ANALYZING MACROECONOMIC FORECASTABILITY

By

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June 2009
Updated: September 2009

COWLES FOUNDATION DISCUSSION PAPER NO. 1706

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Abstract

This paper examines whether recessions and booms are forecastable under the assumption that equity prices, housing prices, import prices, exports, and random shocks are not. Each of the 214 eight-quarter periods within the overall 1954:1–2009:1 period is examined regarding predictions of output growth and inflation. The results for low output growth vary by recession—there is no common pattern. Of the eight recessions, three are forecast well. For four of the five that are not, the main reason for each is not knowing: 1) the random shocks, 2) import prices and equity prices, 3) exports, and 4) exports and equity prices. For the fifth—the last one—all five components are large contributors, including housing prices: a perfect storm.

1 Introduction

This paper analyzes how well recessions and booms can be forecast. It uses a structural macroeconometric model of the United States, denoted the "US model."[1] If recessions and booms are primarily driven by changes in asset prices, they are

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[1]The US model is described in Fair (2004). It has been updated for purposes of this paper. The updated version and documentation are on the website mentioned in the introductory footnote. The model can also be downloaded for use on one's own computer, and the results in this paper can be duplicated. The US model is imbedded in a larger multicountry model, but for purposes of this paper only the US model has been used.

unforecastable to the extent that changes in asset prices are unforecastable. There are four variables in the US model that have important effects on aggregate demand that are unforecastable or at least hard to forecast: equity prices, housing prices, import prices, and exports. Equity prices and housing prices are asset prices and hard to forecast. Import prices depend in large part on oil prices, food prices, and exchange rates, all of which are hard to forecast. U.S. exports depend on the import demands of other countries, and these demands are hard to forecast to the extent that they depend on the importing countries' asset and import prices.

The approach of this paper is to use the US model to forecast each of the 214 eight-quarter periods within the overall 1954:1–2009:1 period under five assumptions: not knowing equity prices, not knowing housing prices, not knowing import prices, not knowing exports, and not knowing the residuals (i.e., the error terms in the structural equations). "Not knowing" the four variables means using simple baseline paths for their forecasts. "Not knowing" the residuals means using zero values. As will be seen, this procedure allows the overall forecast error for any eight-quarter period to be divided into five components, which can then be examined. If the overall forecast error for a particular recession is small, the model has forecast the recession well using only baseline paths and zero residuals. This says that given the structure of the model, the initial conditions, and the values of the other exogenous variables (primarily government policy variables), the recession has been forecast. Otherwise, one or more of the components is the culprit.

There is a large literature on forecasting the *probability* that a recession will occur in some future quarter, in particular using the yield curve to forecast such probabilities. Two recent papers are Chauvet and Potter (2005) and Rudebusch and Williams (2008). For example, Rudebusch and Williams define a recession as a quarter with negative real growth and examine horizons of zero to four quarters ahead. They find that the yield curve has some predictive power relative to predictions from professional forecasters.

There is also a large literature, recently surveyed by Stock and Watson (2003), examining whether asset prices are useful predictors of future output growth and inflation. Stock and Watson examine data on many possible predictor variables for seven countries. Using bivariate and trivariate equations, they get mixed results. For some countries and some periods some asset prices are useful predictors, but the predictive relations are far from stable.

This paper is not an examination of possible single-equation predictive relationships. Instead, a structural model of the economy, which has already been estimated, is used. Consider, for example, the role of equity prices. In the US model household wealth lagged one quarter is a significant and important explanatory variable in the estimated consumption equations. If equity prices rise, household wealth increases, which leads to an increase in consumption demand. Equity prices are thus estimated in the model to affect aggregate demand. These relationships have been estimated and found to be statistically significant. This paper is not a test of them. The aim is to see how the US model's forecasts are affected by knowing or not knowing the path of equity prices over the forecast period. The same is true for housing prices, import prices, and exports. These variables are estimated to have important effects on the economy, and the aim is to see how the model's forecasts are affected by knowing or not knowing them.

