (XNFB) and oil imports (EMP). Aggregation is done in growth rates using weights that are the product of a fixed component (the .035 equilibrium energy share in the XGPOT production function) and a time-varying component (the nominal ratio of oil imports to total domestic energy use)

$$\mathbf{log(XG)} = \log(XG_{t-1})$$
$$+ (1 - .5*(.035*EMPN/(.01*PCENG*CENG) + .035*EMPN_{t-1}/(.01*PCENG_{t-1}*CENG_{t-1}))) * del(1:log(XNFB))$$
$$+ .5*(.035*EMPN/(.01*PCENG*CENG) + .035*EMPN_{t-1}/(.01*PCENG_{t-1}*CENG_{t-1})) * del(1:log(EMP))$$

d.9 XP: Final sales plus imports less gov. labor and ind. bus. taxes, cw 2005$

Real domestic final purchases, excluding government compensation but including exports, are approximated by the Divisia aggregate of its components.

$$\mathbf{log(XP)} = \log(XP_{t-1})$$
$$+ .5 * (ECNIAN/XPN + ECNIAN_{t-1}/XPN_{t-1}) * del(1:log(ECNIA))$$
$$+ .5 * (EHN/XPN + EHN_{t-1}/XPN_{t-1}) * del(1:log(EH))$$
$$+ .5 * (EPDCN/XPN + EPDCN_{t-1}/XPN_{t-1}) * del(1:log(EPDC))$$
$$+ .5 * (EPDON/XPN + EPDON_{t-1}/XPN_{t-1}) * del(1:log(EPDO))$$
$$+ .5 * (EPSN/XPN + EPSN_{t-1}/XPN_{t-1}) * del(1:log(EPS))$$
$$+ .5 * (EGFON/XPN + EGFON_{t-1}/XPN_{t-1}) * del(1:log(EGFO))$$
$$+ .5 * (EGFIN/XPN + EGFIN_{t-1}/XPN_{t-1}) * del(1:log(EGFI))$$
$$+ .5 * (EGSON/XPN + EGSON_{t-1}/XPN_{t-1}) * del(1:log(EGSO))$$
$$+ .5 * (EGSIN/XPN + EGSIN_{t-1}/XPN_{t-1}) * del(1:log(EGSI))$$
$$+ .5 * (EXN/XPN + EXN_{t-1}/XPN_{t-1}) * del(1:log(EX))$$

d.10 HMFPT: Trend growth rate of multifactor productivity

$$\mathbf{HMFPT} = 0.0550 + 0.950 *HMFPT_{t-1}$$

d.11 MFPT: Multifactor productivity, trend level

$$\textbf{log(MFPT)} = 0.00 + \log(\text{MFPT}_{t-1}) + \text{HMFPT}/400$$

d.12 VEO: Desired energy-output ratio

The optimal energy-output ratio for new equipment (VEO) is proportional to the inverse of the relative price of energy inputs, given a KLE Cobb-Douglas production function. PXNFB is the price index for nonfarm business output, and PCENG is a price index for fossil energy inputs.

$$\textbf{log(VEO)} = \log(\text{PXNFB}/\text{PCENG})$$

d.13 VEOA: Average energy-output ratio of existing capital stock

Given Cobb-Douglas production, the optimal energy-output ratio for new equipment (VEO) is proportional to the inverse of the relative price of energy. However, the putty-clay assumption means that the average energy-output ratio for the existing stock of capital (VEOA) will be roughly proportional to a distributed lag of past optimal energy-output ratios (VEOA). An adjustment speed of 1.2 percent per quarter yields a series for VEOA that provides the best fit for the model's energy (CENG) equation. Note: Since the mid-1990s, actual energy use has fallen short of the level consistent with lagged price movements. This shortfall is captured by a trend break that starts in 1994:Q1; this term (UVEOA) reduces the growth rate of VEOA thereafter by 2.5 percent at an annual rate.

$$\begin{aligned}\textbf{log(VEOA)} = {} & 0.988 * \log(\text{VEOA}_{t-1}) \\ & + 0.0120 * \log(\text{VEO}_{t-1}) \\ & + \text{UVEOA}\end{aligned}$$

d.14 XGPOT: Potential output of bus. sector ex. energy, housing, and farm, cw 2005$

Potential output (XGPOT) is based on a three-factor KLE Cobb-Douglas production function. In addition to measures of factor inputs, the equation also contains trend multi-factor productivity (MFPT), which is actual MFP smoothed with the HP filter.

Potential labor input depends on trend employment (LEPPOT), trend hours per worker (QLWW), and trend labor quality (LQUALT). Capital input is measured by capital services (KS), and energy input by the energy-output ratio for the existing stock of capital (VEOA). Because the latter is the ratio of energy to output, rather than energy by itself, solving the equation for output results in the whole right hand side being divided by one minus the energy share parameter.

$$\textbf{log(XGPOT)} = (0.700 * (\log(\text{LEPPOT}) + \log(\text{QLWW}) + \log(\text{LQUALT})) + 0.265 * \log(\text{KS}) + 0.0350 * \log(\text{VEOA}) + \log(\text{MFPT})) / (1-0.0350)$$

d.15 HGX: Growth rate of XGPOT, cw 2005$ (compound annual rate)

$$\textbf{HGX} = (.7*(\text{HLEPT} + \text{HQLWW} + 400*\text{del}(1 : \log(\text{LQUALT}))) + .265*\text{HKS} + .035*400*\text{del}(1 : \log(\text{VEOA})) + \text{HMFPT})/.965$$

d.16 EMPT: Petroleum imports trend, cw 2005$

The trend component of oil imports is updated in simulations using an error-correction equation that ensures gradual adjustment of the trend to actual imports (EMP). In the historical data, however, EMPT is obtained by H-P filtering EMP.

$$\textbf{del(1: log(EMPT))} = 0.100 \ [(\text{const.})] * \log(\text{EMP}_{t-1}/\text{EMPT}_{t-1}) + 1.00 \ [(\text{const.})] * \text{HGX}/400$$

d.17 XGAP: Output gap for bus. sector ex. energy, housing, and farm (actual - potential)

XGAP is the percentage gap between actual and trend output for the adjusted nonfarm business sector.

$$\textbf{XGAP} = 100*\log(\text{XG}/\text{XGPOT})$$

d.18 XGDE: Absorption

Domestic Absorption (or Gross Domestic Expenditure) is approximated by the Divisia aggregate of GDP plus imports less exports.

$$\textbf{log(XGDE)} = \log(\text{XGDE}_{t-1})$$

$$+ .5*((XGDPN/XGDEN + XGDPN_{t-1}/XGDEN_{t-1}) * del(1:log(XGDP))$$
$$- (EXN/XGDEN + EXN_{t-1}/XGDEN_{t-1}) * del(1:log(EX))$$
$$+ (EMON/XGDEN + EMON_{t-1}/XGDEN_{t-1}) * del(1:log(EMO))$$
$$+ (EMPN/XGDEN + EMPN_{t-1}/XGDEN_{t-1}) * del(1:log(EMP)))$$

d.19 XGAP2: Output gap for GDP (actual - potential)

Experimental version -- may have aggregation problems.

$$\mathbf{XGAP2} = 100 * \log(XGDP/XGDPT)$$

d.20 HGGDPT: Growth rate of XGDPT, cw 2005$ (compound annual rate)

The coefficient on trend nonfarm business output growth is the average nominal ratio of nonfarm business output to nominal GDP over the 1965-2007 period. The trend component, HUXNFB, is estimated over history with the Kalman filter. It is typically not shocked in stochastic simulation.

$$\mathbf{HGGDPT} = 0.761 *(HXNFBT - HUXNFB)$$

d.21 XGDPT: Potential GDP, cs 2005$

The coefficient on the log of trend nonfarm business sector output is the average nominal ratio of nonfarm business output to nominal GDP over the 1965-2007 period. The trend component, UXNFBT, is estimated with the Kalman filter.

$$\mathbf{\log(XGDPT)} = 0.761 * (\log(XNFBT) - \log(UXNFBT))$$

d.22 XGDPTN: Potential GDP, nominal

Trend nominal potential GDP is the product of real potential GDP and the GDP deflator.

$$\textbf{XGDPTN} = .01*PGDP*XGDPT$$

d.23 XNFBT: potential NFB output

$$\textbf{log(XNFBT)} = \log(XNFB) + (\log(XGPOT/XG)$$
$$- .5*(.035*EMPN/(.01*PCENG*CENG) + .035*EMPN_{t-1}/(.01*PCENG_{t-1}*CENG_{t-1}))*\log(EMPT/EMP))\ /$$
$$(1 - .5*(.035*EMPN/(.01*PCENG*CENG) + .035*EMPN_{t-1}/(.01*PCENG_{t-1}*CENG_{t-1})))$$

d.24 HXNFBT: Growth rate of XNFBT, cw 2005$ (compound annual rate)

$$\textbf{HXNFBT} = (HGX$$
$$- .5*(.035*EMPN/(.01*PCENG*CENG) + .035*EMPN_{t-1}/(.01*PCENG_{t-1}*CENG_{t-1}))*400*del(1 : \log(EMPT)))\ /$$
$$(1 - .5*(.035*EMPN/(.01*PCENG*CENG) + .035*EMPN_{t-1}/(.01*PCENG_{t-1}*CENG_{t-1})))$$

Labor Market

This sector determines a variety of labor market variables, including hours worked, private employment in the nonfarm business sector, and household employment and labor force participation. The chief equation in the sector is that for growth in hours worked, which is modeled using the polynomial adjustment cost (PAC) framework. Over time, hours worked error-corrects to a long-run equilibrium level consistent with aggregate output and trend labor productivity. The latter is defined in a manner consistent with the aggregate production function, and thus depends on the optimal capital/output and energy/output ratios (which in turn are functions of relative factor prices).

e.1 LHP: Aggregate labor hours, nonfarm business sector (employee and self-employed)

In addition to determining the dynamics of hours adjustment, estimates of the FRB/US hours equation also yield historical values of the trend multifactor productivity (mfp). The latter enters the equation implicitly as a level through its contribution to the target level of hours (QLHP) and as a growth rate through its contribution to the growth rate of trend labor productivity (HLPRDT). Multifactor productivity is modeled as a random walk with drift, which requires that the hours equation be estimated using the Kalman filter.

The level of trend mfp (MFPT) and its growth rate (HMFPT) also appear explicitly in the hours equation, but these terms are present only to make the timing of the implicit contributions consistent with the manner in which the equation was estimated. For example, the first lag of QLHP contains the first lag of MFPT, but we interpret the MFPT series that results from estimating the hours equation as corresponding to contemporaneous MFPT. The extra MFPT term shifts the dating to achieve this.

Hours worked follows the polynomial adjustment cost framework, modified to allow for some portion of labor hours adjusting costlessly. The portion of the equation that corresponds to the costly adjusting hours consists of the three conventional PAC terms -- the degree hours were out of equilibrium last period, lagged hours growth, and expected growth in target hours (ZLHP). The portion of hours that adjust costlessly is captured by the current growth in target hours (the growth rate of XG less the growth rate of trend output per hour, HLPRDT). The coefficient on the latter indicates that nearly 40 percent of hours adjust costlessly and more than 60 percent of hours adjust according to the PAC specification. Lagged growth in target hours enters because of the aggregation of the two types of hours. Based on the derivation of the aggregate equation, its coefficient is restricted to be the negative of the product of the second and fifth coefficients.

del(1 : log(LHP)) =

$$
\begin{aligned}
& 0.234 * (\log(QLHP_{t-1}/LHP_{t-1}) - del(1 : \log(MFPT))/.965) \\
& + 0.188 * del(1 : \log(LHP_{t-1})) \\
& + 0.00 \\
& + 0.586 * ZLHP \\
& + 0.414 * (del(1 : \log(XG)) - HLPRDT_{t-1}/400 - del(1 : HMFPT)/(.965*400)) \\
& - 0.0777 * (del(1 : \log(XG_{t-1})) - HLPRDT_{t-2}/400 - del(1 : HMFPT_{t-1})/(.965*400))
\end{aligned}
$$

Regression statistics

Sample period:	1961Q2 2009Q4
Estimation date:	August 2010
Estimation method:	Maximum likelihood (Marquardt)

e.2 QLHP: Desired level of nonfarm business labor hours, trending component

The equilibrium level of aggregate hours equals gross output (XG) divided by trend labor productivity (LPRDT).

QLHP = XG/LPRDT

e.3 LWW: Workweek, nonfarm business sector (employee and self-employed)

The average workweek in the private nonfarm business sector is a random walk with time-varying drift (HQLWW) plus a cyclical term.

The workweek responds contemporaneously to the growth in total hours (LHP) less its expected rate (HLEPT + HQLWW). About one third of a shift in total hours (LHP) comprises a change in the workweek, with two-thirds being a change in the number of workers. The error-correction term implies that about a quarter of any deviation from trend (QLWW) disappears each quarter.

The trend terms (QLWW and HQLWW) are estimated via the Kalman filter, with the following structure:

log(QLWW) = log(QLWW)(-1) + HQLWW(-1)/400 + err_1

HQLWW = 0.95*HQLWW(-1) + (1-0.95)*0.3 + err_2

As of 2010, the standard deviations of the signal equation errors, err_1, and err_2 were 1.64, 1.56, and 8.0 log points (times 100), respectively. That implies almost all (95%) of surprises to the workweek represent permanent shifts in the level of the workweek, with the remainder largely reflecting growth rate shocks. As of this estimation, temporary disturbances to the workweek (other than through LHP) are negligible.

Further discussion

del(1 : log(LWW)) = HQLWW/400
+ 0.277 [9.707659431771851] * log($QLWW_{t-1}/LWW_{t-1}$)
+ 0.317 [20.75072335285485] * (del(1 : log(LHP)) - (HLEPT + HQLWW)/400)

Regression statistics

Sample period:	1957Q1 2009Q4
Estimation date:	August 2010
Estimation method:	Kalman Filter

e.4 QLWW: Trend workweek, nonfarm business sector (employee and self-employed)

The trend workweek follows a random walk with time-varying drift. The drift term (HQLWW) is persistent but converges to its historic mean. QLWW, HQLWW and the LWW equation are estimated jointly with the Kalman filter.

$$\textbf{log(QLWW)} = \log(QLWW_{t-1}) + HQLWW_{t-1}/400$$

e.5 HQLWW: Trend growth rate of workweek

The expected growth rate of the trend workweek is jointly estimated with QLWW and the LWW equation via the Kalman filter.

HQLWW is persistent, converging to the mean growth of LWW (-0.3 percent annually, as of 2010).

$$\textbf{HQLWW} = 0.950 * HQLWW_{t-1} + (1-0.950) * -0.313$$ [2.434482758761471]

e.6 LEP: Employment in nonfarm business sector (employee and self-employed)

Employment in the non-farm business sector equals aggregate hours divided by the average workweek.

$$\textbf{LEP} = LHP / LWW$$

e.7 LEO: Discrepancy between civilian employment and NFB + gov. emp.

The behavior of LEO -- the difference between total employment in the household survey and the sum of private nonfarm employment (LEP) and government employment(LEF + LES) -- is modeled by the LUR equation

$$\textbf{LEO} = LEH - (LEP + LEF + LES)$$

e.8 LEF: Federal civilian employment ex. gov. enterprise

Federal employment is proportional to constant-dollar federal government expenditures on employee compensation (EGFL), adjusted for trend productivity. Because the national accounts assume that there is no productivity growth in the government sector, the dummy variable DGLPRD is set to 0 over history. In long-run simulations, however, DGLPRD is set to 1.0 to ensure that the government shares of employment and GDP are stationary.

log(LEF) = log(ULEF) + log(EGFL) - DGLPRD*log(LPRDT)

e.9 LES: S&L government employment ex. gov. enterprise

State and local employment is proportional to constant-dollar S&L government expenditures on employee compensation (EGSL), adjusted for trend productivity. Because the national accounts assume that there is no productivity growth in the government sector, the dummy variable DGLPRD is set to 0 over history. In long-run simulations, however, DGLPRD is set to 1.0 to ensure that the government shares of employment and GDP are stationary.

log(LES) = log(ULES) + log(EGSL) - DGLPRD*log(LPRDT)

e.10 LEH: Civilian employment (break adjusted)

Civilian employment from the household survey is the sum of nonfarm business employment (LEP), state and local government employment (LES), federal government employment (LEF), and the employment discrepancy (LEO). LEO is determined by the LUR equation.

LEH = (1-(LUR/100))*LF

e.11 LFPR: Labor force participation rate

The participation rate grows, on average, at its trend rate (HQLFPR) which varies slowly over time. It also adjusts toward its equilibrium level (QLFPR), another slowly varying unobserved variable. The unobserved variables have the following structure:

QLFPR = QLFPR(-1) + HQLFPR + err_1

HQLFPR = 0.95*HQLFPR(-1) + err_2

Cyclical variation in the participation rate is captured by including the gap between the unemployment rate and the NAIRU, which is lagged to avoid coefficient bias that might arise from measurement error that is common to LUR and LFPR.

Coefficients and the relative size of the shocks are estimated by the Kalman filter.

Further discussion

$$\textbf{del(1: LFPR)} = HQLFPR + 0.228\ [3.249311869910366] * (QLFPR - LFPR_{t-1}) - 0.000444[-3.187722525480342] * (LUR_{t-1} - LURNAT_{t-1})$$

Regression statistics

Sample period: 1949Q3 2009Q4
Estimation date: August 2010
Estimation method: Maximum likelihood (Marquardt)

e.12 QLFPR: Trend labor force participation rate (one-sided Kalman filter estimate)

The predicted change in the trend participation rate equals the one-sided Kalman filter estimate of the trend drift in the participation rate. The historical error of this equation differs from zero to the extent that shocks to the participation rate also lead to permanent shifts in the level of the trend.

$$\textbf{QLFPR} = QLFPR_{t-1} + HQLFPR$$

e.13 HQLFPR: Drift component of change in QLFPR (one-sided Kalman filter estimate)

$$\textbf{HQLFPR} = 0.00 + 0.950 * HQLFPR_{t-1}$$

e.14 LF: Civilian labor force (break adjusted)

$$\textbf{LF} = LFPR * N16$$

e.15 LUR: Civilian unemployment rate (break adjusted)

The equation for the unemployment rate is a dynamic Okun's law relationship. It determines the discrepancy between household and payroll employment (LEO) to ensure that the output gap and the unemployment gap co-move in a reasonable manner.

LUR = LURNAT
+ 0.905 [25.80815434175164] * (LUR_{t-1} - $LURNAT_{t-1}$)
+ 0.432 [6.079567562540856] * del(1: LUR_{t-1} - $LURNAT_{t-1}$)
- 0.0631 [-3.444432872634224] * XGAP2
- 0.155 [-4.781955654878094] * del(1: XGAP2)

Regression statistics

Adjusted R^2:	0.99
S.E. of regression:	0.137699
Sum of squared residuals:	1.74441
Durbin-Watson statistic:	2.31
Sample period:	1986Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

e.16 LURBLS: Civilian unemployment rate (published)

LURBLS = LUR

e.17 LURDA: Demographically-adjusted unemployment rate

LURDA is an aggregate of unemployment rates for five age-sex categories, with weights based on the demographic mix of the late 1960s. In model simulations, the demographically-adjusted unemployment rate is linked to the standard civilian unemployment rate (LUR) via an exogenous demographic adjustment factor (LURDF).

LURDA = LUR - LURDF

e.18 QLEP: Desired level of nonfarm business employment

The desired level of private non-farm employment equals aggregate hours in the private non-farm business sector divided by the trend workweek.

$$\mathbf{QLEP} = LHP / QLWW$$

e.19 QLF: Desired level of civilian labor force

The trend labor force is equal to the product of the trend participation rate and the size of the population age 16 and up. The former term is obtained historically by H-P filtering the actual participation rate.

$$\mathbf{QLF} = QLFPR * N16$$

e.20 LEFT: Federal civilian employment ex. gov. enterprise, trend

Trend employment in the federal government sector increases with the trend component of the labor force (QLF) and adjusts gradually to actual federal government employment (LEF).

$$\mathbf{LEFT} = 0.900 \text{ [(const.)]} * LEFT_{t-1} * (HQLFPR + N16/N16_{t-1}) + 0.100 \text{ [(const.)]} * LEF$$

e.21 LEST: S&L government employment ex. gov. enterprise, trend

Trend employment of state and local governments increases with the expected growth in the trend labor force (QLF) and adjusts gradually to actual state and local government employment (LES).

$$\mathbf{LEST} = 0.900 \text{ [(const.)]} * LEST_{t-1} * (HQLFPR + N16/N16_{t-1}) + 0.100 \text{ [(const.)]} * LES$$

e.22 LEPPOT: Potential employment in nonfarm business sector

The trend level of employment in the nonfarm business sector consists of potential economy-wide employment less trend employment in other sectors. Potential economy-wide employment equals the product of the trend labor force (QLF) and the proportion of the labor force employed in equilibrium (1.0 minus the natural rate of unemployment, LURNAT). Trend employment in sectors other than nonfarm business consists of trend government employment (LEST + LEFT) and trend "other" employment (QLEOR * QLF).

LEPPOT = QLF*(1-.01*LURNAT - QLEOR) - LEFT - LEST

e.23 HLEPT: Expected growth rate of potential employment in the adjusted nonfarm business sector

HLEPT is the expected growth rate of potential employment in the adjusted nonfarm business sector. This equals the weighted sum of expected growth rates of the components of LEPPOT.

HLEPT is assumed to not include changes in LEPPOT due to non-recurring level "I(1)" shocks; specifically changes in QLFPR (except those due to HQLFPR), LURNAT and QLEOR. This exclusion is consistent the forecast (where LURNAT and QLEOR are assumed to be I(1)), though not with how LURNAT and QLEOR are constructed, when they are assumed to be I(2).

The variable DMPSTB is set equal to one when the model is used to run stochastic simulations. In this case, we simplify HLEPT to be the growth rate of population. This simplification improves the long-run stability of the model.

HLEPT = (1-DMPSTB) * 400 *
(HQLFPR * N16 * (1-.01*LURNAT-QLEOR)
+ del(1: N16) * QLFPR * (1-.01*LURNAT-QLEOR)
- del(1: LEFT)
- del(1: LEST))
/ mave(2 : LEPPOT $_t$
+ DMPSTB * 400 * del(1 : log(N16))

e.24 LPRDT: Trend labor productivity

Trend labor productivity in the adjusted nonfarm business sector is the ratio of potential output in that sector to trend total hours. The latter is the product of potential employment (LEPPOT) and the trend in hours per worker (QLWW).

log(LPRDT) = log(XGPOT) - log(LEPPOT) - log(QLWW)

e.25 HLPRDT: Trend growth rate of output per hour

$$\textbf{HLPRDT} = HGX - HLEPT - HQLWW$$

e.26 LURNAT: Natural rate of unemployment (NAIRU)

$$\textbf{LURNAT} = LURNAT_{t-1}$$

Nominal Income

This sector consists mainly of accounting identities. The first set of equations specifies that measures of nominal output equal the product of associated prices and real quantities. The second set of equations is for variables appearing on the income side of the national accounts. In this block, liberal use is made of multiplicative conversion factors, so that the full set of variables that appear in the NIPA identities do not have to be included in FRB/US. This part of the sector also contains estimated equations for interest payments by consumers to business, the implicit yield on household financial assets, and dividends.