This study is thus conditional on the estimated structure of the US model.

Using the model allows questions to be considered that cannot be using single-equation relationships. If the model is a good approximation of the economy, it may still not be good at, say, forecasting recessions if what drives recessions are unforecastable exogenous variables in the model, and this type of question can be considered. More economic theory is used than in the use of single equations. A disadvantage of this approach is that it requires a particular model. If the model is a poor approximation of the economy, the results will not be trustworthy. The US model is briefly discussed in the next section and in the appendix.

The basic procedure is as follows. A "baseline" path is chosen for each of the four variables, which is a path based on the variable's average historical behavior. For each of the 214 eight-quarter periods within the overall 1954:1–2009:1 period a baseline forecast is made using the baseline paths of the four variables, zero residuals, and actual values of all the other exogenous variables. Let $\hat{y}_t$ be the predicted value of endogenous variable y_t for the forecast that begins in quarter t. For this paper the two endogenous variables examined are the growth rate of real GDP over the eight quarters and the inflation rate over the eight quarters (both at annual rates). (Figures 1 and 2 plot these two variables for the 1954:1–2009:1 period.) Let $\hat{e}_t = \hat{y}_t - y_t$ denote the forecast error for the given variable. This error will be called the "baseline" error.

Five more forecasts for each eight-quarter period are then made. For the first forecast the residuals are kept at zero but the values of the four variables are set to their actual values. The error from this forecast measures how much of the baseline error is due to not knowing the residuals (i.e., the random shocks to the estimated equations). For the second forecast the residuals are set to their actual

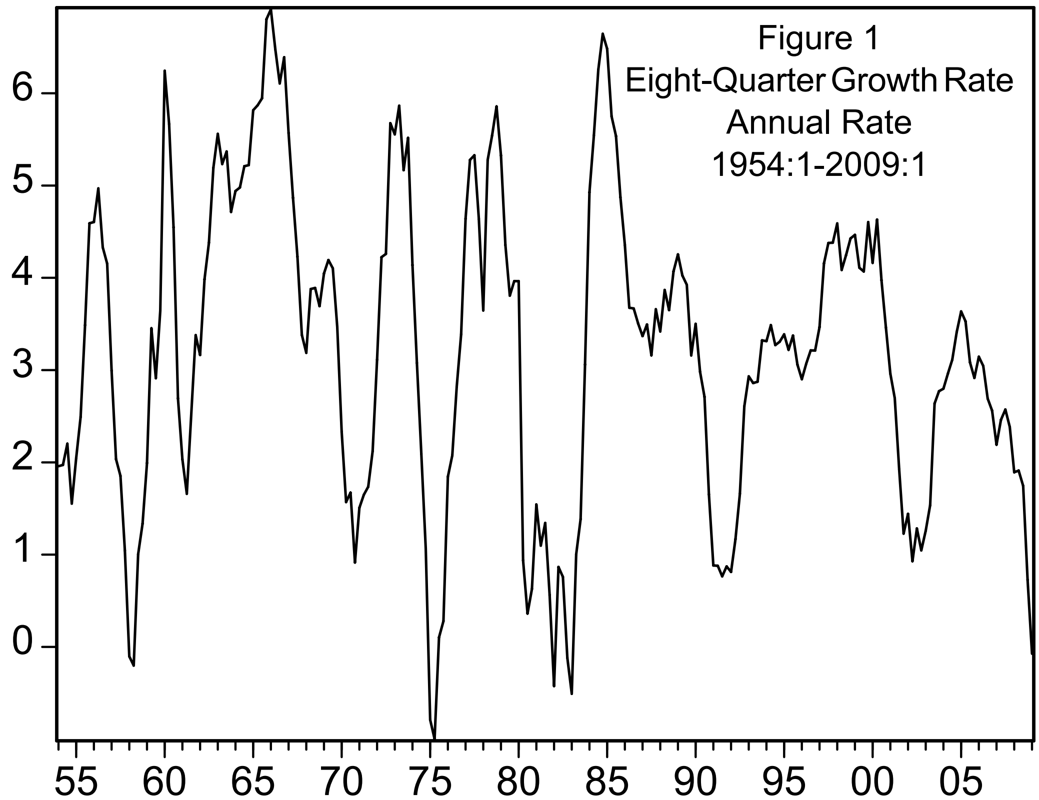


Figure 1
Eight-Quarter Growth Rate
Annual Rate
1954:1-2009:1
6
5
4
3
2
1
0
55
60
65
70
75
80
85
90
95
00
05

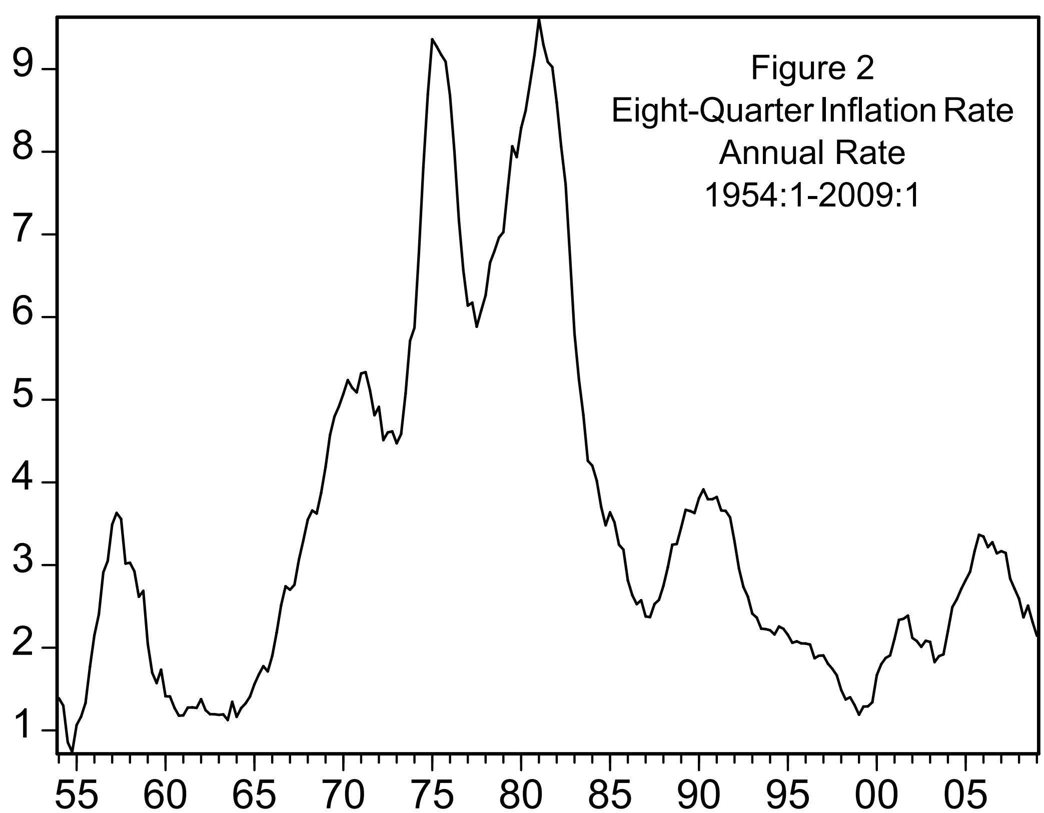


Figure 2
Eight-Quarter Inflation Rate
Annual Rate
1954:1-2009:1
9
8
7
6
5
4
3
2
1
55
60
65
70
75
80
85
90
95
00
05

(i.e., estimated) values, the baseline path for equity prices is used, and actual values for the other three variables are used. The error from this forecast measures how much of the baseline error is due to not knowing equity prices. The third, fourth, and fifth forecasts are similar to the second, where the selected variable is, respectively, housing prices, import prices, and exports.