The sector also determines measures of after-tax household income and its primary components -- labor, transfers, and property -- which are used in the consumption sector. Property income is defined more broadly than in the NIPA accounts. It includes the following additional items: imputed income from the stock of consumer durables, less consumer interest payments to business; corporate retained earnings; and inflation losses on the stock of government debt. These modifications to the definition of household income imply that households see through the corporate veil, and adjust interest income to exclude that portion which compensates for inflation. (Inflation adjustments to interest earned on corporate debt are not necessary, since an offsetting adjustment would need to be made to the definition of corporate profits.)

f.1 EGPDIN: Gross private domestic investment

$$\textbf{EGPDIN} = EPDN + EPSN + EHN + EIN$$

f.2 JCCACN: Consumption of fixed capital, corporate, current $

Corporate consumption of fixed capital (JCCACN) is the product of an exogenous conversion factor (UJCCAC) and non-government consumption of fixed capital less depreciation of the housing stock.

$$\textbf{JCCACN} = UJCCAC*(JCCAN - JYGFGN - JYGFEN - JYGSGN - JYGSEN - .01*JRH*PHR_{t-1}*PXP_{t-1}*KH_{t-1})$$

f.3 JCCAN: Consumption of fixed capital, current $

Consumption of fixed capital (CFC) equals government CFC (four components) plus private CFC. The latter depends on the product of three factors: depreciation rates (JRH, JRPS, JRPDC, JRPDO), real business capital stocks (KH, KPS, KPDC, DKPO), and the prices of new investment or capital goods (the relative prices PHR, PPSR, PKPDCR, and PPDOR, multiplied by PXP). Because investment prices are used in place of capital prices in three of the four instances, an exogenous conversion factor (UJCCA) is used to make the equation an identity.

$$\textbf{JCCAN} = JYGFGN + JYGFEN + JYGSGN + JYGSEN + .01*UJCCA*PXP_{t-1} * (PHR_{t-1}*KH_{t-1}*JRH + PPSR_{t-1}*KPS_{t-1}*JRPS + PKPDCR_{t-1}*KPDC_{t-1}*JRPDC + PPDOR_{t-1}*KPDO_{t-1}*JRPDO)$$

f.4 JYGFEN: CFC, federal government enterprises

$$\textbf{JYGFEN} = UJYGFE * (.01 * PGDP * XGDPT)$$

f.5 JYGFGN: CFC, federal government, general

$$\textbf{JYGFGN} = UJYGFG * (.01 * PGDP * XGDPT)$$

f.6 JYGSEN: CFC, state and local government enterprises

JYGSEN = UJYGSE * (.01 * PGDP * XGDPT)

f.7 JYGSGN: CFC, state and local government, general

JYGSGN = UJYGSG * (.01 * PGDP * XGDPT)

f.8 JYNCN: Noncorporate business CFC

JYNCN = JCCAN - JCCACN - JYGFGN - JYGFEN - JYGSGN - JYGSEN

f.9 QYHIBN: Equilibrium level of interest paid by consumers to business

The equilibrium level of consumer interest payments to business, expressed relative to nominal consumption expenditures, is a function of a post-1979 dummy, the rate of interest on new car loans, the share of nominal spending on durable goods in total consumption, and a time trend. Coefficient values are taken from a regression of the actual ratio on the explanatory variables.

log(QYHIBN) = log(ECNIAN)
+ log(-0.0125
+ 0.00297 * D79A
+ 0.000670 * RCAR
+ 0.207 * .01*PCDR*PCNIA*ECD/ECNIAN
+ 2.00E-05 * T47)

f.10 QYNIDN: Desired level of dividends

The long-run level of dividends (QYNIDN) is modeled as a fraction of after-tax corporate profits, with a shift in the desired ratio starting in 1980. Coefficient values are taken from a regression of the log of the actual ratio of dividends to after-tax profits on the explanatory variables. Note: the max function is used to prevent simulation problems arising from attempts to take the log of a negative number.

$$\textbf{log(QYNIDN)} = -0.897\ [-47.25272474048699] + 0.298\ [12.839968255503143]*D79A + 1.00 * \log(\max(YNICPN - TFCIN - TSCIN, .01))$$

Regression statistics

Adjusted R^2:	0.48
S.E. of regression:	0.14697
Sum of squared residuals:	3.84484
Durbin-Watson statistic:	0.19
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

f.11 RRMET: Real mortgage rate, trend

$$\textbf{RRMET} = 0.905 * RRMET_{t-1} + 0.0952 * (RME - ZPI10)$$

f.12 RSPNIA: Personal saving rate

$$\textbf{RSPNIA} = 100 * YHSN / YDN$$

f.13 TRYH: Average tax rate on household income

The average tax rate on household income is constructed as the ratio of personal income taxes (TFPN + TSPN) to the sum of labor income (YNLN) and taxable property income (YHPTN). Transfer income is assumed not to be taxed.

$$\textbf{TRYH} = (TFPN + TSPN)/(YHLN + YHPTN)$$

f.14 WDNFCN: Net financial liabilities, nonfinancial nonfarm corporations

Net financial liabilities are modeled in an error-correction format, where the long-run desired ratio of net liabilities to nominal potential GDP depends on a time trend. In the short run, growth in the ratio depends on the gap between the actual and the long-run ratio, the output gap, and lagged changes in the ratio.

$$
\begin{aligned}
\textbf{del(1: log(WDNFCN))} = & -0.0360 \; [-3.995096705049314] * \log(WDNFCN_{t-1}/(YNIN_{t-1} - YNILN_{t-1})) \\
& + 0.00867 \; [4.310369170868303] \\
& + 0.204 \; [2.63211187934535] * \text{del}(1: \log(WDNFCN_{t-1})) \\
& + 0.302 \; [4.037582588649031] * \text{del}(1: \log(WDNFCN_{t-2})) \\
& + 0.00196 \; [3.885978647163231] * XGAP2
\end{aligned}
$$

Regression statistics

Adjusted R^2:	0.46
S.E. of regression:	0.0137197
Sum of squared residuals:	0.025411
Durbin-Watson statistic:	2.05
Sample period:	1975Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

f.15 XFSN: Final sales of gross domestic product, current $

$$\textbf{XFSN} = XGDPN - EIN$$

f.16 XGDPN: GDP, current $

$$\textbf{XGDPN} = XPN + EIN - EMN + EGFLN + EGSLN$$

f.17 XGN: Output of business sector ex. energy, housing, and farm, current $

Nominal gross (of energy) output in the adjusted nonfarm business sector (XGN) equals BLS nonfarm output excluding housing, plus oil imports, less indirect business taxes associated with the nonfarm business sector and business transfer payments. The latter two items are excluded so that nominal output (and its price, PXG) is measured at factor cost. Because energy is an input in the production of nonfarm output, the sector's gross output is measured inclusive of energy use (domestic and imported), and thus oil imports are added.

The multiplicative term in the equation for XGN (UXGN) captures the difference between the BLS and BEA measures of nonfarm output (the BEA measure is XBN - XFBN), the difference between total indirect business taxes (TFIBN + TSIBN) and the fraction associated with nonfarm output excluding housing, and the effect of business transfer payments.

XGN = UXGN * (XNFBN + EMPN)

f.18 XNFBN: BLS NFB output

XNFBN = .01*PXNFB*XNFB

f.19 XPN: Final sales plus imports less gov. labor and ind. bus. taxes, current $

XPN = .01 * PXP * XP

f.20 YCSN: Net corporate cash flow with IVA and CCA

YCSN = YNICPN - TFCIN - TSCIN - FTCIN - YNIDN + JCCACN

f.21 YDN: Disposable income

YDN = UYD * (YPN - TFPN - TSPN)

f.22 YH: Income, household, total (real after-tax)

$$\mathbf{YH} = YHL + YHT + YHP$$

f.23 YHGAP: Income, household, total, ratio to XGDP, cyclical component (real after-tax)

YHGAP is the percentage deviation of the actual from the trend ratio of household income to GDP (YHSRH and ZYHST, respectively).

$$\mathbf{YHGAP} = 100*(YHSHR/ZYHST-1)$$

f.24 YHIBN: Income, household, consumer interest payments to business

The growth rate of consumer interest payments to business (deflated by the PCE chain-weight price index) is modeled using an error correction specification. Explanatory variables are the lagged gap between equilibrium and actual interest payments, the lagged growth rate of interest payments, and the current growth rate of the durable goods share of total consumption.

$$\begin{aligned}
\mathbf{del(1 : log(YHIBN))} = {} & 1.00 * \text{mave}(4 : PICXFE_{t}/1600 \\
& - 0.182 \ [-2.383251072890393] \\
& + 0.0739 \ [3.368784950919344] * \log(ECNIAN_{t-1}/YHIBN_{t-1}) \\
& + 0.345 \ [5.095872200149971] * (\text{del}(1 : \log(YHIBN_{t-1})) - \text{mave}(4 : PICXFE_{t-1}/1600) \\
& + 0.0222 \ [2.950769330962771] * D79A \\
& + 0.00331 \ [4.823257919276293] * RCAR_{t-1} \\
& + 0.0642 \ [2.272937943202319] * \log(.01*PCDR_{t-1}*PCNIA_{t-1}*ECD_{t-1}/ECNIAN_{t-1}) \\
& + 0.00513 \ [3.625019565318221] * \text{del}(1 : RFFE)
\end{aligned}$$

Regression statistics

Adjusted R^2:	0.38
S.E. of regression:	0.0198979
Sum of squared residuals:	0.0684951
Durbin-Watson statistic:	2.00
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010

Estimation method: Least Squares

f.25 YHIN: Income, household, net interest and rent

The exogenous conversion factor (UYHI) used in the household interest and rental income identity reflects the deduction in the measurement of GSINTN of dividends received by state and local governments.

YHIN = UYHI * (YNIIN + GFINTN + GSINTN + YHIBN)

f.26 YHL: Income, household, labor compensation (real after-tax)

YHL = (1-TRYH)*YHLN/(.01*PCNIA)

f.27 YHLN: Income, household, labor compensation

YHLN = UYHLN * (YNILN - TFSIN - TSSIN)

f.28 YHP: Income, household, property (real after-tax)

YHP = ((1-TRYH)*YHPTN+YHPNTN)/(.01*PCNIA)

f.29 YHPGAP: Income, household, property, ratio to YH, cyclical component (real after-tax)

YHPGAP is the percentage deviation of the actual from the trend ratio of household property income to total household income (YHPSHR and ZYHPST, respectively).

YHPGAP = 100*(YHPSHR/ZYHPST-1)

f.30 YHPNTN: Income, household, property, non-taxable component

Household non-taxable property income in FRB/US includes several items not included in the NIPA definition of personal income: imputed income from the stock of consumer durables, less consumer interest payments to business; corporate retained earnings; and inflation losses on the stock of government debt.

YHPNTN = .01*PCNIA*PCDR*YHPCD
- YHIBN + YNICPN - TFCIN - TSCIN - YNIDN
- .01 * ZPI10 *(GFDBTN+GSDBTN)
+ UYHPNT*XGDPTN

f.31 YHPSHR: Income, household, property, ratio to YH (real after-tax)

YHPSHR = YHP/YH

f.32 YHPTN: Income, household, property, taxable component

Household taxable property income in FRB/US includes interest and rental income, dividends, and self-employed income. The multiplicative factor UYHPTN adjusts for the difference between total dividends (YNIDN) and personal dividend income, which reflects dividends paid to state and local governments.

YHPTN = UYHPTN*(YNISEN+YHIN+YNIDN)

f.33 YHSHR: Income, household, total, ratio to XGDP (real after-tax)

YHSHR = YH/XGDP

f.34 YHSN: Personal saving

YHSN = YHLN + YHTN + YHPTN - TFPN - TSPN - ECNIAN - YHIBN
+ UYHSN * XGDPTN

f.35 YHT: Income, household, transfer (real after-tax), net basis

YHT = YHTN/(.01*PCNIA)

f.36 YHTGAP: Income, household, transfer, ratio to YH, cyclical component (real after-tax)

YHTGAP is the percentage deviation of the actual from the trend ratio of household transfer income to total household income (YHTSHR and ZYTHST, respectively).

YHTGAP = 100*(YHTSHR/ZYHTST-1)

f.37 YHTN: Income, household, transfer payments. net basis

The exogenous conversion factor (UYHTN) in the identity for transfer payments to persons (YHTN) reflects the omission of business transfer payments from the equation.

YHTN = UYHTN*(GFTN+GSTN)

f.38 YHTSHR: Income, household, transfer, ratio to YH (real after-tax)

YHTSHR = YHT/YH

f.39 YKIN: Income from stock of inventories

$$\textbf{YKIN} = .01*\text{RTINV}*\text{PXNFB}*\text{mave}(\,2:\text{KI}_{\,t})$$

f.40 YKPDCN: Income from stock of computer, software, and communicaitons capital

$$\textbf{YKPDCN} = .01*\text{RTPDC}*\text{PXNFB}*\text{mave}(\,2:\text{KPDC}_{\,t})$$

f.41 YKPDON: Income from stock of E&S capital, excluding computer, software, and communications

$$\textbf{YKPDON} = .01*\text{RTPDO}*\text{PXNFB}*\text{mave}(\,2:\text{KPDO}_{\,t})$$

f.42 YKPSN: Income from stock of nonresidential structures

$$\textbf{YKPSN} = .01*\text{RTPS}*\text{PXNFB}*\text{mave}(\,2:\text{KPS}_{\,t})$$

f.43 YNICPN: Income, national, corporate profits

Corporate profits (YNICPN) are the residual component of national income (YNIN - YNILN - YNIIN - YNISEN). To mitigate numerical problems while iteratively solving the model period by period, the max command is used to placed a positive lower bound on profits; this constraint never binds on the converged solution.

YNICPN UYNICP * max(YNIN-YNILN-YNIIN-YNISEN-TFIBN-
= TSIBN+GFSUBN+GSSUBN,TFCIN+TSCIN+.01*XGDPN)

f.44 YNIDN: Income, national, dividend component

Dividends are modeling using the polynomial adjustment cost framework. Thus growth in real dividends depends on the three standard PAC terms -- the degree to which dividends were out of equilibrium last period , lagged dividend growth, and expected dividend growth (ZYNID). The PAC specification restricts the coefficient on the latter to unity, but the expectation variable itself has an internal weight sum of .97. Note: The equation adjusts for the mammoth one-time Microsoft cash payout of late 2004 by subtracting the payout (YMSDN) from NIPA dividends.

del(1 : log((YNIDN-YMSDN)/PXNFB)) =

0.0583 [5.904433303724187] * $\log(QYNIDN_{t-1}/(YNIDN_{t-1}\text{-}YMSDN_{t-1}))$

$+ 0.543$ [8.988919831193515] * del(1 : $\log((YNIDN_{t-1}\text{-}YMSDN_{t-1})/PXNFB_{t-1}))$

$+ 0.000316$[0.2057881881191638]

$+ 1.00$ * ZYNID

Regression statistics

Adjusted R^2:	0.41
S.E. of regression:	0.0184176
Sum of squared residuals:	0.0600398
Durbin-Watson statistic:	1.88
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

f.45 YNIIN: Income, national, net interest and rental income component

The ratio of net interest plus rental income to net financial liabilities depends on measures of short- and long-term rates of interest, with the bond rate coefficient restricted to be one in the long run. Net interest plus rental income also includes the (real) return to housing. This return is estimated to have a component that is proportional to the housing stock and a component that varies with the product of the real rate of interest and the housing stock.

YNIIN/(YNIN(-1)-YNILN(-1)) = 0.0161 [3.880420974520731]

$+ 0.825$ [18.1269826393192] * $(YNIIN_{t-1}/(YNIN_{t-2}\text{-}YNILN_{t-2}))$

$+ 0.0521$ [2.808911049444033] * $(.01{*}RRMET{*}.01{*}PHR_{t-1}{*}PXP_{t-1}{*}KH_{t-1}/(YNIN_{t-1}\text{-}YNILN_{t-1}))$

$+ 0.175$ * $((.01{*}RBBBE){*}(WDNFCN_{t-1}/(YNIN_{t-1}\text{-}YNILN_{t-1})))$

$+ 0.496$ [5.308757288283164] * (.01*del(1 : $RBBBE{*}(WDNFCN_{t-1}/(YNIN_{t-1}\text{-}YNILN_{t-1}))))$

$+ 0.180$ [0.8406463097739166] $* (.01*FNIN_{t-1}/(YNIN_{t-1}-YNILN_{t-1}))$

Regression statistics

Adjusted R^2:	0.98
S.E. of regression:	0.00672915
Sum of squared residuals:	0.00611299
Durbin-Watson statistic:	1.74
Sample period:	1975Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

f.46 YNILN: Income, national, labor component

The exogenous conversion factor (UYL) in the identity for labor income reflects: (1) the omission of labor income in the farm and household and institutions sectors from the equation; and (2) the use of a measure of aggregate hours that includes not only hours of employees but also hours of the self-employed.

YNILN = 0.01 * UYL * (PL*LHP + PGFL*EGFL + PGSL*EGSL)

f.47 YNIN: Income, national, total

The exogenous conversion factor (UYNI) in the identity for national income (YNIN) reflects the omission of the statistical discrepancy and business transfer payments from the equation.

YNIN = UYNI*(XGDPN+FYNIN-JCCAN)

f.48 YNISEN: Income, national, proprietors

Proprietors' income (nonfarm and farm) is modelled as the product of an exogenous conversion factor (uysen) and nominal output of the nonfarm business sector (XNFBN).

YNISEN = UYSEN*XNFBN

f.49 YPN: Income, personal

The exogenous conversion factor (UYP) used in the personal income identity reflects the ommission of a miscellaneous set of adjustments, such as the difference between total and personal dividend payments, and the omission of business transfers payments to households.

YPN = UYP * (YHLN + YHTN + YHPTN)

f.50 XGDEN: Nominal Absorption

XGDEN = XGDPN + EMN - EXN

Wages and Prices

The FRB/US model contains a large number of individual price series; however, wage and price dynamics in the system are determined by only a few equations. The key long-run relationship in the wage-price sector is contained in the equation for the target price of adjusted non-farm business output (QPXG). The target price is proportional to trend unit labor costs; this same long-run relationship, inverted, also determines the target level of compensation per hour (QPL).

The targets for aggregate prices and wages in turn help to determine actual rates of wage and price inflation. This is done through the polynomial adjustment cost (PAC) framework, so that, for example, current wage inflation depends on lagged wage inflation, expected future growth in target wages (i.e., price inflation adjusted for productivity growth), and the lagged difference between actual and target wages. Because the equilibrium level of the real wage -- that is, the labor income share -- depends on the level of resource utilization in the labor market, current wage inflation also depends on the (weighted) average gap between the actual unemployment rate and the NAIRU expected to prevail into the future. Modifications to the standard PAC framework also cause wage inflation to depend on changes in payroll taxes and the minimum wage.

Price inflation is modeled in a similar manner, except that the target price of adjusted business output is not used to determine the actual price of such output directly. Instead, the target output price (QPXG) is used to define a target price of adjusted final sales (QPXP) through an accounting identity; this accounting identity makes the target price of domestic sales a function of import prices, among other factors. The latter target is then used in the context of the PAC framework to determine the rate of price inflation for adjusted final sales; as with wages, price inflation depends on lagged price inflation, expected future growth in target price inflation, the weighted average gap between the unemployment rate and the NAIRU, and the lagged difference between the actual and target price level. Modifications to the standard PAC framework imply that energy prices and non-oil import prices influence the current inflation rate more quickly than would be predicted by the standard PAC specification alone.

In addition to these two key aggregate wage and price equations, the sector also includes several important behavioral equations for core consumer prices, non-oil imports, crude energy prices, and so forth. These equations are modeled using simple error-correction specifications. Finally, a number of other prices are determined via accounting identities, or by using simple markup equations that make one price proportional to another.

g.1 PCNIA: Price index for personal consumption expenditures, cw (NIA definition)

The wage-price sector contains three key structural equations, for compensation per hour (PIPL), PCE consumer prices (PCNIA), and an aggregate price for household and business investment, government output excluding labor compensation, and exports (PXNC). Each equation takes the form of a hybrid New Keynesian Phillips Curve (h-NKPC). The three equations are estimated simultaneously under the assumption that expectations are model consistent and that they share common estimates of the NAIRU and the equilibrium markup of the NFB price level over trend unit labor costs. The estimated system contains the three structural equations and a set of auxiliary equations (some of which are VARs) for other endogenous variables in the system, including the gap between a demographically adjusted measure of the unemployment rate and the NAIRU, and the federal funds rate. These auxiliary equations are not part of FRB/US, although their structures are implicit in the formulas for the expectations variables that appear in the main price and wage equations under VAR-based expectations. Notably, the auxiliary funds rate equation contains the FRB/US series on long-run inflation expectations (PTR) as a measure of the perception of policymakers' target rate of inflation, and thus PTR ends up being an important determinant of medium-run VAR-based inflation expectations in the wage-price system.

The FRB/US implementation of the h-NKPC approach makes the rate of consumer price inflation a function of its own expected rate of inflation next quarter (ZPC), its average rate of inflation over the previous four quarters, and the first lag of the log of the deviation of real marginal cost from it equilibrium (log(QPCNIA/PCNIA)). The sum of coefficients on future expected and past inflation is constrained to unity.

Three additional terms appear in the equation. Two extend the h-NKPC framework to account for the faster adjustment of consumption prices to energy and food price changes than to changes in other input prices. A third term allows a faster passthrough of changes in the real exchange rate (FPXR). The latter term likely captures the fact that some imports are finished consumption goods.

Of the three key structural wage and price equations, only the wage equation contains the gap between the unemployment rate and the NAIRU. As a result, the effect of this gap on consumer price inflation is indirect, arising through the dependence of expected consumer price inflation on expected growth of wages.

del(1 : log(PCNIA)) = $0.00725 * \log(QPCNIA_{t-1}/PCNIA_{t-1})$

$+ 0.126 * (.25 * \text{mave}(4 : \text{del}(1 : \log(PCNIA_{t-1})) - ZPC/400)$
$+ 1.00 * ZPC/400$
$+ 1.11 * (UCES * \text{del}(1 : \log(PCER)))$
$+ 0.563 * (UCFS * \text{del}(1 : \log(PCFR)))$
$- 0.0737 * \log(FPXR/FPXR_{t-1}) * (EMON_{t-1}/XPN_{t-1})$

Regression statistics

Sample period: 1985:q1 - 2008:q4
Estimation date: August 2010
Estimated by: Leon and Flint

g.2 PXNC: Price of adjusted final sales excluding consumption

The wage-price sector contains three key structural equations, for compensation per hour (PIPL), PCE consumer prices (PCNIA), and an aggregate price for household and business investment, government output excluding labor compensation, and exports (PXNC). Each equation takes the form of a hybrid New Keynesian Phillips Curve (h-NKPC). The three equations are estimated simultaneously under the assumption that expectations are model consistent and that they share common estimates of the NAIRU and the equilibrium markup of the NFB price level over trend unit labor costs. The estimated system contains the three structural equations and a set of auxiliary equations (some of which are VARs) for other endogenous variables in the system, including the gap between a demographically adjusted measure of the unemployment rate and the NAIRU, and the federal funds rate. These auxiliary equations are not part of FRB/US, although their structures are implicit in the formulas for the expectations variables that appear in the main price and wage equations under VAR-based expectations. Notably, the auxiliary funds rate equation contains the FRB/US series on long-run inflation expectations (PTR) as a measure of the perception of policymakers' target rate of inflation, and thus PTR ends up being an important determinant of medium-run VAR-based inflation expectations in the wage-price system.

The FRB/US implementation of the h-NKPC approach makes the rate of non-consumer price inflation a function of its own expected rate of inflation next quarter (ZPNC), its average rate of inflation over the previous four quarters, and the first lag of the log of the deviation of real marginal cost from it equilibrium (log(QPXNCIA/PXNCIA)). The sum of coefficients on future expected and past inflation is constrained to unity.

Two additional terms appear in the equation. One extends the h-NKPC framework to account for the faster adjustment of non-consumption prices to energy price changes than to changes in other input prices (primary via the price of state and local government energy purchases). A second term allows a faster passthrough of changes in the real exchange rate (FPXR). The latter term likely captures the fact that some imports are finished investment goods.

Of the three key structural wage and price equations, only the wage equation contains the gap between the unemployment rate and the NAIRU. As a result, the effect of this gap on non-consumer price inflation is indirect, arising through the dependence of expected price inflation on expected growth of wages.

$$\textbf{del(1 : log(PXNC))} = 0.0160 * \log(QPXNC_{t-1}/PXNC_{t-1})$$
$$+ 0.255 * (.25 * mave(\ 4 : del(1 : \log(PXNC\ _{t-1})) - ZPNC/400)$$
$$+ 1.00 * ZPNC/400$$
$$+ 1.30 * (UCES * del(1 : \log(PCER)))$$
$$- 0.565 * \log(FPXR/FPXR_{t-1}) * (EMON_{t-1}/XPN_{t-1})$$

Regression statistics

Sample period: 1985:q1 - 2008:q4
Estimation date: August 2010
Estimated by: Leon and Flint

g.3 PIPL: Rate of growth of PL

The wage-price sector contains three key structural equations, for compensation per hour (PIPL), PCE consumer prices (PCNIA), and an aggregate price for household and business investment, government output excluding labor compensation, and exports (PXNC). Each equation takes the form of a hybrid New Keynesian Phillips Curve (h-NKPC). The three equations are estimated simultaneously under the assumption that expectations are model consistent and that they share common estimates of the NAIRU and the equilibrium markup of the NFB price level over trend unit labor costs. The estimated system contains the three structural equations and a set of auxiliary equations (some of which are VARs) for other endogenous variables in the system, including the gap between a demographically adjusted measure of the unemployment rate and the NAIRU, and the federal funds rate. These auxiliary equations are not part of FRB/US, although their structures are implicit in the formulas for the expectations variables that appear in the main price and wage equations under VAR-based expectations. Notably, the auxiliary funds rate equation contains the FRB/US series on long-run inflation expectations (PTR) as a measure of the perception of policymakers' target rate of inflation, and thus PTR ends up being an important determinant of medium-run VAR-based inflation expectations in the wage-price system.

The FRB/US implementation of the h-NKPC approach makes the rate of change of NFB compentation per hour a function of its own expected rate of change next quarter (ZPL), its average rate of change over the previous four quarters, and the first lags of the log of the deviation of the inverse of real marginal cost from it equilibrium (log(QPL/PL)) and the gap between the unemployment rate and the NAIRU. The sum of coefficients on future expected and past inflation is constrained to unity.

One additional term appears in the equation to account for effects of changes in the minimum wage (PLMIN).

$$\textbf{PIPL/400} = 0.0132 * \log(QPL_{t-1}/PL_{t-1})$$
$$+ 0.321 * (.25 * (mave(\ 4 : PIPL\ _{t-1}) - ZPL)/400$$
$$+ 1.00 * ZPL/400$$
$$- 0.0211 * (LUR_{t-1}-LURNAT_{t-1})/100$$
$$+ 0.195 * ((del(1 : \log(PLMIN)) - .25*\log(PL_{t-1}/PL_{t-5}))* PLMIN_{t-1} / (.01*PL_{t-1}))$$

Regression statistics

Sample period: 1985:q1 - 2008:q4
Estimation date: August 2010
Estimated by: Leon and Flint

g.4 PL: Compensation per hour, nonfarm business

$$\textbf{log(PL)} = \log(PL_{t-1}) + PIPL/400$$

g.5 QPCNIA: Desired level of consumption price, trending component

$$\textbf{log(QPCNIA)} = \log(QPXP) + \log(UQPC)$$

g.6 QPXNC: Desired level of nonconsumption price, trending component

$$\begin{aligned}\textbf{log(QPXNC)} = {} & \log(PXNC) \\ & + 2.99 * \log(QPXP/PXP) \\ & - 1.99 * \log(QPCNIA/PCNIA)\end{aligned}$$

g.7 QPL: Desired level of compensation per hour, trending component

The trending component of the target level of hourly compensation (QPL) is defined by a condition that is just a rearrangement of the relationship used to define the target price level (QPXG). Given the definitions of these two targets, the percentage wage gap, log(QPL/PL), is the negative of the percentage price gap, log(QPXG/PXG).

$$\textbf{log(QPL)} = \log(PL) + 1.00 * \log(PXG/QPXG)$$

g.8 QPXP: Desired price level of adjusted final sales, trending component

The target price of adjusted final sales is defined as what the actual price of adjusted final sales would equal if the price of adjusted nonfarm business output (PXG) were at its target (QPXG). In the equation, this is implemented by dividing what nominal adjusted final sales would be in this case by real adjusted final sales.