Let $\hat{e}_{it}$ denote the forecast error for forecast i, $i = 1, \ldots, 5$. It turns out, as will be seen, that the sum of these five errors is very close to $\hat{e}_t$. So this procedure essentially divides up the baseline error into five components: not knowing the residuals, not knowing equity prices, not knowing housing prices, not knowing import prices, and not knowing exports. This paper is an analysis of these components for the eight-quarter periods.

2 Background

The US Model

In the appendix the US model is briefly compared to dynamic stochastic general equilibrium (DSGE) models, which are currently popular in macroeconomics. The US model consists of 26 estimated equations and about 100 identities. If the error terms are serially correlated, the serial correlation coefficients are estimated along with the structural coefficients. The error terms after removing possible serial correlation are assumed to be iid. The estimation period is 1954:1–2009:1, and the estimation method is two stage least squares. All the coefficient estimates are consistent under the statistical assumptions. There is no calibration; labor market clearing is not imposed; and rational expectations are not imposed.

There are seven estimated demand equations for good and services, explaining the demand for service consumption, nondurable consumption, durable consumption, housing investment, plant and equipment investment, inventory investment, and imports. The main way that equity prices and housing prices affect demand is through a household wealth variable in the three consumption equations. Import prices affect the demand for imports through an import price variable in the import equation. Lagged stock variables are important explanatory variables in the demand equations: durables goods stock, housing stock, capital stock, and inventory stock.

There are labor force participation equations for prime age men, prime age women, and all others, and there is an equation explaining the number of people holding two jobs. There is a demand for employment equation and a demand for hours worked per worker equation. The unemployment rate is determined by a definition: total labor force minus employment divided by total labor force.

The other main estimated equations are a price equation, a nominal wage equation, an interest rate rule of the Federal Reserve, a term structure equation explaining the AAA corporate bond rate, and a term structure equation explaining a mortgage rate. The import price variable is an important explanatory variable in the price equation; it plays the role of a cost shock variable.

The remaining estimated equations are two demand for money equations and equations explaining dividends, firm interest payments, federal government interest payments, depreciation, and unemployment benefits. In the identities, all flows of funds among the sectors (household, firm, financial, state and local government, federal government, and foreign) are accounted for.

Equity Prices

The variable CG in the model is the nominal value of capital gains or losses on the equity holdings of the household sector. It is based on data from the Flow of Funds accounts. There is an equation in the US model explaining CG, and it has been dropped for purposes of this paper. The left hand side variable in this equation is $CG/(PX_{-1} \cdot YS_{-1})$, where PX is a price deflator and YS is an estimate of potential output. The two right hand side variables are the change in the bond rate and the change in after tax profits (normalized by $PX_{-1} \cdot YS_{-1}$). This equation explains very little of the variation in CG, and the two explanatory variables have very small effects on CG. The equation has been dropped so that CG can be used in the experiments.

The mean of $CG/(PX_{-1} \cdot YS_{-1})$ over the 1954:1–2009:1 period is 0.120. For the experiments in this paper the baseline values of CG were computed using the equation $CG = 0.120(PX_{-1} \cdot YS_{-1})$. This captures the average historical behavior of CG.

As noted above, real wealth of the household sector (lagged one quarter) is an important explanatory variable in the three consumption equations. The wealth variable that appears in the consumption equations is

$$AA = [(AH + MH) + (PKH \cdot KH)]/PH$$

where AH is the nominal value of net financial assets of the household sector excluding demand deposits and currency, MH is the nominal value of demand deposits and currency held by the household sector, KH is the real stock of housing, PKH is the market price of KH, and PH is a price deflator relevant to household spending. $AH + MH$ is thus nominal financial wealth, and $PKH \cdot KH$ is nominal housing wealth.

The identity for AH is

$$AH = AH_{-1} - (MH - MH_{-1}) + SH + CG - DISH$$

where SH is the financial saving of the household sector and $DISH$ is an exogenous discrepancy term. CG thus affects real wealth through this definition. In fact, the main fluctuations in AH are due to fluctuations in CG.

Figure 3 plots $\log(AH + MH)/(PH \cdot Y^*)$ for 1954:1–2009:1, where Y^* is a peak-to-peak interpolation of real GDP. (Y^* is just used for normalization purposes here; it is not a variable in the model.) Dominating the figure are the stock market booms of 1995–1999 and 2003–2006 and the stock market contractions of 2000–2002 and 2007–2008. There were also two fairly large contractions in 1969–1970 and 1973–1974. Most of these fluctuations are driven by changes in CG. Using the baseline values of CG essentially eliminates these fluctuations. The forecasts using the baseline values of CG are thus forecasts with no stock market booms and contractions.

Housing Prices

The real stock of housing of the household sector, KH, is based on data from the Department of Commerce, Fixed Assets, Table 15. The market value of real estate of the household sector is available from the Flow of Funds accounts, line 3,

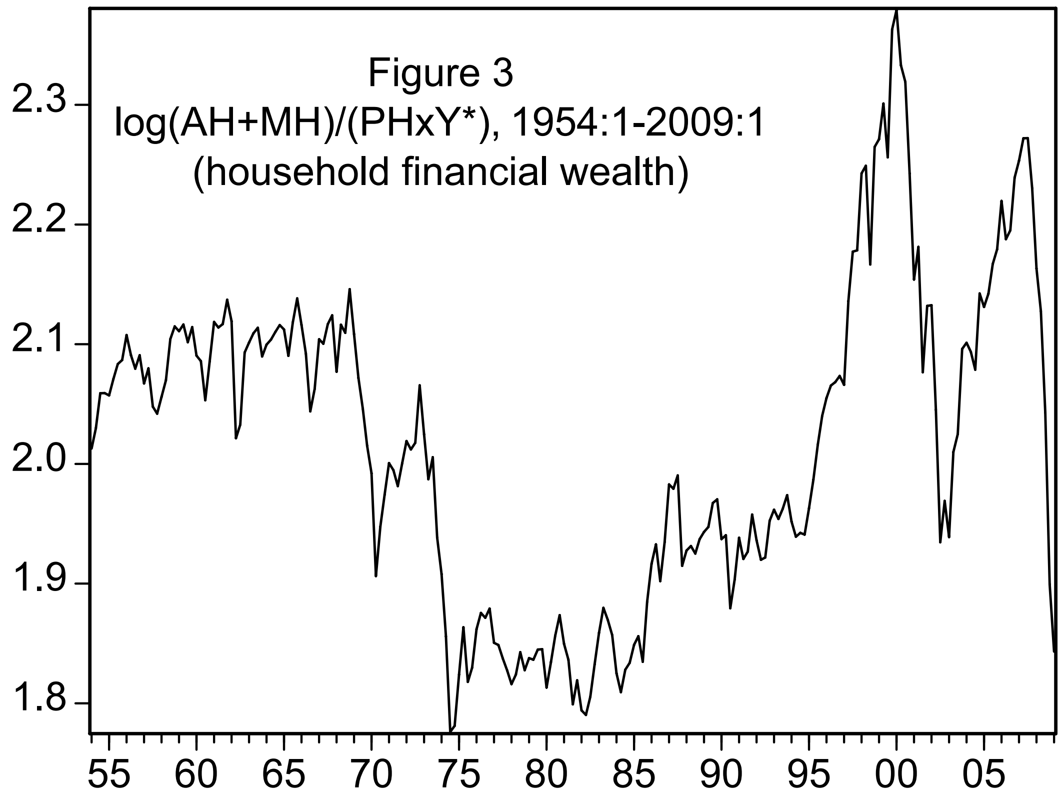


Table B.100. PKH, the market price of KH, is this market value of real estate divided by KH. The *relative* price of KH is taken to be PKH/PD, where PD is the price deflator for domestic goods. Let $PSI14 = PKH/PD$ denote this relative price. Then in the model PKH is determined as $PKH = PSI14 \cdot PD$, where $PSI14$ is taken to be exogenous. This simply means that PKH, the market price of KH, is not explained in the model except as it changes with the overall price of domestic goods.