QPXP = 100*(XPN + (.01*QPXG*XG-XGN)/UXGN)/XP

g.9 QPXG: Desired price level of private output ex. energy, housing, and farm

The key long-run relationship in the wage-price block is contained in the equation for the target output price (QPXG). The target price is proportional to trend unit labor costs.

log(QPXG) = log(PWSTAR) + 0.00 + 1.00 *log(PL/LPRDT)

Regression statistics

Estimation date: July 2010
Estimated by: Flint and Leon

g.10 UQPC: Trend ratio of PCNIA to PXP

log(UQPC) - log(UQPCT) = 0.0103 - 0.583 * ((EMON/ECNIAN) * LOG(PMO/PCNIA))

Regression statistics

Standard deviation of level shock = 0.002288; t-statistic = 4.36 :
Standard deviation of drift shock = 0.096836; t-statistic = 1.79 :

Sample period:	1962:Q1 - 2009:Q4
Estimation date:	August 2010

g.11 UQPCT: Stochastic component of trend ratio of PCNIA to PXP

$$\textbf{log(UQPCT)} = 0.00 + \log(UQPCT_{t-1}) + HUQPCT$$

Regression statistics

Standard deviation of level shock = 0.002288; t-statistic = 4.36 :	
Standard deviation of drift shock = 0.096836; t-statistic = 1.79 :	
Sample period:	1962:Q1 - 2009:Q4
Estimation date:	August 2010

g.12 HUQPCT: Drift term in stochastic component of trend ratio of PCNIA to PXP

$$\textbf{HUQPCT} = 0.00 + 0.950 * HUQPCT_{t-1}$$

Regression statistics

Standard deviation of drift shock = 0.096836; t-statistic = 1.79 :	
Sample period:	1962:Q1 - 2009:Q4
Estimation date:	August 2010

g.13 DPGAP: Price inflation aggregation discrepancy

The price inflation aggregation discrepancy (DPGAP) equals the rate of increase of the price for adjusted final sales excluding consumption less the weighted sum of rates of price increase for the non-consumption components of adjusted final sales.

$$\begin{aligned}
\textbf{DPGAP} = {} & PIPXNC/400 - (\\
& .5 * (EHN/(XPN - ECNIAN) + EHN_{t-1}/(XPN_{t-1} - ECNIAN_{t-1})) \\
& * del(1:\log(PHR*PXP)) \\
& + .5 * (EPDCN/(XPN - ECNIAN) + EPDCN_{t-1}/(XPN_{t-1} - ECNIAN_{t-1})) \\
& * del(1:\log(PPDCR*PXP)) \\
& + .5 * (EPDON/(XPN - ECNIAN) + EPDON_{t-1}/(XPN_{t-1} - ECNIAN_{t-1})) \\
& * del(1:\log(PPDOR*PXP)) \\
& + .5 * (EPSN/(XPN - ECNIAN) + EPSN_{t-1}/(XPN_{t-1} - ECNIAN_{t-1})) \\
& * del(1:\log(PPSR*PXP)) \\
& + .5 * (EGFON/(XPN - ECNIAN) + EGFON_{t-1}/(XPN_{t-1} - ECNIAN_{t-1})) \\
& * del(1:\log(PGFOR*PXP))
\end{aligned}$$

$+ .5 * (EGFIN/(XPN - ECNIAN) + EGFIN_{t-1}/(XPN_{t-1} - ECNIAN_{t-1}))$
$* del(1:log(PGFIR*PXP))$
$+ .5 * (EGSON/(XPN - ECNIAN) + EGSON_{t-1}/(XPN_{t-1} - ECNIAN_{t-1}))$
$* del(1:log(PGSOR*PXP))$
$+ .5 * (EGSIN/(XPN - ECNIAN) + EGSIN_{t-1}/(XPN_{t-1} - ECNIAN_{t-1}))$
$* del(1:log(PGSIR*PXP))$
$+ .5 * (EXN/(XPN - ECNIAN) + EXN_{t-1}/(XPN_{t-1} - ECNIAN_{t-1}))$
$* del(1:log(PXR*PXP)))$

g.14 DPADJ: Price inflation aggregation adjustment

The adjustment factor for non-consumption prices equals the value in the prior quarter plus the price aggregation discrepancy in the prior quarter. Thus, component prices are adjusted to offset any aggregation discrepancy with only a one-quarter lag.

$$\mathbf{DPADJ - DPADJ(-1) =} 1.00 * DPGAP_{t-1}$$

g.15 PGFIR: Price index for federal gov. investment, cw (relative to PXP)

$$\mathbf{log(PGFIR) - log(PGFIR(-1)) =} 0.00 + PIPXNC/400 + DPADJ - del(1:log(PXP))$$

g.16 PGFOR: Price index for federal governemnt consumption ex. emp. comp., cw (relative to PXP)

$$\mathbf{log(PGFOR) - log(PGFOR(-1)) =} 0.00 + PIPXNC/400 + DPADJ - del(1:log(PXP))$$

g.17 PGSIR: Price index for S&L government investment (relative to PXP)

$$\mathbf{log(PGSIR) - log(PGSIR(-1)) =} 0.00 + PIPXNC/400 + DPADJ - del(1:log(PXP))$$

g.18 PGSOR: Price index for S&L government consumption ex. emp. comp., cw (relative to PXP)

log(PGSOR) - log(PGSOR(-1)) = 0.00 + PIPXNC/400 + DPADJ - del(1:log(PXP))

g.19 PHR: Price index for residential investment, cw (relative to PXP)

log(PHR) - log(PHR(-1)) = 0.00 + PIPXNC/400 + DPADJ - del(1:log(PXP))

g.20 PPDCR: Price index for investment in computers, software, communication equip., cw (relative to PXP)

log(PPDCR) - log(PPDCR(-1)) = 0.00 + PIPXNC/400 + DPADJ - del(1:log(PXP))

g.21 PPDOR: Price index for E&S investment, ex. computers, software, communication, cw (relative to PXP)

log(PPDOR) - log(PPDOR(-1)) = 0.00 + PIPXNC/400 + DPADJ - del(1:log(PXP))

g.22 PPSR: Price index for nonresidential structures, cw (relative to PXP)

log(PPSR) - log(PPSR(-1)) = 0.00 + PIPXNC/400 + DPADJ - del(1:log(PXP))

g.23 PXR: Price index for exports, cw (relative to PXP)

log(PXR) - log(PXR(-1)) = 0.00 + PIPXNC/400 + DPADJ - del(1:log(PXP))

g.24 POILR: Price of imported oil, relative to price index for bus. sector output

Real oil prices error-correct to their long-run trend, POILRT.

$$\mathbf{del(1 : log(POILR))} = -0.237 \ [-5.822236920948669] * \log(POILR_{t-1}/POILRT_{t-1}) - 0.00456 [-0.4710540903159681] + 0.394 \ [5.663758859257224] * del(1 : \log(POILR_{t-1})) + 0.235 \ [0.6209169576796155] * del(1 : \log(POILRT))$$

Regression statistics

Adjusted R^2:	0.25
S.E. of regression:	0.11746
Sum of squared residuals:	2.42824
Durbin-Watson statistic:	1.90
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

g.25 POIL: Price of imported oil ($ per barrel)

POIL = POILR*PXNFB

g.26 PMP: Price index for petroleum imports

The chain-weight price index for imported petroleum products (PMP) is proportional to the per barrel price of imported crude oil (POIL).

PMP = UPMP*POIL

g.27 PCENGR: Price index for aggregate energy consumption (relative to PXNFB)

The growth rate of the relative price of crude energy -- which includes oil, coal, and natural gas -- follows a simple error-correction specification in which the real price of oil (POILR) is the key long-run driving variable. Coefficient estimates indicate that a 1 percent change in oil prices leads to a .9 percent change in overall crude energy prices in the long run.

del(1 : log(PCENGR)) = 0.0509 [2.9346568482500053]
+ 0.00766 [0.25010335598657 14] * del(1 : log($PCENGR_{t-1}$))
- 0.0992 [-3.103388264052923] * log($PCENGR_{t-1}$)
+ 0.0874 [3.073687801902987] * log($POILR_{t-1}$)
+ 0.762 [31.3072895835384] * del(1 : log(POILR))

Regression statistics

Adjusted R^2:	0.89
S.E. of regression:	0.0369302
Sum of squared residuals:	0.184119
Durbin-Watson statistic:	1.80
Sample period:	1975Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

g.28 PCENG: Price index for aggregate energy consumption

PCENG = PCENGR*PXNFB

g.29 PCER: Price index for personal consumption expenditures on energy (relative to PCXFE)

Consumer energy prices are a weighted average of the price of crude energy (PCENG) and core consumer prices (PCXFE). Core consumer prices are a proxy for the influence of taxes, refining and distribution costs, the capital cost of generating electricity, and other non-crude-energy factors which are assumed to have a fixed Leontief weight in total costs.

The functional form implies that a dollar-per-barrel increase in the price of crude energy (e.g. crude oil) translates into a dollar-per-barrel increase in consumer prices (e.g. the pump price of gasoline).

The elasticity of consumer energy prices with respect to crude energy prices equals the share of crude energy costs in total costs, which was equal to the coefficient 0.52 in the base year (2005).

About 79 percent of the full effect of crude prices is passed through within the same quarter with the rest (.06+.14 =.20) usually occurring in the following quarter.

Further discussion

del(1 : log(PCER)) = 0.144 [3.848447792733152] * log((0.520 [41.7673360549648] *$PCENG_{t-1}$ + (1-0.520 [41.7673360549648])*$PCXFE_{t-1}$)/($PCER_{t-1}$*$PCXFE_{t-1}$))
+ 0.794 [20.85939927962878] * del(1 : log((0.520 [41.7673360549648] *PCENG + (1-0.520 [41.7673360549648])*PCXFE)/PCXFE))
+ 0.0605 [1.694321701654726] * del(1 : log((0.520 [41.7673360549648] *$PCENG_{t-1}$ + (1-0.520 [41.7673360549648])*$PCXFE_{t-1}$)/$PCXFE_{t-1}$))

Regression statistics

Adjusted R^2:	0.80
S.E. of regression:	0.0187173
Sum of squared residuals:	0.0616593
Durbin-Watson statistic:	2.23
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

g.30 PCFR: Price index for personal consumption expenditures on food (relative to PCXFE)

Growth in relative consumer food prices is modeled using a simple error-correction specification, where the level of prices in the long run is equal to an estimated trend, PCFRT, defined historically by H-P filtering the observed series. This equation is primarily used in stochastic simulations.

del(1 : log(PCFR)) = -0.180 [-6.012827708783508] * log($PCFR_{t-1}$/$PCFRT_{t-1}$)
- 0.000114[-0.21198315884 75699]
+ B1(L) {sum 0.763 } * del(1 : log($PCFR_{t-1}$))
+ 0.272 [1.041311631556897] * del(1 : log(PCFRT))

Distributed lag coefficients

Name	Value
$B1_0$	0.369 0.00
$B1_1$	0.0344 0.00
$B1_2$	0.359 0.00

$B1_{SUM}$	0.763

Regression statistics

Adjusted R^2:	0.36
S.E. of regression:	0.00724305
Sum of squared residuals:	0.00912834
Durbin-Watson statistic:	1.97
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

g.31 UCES: Energy share of nominal consumption expenditures

Growth in the nominal energy share of consumption is modeled using an error-correction specification. The long run share is a function of the relative price of consumer energy (PCER), the real share of energy in gross output (CENG/XG), and a time trend (T47). In the short run, growth in the share is affected by the lagged difference between the actual share and its long-term level, lagged growth in the share, current growth in relative energy prices, and current growth in the energy intensity of overall production.

$$\begin{aligned}
\textbf{del(1 : log(UCES))} = & -0.272\ [-5.435729556058011] * \log(UCES_{t-1}) \\
& + 0.231\ [5.305464229772445] * \log(PCER_{t-1}) \\
& + 0.119\ [4.310571582353676] * \log(CENG_{t-1}/XG_{t-1}) \\
& - 0.000552 [-3.667765472992334] * T47 \\
& - 0.328\ [-4.711304586507641] \\
& - 0.0369\ [-1.05339231760152] * del(1 : \log(UCES_{t-1})) \\
& + 0.816\ [25.39012059369288] * del(1 : \log(PCER)) \\
& + 0.180\ [4.015373058921116] * del(1 : \log(CENG/XG))
\end{aligned}$$

Regression statistics

Adjusted R^2:	0.80
S.E. of regression:	0.0168479
Sum of squared residuals:	0.0488222
Durbin-Watson statistic:	2.23
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

g.32 UCFS: Food share of nominal consumption expenditures

Growth in the nominal food share of consumption is modeled using an error-correction specification. The long run share is a function of the relative price of consumer food (PCFR) and a time trend (T47). In the short run, growth in the share is affected by the lagged difference between the actual share and its long-term level, lagged growth in the share, and current growth in relative food prices, broken down into its trend (PCFRT) and non-trend (PCFR/PCFRT) components.

del(1 : log(UCFS)) = -0.0412 [-1.552358433299862] * log($UCFS_{t-1}$)
+ 0.0448 [2.065934097174645] * log($PCFR_{t-1}$)
- 0.000176[-1.3440162853824] * T47
- 0.0681 [-1.790705579921629]
+ 0.0144 [0.1961668876770996] * del(1 : log($UCFS_{t-1}$))
+ 0.990 [3.779945649018858] * del(1 : log(PCFRT))
+ 0.309 [4.24798986644402] * del(1 : log(PCFR/PCFRT))

Regression statistics

Adjusted R^2:	0.17
S.E. of regression:	0.00791588
Sum of squared residuals:	0.0108404
Durbin-Watson statistic:	2.00
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

g.33 PCXFE: Price index for personal consumption expendits ex. food and energy, cw (NIA def.)

del(1:log(PCXFE)) = del(1:log(PCNIA))
- del(1:log(UPCNIA))
- (mave(2 : $UCFS_t$)) * del(1:log(PCFR))
- (mave(2 : $UCES_t$)) * del(1:log(PCER))

g.34 PCPI: Consumer price index,total

The overall CPI equals the product of the PCE chain-weight price index and a proportionality factor. This factor has two components, one to account for the effect of different weights on energy in the two price indices, and the other to account for all other differences.

PCPI = UPCPI * EXP(.025*LOG(PCER)) * PCNIA

g.35 PCPIX: Consumer price index,excluding food and energy

PCPIX = UPCPIX * PCXFE

g.36 PMO: Price index for imports ex. petroleum, cw

Growth in non-oil import prices is modeled using a Kalman filter specification in which the level of non-oil import prices (PMO) gradually converges to a steady-state target. The latter has two elements: a stochastic random walk (QPMO) and a weighted average of aggregate foreign and domestic prices. Empirical work suggests that the pass-through of changes in the exchange rate (FPXM) or foreign prices (FPCM) into dollar-denominated import prices is incomplete. In accordance with this evidence, in FRB/US only 64 percent of any movement in FPCM or FPXM is allowed to pass through to PMO in the long run. This pass-thru relationship is defined in relative terms using the price of US business output, which accounts for the presence of PXB in the equilibrium formula. The PMO equation also contains the contemporaneous rates of foreign and domestic price inflation with the two coefficients restricted to sum to one.

QPMO is a random walk with constant drift:

log(QPMO) = log(QPMO(-1)) - .003621

The standard error of the additive errors term in the PMO equation is .00376, and the standard error of the error in the random walk equation for QPMO is .0172.

$$
\begin{aligned}
\textbf{del(1 : log(PMO)) =} & -0.00362\,[2.5] \\
& + 0.429\,[4.7] * (\log(QPMO) + .64*\log(FPCM_{t-1}/FPXM_{t-1}) + .36*\log(PXNFB_{t-1}) \\
& - \log(PMO_{t-1})) \\
& + 0.300\,[9.8] * del(1 : \log(FPCM/FPXM)) \\
& + 0.700\,[21.1] * del(1 : \log(PXNFB))
\end{aligned}
$$

Regression statistics

Sample period: 1965:q1 - 2007:q4
Estimation date: May 2009

g.37 QPMO: Random walk component of non-oil import prices

In the long run, the level of non-oil import prices is determined by two factors -- a weighted average of foreign consumer prices expressed in dollars and domestic output prices; and a stochastic trend component that takes account of permanent movements in the relative price of imported goods with respect to the prices of both foreign consumption and domestic output. The stochastic trend component, QPMO, is derived from Kalman filter estimation of the dynamic non-oil import price equation; estimation suggested that QPMO is subject to significant I(1), but not I(2), shocks.

$$\mathbf{log(QPMO) =} \log(QPMO_{t-1}) - 0.00335$$

g.38 PGDP: Price index for GDP, cw

$$\mathbf{PGDP =} 100*XGDPN/XGDP$$

g.39 PGFL: Price index for federal government employee compensation, cw

The price index for federal employee compensation (PGFL) is proportional to the economy-wide compensation rate (PL). They are linked by the exogenous conversion factor UPGFL, adjusted for trend labor productivity. Because the national accounts assume that there is no productivity growth in the government sector, the dummy variable DGLPRD is set to 0 over history. In long-run simulations, however, DGLPRD is set to 1.0 to ensure that the government shares of employment and GDP are stationary.

$$\mathbf{log(PGFL) =} \log(UPGFL) + \log(PL) - DGLPRD*\log(LPRDT)$$

g.40 PGSL: Price index for S&L government employee compensation, cw

The price index for state and local employee compensation (PGSL) i sproportional to the economy-wide compensation rate (PL). They are linked by the exogenous conversion factor UPGSL, adjusted for trend labor productivity. Because the national accounts assume that there is no productivity growth in the government sector, the dummy variable DGLPRD is set to 0 over history. In long-run simulations, however, DGLPRD is set to 1.0 to ensure that the government shares of employment and GDP are stationary.

log(PGSL) = log(UPGSL) + log(PL) - DGLPRD*log(LPRDT)

g.41 PKPDCR: Price index for stock of computers, software, communication equip., cw (relative to PXP)

The relative price index for the stock of computer equipment (PKPDCR) is proportional to the relative price index for computer investment (PPDCR).

PKPDCR = UPKPDC * PPDCR

g.42 PLMIN: Minimum wage

The minimum wage (PLMIN) equals the product of the exogenous real minimum wage (PLMINR) and compensation per hour (PL).

PLMIN = PLMINR*.01*PL

g.43 PXG: Price index for nonfarm, nonhousing business output plus oil imports (net of IBT)

PXG = 100*XGN/XG

g.44 PXNFB: BLS NFB price

The BLS nonfarm business sector price is assumed to move with the GDP price, up to an exogenous multiplicative scale factor.

PXNFB = UPXNFB*PGDP

g.45 PXP: Price index for final sales plus imports less gov. labor

del(1 : log(PXP)) =

$$.5*(ECNIAN/XPN + ECNIAN_{t-1}/XPN_{t-1}) * del(1: log(PCNIA))$$
$$+ .5*((XPN-ECNIAN)/XPN + (XPN_{t-1}-ECNIAN_{t-1})/XPN_{t-1}) * del(1: log(PXNC))$$

g.46 HGPDCR: Trend growth rate of PPDCR

$$\mathbf{HGPDCR} = 0.900 * HGPDCR_{t-1} + 0.100 * 400*log(PPDCR/PPDCR_{t-1})$$

g.47 HGPDOR: Trend growth rate of PPDOR

$$\mathbf{HGPDOR} = 0.900 * HGPDOR_{t-1} + 0.100 * 400*log(PPDOR/PPDOR_{t-1})$$

g.48 HGPKIR: Trend growth rate of PKIR

$$\mathbf{HGPKIR} = 0.900 * HGPKIR_{t-1} + 0.100 * 400*log(PKIR/PKIR_{t-1})$$

g.49 HGPPSR: Trend growth rate of PPSR

$$\mathbf{HGPPSR} = 0.900 * HGPPSR_{t-1} + 0.100 * 400*log(PPSR/PPSR_{t-1})$$

g.50 DLQPXP: del(log(qpxp))

$$\textbf{DLQPXP} = \mathrm{del}(1: \log(QPXP))$$

g.51 PICNGR: Weighted growth rate of relative energy price

$$\textbf{PICNGR} = (\mathrm{del}(1 : \log(PCENG/PXP_{t-1})) * \mathrm{mave}(2 : PCENG_{\,t}*CENG_{\,t}/(PXP_{\,t}*XP_{\,t})))$$

g.52 PICNIA: Inflation rate, personal consumption expenditures, cw

$$\textbf{PICNIA} = 400*\mathrm{del}(1 : \log(PCNIA))$$

g.53 PICXFE: Inflation rate, personal consumption expenditures, ex. food and energy, cw

$$\textbf{PICXFE} = 400*\mathrm{del}(1 : \log(PCXFE))$$

g.54 PIGDP: Inflation rate, GDP, cw

$$\textbf{PIGDP} = 400*\mathrm{del}(1 : \log(PGDP))$$

g.55 PIPXNC: Inflation rate, price of adjusted final sales excluding consumption (annual rate)

$$\textbf{PIPXNC} = 400 * \mathrm{del}(1{:}\ \log(PXNC))$$

g.56 PCOR: Price index for non-durable goods and non-housing services, cw (relative to to PCNIA)

The relative price of non-durable goods and non-housing services (PCOR) is chain disaggregated from PCNIA using the relative prices for durable goods (PCDR) and housing services (PCHR).

$$\begin{aligned}
\textbf{log(PCOR) - log(PCOR(-1))} = \ & \\
& (-\ .5 * .01 * (PCDR*PCNIA*ECD/ECNIAN \\
& + PCDR_{t-1}*PCNIA_{t-1}*ECD_{t-1}/ECNIAN_{t-1})) \\
& /\ (.5 * .01 * (PCOR*PCNIA*ECO/ECNIAN \\
& + PCOR_{t-1}*PCNIA_{t-1}*ECO_{t-1}/ECNIAN_{t-1})) \\
& *\ \mathrm{del}(1{:}\log(PCDR)) \\
& -\ .5 * .01 * (PCHR*PCNIA*ECH/ECNIAN \\
& + PCHR_{t-1}*PCNIA_{t-1}*ECH_{t-1}/ECNIAN_{t-1}) \\
& *\ \mathrm{del}(1{:}\log(PCHR)) \\
& /\ (.5 * .01 * (PCOR*PCNIA*ECO/ECNIAN \\
& + PCOR_{t-1}*PCNIA_{t-1}*ECO_{t-1}/ECNIAN_{t-1}))
\end{aligned}$$

g.57 PCHR: Price index for housing services, cw (relative to to PCNIA)

The growth rate of the relative (to PCNIA) price of housing services (PCHR) is assumed to follow a first order autoregression. The constant is equal to the drift times one minus the lag coefficient.

$$\begin{aligned}
\textbf{del(1:log(PCHR))} = \ & 0.000287\,[0.8913028126241606] \\
& + 0.597\ [9.911884780755525]*\mathrm{del}(1{:}\log(PCHR_{t-1}))
\end{aligned}$$

Regression statistics

Adjusted R^2:	0.35
S.E. of regression:	0.00430429
Sum of squared residuals:	0.00335336
Durbin-Watson statistic:	2.00
Sample period:	1964Q2 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

g.58 PICX4: Four-quarter percent change core in PCE prices

$$\textbf{PICX4} = 100*(PCXFE/PCXFE_{t-4} - 1)$$

g.59 PCDR: Price index for consumer durables, cw (relative to to PCNIA)

The growth rate of the relative (to PCNIA) price of consumer durable goods (PCDR) is assumed to follow a second order autoregression. The constant is equal to the drift times one minus the sum of the lag coefficients.

$$\textbf{del(1:log(PCDR))} = -0.00298[-5.799165686863838] + 0.521\ [8.216250112308705]*del(1:log(PCDR_{t-1}))$$

Regression statistics

Adjusted R^2:	0.27
S.E. of regression:	0.00448124
Sum of squared residuals:	0.00363475
Durbin-Watson statistic:	2.00
Sample period:	1964Q2 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

g.60 PIC4: Four-quarter percent change in PCE prices

$$\textbf{PIC4} = 100*(PCNIA/PCNIA_{t-4} - 1)$$

g.61 PWSTAR: Equilibrium NFB price markup

$$\textbf{PWSTAR} = 0.00 + 1.00 *PWSTAR_{t-1}$$

Government

The bulk of the government sector consists of identities that: (1) relate nominal purchases, transfers, and grants to associated constant-dollar variables and price indexes; (2) link tax receipts to associated tax rates and tax bases; and (3) compute the budget surplus and stock of debt. In constructing these identities, the government sector is disaggregated into its federal and state and local components.

Aside from these identities, the sector also contains a number of simple reduced-form behavioral equations. For example, there are a several dynamic error-correction equations that link growth in spending on various types of goods and services to trend spending in these categories. Other estimated behavioral equations in the government sector account for the average interest rate paid on government debt, the cyclical component of transfer payments, and short-run fluctuations in a variety of tax rates.

Finally, the sector includes a pair of equations that determine the overall stance of fiscal policy, as defined by the government debt-to-GDP ratio on both the federal and state/local levels. These equations work by adjusting personal income tax rates to ensure that actual debt ratios gradually converge to specified target values.

h.1 EGF: Federal government consumption and gross investment, cw 2005$

Total federal government expenditures are approximated by the Divisia aggregate of its components.

$$\begin{aligned}\mathbf{log(EGF)} = {} & \log(EGF_{t-1}) \\ & + .5 * (EGFON/EGFN + EGFON_{t-1}/EGFN_{t-1}) * del(1:\log(EGFO)) \\ & + .5 * (EGFIN/EGFN + EGFIN_{t-1}/EGFN_{t-1}) * del(1:\log(EGFI)) \\ & + .5 * (EGFLN/EGFN + EGFLN_{t-1}/EGFN_{t-1}) * del(1:\log(EGFL))\end{aligned}$$

h.2 EGFI: Federal government gross investment, cw 2005$

Federal government investment expenditures error-correct to their long-run trend, EGFIT.

$$\mathbf{del(1 : log(EGFI))} = -0.00361[-0.776796215793119]$$
$$- 0.181\ [-3.127364965411845] * \log(EGFI_{t-1}/EGFIT_{t-1})$$
$$+ A2(L)\ \{sum\ -0.422\} * del(1 : \log(EGFI_{t-1}))$$
$$+ 1.87\ [4.965707712120396] * del(1 : \log(EGFIT))$$
$$+ A4(L)\ \{sum\ 0.00144\} * XGAP2_t$$

Distributed lag coefficients

Name	Value
$A2_0$	-0.253 0.00
$A2_1$	-0.169 0.00
$A2_{SUM}$	-0.422
$A4_0$	0.00771 0.00
$A4_1$	-0.006280.00
$A4_{SUM}$	0.00144

Regression statistics

Adjusted R^2:	0.24
S.E. of regression:	0.0547352
Sum of squared residuals:	0.518297
Durbin-Watson statistic:	1.97
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

h.3 EGFIN: Federal government gross investment, current $

$$\mathbf{EGFIN} = .01 * PXP * PGFIR * EGFI$$

h.4 EGFIT: Federal government gross investment, cw 2005$, trend

$$\mathbf{del(1 : log(EGFIT))} = -0.463$$
$$- 0.100 * \log(.01*PGFIR_{t-1}*PXP_{t-1}*EGFIT_{t-1}/XGDPTN_{t-1})$$
$$+ 1.00 * (HGGDPT+HGGDPT_{t-1}+HGGDPT_{t-2}+HGGDPT_{t-3}) / 1600$$

h.5 EGFL: Federal government employee compensation, cw 2005$

Federal government employee compensation error-corrects to its long-run trend, EGFLT.

del(1 : log(EGFL)) = 0.000349[0.5530328523610169]
- 0.0766 [-3.075746702719682] * $\log(EGFL_{t-1}/EGFLT_{t-1})$
+ A2(L) {sum 0.215 } * del(1 : $\log(EGFL_{t-1})$)
+ 1.18 [5.873703487724603] * del(1 : log(EGFLT))
+ A4(L) {sum 7.36E-05} * $XGAP2_t$

Distributed lag coefficients

Name	Value
$A2_0$	0.278 0.00
$A2_1$	-0.0622 0.00
$A2_{SUM}$	0.215
$A4_0$	-0.000951 0.00
$A4_1$	0.00102 0.00
$A4_{SUM}$	7.36E-05

Regression statistics

Adjusted R^2:	0.39
S.E. of regression:	0.00837942
Sum of squared residuals:	0.0121471
Durbin-Watson statistic:	2.02
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

h.6 EGFLN: Federal government employee compensation, current $

EGFLN = .01 * PGFL * EGFL

h.7 EGFLT: Federal government employee compensation, cw 2005$, trend

$$\textbf{del(1 : log(EGFLT))} = -0.369 - 0.100 * \log(.01*PGFL_{t-1}*EGFLT_{t-1}/XGDPTN_{t-1}) + 1.00 * (HGGDPT+HGGDPT_{t-1}+HGGDPT_{t-2}+HGGDPT_{t-3}) / 1600$$

h.8 EGFN: Federal government consumption and gross investment, current $

$$\textbf{EGFN} = EGFLN + EGFIN + EGFON$$

h.9 EGFO: Federal government consumption ex. employee comp., cw 2005$

Federal government consumption expenditure ex employee compensation error-corrects to its long-run trend, EGFOT.

$$\textbf{del(1 : log(EGFO))} = -0.00193 [-0.71843194837922 81] - 0.168 [-3.2557500176319 58] * \log(EGFO_{t-1}/EGFOT_{t-1}) + A2(L) \{sum\ -0.358\} * del(1 : \log(EGFO_{t-1})) + 1.77 [5.294460499807873] * del(1 : \log(EGFOT)) + A4(L) \{sum\ 0.000349\} * XGAP2_{t}$$

Distributed lag coefficients

Name	Value
$A2_0$	-0.253 0.00
$A2_1$	-0.105 0.00
$A2_{SUM}$	-0.358
$A4_0$	-0.000247 0.00
$A4_1$	0.000597 0.00
$A4_{SUM}$	0.000349

Regression statistics

Adjusted R^2: 0.24

S.E. of regression:	0.0271321
Sum of squared residuals:	0.127354
Durbin-Watson statistic:	2.04
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

h.10 EGFON: Federal government consumption ex. employee comp., current $

$$\textbf{EGFON} = .01 * PXP * PGFOR * EGFO$$

h.11 EGFOT: Federal government consumption ex. employee comp., cw 2005$, trend

$$\begin{aligned}\textbf{del(1 : log(EGFOT))} = & -0.346 \\ & - 0.100 * \log(.01*PGFOR_{t-1}*PXP_{t-1}*EGFOT_{t-1}/XGDPTN_{t-1}) \\ & + 1.00 * (HGGDPT+HGGDPT_{t-1}+HGGDPT_{t-2}+HGGDPT_{t-3}) / 1600\end{aligned}$$

h.12 EGS: S&L government consumption and gross investment, cw 2005$

Total state and local government expenditures are approximated by the Divisia aggregate of its components.

$$\begin{aligned}\textbf{log(EGS)} = & \log(EGS_{t-1}) \\ & + .5 * (EGSON/EGSN + EGSON_{t-1}/EGSN_{t-1}) * del(1:\log(EGSO)) \\ & + .5 * (EGSIN/EGSN + EGSIN_{t-1}/EGSN_{t-1}) * del(1:\log(EGSI)) \\ & + .5 * (EGSLN/EGSN + EGSLN_{t-1}/EGSN_{t-1}) * del(1:\log(EGSL))\end{aligned}$$

h.13 EGSI: S&L government gross investment, cw 2005$

State and local government investment spending error-corrects to its long-run trend, EGSIT.

$$\mathbf{del(1 : log(EGSI))} = -0.000535[-0.18170059048247 14] - 0.202\ [-3.6575668891717 33] * \log(EGSI_{t-1}/EGSIT_{t-1}) + A2(L)\ \{sum\ -0.0552\} * del(1 : \log(EGSI_{t-1})) + 1.18\ [2.8677051072403 74] * del(1 : \log(EGSIT)) + A4(L)\ \{sum\ 0.00199\} * XGAP2_t$$

Distributed lag coefficients

Name	Value
$A2_0$	0.0390 0.00
$A2_1$	-0.0942 0.00
$A2_{SUM}$	-0.0552
$A4_0$	0.00643 0.00
$A4_1$	-0.004440.00
$A4_{SUM}$	0.00199

Regression statistics

Adjusted R^2:	0.19
S.E. of regression:	0.0296497
Sum of squared residuals:	0.152085
Durbin-Watson statistic:	2.02
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

h.14 EGSIN: S&L government gross investment, current $

$$\mathbf{EGSIN} = .01 * PXP * PGSIR * EGSI$$

h.15 EGSIT: S&L government gross investment, cw 2005$, trend

$$\mathbf{del(1 : log(EGSIT))} = -0.379 - 0.100 * \log(.01*PGSIR_{t-1}*PXP_{t-1}*EGSIT_{t-1}/XGDPTN_{t-1}) + 1.00 * (HGGDPT+HGGDPT_{t-1}+HGGDPT_{t-2}+HGGDPT_{t-3}) / 1600$$

h.16 EGSL: S&L government employee compensation, cw 2005$

State and local government employee compensation error-corrects to its long-run trend, EGSLT.

$$
\begin{aligned}
\textbf{del(1 : log(EGSL))} = {} & 0.000586[1.118962155771013] \\
& - 0.119\ [-3.595028713371106] * \log(EGSL_{t-1}/EGSLT_{t-1}) \\
& + A2(L)\ \{sum\ 0.169\ \} * del(1 : \log(EGSL_{t-1})) \\
& + 0.692\ [5.279042924387616] * del(1 : \log(EGSLT)) \\
& + A4(L)\ \{sum\ 0.000389\} * XGAP2_{t}
\end{aligned}
$$

Distributed lag coefficients

Name	Value
$A2_0$	0.173 0.00
$A2_1$	-0.00384 0.00
$A2_{SUM}$	0.169
$A4_0$	-0.000734 0.00
$A4_1$	0.00112 0.00
$A4_{SUM}$	0.000389

Regression statistics

Adjusted R^2:	0.60
S.E. of regression:	0.00319902
Sum of squared residuals:	0.00177044
Durbin-Watson statistic:	2.02
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

h.17 EGSLN: S&L government employee compensation, current $

$$\textbf{EGSLN} = .01 * PGSL * EGSL$$

h.18 EGSLT: S&L government employee compensation, cw 2005$, trend

$$\text{del}(1 : \log(\text{EGSLT})) = -0.269 - 0.100 * \log(.01*\text{PGSL}_{t-1}*\text{EGSLT}_{t-1}/\text{XGDPTN}_{t-1}) + 1.00 * (\text{HGGDPT}+\text{HGGDPT}_{t-1}+\text{HGGDPT}_{t-2}+\text{HGGDPT}_{t-3}) / 1600$$

h.19 EGSN: S&L government consumption and gross investment, current $

$$\text{EGSN} = \text{EGSLN} + \text{EGSIN} + \text{EGSON}$$

h.20 EGSO: S&L government consumption ex. employee comp., cw 2005$

State and local government consumption expenditure ex employee compensation error-corrects to its long-run trend, EGSOT.

$$\text{del}(1 : \log(\text{EGSO})) = -0.000524[-0.3696153052446315] - 0.0787\ [-4.563507086435643] * \log(\text{EGSO}_{t-1}/\text{EGSOT}_{t-1}) + \text{A2(L)}\ \{\text{sum } 0.734\} * \text{del}(1 : \log(\text{EGSO}_{t-1})) + 0.280\ [1.88529142560965] * \text{del}(1 : \log(\text{EGSOT})) + \text{A4(L)}\ \{\text{sum } 2.08\text{E-}05\} * \text{XGAP2}_t$$

Distributed lag coefficients

Name	Value
$A2_0$	0.557 0.00
$A2_1$	0.177 0.00
$A2_{SUM}$	0.734
$A4_0$	-0.001550.00
$A4_1$	0.00157 0.00
$A4_{SUM}$	2.08E-05

Regression statistics

Adjusted R^2: 0.67

S.E. of regression:	0.00760153
Sum of squared residuals:	0.0099965
Durbin-Watson statistic:	2.02
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

h.21 EGSON: S&L government consumption ex. employee comp., current $

$$\textbf{EGSON} = .01 * PXP * PGSOR * EGSO$$

h.22 EGSOT: S&L government consumption ex. employee comp., cw 2005$, trend

$$\begin{aligned}\textbf{del(1 : log(EGSOT))} = & -0.371 \\ & - 0.100 * \log(.01*PGSOR_{t-1}*PXP_{t-1}*EGSOT_{t-1}/XGDPTN_{t-1}) \\ & + 1.00 * (HGGDPT+HGGDPT_{t-1}+HGGDPT_{t-2}+HGGDPT_{t-3}) / 1600\end{aligned}$$

h.23 GFDBTN: Federal government debt stock, current $

$$\begin{aligned}\textbf{GFDBTN} = & UGFDBT*(GFDBTN_{t-1} - .25*GFSRPN + .25*EGFIN \\ & - .25*JYGFGN - .25*JYGFEN)\end{aligned}$$

h.24 GFINTN: Federal government net interest payments, current $

$$\textbf{GFINTN} = RGFINT*GFDBTN_{t-1}$$

h.25 GFS: Federal government grants-in-aid to S&L government, deflated by PCNIA

$$\mathbf{del(1 : log(GFS))} = -0.361 - 0.100 * \log(GFSN_{t-1}/XGDPTN_{t-1}) + 1.00 * (HGGDPT+HGGDPT_{t-1}+HGGDPT_{t-2}+HGGDPT_{t-3}) / 1600$$

h.26 GFSN: Federal government grants-in-aid to S&L government, current $

$$\mathbf{GFSN} = .01*PGDP*GFS$$

h.27 GFSRPN: Federal government budget surplus, current $

$$\mathbf{GFSRPN} = TFPN + TFCIN + TFIBN + TFSIN - EGFLN - EGFON - GFTN - GFINTN - GFSUBN - GFSN$$

h.28 GFSUB: Federal government subsidies less surplus, deflated by PCNIA

$$\mathbf{del(1 : log(GFSUB))} = -0.550 - 0.100 * \log(GFSUBN_{t-1}/XGDPTN_{t-1}) + 1.00 * (HGGDPT+HGGDPT_{t-1}+HGGDPT_{t-2}+HGGDPT_{t-3}) / 1600$$

h.29 GFSUBN: Federal government subsidies less surplus, current $

$$\mathbf{GFSUBN} = .01*PGDP*GFSUB$$

h.30 GFT: Federal government net transfer payments, deflated by PCNIA

Real federal transfers equals the sum of the cyclical and trend transfer ratios (GFTRD and GFTRT) multiplied by potential GDP.

GFT = (GFTRD+GFTRT)*XGDPT

h.31 GFTN: Federal government net transfer payments, current $

GFTN = .01*PCNIA*GFT

h.32 GFTRD: Deviation of ratio of federal transfers to GDP from trend ratio

The deviation of the ratio of real federal transfers to real GDP from its trend is estimated to vary countercyclically. Historically, the trend ratio (GFTRT) is estimated by H-P filtering the actual ratio.

$$\mathbf{GFTRD} = 2.42E\text{-}05_{[0.1551334562241885]} + 0.650\ [12.39300446281977] * GFTRD_{t-1} - 0.000244_{[-4.3278079837172]} * XGAP2$$

Regression statistics

Adjusted R^2:	0.55
S.E. of regression:	0.00209033
Sum of squared residuals:	0.0007734
Durbin-Watson statistic:	2.10
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

h.33 GSDBTN: S&L government debt stock, current $

$$\mathbf{GSDBTN} = UGSDBT*(GSDBTN_{t-1} - .25*GSSRPN + .25 * EGSIN$$

$$- .25*JYGSGN - .25*JYGSEN)$$

h.34 GSINTN: S&L government net interest payments, current $

State and local net interest payments combine the interest paid on the financial liabilities of these entities with the interest received by their pension funds. It is a negative number. Because FRB/US includes only the debt position excluding the social insurance funds, the equation for net interest assumes that state and local governments pay the same rate of interest as does the federal government (RGFINT) on debt excluding social insurance funds (GSDBTN), and that the interest receipts of the social insurance funds are an exogenous fraction (UGSINT) of nonfarm business sector output (XNFBN).

$$\mathbf{GSINTN} = RGFINT*GSDBTN_{t-1} + UGSINT*XNFBN$$

h.35 GSSRPN: S&L government budget surplus, current $

$$\mathbf{GSSRPN} = TSPN + TSCIN + TSIBN + TSSIN + GFSN$$
$$- EGSLN - EGSON - GSTN - GSINTN - GSSUBN$$

h.36 GSSUB: S&L government subsidies less surplus, deflated by PCNIA

$$\mathbf{GSSUB} = UGSSUB*XGDPT$$

h.37 GSSUBN: S&L government subsidies less surplus, current $

$$\mathbf{GSSUBN} = .01*PGDP*GSSUB$$

h.38 GST: S&L government net transfer payments, deflated by PCNIA

$$\textbf{GST} = (\text{GSTRD}+\text{GSTRT})*\text{XGDPT}$$

h.39 GSTN: S&L government net transfer payments, current $

$$\textbf{GSTN} = .01*\text{PCNIA}*\text{GST}$$

h.40 GSTRD: Deviation of ratio of S&L transfers to GDP from trend ratio

Real state and local transfer payments relative to potential GDP are assumed to deviate from their trend rate of growth when aggregate output deviates from its trend. When the economy is cyclically strong (XGAP2 greater than zero), transfer payments are below trend.

$$\begin{aligned}\textbf{GSTRD} = {} & 1.68\text{E-}06[0.03872835710754526] \\ & + 0.743\ [15.54662026896159] * \text{GSTRD}_{t-1} \\ & - 4.28\text{E-}05[-2.805647749807061] * \text{XGAP2}\end{aligned}$$

Regression statistics

Adjusted R^2:	0.61
S.E. of regression:	0.00057935
Sum of squared residuals:	5.94094e-05
Durbin-Watson statistic:	2.41
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

h.41 RGFINT: Ratio of federal government net interest payments to lagged stock of debt

The average rate of interest on federal government debt (RGFINT) is measured historically as the ratio of interest paid to the lagged stock of debt outstanding. Its equation is specified in a partial adjustment format, with an estimated adjustment speed of about 8 percent per quarter. The steady-state average interest rate equals an average of the yields on treasury bills (RTB) and 5-year bonds (RG5).

$$\textbf{del(1 : RGFINT)} = 0.0533\ [5.000669324597904] * (\text{RG5}_{t-1}/100-\text{RGFINT}_{t-1})$$

$+ 0.0687$ [3.8557605109402 53] $* (RTB_{t-1}/100-RG5_{t-1}/100)$
$+ 0.000775$[2.78614287417121]
$- 0.194$ [-2.990975204738243] $*$ del(1 : $RGFINT_{t-1}$)
$+ 0.195$ [6.263224931431775] $*$ del(1 : $RG5_{t-1}/100$)
$+ 0.0600$ [2.766742658055269] $*$ del(1 : $RTB/100$)

Regression statistics

Adjusted R^2:	0.42
S.E. of regression:	0.00227636
Sum of squared residuals:	0.000901633
Durbin-Watson statistic:	2.14
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

h.42 TFCIN: Federal corporate income tax accruals, current $

TFCIN = TRFCI * YNICPN

h.43 TFIBN: Federal indirect business tax receipts, current $

TFIBN = TRFIB * ECNIAN

h.44 TFPN: Federal personal income tax and nontax receipts, current $

TFPN = TRFP * (YPN - GFTN - GSTN)

h.45 TFSIN: Federal social insurance tax receipts

TFSIN = TRFSI * YNILN

h.46 TRFCI: Average federal corporate income tax rate

The average federal corporate income tax rate varies with the statutory marginal rate (TRFCIM), the investment tax credit (TAPDTO and TAPDTC), the cyclical state of the economy (XGAP2), and the rate of inflation (PICNIA). The latter captures two effects of higher inflation: it boosts taxable capital gains on inventory stocks and lowers the value of historical cost depreciation allowances.

TRFCI = -0.00350[-0.3909668902137969]

+ 0.760 [21.44667037278419] * $TRFCI_{t-1}$

+ 0.152 [4.415986686152431] * TRFCIM

- 0.187 [-3.622892196420558] * (.01*PXP*(EPDO*PPDOR*.01*TAPDTO+EPDC*PPDCR*.01*TAPDTC)/YNICPN)

+ 0.00184 [4.164177447841364] * XGAP2

+ 0.00312 [5.459420826232798] * PICNIA

Regression statistics

Adjusted R^2:	0.96
S.E. of regression:	0.012813
Sum of squared residuals:	0.0285661
Durbin-Watson statistic:	1.77
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

h.47 TRFP: Average federal tax rate for personal income tax and nontax receipts

The average federal personal income tax rate varies procyclically and adjusts gradually to eliminate deviations between the average and trend (TRFPT) tax rate.

TRFP = 1.00 * TRFPT

+ A2(L) {sum 0.923 } * ($TRFP_{t-1}$-$TRFPT_{t-1}$)

+ 0.000559[3.974788832969011] * $XGAP2_{t-1}$

Distributed lag coefficients

Name	Value
$A2_0$	0.596 0.00
$A2_1$	0.327 0.00
$A2_{SUM}$	0.923

Regression statistics

Adjusted R^2:	0.76
S.E. of regression:	0.00520228
Sum of squared residuals:	0.00479028
Durbin-Watson statistic:	2.00
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

h.48 TRFPT: Average federal tax rate for personal income tax, trend

The equation for TRFPT (the trend component of the average federal personal income tax rate) has three settings. The trend tax rate is exogenous if DFPEX is set to 1; the trend rate adjusts to deviations of the debt ratio from its target is DFDBT is 1, and it adjusts to deviations of the surplus ratio from its target if DFSRP it 1.

$$
\begin{aligned}
\textbf{TRFPT} = {} & DFPEX * TRFPTX \\
& + DFPDBT * (TRFPT_{t-1} \\
& + 0.0500 \text{ [(const.)]} * (GFDBTN_{t-1}/XGDPN_{t-1} - GFDRT_{t-1}) \\
& + 0.500 \text{ [(const.)]} * del(1 : GFDBTN_{t-1}/XGDPN_{t-1} - GFDRT_{t-1})) \\
& + DFPSRP * (TRFPT_{t-1} \\
& - 0.100 \text{ [(const.)]} * ((GFSRPN_{t-1} - EGFIN_{t-1} + JYGFGN_{t-1} \\
& + JYGFEN_{t-1})/XGDPN_{t-1} - GFSRT_{t-1}))
\end{aligned}
$$

h.49 TRSCI: Average S&L corporate income tax rate

The average state and local corporate income tax rate varies countercyclically, moves in tandem with the average federal rate, and adjusts gradually to eliminate deviations between the average rate and its trend

(TRSCIT).

$$\textbf{TRSCI} = 0.792\ [17.60064638639834] * TRSCI_{t-1}$$
$$+ A2(L)\ \{sum\ 0.208\ \} * TRSCIT_{t}$$
$$+ A3(L)\ \{sum\ -5.44E-05\} * XGAP2_{t}$$
$$+ 0.137\ [11.27338471653627] * del(1 : TRFCI)$$

Distributed lag coefficients

Name	Value
$A2_0$	1.11 0.00
$A2_1$	-0.902 0.00
$A2_{SUM}$	0.208
$A3_0$	-0.000647 0.00
$A3_1$	0.000592 0.00
$A3_{SUM}$	-5.44E-05

Regression statistics

Adjusted R^2:	0.97
S.E. of regression:	0.00216303
Sum of squared residuals:	0.000818769
Durbin-Watson statistic:	2.13
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

h.50 TRSIB: Average S&L indirect business tax rate

The average state and local corporate indirect business tax rate varies countercyclically, and adjusts gradually to eliminate deviations between the average rate and its trend (TRSIBT).

$$\textbf{TRSIB} = 0.922\ [31.53232900209978] * TRSIB_{t-1}$$
$$+ A2(L)\ \{sum\ 0.0778\ \} * TRSIBT_{t}$$
$$- 3.31E-05[-1.929421590502045] * XGAP2$$

Distributed lag coefficients

Name	Value

$A2_0$	1.35 0.00
$A2_1$	-1.27 0.00
$A2_{SUM}$	0.0778

Regression statistics

Adjusted R^2:	0.99
S.E. of regression:	0.000635489
Sum of squared residuals:	7.14808e-05
Durbin-Watson statistic:	1.89
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

h.51 TRSP: Average S&L tax rate for personal income tax and nontax receipts

The average state and local personal income tax rate varies countercyclically, moves in tandem with the average federal rate (TRFP), and adjusts gradually to eliminate deviations between the average and trend (TRSPT) tax rates.

$$\mathbf{TRSP} = 0.638\ [10.857524883699917] * TRSP_{t-1}$$
$$+ A2(L)\ \{sum\ 0.362\ \} * TRSPT_t$$
$$+ 2.69E\text{-}05[1.178494664755758] * XGAP2_{t-1}$$
$$+ 0.0170\ [1.711478814719414] * del(1 : TRFP)$$

Distributed lag coefficients

Name	Value
$A2_0$	0.784 0.00
$A2_1$	-0.422 0.00
$A2_{SUM}$	0.362

Regression statistics

Adjusted R^2:	0.98
S.E. of regression:	0.000746032
Sum of squared residuals:	9.79553e-05
Durbin-Watson statistic:	2.06

Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

h.52 TRSPT: Trend S&L personal income tax rate

The equation for TRSPT (the trend component of the average state and local personal income tax rate) has three settings. The trend tax rate is exogenous if DFPEX is set to 1; the trend rate adjusts to deviations of the debt ratio from its target is DFDBT is 1, and it adjusts to deviations of the surplus ratio from its target if DFSRP it 1.

TRSPT = DFPEX * TRSPTX

+ DFPDBT * ($TRSPT_{t-1}$

+ 0.0500 [(const.)] * ($GSDBTN_{t-1}$/$XGDPN_{t-1}$ - $GSDRT_{t-1}$)

+ 0.500 [(const.)] * del(1 : $GSDBTN_{t-1}$/$XGDPN_{t-1}$ - $GSDRT_{t-1}$))

+ DFPSRP * ($TRSPT_{t-1}$

- 0.250 [(const.)] * (($GSSRPN_{t-1}$ - $EGSIN_{t-1}$ + $JYGSGN_{t-1}$

+ $JYGSEN_{t-1}$)/$XGDPN_{t-1}$ - $GSSRT_{t-1}$))

h.53 TRSSI: Average S&L social insurance tax rate

The average state and local social insurance tax rate varies countercyclically, and adjusts gradually to eliminate deviations between the average rate and its trend (TRSSIT).

TRSSI = A1(L) {sum 0.947 } * TRSSI $_{t-1}$

+ A2(L) {sum 0.0534 } * TRSSIT $_t$

- 4.76E-06[-2.581994644264019] * XGAP2

Distributed lag coefficients

Name	Value
$A1_0$	1.22 0.00
$A1_1$	-0.276 0.00
$A1_{SUM}$	0.947
$A2_0$	1.41 0.00
$A2_1$	-1.36 0.00

$A2_{SUM}$	0.0534

Regression statistics

Adjusted R^2:	0.99
S.E. of regression:	7.0443e-05
Sum of squared residuals:	8.73351e-07
Durbin-Watson statistic:	2.04
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

h.54 TSCIN: S&L corporate income tax accruals, current $

TSCIN = TRSCI * YNICPN

h.55 TSIBN: S&L indirect business tax receipts, current $

TSIBN = TRSIB * ECNIAN

h.56 TSIEN: Employer social insurance taxes, current $

TSIEN = UTSIE * (TFSIN + TSSIN)

h.57 TSPN: S&L personal income tax and nontax receipts, current $

TSPN = TRSP * (YPN - GFTN - GSTN)

h.58 TSSIN: S&L social insurance tax receipts, current $

TSSIN = TRSSI * YNILN

h.59 YGFSN: Federal government saving

YGFSN = GFSRPN + JYGFGN + JYGFEN

h.60 YGSSN: State and Local government saving

YGSSN = GSSRPN + JYGSGN + JYGSEN

Financial Sector

The financial sector of FRB/US can be sub-divided into three blocks of equations: equations determining the stance of monetary policy, defined as the value of the nominal federal funds rate; equations for other interest rates based on arbitrage relationships; and a set of identities for household wealth, including equations that relate the value of the stock market to real bond yields and expected growth in dividends.

In the monetary policy block, there are five options for setting the federal funds rate: (1) The funds rate follows a pre-determined path. (2) Policy is defined by a policy reaction function which is estimated over the period 1963 to 1994 and is identical to that embedded in the construction of VAR expectations. (3) Policy is modeled as a version of the Taylor rule. (4) Policy is defined by a policy reaction function estimated over the 1980-1995 period. (5) The funds rate is set according to a generalized policy rule that can be used, among other things, to target either inflation or the price level. These five options are mutually exclusive, although it is possible to switch from one option to another in multi-period simulations by manipulating a group of exogenous "switches" (DMPEX, DMPVAR, DMPTAY, DMTP79 and DMPGEN).

In the block of equations that determine other interest rates, the most important are those for yields on 5- and 10-year government bonds and for the yield on corporate bonds. These equations are based on the expectations theory of the term structure, whereby the yield on a long-term bond equals a weighted average of expected rates on short-term assets over the maturity of the long-term bond plus a term premium. A weighted average (with weights declining about 2 percent per quarter), rather than a simple average, of expected future rates is computed, because the value of a coupon bond depends on both the level and the time-ordering of expected short-term rates. In these equations, term/risk premiums are modeled as having four components: a constant, an element that varies inversely with the expected cyclical state of the economy, an element that captures low-frequency shifts in the slope, and an unexplained component which is serially correlated. (An alternative interpretation of the latter component is that it represents errors in the model's proxies for expectations.)

Aside from the three main bond rate variables, the second block of equations also contains estimated equations for several other interest rates, including yields on Treasury bills, home mortgages, new car loans, and M2 deposits. Unlike the bond rate equations, however, these expressions do not directly use any expectional variables. In addition, the block also contains an equation for M2.

The final block of the sector determines the value of household net worth, as measured by the Federal Reserve's Flow-of-Funds accounts. Household net worth is divided into two components, corporate equity and other. The former is determined using the standard Gordon formula, in which stock prices depend on the current level of dividends, expected future growth in dividends, the real interest rate, and an equity premium; historical estimates of the latter are derived by inverting the formula. Household net worth excluding corporate equity equals the accumulated flow of household saving plus cumulated capital gains.

i.1 RFFTAY: Value of eff. federal funds rate given by the Taylor rule with output gap

RFFTAY is a version of the Taylor Rule. According to the equation, the nominal funds rate is set equal to the sum of the equilibrium real funds rate as perceived by policymakers (RSTAR) and a four-quarter moving average of actual inflation. This value is then adjusted in response to deviations of actual inflation from the target rate of inflation (PITARG) and deviations of the level of output from potential (XGAP2).

RFFTAY = RSTAR
+ mave(4 : PICXFE $_t$)
+ 0.500 * (mave(4 : PICXFE $_t$) -PITARG)
+ 1.00 * XGAP2

i.2 RFFTLR: Value of eff. federal funds rate given by the Taylor rule with unemployment gap

RFFTLR is a version of the Taylor Rule. According to the equation, the nominal funds rate is set equal to the sum of the equilibrium real funds rate as perceived by policymakers (RSTAR) This value is then adjusted in response to deviations of actual inflation from the target rate of inflation (PITARG) and deviations of the unemployment rate from the natural rate of unemployment.

$$
\begin{aligned}
\mathbf{RFFTLR} = {} & \text{RSTAR} \\
& - 0.500 * \text{PITARG} \\
& + 0.375 * (\text{mave}(4 : \text{PICXFE}_{t}) \\
& + 1.10 * (\text{LURNAT} + \text{DEUC} * \text{LEUC} - \text{LUR})
\end{aligned}
$$

i.3 RFFP87: Value of eff. federal funds rate given by the post-87 estimated reaction function

RFFP87 is a version of the Taylor Rule estimated over the period 1987 to 2000. In estimation, the core inflation terms are aggregated and a constant intercept in used in place of the equilibrium real funds rate as perceived by policymakers (RSTAR) and the target rate of core inflation (PITARG). The estimated value of the intercept (.40032) is consistent with RSTAR equal to 2.5 percent and PITARG equal to 1.5 percent.

$$
\begin{aligned}
\mathbf{RFFP87} = {} & 0.705 * \text{RFFP87}_{t-1} \\
& + 0.295 * (\text{RSTAR} + \text{mave}(4 : \text{PICXFE}_{t})) \\
& + 0.220 * (\text{mave}(4 : \text{PICXFE}_{t}) - \text{PITARG}) \\
& + 0.315 * \text{XGAP2}
\end{aligned}
$$

i.4 RFFGEN: Value of eff. federal funds rate given by the generalize reaction function

The equation for RFFGEN expresses a generalized description of a monetary policy reaction function. By altering the rule's coefficients, policy can target either inflation or the price level in the long-run. Similarly, parameters can be manipulated to allow the federal funds rate to respond (as desired) to transitory movements in past interest rates, inflation, prices, the output gap and the deviation of unemployment from the NAIRU. The default coefficient setting for RFFGEN makes the equation equivalent to the Taylor rule.

$$
\begin{aligned}
\mathbf{RFFGEN} = {} & 0.00 \\
& + A1(L) \{\text{sum } 0.00 \} * \text{RFFE}_{t-1} \\
& + A2(L) \{\text{sum } 1.50 \} * \text{PICNIA}_{t} \\
& + A3(L) \{\text{sum } 0.500 \} * \text{XGAP2}_{t} \\
& + A4(L) \{\text{sum } 0.00 \} * \text{LUR}_{t} \\
& + A5(L) \{\text{sum } 0.00 \} * \text{PCNIA}_{t} \\
& + B1(L) \{\text{sum } 1.00 \} * \text{RSTAR}_{t} \\
& + B2(L) \{\text{sum } -0.500 \} * \text{PITARG}_{t} \\
& + B4(L) \{\text{sum } 0.00 \} * \text{LURNAT}_{t} \\
& + B5(L) \{\text{sum } 0.00 \} * \text{PCSTAR}_{t}
\end{aligned}
$$

+ B6(L) {sum 0.00 } * PICXFE $_t$

Distributed lag coefficients

Name	Value
$A1_0$	0.00 0.00
$A1_1$	0.00 0.00
$A1_2$	0.00 0.00
$A1_3$	0.00 0.00
$A1_{SUM}$	0.00
$A2_0$	0.375 0.00
$A2_1$	0.375 0.00
$A2_2$	0.375 0.00
$A2_3$	0.375 0.00
$A2_4$	0.00 0.00
$A2_{SUM}$	1.50
$A3_0$	0.500 0.00
$A3_1$	0.00 0.00
$A3_2$	0.00 0.00
$A3_3$	0.00 0.00

Name	Value
$A3_4$	0.00 0.00
$A3_{SUM}$	0.500
$A4_0$	0.00 0.00
$A4_1$	0.00 0.00
$A4_2$	0.00 0.00
$A4_3$	0.00 0.00
$A4_4$	0.00 0.00
$A4_{SUM}$	0.00
$A5_0$	0.00 0.00
$A5_1$	0.00 0.00
$A5_2$	0.00 0.00
$A5_3$	0.00 0.00
$A5_4$	0.00 0.00
$A5_{SUM}$	0.00
$B1_0$	1.00 0.00
$B1_1$	0.00 0.00

Name	Value
$B1_2$	0.00 0.00
$B1_3$	0.00 0.00
$B1_4$	0.00 0.00
$B1_{SUM}$	1.00
$B2_0$	-0.500 0.00
$B2_1$	0.00 0.00
$B2_2$	0.00 0.00
$B2_3$	0.00 0.00
$B2_4$	0.00 0.00
$B2_{SUM}$	-0.500
$B4_0$	0.00 0.00
$B4_1$	0.00 0.00
$B4_2$	0.00 0.00
$B4_3$	0.00 0.00
$B4_4$	0.00 0.00

Name	Value
$B4_{SUM}$	0.00
$B5_0$	0.00 0.00
$B5_1$	0.00 0.00
$B5_2$	0.00 0.00
$B5_3$	0.00 0.00
$B5_4$	0.00 0.00
$B5_{SUM}$	0.00
$B6_0$	0.00 0.00
$B6_1$	0.00 0.00
$B6_2$	0.00 0.00
$B6_3$	0.00 0.00
$B6_4$	0.00 0.00

i.5 RFFE: Federal funds rate (effective ann. yield)

The equation for the effective federal funds rate determines which of six monetary policy options is used in simulations of the model. To simulate with an exogenous nominal funds rate, one sets the policy switch variable DMPEX to 1, assigns a path for the exogenous funds rate (RFFFIX), and sets the other five policy switches to zero. Similarly, to simulate with an exogenous real funds rate, one sets DMPRR to 1, assigns a path for the exogenous real funds rate (RRFIX), and sets the remaining policy switches (DPMxxx) to zero. Alternatively, the funds rate can be determined by one of the policy reaction functions. Which specific rule is used depends on the settings of the three policy dummy variables -- DMPTAY, DMPP87, and DMPGEN. A setting of zero turns off the corresponding policy rule, a setting of 1 turns it on. Finally, the equation specification sets a lower limit on the nominal funds rate. Setting RFFMIN to zero imposes the zero lower bound; setting RFFMIN to a large negative number effectively eliminates the constraint.

RFFE = MAX(DMPEX * 100 * ((1+RFFFIX/36000)**365-1)

+ DMPRR * (RRFIX + mave(4 : PICXFE $_t$))

+ DMPTAY * RFFTAY

+ DMPTLR * RFFTLR

+ DMPP87 * RFFP87
+ DMPALT * 100*((1+RFFALT/36000)**365-1)
+ DMPGEN * RFFGEN, RFFMIN)

i.6 RFF: Federal funds rate

RFF = 36000*((1+.01*RFFE)**(1/365) - 1)

i.7 RRFFE: Real federal funds rate (effective ann. yield)

The real federal funds rate (RRFFE) is defined as the nominal effective funds rate (RFFE) minus a 4-quarter moving average of core consumer price inflation (PICXFE).

RRFFE = RFFE - mave(4 : $PICXFE_{t}$)

i.8 RTB: 3-month Treasury bill rate

RTB = 36000/90 * (1-(.01*RTBE+1)**(-90/365))

i.9 RTBE: 3-month Treasury bill rate (effective ann. yield)

In the long run, the yield on 3-month Treasury bills equals the federal funds rate, less a fixed factor that adjusts for the default risk associated with the latter. Lags of RTBE are included in the equation to control for the sluggish adjustment of Treasury yields to the funds rate.

RTBE = -0.0759 [-2.187667762364632]
+ B1(L) {sum 0.889 } * $RTBE_{t-1}$
+ B2(L) {sum 0.111 } * $RFFE_{t}$

Distributed lag coefficients

Name	Value
$B1_0$	0.766 0.00
$B1_1$	0.123 0.00
$B1_{SUM}$	0.889
$B2_0$	0.786 0.00
$B2_1$	-0.675 0.00
$B2_{SUM}$	0.111

Regression statistics

Adjusted R^2:	0.99
S.E. of regression:	0.35645
Sum of squared residuals:	22.362
Durbin-Watson statistic:	2.17
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

i.10 RG5: 5-year Treasury note rate

RG5 = (((.01*RG5E + 1)**.5 - 1) * 200)

i.11 RG5E: 5-year Treasury note rate (effective ann. yield)

The yield on the five-year Treasury is equal to a weighted average of the values of the federal funds rates expected over the next 5 years (ZRFF5) plus a term premium (RG5P). The latter is not exogenous but is assumed to vary with the expected state of the economy.

RG5E = ZRFF5 + RG5P

i.12 RG5P: 5-year Treasury note rate. term premium

The term premium on 5-year Treasury bonds varies with the expected state of the business cycle, as proxied by the weighted forward average of the expected future output gap (ZGAP05). The weights used to calculate ZGAP05 match those used to calculate ZRFF5, and decline geometrically at a rate of .98 per quarter over the coming 5 years. The bond premium also has an exogenous component that is captured by the intercept Finally, there is an unexplained stochastic component of the bond premium that is serially correlated.

RG5P = 0.444 [1.267833788030089]
- 0.284 [-3.09031075321398] * ZGAP05
+ 0.864 [18.77237507879825] * ($RG5P_{t-1}$ - 0.444 - -0.284 *$ZGAP05_{t-1}$)

Regression statistics

Adjusted R^2:	0.80
S.E. of regression:	0.521727
Sum of squared residuals:	31.8473
Durbin-Watson statistic:	1.75
Sample period:	1980Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

i.13 RG10: 10-year Treasury bond rate

RG10 = (((.01*RG10E + 1)**.5 - 1) * 200)

i.14 RG10E: 10-year Treasury bond rate (effective ann. yield)

The yield on 10-year Treasury bonds is equal to a weighted average of the values of the federal funds rates expected over the next 10 years (ZRFF10) plus a term premium (RG10P). The latter is not exogenous but is assumed to vary with the expected state of the economy.

RG10E = ZRFF10 + RG10P

i.15 RG10P: 10-year Treasury bond rate, term premium

The term premium on 10-year Treasury bonds varies with the expected state of the business cycle, as proxied by the weighted forward average of the expected future output gap (ZGAP10). The weights used to calculate ZGAP10 match those used to calculate ZRFF10, and decline geometrically at a rate of .98 per quarter over the coming 10 years. The bond premium also has an exogenous component that is captured by the intercept. Finally, there is an unexplained stochastic component of the bond premium that is serially correlated.

$$\mathbf{RG10P} = 0.882\ [3.015272369921098] - 0.302\ [-1.859602943368 42] * ZGAP10 + 0.857\ [18.40966709189616] * (RG10P_{t-1} - 0.882 - -0.302 * ZGAP10_{t-1})$$

Regression statistics

Adjusted R^2:	0.76
S.E. of regression:	0.457716
Sum of squared residuals:	24.512
Durbin-Watson statistic:	1.71
Sample period:	1980Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

i.16 RBBB: S&P BBB corporate bond rate

$$\mathbf{RBBB} = (((0.01*RBBBE + 1)**.5 - 1) * 200)$$

i.17 RBBBE: S&P BBB corporate bond rate (effective ann. yield)

The yield on long-term BBB corporate bonds is equal to the ten-year Treasury note yiled (RG10E) plus a risk premium (RBBBP). The latter is not exogenous but is assumed to vary with the expected state of the economy.

$$\mathbf{RBBBE} = RBBBP + RG10E$$

i.18 RBBBP: S&P BBB corporate bond rate, risk/term premium

The risk premium on BBB bonds varies with the expected state of the business cycle, as proxied by the weighted forward average of the expected future output gap (ZGAP10). The weights used to calculate ZGAP10 decline geometrically at a rate of .98 per quarter over the coming 10 years. The bond premium also has an exogenous component that is captured by the intercept. Finally, there is an unexplained stochastic component of the bond premium that follows an AR(1) process.

RBBBP = 1.65 [8.657320814912861]
- 0.196 [-2.473077572533404] * ZGAP10
+ 0.873 [20.57805998405231] * ($RBBBP_{t-1}$ - 1.65 - -0.196 *$ZGAP10_{t-1}$)

Regression statistics

Adjusted R^2:	0.81
S.E. of regression:	0.286961
Sum of squared residuals:	11.2815
Durbin-Watson statistic:	1.77
Sample period:	1973Q1 2007Q4
Estimation date:	September 2010
Estimation method:	Least Squares

i.19 RCAR: New car loan rate at finance companies

In the long run, the rate on new car loans equals the yield on 5-year Treasury bonds, plus an exogenous risk premium. This risk premium declined over the 1960s and 1970s, but appears to have been stable since 1980; this effect is captured using the dummy variable D79A and time trend T47. The lagged value of the auto loan rate is included in the equation to capture the sluggish adjustment of bank loan rates to movements in market interest rates.

RCAR = 2.72 [6.861396498398728]
- 1.74 [-5.255927808262106] * D79A
- 0.0106 [-3.653206718920436] * ((1-D79A)*T47)
+ 0.645 [17.82818993279325] * $RCAR_{t-1}$
+ A4(L) {sum 0.355 } * $RG5_t$

Distributed lag coefficients

Name	Value
$A4_0$	0.212 0.00
$A4_1$	0.143 0.00
$A4_{SUM}$	0.355

Regression statistics

Adjusted R^2:	0.98
S.E. of regression:	0.354985
Sum of squared residuals:	22.0525
Durbin-Watson statistic:	1.80
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

i.20 RME: Interest rate on conventional mortgages (effective ann. yield)

In the long run, the mortgage rate equals the yield on BBB bonds, plus a combined term/risk premium. This premium has a fixed component captured by the intercept, but another component moves with the slope of the yield curve: When the yield curve is steep mortgage rates are modestly lower than they otherwise would be, all else equal. The lagged value of the mortgage rate is included in the equation to capture the sluggish adjustment of these loan rates to movements in market interest rates.

$$\begin{aligned}\textbf{RME} = {} & 0.421\ [6.460747762858074] \\ & + 0.728\ [18.47502302419704] * RME_{t-1} \\ & + A2(L)\ \{\text{sum } 0.272\ \} * RBBBE_{t} \\ & - 0.126\ [-6.903630495843385] * (RBBBE-RTBE)\end{aligned}$$

Distributed lag coefficients

Name	Value
$A2_0$	0.509 0.00
$A2_1$	-0.237 0.00
$A2_{SUM}$	0.272

Regression statistics

Adjusted R^2:	0.99
S.E. of regression:	0.358788
Sum of squared residuals:	22.6563
Durbin-Watson statistic:	1.88
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

i.21 DELRFF: Federal funds rate, first diff

$$\mathbf{DELRFF} = RFF - RFF_{t-1}$$

i.22 REQ: Real expected rate of return on equity

The rate of return on equity equals the effective ten-year Treasury note rate (RG10E), minus the average rate of inflation expected to prevail over the coming 10 years (ZPIC10), plus an equity premium (REQP). The latter varies with the corporate bond premium (RBBBP) and also includes an AR(1) error term.

$$\mathbf{REQ} = RG10E - ZPIC30 + REQP$$

i.23 REQP: Real expected rate of return on equity, premium component

The equity premium varies with the corporate bond risk premium (RBBBP). It also has a serially correlated, but stationary, exogenous component.

$$\mathbf{REQP} = 2.40\ [4.488519606893773] + 0.454\ [2.179867683929962] * RBBBP$$
$$+ 0.799\ [12.55683254228249] * (REQP_{t-1} - 2.40 - 0.454 * RBBBP_{t-1})$$

Regression statistics

Adjusted R^2:	0.69
S.E. of regression:	0.816297
Sum of squared residuals:	64.635
Durbin-Watson statistic:	2.46
Sample period:	1985Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

i.24 WPSN: Household stock market wealth, current $

The equation for the market value of equities held by households (WPSN) is derived from the standard Gordon model for valuing a firm's share price. Aggregating across firms, this model implies that WPSN equals the current level of corporate cash payments, scaled up by the difference between the expected real rate of return on equity (REQ) and the expected real growth rate of dividends (ZDIVGR). Corporate cash payments are approximated by half corporate profits (YNICPN) less corporate taxes (TFCIN+TSCIN). Multiplying by 0.5 seems roughly consistent with disaggregated estimates and with the NIPA dividend payout ratio before this was seriously distorted by bond mutual fund "dividends" and S-corporation income.

Note: When the model is used for stochastic simulations, a MAX function is added to the second term, to prevent it from taking on very small values. This equation does not include the MAX function for standard operations for technical reasons (for MAQS insiders, these involve the match run).

$$\mathbf{log(WPSN)} = \log((YNICPN-TFCIN-TSCIN)*.5) - \log(.01*REQ-.01*ZDIVGR)$$

i.25 WPS: Household stock market wealth, real

$$\mathbf{WPS} = WPSN/(.01*PCNIA)$$

i.26 RCGAIN: Rate of capital gain on the non-equity portion of household wealth

RCGAIN measures the rate of capital gain on non-equity, non-housing household net worth, after adjusting for inflation. It has a cyclical component that is positively correlated with the output gap (XGAP2).

$$\begin{aligned}\mathbf{RCGAIN} = {} & PICX4 - 0.614\ [-1.615311161980729] \\ & + 0.685\ [5.178485836626434] * XGAP2 \\ & + 0.220\ [3.1233465776965] * (RCGAIN_{t-1} - PICX4_{t-1} - -0.614 \\ & - 0.685 * XGAP2_{t-1})\end{aligned}$$

Regression statistics

Adjusted R^2:	0.21
S.E. of regression:	4.12106
Sum of squared residuals:	3243.8
Durbin-Watson statistic:	2.10
Sample period:	1962Q2 2009Q4

Estimation date:	November 2010
Estimation method:	Least Squares

i.27 WPON: Household property wealth ex. stock market, current $

The change in the non-equity portion of household net worth has three components -- NIPA personal savings, net investment in consumer durable goods, and capital gains on houses and other assets. The capital gains on housing and other assets are weighted by their shares in WPON. PHOUSE is scaled by a factor of 116 so that PHOUSE*KH matches housing wealth (both owner occupied and noncorporate rental real estate) from the Flow of Funds over the past decade.

$$\mathbf{WPON} = WPON_{t-1}*exp(\ (1-((PHOUSE_{t-1}*KH_{t-1}/116)/WPON_{t-1}))*RCGAIN/400$$
$$+ ((PHOUSE_{t-1}*KH_{t-1}/116)/WPON_{t-1})*del(1{:}\ log(PHOUSE))\ )$$
$$+ .25 * (YDN-ECNIAN-YHIBN)$$
$$+ .25 * (.01*PCDR*PCNIA*(ECD-JKCD))$$

i.28 WPO: Household property wealth ex. stock market, real

$$\mathbf{WPO} = WPON/(.01*PCNIA)$$

i.29 RFFALT: Federal funds rate given by MA rule

$$\mathbf{RFFALT} = 0.222$$
$$+ 1.20 * RFF_{t-1}$$
$$- 0.390 * RFF_{t-2}$$
$$+ 0.695 * XGAP2$$
$$- 0.517 * XGAP2_{t-1}$$
$$+ 0.329 * (mave(\ 4 : PICXFE_{\ t})\ )$$

i.30 PHOUSE: Loan Performance House Price Index

The price of owner-occupied real estate (PHOUSE) is assumed to be cointegrated with rents (PCHR*PCNIA).

$$\textbf{del(1: log(PHOUSE))} = 0.00542\ [3.296228255746413] + 0.772\ [14.67227105806942] * \text{del}(1: \log(PHOUSE_{t-1})) - 0.0141\ [-2.526906187965989] * \log(PHOUSE_{t-1}/(PCHR_{t-1} * PCNIA_{t-1}))$$

Regression statistics

Adjusted R^2:	0.6354405634325645
S.E. of regression:	0.01224068224826099
Sum of squared residuals:	0.01992796215308459
Durbin-Watson statistic:	2.250907693419639
Sample period:	1976Q1 2009Q4
Estimation date:	August 2010
Estimation method:	Least Squares

Foreign Activity

In essence, the foreign activity sector is an estimated small-scale reduced-form forecasting model for the G10 economies. The system contains five primary equations: an "IS" curve equation, in which the level of foreign output relative to trend is a function of the real long-term interest rate abroad; an inflation equation, based on a simple Phillips curve specification augmented to control for the effects of oil price shocks; a monetary policy reaction function that determines the short-term rate of interest in the G10 economies; and a reduced-form yield curve equation that makes foreign bond rates a function of the long-run level of short-term interest rates. In estimating this system, coefficient restrictions were imposed to ensure long-run stability.

In addition to the G10 forecasting system, the foreign activity sector also contains equations for the level of consumer prices in the G39 economies, as well as the exchange value of dollar vis-a-vis the currencies of the same countries. Aggregate indices for both foreign consumer prices and the exchange rate are constructed using chain-aggregation, in which the weights are based on either bilaterial export or import shares in U.S. trade.

j.1 FXGAP: Foreign output gap (world, bilateral export weights)

The foreign output gap is expressed as a reduced-form IS curve. The gap depends on lags of the foreign output gap, the real long-term foreign interest rate (FRL10-FPI10T), the domestic output gap (XGAP2), and dummy shift variable that controls for an apparent increase in the foreign equilibrium real rate after 1980. The equation is also coded to allow the user to build in a link between US and foreign equilibrium real rate, if desired. However, in estimation this link is suppressed by constraining the coefficient on the US equilibrium rate (RRTR) to be zero. (When freely estimated, this coefficient is insignificantly different from zero.)

FXGAP = -0.0228 [-0.3082955202216146]
+ B1(L) {sum 0.809 } * FXGAP $_{t-1}$
- 0.0676 [-2.548668841229607] * (FRL10$_{t-1}$-FPI10T$_{t-1}$)
+ 0.0520 [3.046906763212628] * XGAP2$_{t-1}$
+ 0.00 * RRTR$_{t-1}$
+ 0.289 [2.361021939951719] * D79A

Distributed lag coefficients

Name	Value
$B1_0$	1.23 0.00
$B1_1$	-0.424 0.00
$B1_{SUM}$	0.809

Regression statistics

Adjusted R^2:	0.86
S.E. of regression:	0.490811
Sum of squared residuals:	41.9158
Durbin-Watson statistic:	1.97
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

j.2 FGDP: Foreign aggregate GDP (world, bilateral export weights)

The level of foreign GDP is determined via the identity that links it to the level of potential foreign output (FGDPT) and the foreign output gap (FXGAP).

FGDP = FGDPT*exp(FXGAP/100)

j.3 FGDPT: Foreign aggregate GDP (world, bilateral export weights), trend

$$\textbf{del(1 : log(FGDPT))} = -0.458 - 0.100 * \log(FGDPT_{t-1}/XGDPT_{t-1}) + 1.00 * (HGGDPT + HGGDPT_{t-1} + HGGDPT_{t-2} + HGGDPT_{t-3}) / 1600$$

j.4 FPI10: Foreign consumer price inflation (G10)

Foreign CPI inflation, as measured on a G-10 basis, is determined via a simple Phillips curve in which the change in inflation from its 4-quarter moving average is a function of the foreign output gap, plus current and lagged changes in the relative price of oil.

$$\textbf{FPI10} = 0.693\ [13.071933679295574] * (\text{mave}(4 : FPI10_{t-1})) + 0.307 * FPITRG + 0.272\ [4.172669284184813] * FXGAP_{t-1} + B4(L)\ \{\text{sum } 5.97\} * \text{del}(1 : \log(POILR_t))$$

Distributed lag coefficients

Name	Value
$B4_0$	5.01 0.00
$B4_1$	0.959 0.00
$B4_{SUM}$	5.97

Regression statistics

Adjusted R^2:	0.90
S.E. of regression:	1.07059
Sum of squared residuals:	192.555
Durbin-Watson statistic:	1.42
Sample period:	1967Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

j.5 FPI10T: Foreign consumer price inflation, trend (G10)

The trend component of foreign inflation adjusts at 5 percent per quarter to movements in actual foreign inflation.

$$\textbf{FPI10T} = 0.950 \ [\text{const.}] * FPI10T_{t-1} + 0.0500 \ [\text{const.}] * FPI10$$

j.6 FPIC: Foreign consumer price inflation (G39, bilateral export trade weights)

In the long run, foreign consumer price inflation as measured on a G-29 basis moves one for one with foreign inflation as measured on a G-10 basis. The estimated coefficients indicate that G-29 inflation on average is 7.5 percentage points higher than G10 inflation (i.e., 1.261/.168 = 7.5).

$$\textbf{FPIC} = 2.25 \ [5.772878974188214] + 0.681 \ [9.905601690494445] * FPI10 + 0.319 * FPIC_{t-1}$$

Regression statistics

Adjusted R^2:	0.44
S.E. of regression:	4.24826
Sum of squared residuals:	3212.49
Durbin-Watson statistic:	2.10
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

j.7 FPC: Foreign aggregate consumer price (G39, import/export trade weights)

$$\textbf{FPC} = FPC_{t-1} * \exp(FPIC/400)$$

j.8 FPCM: Foreign aggregate consumer price (G39, bilateral non-oil import trade weights)

$$\textbf{FPCM} = UFPCM*FPC$$

j.9 FRS10: Foreign short-term interest rate (G10)

The foreign short-term interest rate (FRS10) is set either according to the standard version of the Taylor rule (DFMPRR = 0) or so that its real value matches exogenous variable RFRS10 (DFMPRR = 1)

$$\begin{aligned}\textbf{FRS10} = {} & DFMPRR * (0.00 \\ & + 1.00 * FRSTAR_{t-1} \\ & + 1.00 * (mave(\ 4 : FPI10_{\ t})) \\ & + 0.500 * (mave(\ 4 : FPI10_{\ t}) - FPITRG) \\ & + 1.00 * FXGAP) \\ & + (1-DFMPRR) * (RFRS10 + mave(\ 4 : FPI10_{\ t}))\end{aligned}$$

j.10 FRSTAR: Equilibrium real short-term interest rate used in foreign Taylor rule

The estimate of the foreign equilibrium real short-term interest rate used in the foreign Taylor rule is updated each period by 5 percent of the gap between the ex post real short rate and the prior estimate.

$$\begin{aligned}\textbf{FRSTAR} = {} & 0.950 * FRSTAR_{t-1} \\ & + 0.0500 * (FRS10 - mave(\ 4 : FPI10_{\ t}))\end{aligned}$$

j.11 FRL10: Foreign long-term interest rate (G10)

Foreign long-term interest rates (FRL10) are modeled using a reduced-form error-correction specification in which long rates converge to the foreign short-term interest rate plus a constant premium.

$$\begin{aligned}\textbf{FRL10 - FRL10(-1)} = {} & 0.0450\ [1.210011139451792] \\ & - 0.0613\ [-2.656936622628951] * (FRL10_{t-1} - FRS10_{t-1}) \\ & + 0.0749\ [0.9816707245563588] * (FRL10_{t-1} - FRL10_{t-2}) \\ & + 0.358\ [6.444800679237305] * (FRS10 - FRS10_{t-1}) \\ & + 0.126\ [2.242910685189529] * (FXGAP - FXGAP_{t-1})\end{aligned}$$

Regression statistics

Adjusted R^2:	0.38
S.E. of regression:	0.307909
Sum of squared residuals:	10.9029
Durbin-Watson statistic:	1.76
Sample period:	1980Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

j.12 FPXR: Real exchange rate (G39, import/export trade weights)

The real exchange rate is determined via an open interest parity condition, in which a 1 percentage point increase in the spread between domestic and foreign real long-term interest rates causes the dollar to appreciate 6 percent, on the assumption that the average duration of long-term interest rates is about 6 years. The value of the dollar is also assumed to be influenced by country risk, which is proxied by the ratio of net foreign assets to GDP. Finally, the equation is written as an identity through the use of a multiplicative residual, FPXRR.

log(FPXR) - log(FPXRR) =

0.0600 *(RG10E-ZPI10F-FRL10+FPI10T)
+ 0.200 *(FNIN/XGDPN)

Regression statistics

R^2:	1
Sum of squared residuals:	2.1176E-29
Standard error of regression:	3.9253E-16
Durbin Watson statistic:	2.0905
Sample period:	1965:q1 - 1998:q4
Estimation date:	February 2000

j.13 FPXRR: Real exchange rate residual

The unexplained component of the exchange rate error-corrects to its long-run exogenous trend (FPXRRT). This equation is primarily used in stochastic simulations.

$$\mathbf{del(1 : log(FPXRR))} = 0.180\ [4.241024193925358] * \log(FPXRRT_{t-1}/FPXRR_{t-1})$$
$$+\ 0.111\ [1.489382207871805] * del(1 : \log(FPXRR_{t-1}))$$
$$+\ 0.889 * del(1 : \log(FPXRRT))$$

Regression statistics

Adjusted R^2:	0.18
S.E. of regression:	0.0292683
Sum of squared residuals:	0.152481
Durbin-Watson statistic:	1.99
Sample period:	1965Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

j.14 FPX: Nominal exchange rate (G39, import/export trade weights)

FPX = FPXR*FPC/PCPI

j.15 FPXM: Nominal exchange rate (G39, bilateral import trade weights)

FPXM = UFPXM*FPX*FPCM/FPC

Expectations

This sector contains the equations that are used for expectational variables when the assumption of "VAR" expectations is employed. Each equation defines the expectation of a weighted average of a variable over future quarters as a linear function of an observable information set. Two types of parameters determine the coefficient values in the expectations equations: the coefficients of the estimated VAR model used to generate forecasts that proxy for expectations; and discounting weights that specify the horizon of each expectation. Thus these equations are best thought of as formulas expressing the discounted present value of a particular variable as a function of an information set.

In these formulas, the information set always includes a core set of macro variables: actual consumer price inflation (PICNIA) and the value expected to prevail in the long run (PTR); the actual federal funds rate (RFFE) and the value expected to prevail in the long run (RTR); and the output gap (XGAP). (By definition, the latter is assumed to be zero in the long run.) The structure of the core VAR model is such that interest rate and inflation expectations converge to long-run expectations as the forecast horizon lengthens. The long-run expectations are modeled as random walks in the core VAR. For many expectational variables, the information set also includes one or more sector-specific variables. Expectations in most financial equations assume that current-period data are in the information set, while those in most nonfinancial equations assume that only lagged data are in the information set.

For expectations appearing in PAC equations, the discounting weights depend on a general discount factor (.98 per quarter) and on the estimated adjustment cost parameters as given by the error-correction coefficient and coefficients on lags of the dependent variable. In most cases, the effective forward horizon of these expectations is only a few years. Note that the sum of the discounting weights in PAC expectations is not unity; the actual sum of the PAC discounting weights is given in the definition of each expectational variable.

Financial equations for long-term interest rates and the stock market do not contain adjustment costs. In these instances, the discounting weights depend on the maturity and duration of the financial instrument. In the bond rate equations, the sum of the discounting weights is unity and the forward horizon is finite. In the stock market equation, the sum of the discounting weights is not unity and the forward horizon is infinite.

z.1 DLQEC: del(log(qec))

DLQEC = del(1 : log(QEC))

z.2 DLQECD: del(log(qecd))

DLQECD = del(1 : log(QECD))

z.3 DLQEH: del(log(qeh))

DLQEH = del(1 : log(QEH))

z.4 DLQLHP: del(log(qlhp))

DLQLHP = del(1 : log(QLHP))

z.5 DLQPC: del(log(qpcnia))

DLQPC = del(1 : log(QPCNIA))

z.6 DLQPL: del(log(qpl))

DLQPL = del(1 : log(QPL))

z.7 DLQPX: del(log(qpxnc))

DLQPX = del(1 : log(QPXNC))

z.8 DLQYDV: del(log(qynidn/pxg))

DLQYDV = del(1 : log(QYNIDN/PXG))

z.9 DLVPDC: del(log(vpdc))

DLVPDC = del(1 : log(VPDC))

z.10 DLVPDO: del(log(vpdo))

DLVPDO = del(1 : log(VPDO))

z.11 DLVPS: del(log(vps))

DLVPS = del(1 : log(VPS))

z.12 DLYNID: del(log(ynidn/pxg))

DLYNID = del(1 : log(YNIDN/PXG))

z.13 HGYNID: 400*del(log(ynidn/pxg))

HGYNID = 400*del(1 : log((YNICPN-TFCIN-TSCIN)*.5/PXG))

z.14 HPRDTP: Expected growth rate of trend labor productivity for PXP equation

HPRDTP = 0.00 * HPRDTP_{t-1}
+ 1.00 * HLPRDT/400

z.15 HPRDTW: Expected growth rate of trend labor productivity for PIPL equation

HPRDTW = 0.963 * $HPRDTW_{t-1}$
+ 0.0370 * HLPRDT/400

Regression statistics

Estimation date: August 2006
Estimated by: John Roberts

z.16 PTR: 10-year expected inflation (Hoey/Philadelphia survey)

Regressions statistics refer to the change in PTR (DEL(PTR)), as the lagged level makes the R-squared exceed .99 in a level regression regardless of the other determinants included. Long-run expectations are determined by core inflation, the monetary policy stance (relative to the perceived neutral setting, and the output gap; such a specification is consistent with the updating of expectations from deviations of the federal funds rate from a policy rule via the Kalman filter. The equation is estimated off of survey expectations (and hence over the period 1981q1 to 2006).

PTR = 0.00
+ A1(L) {sum 0.100 } * PICXFE $_{t-1}$
+ A2(L) {sum -0.0106 } * RFFE $_{t-1}$
+ 0.0106 * RTR_{t-1}
+ 0.900 * PTR_{t-1}
+ A5(L) {sum 0.0137 } * XGAP $_{t-1}$

Distributed lag coefficients

Name	Value
$A1_0$	0.0512 0.00
$A1_1$	0.00940 0.00
$A1_2$	0.0499 0.00
$A1_3$	-0.0105 0.00

Name	Value
$A1_{SUM}$	0.100
$A2_0$	0.0117 0.00
$A2_1$	-0.0641 0.00
$A2_2$	0.0253 0.00
$A2_3$	0.0165 0.00

Name	Value
$A2_{SUM}$	-0.0106
$A5_0$	0.0737 0.00
$A5_1$	-0.0670 0.00
$A5_2$	-0.0124 0.00
$A5_3$	0.0193 0.00
$A5_{SUM}$	0.0137

Regression statistics

R-Squared :	.429350768374369
Adjusted R-Squared :	.367990635941505
Durbin-Watson Statistic :	2.11681933546427

Sum of squares of residuals :	1.74147215883964
Standard Error of Regression :	.135926190326177
Log of the Likelihood Function :	65.0927164638909
F-statistic (10 , 93) :	6.99722688578186
F-probability :	5.96046447753906E-8
Mean of Dependent Variable :	-.0485817307692308
Number of Observations :	104
Number of Degrees of Freedom :	93
Current Sample :	1981 1 2006 4

z.17 RRTR: Expected long-run real federal funds rate

The expected long-run value of the real federal funds rate (RRTR) is assumed each quarter to close 3 percent of the gap between the current ex post real funds rate and last quarter's estimate of RRTR.

$$\textbf{RRTR} = 0.970 * RRTR_{t-1} + 0.0300 * RRFFE$$

z.18 RSTAR: Equilibrium real federal funds rate (for monetary policy reaction functions)

The estimate of the equilibrium real federal funds rate used in the monetary policy rules is updated each period by 5 percent of the gap between the ex post real short rate and the prior estimate, if the switch DRSTAR is set to 1.

$$\textbf{RSTAR} = RSTAR_{t-1} + 0.0500 * ((RRFFE-RSTAR_{t-1})*DRSTAR)$$

z.19 RTR: Expected average federal funds rate 10-30 years ahead

$$\textbf{RTR} = RRTR + PTR$$

z.20 ZDIVGR: Expected growth rate of real dividends, for WPSN eq. (weight: 1.0)

ZDIVGR= 2.18
+ A1(L) {sum 0.0989 } * PICNIA $_t$
+ A2(L) {sum -0.0685 } * RFFE $_t$
+ 0.0685 * RTR
- 0.0989 * PTR
+ A5(L) {sum -0.124 } * XGAP $_t$
+ A6(L) {sum 0.00703 } * (400*del(1 : log((YNICPN $_t$-TFCIN $_t$-TSCIN $_t$)*.5/(.01*PXG $_t$))))
+ 0.243 * HGX

Distributed lag coefficients

Name	Value
$A1_0$	-0.0195 0.00
$A1_1$	0.0406 0.00
$A1_2$	0.0266 0.00
$A1_3$	0.0513 0.00

Name	Value
$A1_{SUM}$	0.0989
$A2_0$	-0.117 0.00
$A2_1$	0.0555 0.00
$A2_2$	-0.0565 0.00
$A2_3$	0.0492 0.00

Name	Value
$A2_{SUM}$	-0.0685
$A5_0$	-0.200 0.00
$A5_1$	0.0838 0.00
$A5_2$	-0.00530 0.00
$A5_3$	-0.00252 0.00

Name	Value
$A5_{SUM}$	-0.124
$A6_0$	0.0143 0.00
$A6_1$	-0.00265 0.00
$A6_2$	-0.00154 0.00
$A6_3$	-0.00305 0.00
$A6_{SUM}$	0.00703

Regression statistics

Sample period: 1962Q1 2009Q4
Estimation date: September 2010
Estimation method: Least Squares

z.21 ZECD: Expected growth rate of target durable consumption, for ECD eq. (weight: 1.05)

The weighted average growth rate of expected future target outlays on consumer durable goods, ZECD, is computed using (1) forecasts from a small scale VAR model (2) combined with the PAC weights implied by the estimated coefficients of the dynamic ECD equation. The equation shown below is the reduced-form representation of this expectational computation.

ZECD= 0.00582
+ B1(L) {sum -0.00135} * PICNIA $_{t-1}$
+ B2(L) {sum 0.000523} * RFFE $_{t-1}$
+ B3(L) {sum -0.000108} * XGAP2 $_{t-1}$
+ 0.00135 * PTR$_{t-1}$

$- 0.000523 * \mathrm{RTR}_{t-1}$

$+ \mathrm{B6(L)}$ {sum 0.000377} $* \mathrm{YHGAP}_{t-1}$

$+ \mathrm{B7(L)}$ {sum 0.000113} $* \mathrm{YHTGAP}_{t-1}$

$+ \mathrm{B8(L)}$ {sum 0.000234} $* \mathrm{YHPGAP}_{t-1}$

$+ 0.750 * (\mathrm{HGGDPT}_{t-1}/400)$

$- 0.584 * (\mathrm{HGPCDR}_{t-1}/400)$

$+ \mathrm{B11(L)}$ {sum 0.0218 } $* \mathrm{del}(1 : \log(\mathrm{QECD}_{t-1}))$

Distributed lag coefficients

Name	Value
$B1_0$	-0.000588 0.00
$B1_1$	-0.000334 0.00
$B1_2$	-0.000343 0.00
$B1_3$	-8.83E-05 0.00
$B1_{SUM}$	-0.00135
$B2_0$	-0.00119 0.00
$B2_1$	0.00145 0.00
$B2_2$	-8.82E-05 0.00

Name	Value
$B2_3$	0.000348 0.00
$B2_{SUM}$	0.000523
$B3_0$	0.000768 0.00
$B3_1$	-8.75E-05 0.00
$B3_2$	-0.000716 0.00
$B3_3$	-7.18E-05 0.00
$B3_{SUM}$	-0.000108
$B6_0$	0.000662 0.00
$B6_1$	-0.000188 0.00

Name	Value
$B6_2$	-0.000200 0.00
$B6_3$	0.000103 0.00
$B6_{SUM}$	0.000377
$B7_0$	-1.12E-05 0.00
$B7_1$	6.74E-05 0.00
$B7_2$	6.22E-05 0.00
$B7_3$	-5.08E-06 0.00
$B7_{SUM}$	0.000113
$B8_0$	-0.000191 0.00

Name	Value
$B8_1$	5.63E-05 0.00
$B8_2$	0.000125 0.00
$B8_3$	0.000243 0.00
$B8_{SUM}$	0.000234
$B11_0$	0.0210 0.00
$B11_1$	0.0109 0.00
$B11_2$	-0.00301 0.00
$B11_3$	-0.00703 0.00
$B11_{SUM}$	0.0218

Regression statistics

Sample period:	1964Q2 2008Q4
Estimation date:	August 2009
Estimation method:	Least Squares

z.22 ZEH: Expected growth rate of desired residential investment, for EH eq. (weight: .53)

The weighted average growth rate of expected future target housing investment, ZEH, is computed using (1) forecasts from a small-scale VAR model combined with (2) the PAC weights implied by the estimated coefficients of the dynamic housing equation. The equation shown below is the reduced-form representation of this expectational computation.

ZEH= 0.00387

$+ \mathrm{B1(L)}$ {sum -0.000833} $* \mathrm{PICNIA}_{t-1}$

$+ \mathrm{B2(L)}$ {sum 0.000977} $* \mathrm{RFFE}_{t-1}$

$+ \mathrm{B3(L)}$ {sum -0.000356} $* \mathrm{XGAP2}_{t-1}$

+ 0.000833 * PTR$_{t-1}$

- 0.00147 * RTR$_{t-1}$

+ B6(L) {sum 0.000947} * YHGAP $_{t-1}$

+ B7(L) {sum 5.24E-05} * YHTGAP $_{t-1}$

+ B8(L) {sum 0.000364} * YHPGAP $_{t-1}$

+ 0.302 * (HGGDPT$_{t-1}$/400)

+ B10(L) {sum -0.0176 } * del(1 : log(QEH $_{t-1}$))

Distributed lag coefficients

Name	Value
B1$_0$	-0.0005490.00
B1$_1$	-0.0002450.00
B1$_2$	-8.39E-050.00
B1$_3$	4.52E-050.00
B1$_{SUM}$	-0.000833
B2$_0$	0.0002480.00
B2$_1$	0.0004270.00
B2$_2$	0.0001650.00

Name	Value
B2$_3$	0.0001370.00
B2$_{SUM}$	0.000977
B3$_0$	0.0003900.00
B3$_1$	-0.0004180.00
B3$_2$	-0.0004030.00
B3$_3$	7.51E-050.00
B3$_{SUM}$	-0.000356
B6$_0$	0.0003800.00
B6$_1$	2.53E-050.00

Name	Value
B6$_2$	0.0002220.00
B6$_3$	0.0003190.00
B6$_{SUM}$	0.000947
B7$_0$	-5.77E-050.00
B7$_1$	6.53E-050.00
B7$_2$	-3.22E-050.00
B7$_3$	7.69E-050.00
B7$_{SUM}$	5.24E-05
B8$_0$	0.0001060.00

Name	Value
B8$_1$	9.84E-050.00
B8$_2$	4.24E-070.00
B8$_3$	0.0001600.00
B8$_{SUM}$	0.000364
B10$_0$	-0.002950.00
B10$_1$	-0.007270.00
B10$_2$	-0.005150.00
B10$_3$	-0.002200.00
B10$_{SUM}$	-0.0176

Regression statistics

Sample period: 1964Q2 2009Q4
Estimation date: September 2010
Estimation method: Least Squares

z.23 ZGAP05: Expected output gap, for RG5E eq. (weight: 1.0)

ZGAP05= 2.25E-14

+ A1(L) {sum -0.356 } * PICNIA $_t$

+ A2(L) {sum -0.117 } * RFFE $_t$

+ 0.117 * RTR

+ 0.356 * PTR

+ A5(L) {sum 0.320 } * XGAP $_t$

Distributed lag coefficients

Name	Value
$A1_0$	-0.204 0.00
$A1_1$	-0.0898 0.00
$A1_2$	-0.0658 0.00
$A1_3$	0.00389 0.00

Name	Value
$A1_{SUM}$	-0.356
$A2_0$	-0.327 0.00
$A2_1$	0.0589 0.00
$A2_2$	0.102 0.00
$A2_3$	0.0490 0.00

Name	Value
$A2_{SUM}$	-0.117
$A5_0$	0.560 0.00
$A5_1$	-0.0444 0.00
$A5_2$	-0.119 0.00
$A5_3$	-0.0767 0.00
$A5_{SUM}$	0.320

Regression statistics

Sample period: 1962Q1 2009Q4

Estimation date: August 2010

Estimation method: Least Squares

z.24 ZGAP10: Expected output gap, for RG10E eq. (weight: 1.0)

ZGAP10= 7.31E-15

+ A1(L) {sum -0.179 } * PICNIA $_t$

+ A2(L) {sum -0.0304 } * RFFE $_t$

+ 0.0304 * RTR

+ 0.179 * PTR

+ A5(L) {sum 0.163 } * XGAP $_t$

Distributed lag coefficients

Name	Value
$A1_0$	-0.0997 0.00
$A1_1$	-0.0457 0.00
$A1_2$	-0.0342 0.00
$A1_3$	0.0001050.00

Name	Value
$A1_{SUM}$	-0.179
$A2_0$	-0.134 0.00
$A2_1$	0.0229 0.00
$A2_2$	0.0647 0.00
$A2_3$	0.0160 0.00

Name	Value
$A2_{SUM}$	-0.0304
$A5_0$	0.299 0.00
$A5_1$	-0.0349 0.00
$A5_2$	-0.0632 0.00
$A5_3$	-0.0373 0.00
$A5_{SUM}$	0.163

Regression statistics

Sample period: 1962Q1 2009Q4

Estimation date: August 2010
Estimation method: Least Squares

z.25 ZGAPC2: Expected output gap, for ECD eq. (weight: .35)

The weighted average of expected future output gaps for the ECD equation, ZGAPC2, is computed using (1) forecasts from a small-scale VAR model combined with (2) the PAC weights implied by the estimated coefficients of the dynamic consumer durables equation. The equation shown below is the reduced-form representation of this expectational computation.

$$\begin{aligned}\textbf{ZGAPC2} = {} & B1(L)\ \{\text{sum } -0.0463\ \} * PICNIA_{t-1} \\ & + B2(L)\ \{\text{sum } -0.0274\ \} * RFFE_{t-1} \\ & + B3(L)\ \{\text{sum } 0.0929\ \} * XGAP2_{t-1} \\ & + 0.0463 * PTR_{t-1} \\ & + 0.0274 * RTR_{t-1}\end{aligned}$$

Distributed lag coefficients

Name	Value
$B1_0$	-0.0327 0.00
$B1_1$	-0.0128 0.00
$B1_2$	-0.00857 0.00
$B1_3$	0.00773 0.00

Name	Value
$B1_{SUM}$	-0.0463
$B2_0$	-0.0415 0.00
$B2_1$	-0.00509 0.00
$B2_2$	0.0164 0.00
$B2_3$	0.00282 0.00

Name	Value
$B2_{SUM}$	-0.0274
$B3_0$	0.118 0.00
$B3_1$	-0.000284 0.00
$B3_2$	-0.0139 0.00
$B3_3$	-0.0107 0.00
$B3_{SUM}$	0.0929

Regression statistics

Sample period: 1964Q2 2008Q4
Estimation date: August 2009
Estimation method: Least Squares

z.26 ZLHP: Expected growth rate of desired aggregate hours (weight: .58)

ZLHP is calculated as weighted average of VAR and AR expectations. Let zlhpvar be the former and zlhpar be the latter. ZLHP is defined as, ZLHP = 0.126 zlhpvar + 0.874 zlhpar,

where the weights were estimated as part of the estimation of the lhp equation.

ZLHP= 0.000189
+ A1(L) {sum 8.57E-05} * $PICNIA_{t-1}$
+ A2(L) {sum 3.79E-05} * $RFFE_{t-1}$
- 3.79E-05 * RTR_{t-1}
- 8.58E-05 * PTR_{t-1}
+ A5(L) {sum 2.19E-05} * $XGAP_{t-1}$
+ 0.123 * (del(1 : log(XG_{t-1})) - $HLPRDT_{t-1}$/400)
+ 0.595 * ((HGX_{t-1} - $HLPRDT_{t-1}$)/400)

Distributed lag coefficients

Name	Value
$A1_0$	3.80E-05 0.00
$A1_1$	2.29E-05 0.00
$A1_2$	1.83E-05 0.00
$A1_3$	6.57E-06 0.00

Name	Value
$A1_{SUM}$	8.57E-05
$A2_0$	8.72E-05 0.00
$A2_1$	1.08E-05 0.00
$A2_2$	-6.67E-05 0.00
$A2_3$	6.64E-06 0.00

Name	Value
$A2_{SUM}$	3.79E-05
$A5_0$	-6.85E-05 0.00
$A5_1$	4.53E-05 0.00
$A5_2$	4.29E-05 0.00
$A5_3$	2.27E-06 0.00
$A5_{SUM}$	2.19E-05

Regression statistics

Sample period:	1989Q4 2009Q4
Estimation date:	August 2010
Estimation method:	Least Squares

z.27 ZLURC: Expected unemployment rate, for PCNIA eq.

ZLURC is a discounted sum of expected future unemployment gaps. It enters the PCNIA equation.

ZLURC= -9.31E-07
+ A1(L) {sum 0.532 } * $PIPL_{t-1}$/400
+ A2(L) {sum 0.0136 } * del(1 : log(PXP_{t-1}))
+ A3(L) {sum 4.30 } * ($PICNIA_{t-1}$/400)
+ A4(L) {sum 0.187 } * del(1 : log($PXNC_{t-1}$))
+ A5(L) {sum 0.000104} * del(1 : log(PXG_{t-1}))

$- 5.04 * (PTR_{t-1}/400)$

$- 0.158 * (\log(PCNIA_{t-1}/QPCNIA_{t-1}))$

$+ 0.0221 * (\log(PXNC_{t-1}/QPXNC_{t-1}))$

$+ 3.85 * HPRDTW_{t-1}$

$- 4.38 * HPRDTP_{t-1}$

+ A11(L) {sum 0.0208 } $* ((LUR_{t-1} - LURNAT_{t-1}))$

+ A12(L) {sum 0.925 } $* (RFFE_{t-1}/400)$

$- 0.925 * (RTR_{t-1}/400)$

$- 0.0441 * (UCFS_{t-1} * del(1 : \log(PCFR_{t-1})))$

$+ 3.26E-06 * (UCES_{t-1} * del(1 : \log(PCER_{t-1})))$

$+ 0.730 * UQPXP_{t-1}$

$+ 1.10 * HUQPCT_{t-1}$

Distributed lag coefficients

Name	Value
$A1_0$	0.284 0.00
$A1_1$	0.180 0.00
$A1_2$	0.0684 0.00
$A1_{SUM}$	0.532
$A2_0$	-0.0102 0.00
$A2_1$	0.0161 0.00
$A2_2$	0.00769 0.00
$A2_{SUM}$	0.0136
$A3_0$	1.63 0.00

Name	Value
$A3_1$	0.986 0.00
$A3_2$	1.30 0.00
$A3_3$	0.392 0.00
$A3_{SUM}$	4.30
$A4_0$	0.119 0.00
$A4_1$	0.0551 0.00
$A4_2$	0.0129 0.00
$A4_{SUM}$	0.187
$A5_0$	0.00644 0.00

Name	Value
$A5_1$	-0.00721 0.00
$A5_2$	-0.00326 0.00
$A5_3$	0.00413 0.00
$A5_{SUM}$	0.000104
$A11_0$	0.0473 0.00
$A11_1$	-0.0286 0.00
$A11_2$	0.000526 0.00
$A11_3$	0.00163 0.00

Name	Value
$A11_{SUM}$	0.0208
$A12_0$	1.42 0.00
$A12_1$	-0.0148 0.00
$A12_2$	-0.455 0.00
$A12_3$	-0.0250 0.00
$A12_{SUM}$	0.925

z.28 ZLURL: Expected unemployment rate, for PL eq.

ZLURL is a discounted sum of expected future unemployment gaps. It enters the PIPL equation.

ZLURL= -1.01E-06

+ A1(L) {sum 0.557 } $* PIPL_{t-1}/400$

+ A2(L) {sum 0.0157 } $* del(1 : \log(PXP_{t-1}))$

+ A3(L) {sum 5.78 } $* (PICNIA_{t-1}/400)$

+ A4(L) {sum 0.186 } $* del(1 : \log(PXNC_{t-1}))$

+ A5(L) {sum 9.49E-05} $* del(1 : \log(PXG_{t-1}))$

$- 6.54 * (PTR_{t-1}/400)$

- 0.180 * (log(PCNIA$_{t-1}$/QPCNIA$_{t-1}$))
+ 0.0231 * (log(PXNC$_{t-1}$/QPXNC$_{t-1}$))
+ 3.35 * HPRDTW$_{t-1}$
- 3.91 * HPRDTP$_{t-1}$
+ A11(L) {sum 0.0314 } * ((LUR $_{t-1}$ - LURNAT $_{t-1}$))
+ A12(L) {sum 1.37 } * (RFFE $_{t-1}$/400)
- 1.37 * (RTR$_{t-1}$/400)
- 0.0511 * (UCFS$_{t-1}$ * del(1 : log(PCFR$_{t-1}$)))
+ 2.54E-07 * (UCES$_{t-1}$ * del(1 : log(PCER$_{t-1}$)))
+ 0.623 * UQPXP$_{t-1}$
+ 1.13 * HUQPCT$_{t-1}$

Distributed lag coefficients

Name	Value
A1$_0$	0.295 0.00
A1$_1$	0.189 0.00
A1$_2$	0.0723 0.00
A1$_{SUM}$	0.557
A2$_0$	-0.0120 0.00
A2$_1$	0.0186 0.00
A2$_2$	0.00905 0.00
A2$_{SUM}$	0.0157
A3$_0$	2.14 0.00

Name	Value
A3$_1$	1.29 0.00
A3$_2$	1.83 0.00
A3$_3$	0.525 0.00
A3$_{SUM}$	5.78
A4$_0$	0.118 0.00
A4$_1$	0.0549 0.00
A4$_2$	0.0129 0.00
A4$_{SUM}$	0.186
A5$_0$	0.00748 0.00

Name	Value
A5$_1$	-0.00837 0.00
A5$_2$	-0.00380 0.00
A5$_3$	0.00478 0.00
A5$_{SUM}$	9.49E-05
A11$_0$	0.0712 0.00
A11$_1$	-0.0430 0.00
A11$_2$	0.000775 0.00
A11$_3$	0.00245 0.00

Name	Value
A11$_{SUM}$	0.0314
A12$_0$	2.11 0.00
A12$_1$	-0.0178 0.00
A12$_2$	-0.683 0.00
A12$_3$	-0.0376 0.00
A12$_{SUM}$	1.37

z.29 ZLURNC: Expected unemployment rate, for PXNC eq.

ZLURNC is a discounted sum of expected future unemployment gaps. It enters the PXNC equation.

ZLURNC= -8.81E-07
+ A1(L) {sum 0.491 } * PIPL $_{t-1}$/400
+ A2(L) {sum 0.0138 } * del(1 : log(PXP $_{t-1}$))
+ A3(L) {sum 5.05 } * (PICNIA $_{t-1}$/400)
+ A4(L) {sum 0.164 } * del(1 : log(PXNC $_{t-1}$))
+ A5(L) {sum 8.39E-05} * del(1 : log(PXG $_{t-1}$))
- 5.72 * (PTR$_{t-1}$/400)
- 0.159 * (log(PCNIA$_{t-1}$/QPCNIA$_{t-1}$))

$+ 0.0204 * (\log(PXNC_{t-1}/QPXNC_{t-1}))$
$+ 2.97 * HPRDTW_{t-1}$
$- 3.46 * HPRDTP_{t-1}$
$+ A11(L)$ {sum 0.0265 } $* ((LUR_{t-1} - LURNAT_{t-1}))$
$+ A12(L)$ {sum 1.18 } $* (RFFE_{t-1}/400)$
$- 1.18 * (RTR_{t-1}/400)$
$- 0.0450 * (UCFS_{t-1} * del(1 : \log(PCFR_{t-1})))$
$+ 4.07E-07 * (UCES_{t-1} * del(1 : \log(PCER_{t-1})))$
$+ 0.553 * UQPXP_{t-1}$
$+ 0.995 * HUQPCT_{t-1}$

Distributed lag coefficients

Name	Value
$A1_0$	0.261 0.00
$A1_1$	0.167 0.00
$A1_2$	0.0638 0.00
$A1_{SUM}$	0.491
$A2_0$	-0.0105 0.00
$A2_1$	0.0164 0.00
$A2_2$	0.00796 0.00
$A2_{SUM}$	0.0138
$A3_0$	1.87 0.00

Name	Value
$A3_1$	1.14 0.00
$A3_2$	1.58 0.00
$A3_3$	0.457 0.00
$A3_{SUM}$	5.05
$A4_0$	0.104 0.00
$A4_1$	0.0485 0.00
$A4_2$	0.0114 0.00
$A4_{SUM}$	0.164
$A5_0$	0.00658 0.00

Name	Value
$A5_1$	-0.00737 0.00
$A5_2$	-0.00334 0.00
$A5_3$	0.00421 0.00
$A5_{SUM}$	8.39E-05
$A11_0$	0.0605 0.00
$A11_1$	-0.0368 0.00
$A11_2$	0.000687 0.00
$A11_3$	0.00209 0.00

Name	Value
$A11_{SUM}$	0.0265
$A12_0$	1.82 0.00
$A12_1$	-0.0218 0.00
$A12_2$	-0.585 0.00
$A12_3$	-0.0321 0.00
$A12_{SUM}$	1.18

z.30 ZPC: Expected growth rate of desired price level, for PCNIA eq.

ZPC is a expected value of PICNIA in the next quarter

ZPC= 3.01E-12
$+ A1(L)$ {sum 0.168 } $* 400*PIPL_{t-1}/400$
$+ A2(L)$ {sum 0.202 } $* PICNIA_{t-1}$
$+ A3(L)$ {sum 0.0340 } $* PIPXNC_{t-1}$
$+ A4(L)$ {sum 0.00291 } $* 400*del(1 : \log(PXP_{t-1}))$
$+ A5(L)$ {sum 0.000738} $* 400*del(1 : \log(PXG_{t-1}))$
$+ 0.592 * PTR_{t-1}$
$+ 0.452 * (400*\log(QPCNIA_{t-1}/PCNIA_{t-1}))$
$+ 0.205 * (400*\log(QPXNC_{t-1}/PXNC_{t-1}))$

+ 0.481 * (400*log(QPL_{t-1}/PL_{t-1}))

- 0.168 * $HLPRDT_{t-1}$

+ A11(L) {sum -0.188 } * ((LUR_{t-1} - $LURNAT_{t-1}$))

+ A12(L) {sum -0.0565 } * $RFFE_{t-1}$

+ 0.0565 * RTR_{t-1}

- 3.57 * ($UCFS_{t-1}$ * del(1 : log($PCFR_{t-1}$)))

+ 0.273 * 400*$HUQPCT_{t-1}$

Distributed lag coefficients

Name	Value
$A1_0$	0.0795 0.00
$A1_1$	0.0512 0.00
$A1_2$	0.0276 0.00
$A1_3$	0.00991 0.00
$A1_{SUM}$	0.168
$A2_0$	0.116 0.00
$A2_1$	0.0601 0.00
$A2_2$	0.0242 0.00

Name	Value
$A2_3$	0.00181 0.00
$A2_{SUM}$	0.202
$A3_0$	0.0164 0.00
$A3_1$	0.0103 0.00
$A3_2$	0.00540 0.00
$A3_3$	0.00188 0.00
$A3_{SUM}$	0.0340
$A4_0$	0.00144 0.00
$A4_1$	-0.000881 0.00

Name	Value
$A4_2$	0.00147 0.00
$A4_3$	0.000877 0.00
$A4_{SUM}$	0.00291
$A5_0$	-0.000559 0.00
$A5_1$	0.00219 0.00
$A5_2$	-0.000896 0.00
$A5_{SUM}$	0.000738
$A11_0$	-0.369 0.00
$A11_1$	0.219 0.00

Name	Value
$A11_2$	-0.0180 0.00
$A11_3$	-0.0203 0.00
$A11_{SUM}$	-0.188
$A12_0$	-0.0467 0.00
$A12_1$	-0.00642 0.00
$A12_2$	0.00288 0.00
$A12_3$	-0.00625 0.00
$A12_{SUM}$	-0.0565

z.31 ZPI10: Expected cons. price infl., for RCCH and RG10E eqs. (10-yr mat., weight: 1.0)

ZPI10= B1(L) {sum 0.0580 } * $PICNIA_{t-1}$

+ B2(L) {sum -0.118 } * $RFFE_{t-1}$

+ 0.118 * RTR_{t-1}

+ 0.942 * PTR_{t-1}

+ B5(L) {sum 0.0887 } * $XGAP_{t-1}$

Distributed lag coefficients

Name	Value
$B1_0$	0.0393 0.00
$B1_1$	0.0104 0.00
$B1_2$	0.0108 0.00
$B1_3$	-0.00248 0.00

Name	Value
$B1_{SUM}$	0.0580
$B2_0$	-0.0792 0.00
$B2_1$	-0.0138 0.00
$B2_2$	-0.0195 0.00
$B2_3$	-0.00559 0.00

Name	Value
$B2_{SUM}$	-0.118
$B5_0$	0.0474 0.00
$B5_1$	-0.000630 0.00
$B5_2$	0.0214 0.00
$B5_3$	0.0206 0.00

$B5_{SUM}$	0.0887

Regression statistics

Sample period: 1962Q2 2009Q4
Estimation date: August 2010
Estimation method: Least Squares

z.32 ZPI10F: FL Expected cons. price infl., for RCCH and RG10E eqs. (10-yr mat., weight: 1.0)

ZPI10F= ZPI10

z.33 ZPI5: Expected cons. price infl., for RG5E eq. (5-yr mat., weight: 1.0)

ZPI5= B1(L) {sum 0.0965 } * PICNIA $_{t-1}$
+ B2(L) {sum -0.226 } * RFFE $_{t-1}$
+ 0.226 * RTR$_{t-1}$
+ 0.904 * PTR$_{t-1}$
+ B5(L) {sum 0.181 } * XGAP $_{t-1}$

Distributed lag coefficients

Name	Value
$B1_0$	0.0685 0.00
$B1_1$	0.0162 0.00
$B1_2$	0.0169 0.00
$B1_3$	-0.00512 0.00

Name	Value
$B1_{SUM}$	0.0965
$B2_0$	-0.155 0.00
$B2_1$	-0.0278 0.00
$B2_2$	-0.0314 0.00
$B2_3$	-0.0116 0.00

Name	Value
$B2_{SUM}$	-0.226
$B5_0$	0.112 0.00
$B5_1$	-0.00360 0.00
$B5_2$	0.0366 0.00
$B5_3$	0.0363 0.00
$B5_{SUM}$	0.181

Regression statistics

Sample period: 1962Q2 2009Q4
Estimation date: August 2010

Estimation method: Least Squares

z.34 ZPIB5: Expected output price infl., for RPD eq. (5-yr dur., weight: 1.0)

ZPIB5= -5.24E-14
+ A1(L) {sum 0.203 } * PICNIA $_{t-1}$
+ A2(L) {sum -0.288 } * RFFE $_{t-1}$
+ 0.288 * RTR$_{t-1}$
+ 0.774 * PTR$_{t-1}$
+ A5(L) {sum 0.217 } * XGAP $_{t-1}$
+ A6(L) {sum 0.0231 } * (400*del(1 : log(PXNFB $_{t-1}$)))

Distributed lag coefficients

Name	Value
$A1_0$	0.116 0.00
$A1_1$	0.0381 0.00
$A1_2$	0.0365 0.00
$A1_3$	0.0118 0.00

Name	Value
$A1_{SUM}$	0.203
$A2_0$	-0.180 0.00
$A2_1$	-0.0480 0.00
$A2_2$	-0.0391 0.00
$A2_3$	-0.0217 0.00

Name	Value
$A2_{SUM}$	-0.288
$A5_0$	0.140 0.00
$A5_1$	-0.00665 0.00
$A5_2$	0.0429 0.00
$A5_3$	0.0412 0.00

Name	Value
$A5_{SUM}$	0.217
$A6_0$	0.0133 0.00
$A6_1$	0.0163 0.00
$A6_2$	0.000206 0.00
$A6_3$	-0.00672 0.00
$A6_{SUM}$	0.0231

Regression statistics

Sample period: 1962Q2 2009Q4
Estimation date: August 2010
Estimation method: Least Squares

z.35 ZPIC30: Expected cons. price infl., for RCBE and WPSN eqs. (30-yr mat., weight: 1.0)

ZPIC30= 3.59E-15
+ A1(L) {sum 0.0505 } * PICNIA $_t$
+ A2(L) {sum -0.0665 } * RFFE $_t$
+ 0.0665 * RTR
+ 0.949 * PTR

$+ A5(L)$ {sum 0.0502 } * XGAP $_t$

Distributed lag coefficients

Name	Value
$A1_0$	0.0405 0.00
$A1_1$	0.00560 0.00
$A1_2$	0.00583 0.00
$A1_3$	-0.001360.00

Name	Value
$A1_{SUM}$	0.0505
$A2_0$	-0.0451 0.00
$A2_1$	-0.007600.00
$A2_2$	-0.0108 0.00
$A2_3$	-0.002970.00

Name	Value
$A2_{SUM}$	-0.0665
$A5_0$	0.0275 0.00
$A5_1$	-0.0002850.00
$A5_2$	0.0117 0.00
$A5_3$	0.0113 0.00
$A5_{SUM}$	0.0502

Regression statistics

Sample period:	1962Q1 2009Q4
Estimation date:	August 2010
Estimation method:	Least Squares

z.36 ZPL: Expected growth rate of desired comp. per hour, for PL eq.

ZPL is a expected value of PICNIA in the next quarter

ZPL= -2.86E-11
+ A1(L) {sum 0.681 } * PIPL $_{t-1}$
+ A2(L) {sum -0.0317 } * PICNIA $_{t-1}$
+ A3(L) {sum 0.0408 } * PIPXNC $_{t-1}$
+ A4(L) {sum -0.00960} * 400*del(1 : log(PXP $_{t-1}$))
+ A5(L) {sum -0.00248} * 400*del(1 : log(PXG $_{t-1}$))
+ 0.322 * PTR$_{t-1}$
+ 0.131 * (400*log(QPCNIA$_{t-1}$/PCNIA$_{t-1}$))
+ 0.0778 * (400*log(QPXNC$_{t-1}$/PXNC$_{t-1}$))
+ 0.238 * (400*log(QPL$_{t-1}$/PL$_{t-1}$))
+ 0.319 * HLPRDT$_{t-1}$
+ A11(L) {sum -0.469 } * ((LUR $_{t-1}$ - LURNAT $_{t-1}$))
+ A12(L) {sum -0.0724 } * RFFE $_{t-1}$
+ 0.0724 * RTR$_{t-1}$
+ 12.2 * (UCFS$_{t-1}$ * del(1 : log(PCFR$_{t-1}$)))
- 0.209 * 400*HUQPCT$_{t-1}$

Distributed lag coefficients

Name	Value
$A1_0$	0.301 0.00
$A1_1$	0.225 0.00
$A1_2$	0.134 0.00
$A1_3$	0.0213 0.00
$A1_{SUM}$	0.681
$A2_0$	-0.000120 0.00
$A2_1$	-0.00693 0.00
$A2_2$	-0.0232 0.00

Name	Value
$A2_3$	-0.00143 0.00
$A2_{SUM}$	-0.0317
$A3_0$	0.0187 0.00
$A3_1$	0.0125 0.00
$A3_2$	0.00701 0.00
$A3_3$	0.00263 0.00
$A3_{SUM}$	0.0408
$A4_0$	-0.00485 0.00
$A4_1$	0.00321 0.00

Name	Value
$A4_2$	-0.00496 0.00
$A4_3$	-0.00300 0.00
$A4_{SUM}$	-0.00960
$A5_0$	0.00203 0.00
$A5_1$	-0.00758 0.00
$A5_2$	0.00307 0.00
$A5_{SUM}$	-0.00248
$A11_0$	-0.873 0.00
$A11_1$	0.473 0.00

Name	Value
$A11_2$	-0.0265 0.00
$A11_3$	-0.0423 0.00
$A11_{SUM}$	-0.469
$A12_0$	-0.0561 0.00
$A12_1$	-0.0126 0.00
$A12_2$	0.00933 0.00
$A12_3$	-0.0130 0.00
$A12_{SUM}$	-0.0724

z.37 ZPNC: Expected growth rate of desired price level, for PXNC eq.

ZPNC is a expected value of PICNIA in the next quarter

ZPNC= 7.18E-12
+ A1(L) {sum 0.192 } * PIPL $_{t-1}$
+ A2(L) {sum -0.00448} * PICNIA $_{t-1}$
+ A3(L) {sum 0.469 } * PIPXNC $_{t-1}$
+ A4(L) {sum 0.00582 } * 400*del(1 : log(PXP $_{t-1}$))
+ A5(L) {sum 0.00154 } * 400*del(1 : log(PXG $_{t-1}$))
+ 0.336 * PTR$_{t-1}$
+ 0.171 * (400*log(QPCNIA$_{t-1}$/PCNIA$_{t-1}$))
+ 0.204 * (400*log(QPXNC$_{t-1}$/PXNC$_{t-1}$))
+ 0.239 * (400*log(QPL$_{t-1}$/PL$_{t-1}$))
- 0.192 * HLPRDT$_{t-1}$
+ A11(L) {sum -0.190 } * ((LUR $_{t-1}$ - LURNAT $_{t-1}$))
+ A12(L) {sum -0.0464 } * RFFE $_{t-1}$
+ 0.0464 * RTR$_{t-1}$
- 7.78 * (UCFS$_{t-1}$ * del(1 : log(PCFR$_{t-1}$)))
- 1.39 * 400*HUQPCT$_{t-1}$

Distributed lag coefficients

Name	Value

Name	Value

Name	Value

Name	Value

$A1_0$	0.0876 0.00
$A1_1$	0.0587 0.00
$A1_2$	0.0329 0.00
$A1_3$	0.0123 0.00
$A1_{SUM}$	0.192
$A2_0$	0.00995 0.00
$A2_1$	-0.00437 0.00
$A2_2$	-0.0102 0.00

$A2_3$	0.000163 0.00
$A2_{SUM}$	-0.00448
$A3_0$	0.213 0.00
$A3_1$	0.157 0.00
$A3_2$	0.0898 0.00
$A3_3$	0.00999 0.00
$A3_{SUM}$	0.469
$A4_0$	0.00302 0.00
$A4_1$	-0.00221 0.00

$A4_2$	0.00309 0.00
$A4_3$	0.00191 0.00
$A4_{SUM}$	0.00582
$A5_0$	-0.00141 0.00
$A5_1$	0.00490 0.00
$A5_2$	-0.00195 0.00
$A5_{SUM}$	0.00154
$A11_0$	-0.366 0.00
$A11_1$	0.212 0.00

$A11_2$	-0.0159 0.00
$A11_3$	-0.0194 0.00
$A11_{SUM}$	-0.190
$A12_0$	-0.0376 0.00
$A12_1$	-0.00594 0.00
$A12_2$	0.00313 0.00
$A12_3$	-0.00597 0.00
$A12_{SUM}$	-0.0464

z.38 ZRFF10: Expected federal funds rate, for RG10E eq. (10-yr mat., weight: 1.0)

ZRFF10= 1.30E-13
+ A1(L) {sum -0.0459 } * PICNIA $_t$
+ A2(L) {sum 0.151 } * RFFE $_t$
+ 0.849 * RTR
+ 0.0459 * PTR
+ A5(L) {sum 0.0610 } * XGAP $_t$

Distributed lag coefficients

Name	Value
$A1_0$	-0.00334 0.00
$A1_1$	-0.0153 0.00
$A1_2$	-0.0154 0.00
$A1_3$	-0.0119 0.00

Name	Value
$A1_{SUM}$	-0.0459
$A2_0$	0.152 0.00
$A2_1$	-0.0416 0.00
$A2_2$	0.0910 0.00
$A2_3$	-0.0496 0.00

Name	Value
$A2_{SUM}$	0.151
$A5_0$	0.170 0.00
$A5_1$	-0.0799 0.00
$A5_2$	-0.0312 0.00
$A5_3$	0.00183 0.00
$A5_{SUM}$	0.0610

Regression statistics

Sample period: 1962Q1 2009Q4
Estimation date: August 2010
Estimation method: Least Squares

z.39 ZRFF5: Expected federal funds rate, for RG5E eq. (5-yr mat., weight: 1.0)

$$ZRFF5 = 3.18E\text{-}13 + A1(L)\ \{sum\ -0.0719\} * PICNIA_t + A2(L)\ \{sum\ 0.229\} * RFFE_t + 0.771 * RTR + 0.0719 * PTR + A5(L)\ \{sum\ 0.133\} * XGAP_t$$

Distributed lag coefficients

Name	Value
$A1_0$	0.000264 0.00
$A1_1$	-0.0253 0.00
$A1_2$	-0.0260 0.00
$A1_3$	-0.0209 0.00

Name	Value
$A1_{SUM}$	-0.0719
$A2_0$	0.238 0.00
$A2_1$	-0.0755 0.00
$A2_2$	0.153 0.00
$A2_3$	-0.0860 0.00

Name	Value
$A2_{SUM}$	0.229
$A5_0$	0.313 0.00
$A5_1$	-0.135 0.00
$A5_2$	-0.0500 0.00
$A5_3$	0.00577 0.00
$A5_{SUM}$	0.133

Regression statistics

Sample period:	1962Q1 2009Q4
Estimation date:	August 2010
Estimation method:	Least Squares

z.40 ZVPDC: Expected growth rate of des. capital-output ratio, for EPDCeq. (weight: .68)

$$ZVPDC = -4.50E\text{-}16 + A1(L)\ \{sum\ -0.000488\} * PICNIA_{t-1} + A2(L)\ \{sum\ 0.000112\} * RFFE_{t-1} - 0.000112 * RTR_{t-1} + 0.000488 * PTR_{t-1} + A5(L)\ \{sum\ -8.00E\text{-}05\} * XGAP_{t-1} + A6(L)\ \{sum\ -4.01E\text{-}15\} * del(1 : \log(XNFB_{t-1})) + A7(L)\ \{sum\ 0.325\} * del(1 : \log(VPDC_{t-1})) - 8.65E\text{-}15 * HGVPDC_{t-1}$$

Distributed lag coefficients

Name	Value
$A1_0$	-0.001790.00
$A1_1$	-0.0006000.00
$A1_2$	0.00120 0.00
$A1_3$	0.0006950.00
$A1_{SUM}$	-0.000488
$A2_0$	0.0002980.00

Name	Value
$A2_1$	2.80E-050.00
$A2_2$	-0.001110.00
$A2_3$	0.0008930.00
$A2_{SUM}$	0.000112
$A5_0$	0.0003620.00
$A5_1$	0.0005000.00

Name	Value
$A5_2$	-0.001750.00
$A5_3$	0.0008040.00
$A5_{SUM}$	-8.00E-05
$A6_0$	2.71E-150.00
$A6_1$	-2.05E-140.00
$A6_2$	1.01E-140.00

Name	Value
$A6_3$	3.71E-150.00
$A6_{SUM}$	-4.01E-15
$A7_0$	0.249 0.00
$A7_1$	0.0287 0.00
$A7_2$	0.0196 0.00
$A7_3$	0.0275 0.00
$A7_{SUM}$	0.325

Regression statistics

Sample period: 1976Q1 2009Q4
Estimation date: September 2010
Estimation method: Least Squares

z.41 ZVPDO: Expected growth rate of des. capital-output ratio, for EPDOeq. (weight: .68)

ZVPDO= -8.66E-17
+ A1(L) {sum 2.58E-05} * PICNIA $_{t-1}$
+ A2(L) {sum 6.85E-05} * RFFE $_{t-1}$
- 6.85E-05 * RTR$_{t-1}$
- 2.58E-05 * PTR$_{t-1}$
+ A5(L) {sum -3.43E-06} * XGAP $_{t-1}$
+ A6(L) {sum -1.23E-15} * del(1 : log(XNFB $_{t-1}$))
+ A7(L) {sum 0.00127 } * del(1 : log(VPDO $_{t-1}$))
+ 0.213 * HGVPDO$_{t-1}$

Distributed lag coefficients

Name	Value
$A1_0$	1.65E-050.00
$A1_1$	-1.30E-050.00
$A1_2$	1.16E-050.00
$A1_3$	1.06E-050.00
$A1_{SUM}$	2.58E-05

Name	Value
$A2_1$	3.31E-050.00
$A2_2$	-1.07E-050.00
$A2_3$	1.89E-050.00
$A2_{SUM}$	6.85E-05
$A5_0$	-3.59E-050.00

Name	Value
$A5_2$	1.33E-050.00
$A5_3$	1.42E-050.00
$A5_{SUM}$	-3.43E-06
$A6_0$	-6.46E-160.00
$A6_1$	1.83E-160.00

Name	Value
$A6_3$	-9.42E-170.00
$A6_{SUM}$	-1.23E-15
$A7_0$	3.12E-050.00
$A7_1$	-0.0002140.00
$A7_2$	0.0005810.00

$A2_0$	2.72E-05 0.00

$A5_1$	4.97E-06 0.00

$A6_2$	-6.76E-16 0.00

$A7_3$	0.000871 0.00
$A7_{SUM}$	0.00127

Regression statistics

Sample period: 1976Q1 2009Q4
Estimation date: September 2010
Estimation method: Least Squares

z.42 ZVPS: Expected growth rate of des. capital-output ratio, for EPS eq. (weight: .68)

ZVPS= -0.00184
+ A1(L) {sum 0.00115 } * PICNIA $_{t-1}$
+ A2(L) {sum -0.000724} * RFFE $_{t-1}$
+ 0.000724 * RTR$_{t-1}$
- 0.00115 * PTR$_{t-1}$
+ A5(L) {sum -0.00110} * XGAP $_{t-1}$
+ A6(L) {sum 3.52E-15} * del(1 : log(XNFB $_{t-1}$))
+ A7(L) {sum 0.160 } * del(1 : log(VPS $_{t-1}$))
+ 1.60E-15 * HGVPS$_{t-1}$

Distributed lag coefficients

Name	Value
$A1_0$	0.00202 0.00
$A1_1$	-0.00143 0.00
$A1_2$	0.000348 0.00
$A1_3$	0.000211 0.00
$A1_{SUM}$	0.00115
$A2_0$	-0.000266 0.00

Name	Value
$A2_1$	0.000271 0.00
$A2_2$	2.81E-05 0.00
$A2_3$	-0.000756 0.00
$A2_{SUM}$	-0.000724
$A5_0$	0.000133 0.00
$A5_1$	-0.00239 0.00

Name	Value
$A5_2$	0.00160 0.00
$A5_3$	-0.000455 0.00
$A5_{SUM}$	-0.00110
$A6_0$	-1.47E-14 0.00
$A6_1$	2.71E-14 0.00
$A6_2$	-9.62E-15 0.00

Name	Value
$A6_3$	6.85E-16 0.00
$A6_{SUM}$	3.52E-15
$A7_0$	0.0835 0.00
$A7_1$	0.000483 0.00
$A7_2$	0.0840 0.00
$A7_3$	-0.00794 0.00
$A7_{SUM}$	0.160

Regression statistics

Sample period: 1976Q1 2009Q4
Estimation date: September 2010
Estimation method: Least Squares

z.43 ZXNFBC: Expected growth rate of business output, for EPDCeq. (weight: .68)

ZXNFBC= 6.11E-16
+ A1(L) {sum -0.000114} * PICNIA $_{t-1}$
+ A2(L) {sum -0.000441} * RFFE $_{t-1}$
+ 0.000441 * RTR$_{t-1}$
+ 0.000114 * PTR$_{t-1}$
+ A5(L) {sum 9.05E-05} * XGAP $_{t-1}$
+ A6(L) {sum 0.325 } * del(1 : log(XNFB $_{t-1}$))
+ A7(L) {sum 2.26E-16} * del(1 : log(VPDC $_{t-1}$))
- 2.29E-16 * HGX$_{t-1}$/400

Distributed lag coefficients

Name	Value
$A1_{0}$	2.22E-05 0.00
$A1_{1}$	-0.000108 0.00
$A1_{2}$	-4.56E-05 0.00
$A1_{3}$	1.79E-05 0.00
$A1_{SUM}$	-0.000114
$A2_{0}$	-0.00103 0.00

Name	Value
$A2_{1}$	-0.000238 0.00
$A2_{2}$	0.000652 0.00
$A2_{3}$	0.000177 0.00
$A2_{SUM}$	-0.000441
$A5_{0}$	-3.20E-06 0.00
$A5_{1}$	2.04E-05 0.00

Name	Value
$A5_{2}$	6.32E-05 0.00
$A5_{3}$	1.01E-05 0.00
$A5_{SUM}$	9.05E-05
$A6_{0}$	0.117 0.00
$A6_{1}$	0.104 0.00
$A6_{2}$	0.0637 0.00

Name	Value
$A6_{3}$	0.0395 0.00
$A6_{SUM}$	0.325
$A7_{0}$	1.39E-16 0.00
$A7_{1}$	1.32E-16 0.00
$A7_{2}$	-6.38E-17 0.00
$A7_{3}$	1.97E-17 0.00
$A7_{SUM}$	2.26E-16

Regression statistics

Sample period: 1976Q1 2009Q4
Estimation date: September 2010
Estimation method: Least Squares

z.44 ZXNFBO: Expected growth rate of business output, for EPDOeq. (weight: .68)

ZXNFBO= 4.40E-16
+ A1(L) {sum -8.29E-07} * PICNIA $_{t-1}$
+ A2(L) {sum 0.000265} * RFFE $_{t-1}$
- 0.000265 * RTR$_{t-1}$

+ 8.29E-07 * PTR$_{t-1}$
+ A5(L) {sum -6.05E-05} * XGAP $_{t-1}$
+ A6(L) {sum 0.215 } * del(1 : log(XNFB $_{t-1}$))
+ A7(L) {sum -6.00E-16} * del(1 : log(VPDO $_{t-1}$))
- 2.30E-16 * HGX$_{t-1}$/400

Distributed lag coefficients

Name	Value
$A1_0$	-2.57E-05 0.00
$A1_1$	-1.46E-05 0.00
$A1_2$	1.21E-05 0.00
$A1_3$	2.73E-05 0.00
$A1_{SUM}$	-8.29E-07
$A2_0$	-0.000301 0.00

Name	Value
$A2_1$	0.000149 0.00
$A2_2$	0.000264 0.00
$A2_3$	0.000154 0.00
$A2_{SUM}$	0.000265
$A5_0$	-0.000217 0.00
$A5_1$	0.000126 0.00

Name	Value
$A5_2$	3.90E-05 0.00
$A5_3$	-7.99E-06 0.00
$A5_{SUM}$	-6.05E-05
$A6_0$	0.0973 0.00
$A6_1$	0.0658 0.00
$A6_2$	0.0342 0.00

Name	Value
$A6_3$	0.0172 0.00
$A6_{SUM}$	0.215
$A7_0$	-1.58E-16 0.00
$A7_1$	7.00E-17 0.00
$A7_2$	-2.75E-16 0.00
$A7_3$	-2.37E-16 0.00
$A7_{SUM}$	-6.00E-16

Regression statistics

Sample period: 1976Q1 2009Q4
Estimation date: September 2010
Estimation method: Least Squares

z.45 ZXNFBS: Expected growth rate of business output, for EPS eq. (weight: .68)

ZXNFBS= 1.01E-15
+ A1(L) {sum -0.000152} * PICNIA $_{t-1}$
+ A2(L) {sum -0.000361} * RFFE $_{t-1}$
+ 0.000361 * RTR$_{t-1}$
+ 0.000152 * PTR$_{t-1}$
+ A5(L) {sum 2.83E-05} * XGAP $_{t-1}$
+ A6(L) {sum 0.454 } * del(1 : log(XNFB $_{t-1}$))
+ A7(L) {sum 1.13E-15} * del(1 : log(VPS $_{t-1}$))
- 3.96E-16 * HGX$_{t-1}$/400

Distributed lag coefficients

Name	Value
$A1_0$	-3.53E-05 0.00
$A1_1$	-0.000124 0.00
$A1_2$	-3.84E-05 0.00
$A1_3$	4.58E-05 0.00
$A1_{SUM}$	-0.000152
$A2_0$	-0.00137 0.00

Name	Value
$A2_1$	-0.000120 0.00
$A2_2$	0.000801 0.00
$A2_3$	0.000326 0.00
$A2_{SUM}$	-0.000361
$A5_0$	-0.000188 0.00
$A5_1$	0.000146 0.00

Name	Value
$A5_2$	8.08E-05 0.00
$A5_3$	-9.90E-06 0.00
$A5_{SUM}$	2.83E-05
$A6_0$	0.175 0.00
$A6_1$	0.144 0.00
$A6_2$	0.0835 0.00

Name	Value
$A6_3$	0.0518 0.00
$A6_{SUM}$	0.454
$A7_0$	-7.85E-17 0.00
$A7_1$	1.02E-15 0.00
$A7_2$	-3.62E-17 0.00
$A7_3$	2.30E-16 0.00
$A7_{SUM}$	1.13E-15

Regression statistics

Sample period:	1976Q1 2009Q4
Estimation date:	September 2010
Estimation method:	Least Squares

z.46 ZYH: Expected level of real after-tax household income, for QEC eq. (weight: 1.0)

Permanent household income is approximated by the product of four factors: (1) potential output XGDPT; (2) the trend ratio of of household income to potential GDP, ZYHST; (3) the weighted average of expected future log deviations of actual GDP from its potential; and (4) the weighted average of expected future log deviations of the actual ratio of household income to GDP from its trend ZYHST. In the case of the last two factors, the expectations are derived from a small-scale VAR forecasting system using time t information; forward averages through infinity for these forecasts are then computed using weights that decline geometrically, based on a discount rate of 20 percent per year. The equation shown below is the reduced-form representation of this expectational system.

log(ZYH) = B1(L) {sum 1.86E-05} * PICNIA $_t$
+ B2(L) {sum -0.000578} * RFFE $_t$
+ B3(L) {sum 0.00275 } * XGAP2 $_t$
- 1.86E-05 * PTR
+ 0.000578 * RTR
+ B6(L) {sum 0.00253 } * YHGAP $_t$
+ log(ZYHST*XGDPT)

Distributed lag coefficients

Name	Value
$B1_0$	-0.000768 0.00

Name	Value
$B1_{SUM}$	1.86E-05

Name	Value
$B2_{SUM}$	-0.000578

Name	Value
$B3_{SUM}$	0.00275

$B1_1$	0.0001580.00
$B1_2$	5.72E-050.00
$B1_3$	0.0005720.00

$B2_0$	-0.001760.00
$B2_1$	0.0003610.00
$B2_2$	0.0003980.00
$B2_3$	0.0004220.00

$B3_0$	0.00366 0.00
$B3_1$	0.0007040.00
$B3_2$	-0.0005760.00
$B3_3$	-0.001040.00

$B6_0$	0.00228 0.00
$B6_1$	0.0004590.00
$B6_2$	-0.0001700.00
$B6_3$	-3.31E-050.00
$B6_{SUM}$	0.00253

Regression statistics

Sample period: 1963Q2 2008Q4
Estimation date: August 2009
Estimation method: Least Squares

z.47 ZYHP: Expected level of real after-tax property income, for QEC eq. (weight: 1.0)

The property component of permanent household income is approximated by the product of six factors: (1) potential output XGDPT; (2) the trend ratio of household income to potential GDP, ZYHST; (3) the trend share of property income in total household income, ZYHPST; (4) the weighted average of expected future log deviations of actual GDP from its potential; (5) the weighted average of expected future log deviations of the actual ratio of household income to GDP from its trend ZYHST; and (6) the weighted average of expected future log deviations of the actual property share from its trend. In the case of the last three factors, the expectations are derived from a small-scale VAR forecasting system using time t information; forward averages through infinity for these forecasts are then computed using weights that decline geometrically, based on a discount rate of 20 percent per year. The equation shown below is the reduced-form representation of this expectational system.

log(ZYHP) = B1(L) {sum 0.00249 } * PICNIA $_t$
+ B2(L) {sum -0.000846} * RFFE $_t$
+ B3(L) {sum 0.000489} * XGAP2 $_t$
- 0.00249 * PTR
+ 0.000846 * RTR
+ B6(L) {sum 0.00205 } * YHGAP $_t$
+ B7(L) {sum 0.00155 } * YHPGAP $_t$
+ log(ZYHPST*ZYHST*XGDPT)

Distributed lag coefficients

Name	Value
$B1_0$	0.0006040.00
$B1_1$	0.0008530.00

Name	Value
$B2_1$	-9.96E-050.00
$B2_2$	0.0008260.00

Name	Value
$B3_2$	-0.0008300.00
$B3_3$	-0.001190.00

Name	Value
$B6_3$	-0.0003480.00
$B6_{SUM}$	0.00205

$B1_2$	0.000588 0.00
$B1_3$	0.000448 0.00
$B1_{SUM}$	0.00249
$B2_0$	-0.00134 0.00

$B2_3$	-0.000234 0.00
$B2_{SUM}$	-0.000846
$B3_0$	0.00233 0.00
$B3_1$	0.000180 0.00

$B3_{SUM}$	0.000489
$B6_0$	0.00255 0.00
$B6_1$	0.000115 0.00
$B6_2$	-0.000260 0.00

$B7_0$	0.00191 0.00
$B7_1$	-0.000273 0.00
$B7_2$	4.48E-05 0.00
$B7_3$	-0.000130 0.00
$B7_{SUM}$	0.00155

Regression statistics

Sample period: 1964Q2 2008Q4
Estimation date: August 2009
Estimation method: Least Squares

z.48 ZYHPST: Expected trend share of property income in household income

Each quarter, the estimated long-run share of property income in total income is assumed to close 5% of the gap between the actual share and last period's estimate.

ZYHPST= ZYHPST_{t-1} + 0.0500 [(const.)]*(YHPSHR-ZYHPST_{t-1})

z.49 ZYHST: Expected trend ratio of household income to GDP

Each quarter, the estimated trend ratio of household income to GDP is assumed to close 5% of the gap between the actual share and last period's estimate.

ZYHST= ZYHST_{t-1} + 0.0500 [(const.)]*(YHSHR-ZYHST_{t-1})

z.50 ZYHT: Expected level of real transfer income, for QEC eq. (weight: 1.0)

The transfer component of permanent household income is approximated by the product of six factors: (1) potential output XGDPT; (2) the trend ratio of household income to potential GDP, ZYHST; (3) the trend share of transfer income in total household income, ZYHTST; (4) the weighted average of expected future log deviations of actual GDP from its potential; (5) the weighted average of expected future log deviations of the actual ratio of household income to GDP from its trend ZYHST; and (6) the weighted average of expected future log deviations of the actual transfer share from its trend. In the case of the last three factors, the expectations are derived from a small-scale VAR forecasting system using time t information; forward averages through infinity for these forecasts are then computed using weights that decline geometrically, based on a discount rate of 20 percent per year. The equation shown below is the reduced-form representation of this expectational system.

log(ZYHT) = B1(L) {sum -0.00182} * PICNIA $_t$
+ B2(L) {sum 0.000202} * RFFE $_t$
+ B3(L) {sum 0.00773 } * XGAP2 $_t$
+ 0.00182 * PTR
- 0.000202 * RTR
+ B6(L) {sum 0.00277 } * YHGAP $_t$
+ B7(L) {sum 0.00289 } * YHTGAP $_t$
+ log(ZYHTST*ZYHST*XGDPT)

Distributed lag coefficients

Name	Value
$B1_0$	-0.00150 0.00
$B1_1$	-0.000383 0.00
$B1_2$	-0.000356 0.00
$B1_3$	0.000424 0.00
$B1_{SUM}$	-0.00182
$B2_0$	-0.00154 0.00

Name	Value
$B2_1$	0.00108 0.00
$B2_2$	0.000149 0.00
$B2_3$	0.000512 0.00
$B2_{SUM}$	0.000202
$B3_0$	0.00554 0.00
$B3_1$	0.00196 0.00

Name	Value
$B3_2$	0.000444 0.00
$B3_3$	-0.000214 0.00
$B3_{SUM}$	0.00773
$B6_0$	0.00155 0.00
$B6_1$	0.000597 0.00
$B6_2$	0.000507 0.00

Name	Value
$B6_3$	0.000113 0.00
$B6_{SUM}$	0.00277
$B7_0$	0.00223 0.00
$B7_1$	0.000568 0.00
$B7_2$	-0.000189 0.00
$B7_3$	0.000277 0.00
$B7_{SUM}$	0.00289

Regression statistics

Sample period: 1964Q2 2008Q4
Estimation date: August 2009
Estimation method: Least Squares

z.51 ZYHTST: Expected trend share of transfer income in household income

Each quarter, the estimated long-run share of transfer income in total income is assumed to close 5% of the gap between the actual share and last period's estimate.

ZYHTST = ZYHTST_{t-1} + 0.0500 [(const.)]*(YHTSHR-ZYHTST_{t-1})

z.52 ZYNID: Expected rate of growth of desired real dividends, for YNIDN eq. (weight: .48)

ZYNID = 0.00261
+ A1(L) {sum 0.000709} * PICNIA $_{t-1}$
+ A2(L) {sum -0.000512} * RFFE $_{t-1}$
+ 0.000512 * RTR$_{t-1}$
- 0.000709 * PTR$_{t-1}$
+ A5(L) {sum -0.00157} * XGAP $_{t-1}$
+ A6(L) {sum -0.0334 } * del(1 : log(QYNIDN $_{t-1}$/PXNFB $_{t-1}$))
+ 0.358 * (HGGDPT$_{t-1}$/400)

Distributed lag coefficients

Name	Value
$A1_0$	-5.82E-05 0.00
$A1_1$	0.000297 0.00
$A1_2$	0.000214 0.00
$A1_3$	0.000256 0.00

Name	Value
$A1_{SUM}$	0.000709
$A2_0$	-0.000334 0.00
$A2_1$	-3.90E-05 0.00
$A2_2$	-0.000274 0.00
$A2_3$	0.000134 0.00

Name	Value
$A2_{SUM}$	-0.000512
$A5_0$	-0.00172 0.00
$A5_1$	0.000336 0.00
$A5_2$	-0.000192 0.00
$A5_3$	9.17E-06 0.00

Name	Value
$A5_{SUM}$	-0.00157
$A6_0$	-0.0101 0.00
$A6_1$	-0.00963 0.00
$A6_2$	-0.00500 0.00
$A6_3$	-0.00866 0.00
$A6_{SUM}$	-0.0334

Regression statistics

Sample period: 1965Q1 2009Q4
Estimation date: September 2010
Estimation method: Least Squares

z.53 ZECO: Expected growth rate of target non-durables and non-housing services, for ECO eq. (weight:.72)

The weighted average growth rate of expected future target "other" consumption, ZECO, is computed using forecasts from a small scale VAR model combined with the PAC weights implied by the estimated coefficients of the dynamic consumption equation. The equation shown below is the reduced-form representation of this expectational computation.

ZECO= 0.00251
+ B1(L) {sum -3.92E-06} * PICNIA $_{t-1}$
+ B2(L) {sum 6.43E-05} * RFFE $_{t-1}$

+ B3(L) {sum -6.72E-05} * XGAP2 $_{t-1}$

+ 3.92E-06 * PTR$_{t-1}$

- 6.43E-05 * RTR$_{t-1}$

+ B6(L) {sum 0.000221} * YHGAP $_{t-1}$

+ B7(L) {sum 1.04E-05} * YHTGAP $_{t-1}$

+ B8(L) {sum -0.000132} * YHPGAP $_{t-1}$

+ 0.592 * ((HGGDPT$_{t-1}$/400) - del(1 : log(N16$_{t-1}$)))

+ B10(L) {sum 0.0756 }

* (del(1 : log(QEC $_{t-1}$)) - del(1 : log(PCOR $_{t-1}$)))

Distributed lag coefficients

Name	Value
$B1_0$	-0.000167 0.00
$B1_1$	-5.98E-05 0.00
$B1_2$	3.39E-05 0.00
$B1_3$	0.000189 0.00
$B1_{SUM}$	-3.92E-06
$B2_0$	2.62E-05 0.00
$B2_1$	0.000108 0.00
$B2_2$	-6.34E-05 0.00

Name	Value
$B2_3$	-6.65E-06 0.00
$B2_{SUM}$	6.43E-05
$B3_0$	-0.000112 0.00
$B3_1$	0.000122 0.00
$B3_2$	4.95E-06 0.00
$B3_3$	-8.28E-05 0.00
$B3_{SUM}$	-6.72E-05
$B6_0$	-0.000140 0.00
$B6_1$	0.000213 0.00

Name	Value
$B6_2$	0.000283 0.00
$B6_3$	-0.000135 0.00
$B6_{SUM}$	0.000221
$B7_0$	3.22E-05 0.00
$B7_1$	-3.65E-05 0.00
$B7_2$	7.07E-05 0.00
$B7_3$	-5.60E-05 0.00
$B7_{SUM}$	1.04E-05
$B8_0$	4.93E-06 0.00

Name	Value
$B8_1$	-0.000237 0.00
$B8_2$	8.48E-05 0.00
$B8_3$	1.53E-05 0.00
$B8_{SUM}$	-0.000132
$B10_0$	0.0548 0.00
$B10_1$	0.00800 0.00
$B10_2$	-0.00812 0.00
$B10_3$	0.0210 0.00
$B10_{SUM}$	0.0756

Regression statistics

Sample period:	1964Q2 2008Q4
Estimation date:	August 2009
Estimation method:	Least Squares