When $PSI14$ increases, nominal housing wealth, $PKH{\cdot}KH$, increases, which leads to an increase in the above wealth variable AA that is an explanatory variable in the three consumption equations. Housing wealth, like financial wealth, affects aggregate demand through the wealth effect on consumption.

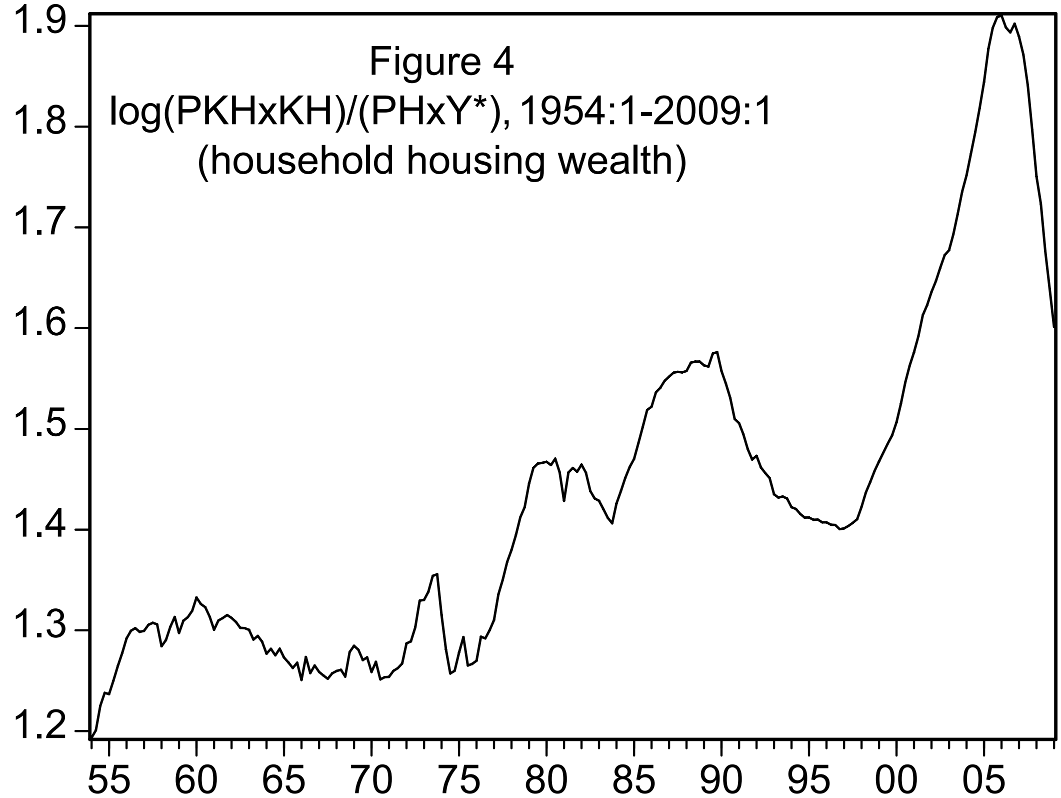
The mean of $\log PSI14 - \log PSI14_{-1}$ over the 1954:1–2009:1 period is 0.00266, which says that the growth rate of $PSI14$ has been about 1.1 percent at an annual rate. For the experiments in this paper the baseline values of $PSI14$ were computed using the equation $\log PSI14 = \log PSI14_{-1} + 0.00266$. This captures the average historical behavior of $PSI14$.

Figure 4 plots $\log(PKH \cdot KH)/(PH \cdot Y^{*})$ for 1954:1–2009:1. Dominating the figure are the huge increase in housing prices between 1998 and 2006 and the rapid fall in 2007–2009. There are also noticeable increases in 1977–1979 and 1984–1987 and a noticeable decrease in 1990–1993. Using the baseline values of $PSI14$ essentially eliminates these fluctuations.

Import Prices

Variable PIM in the US model is the U.S. import price deflator. It is exogenous in the US model. It is endogenous when the US model is imbedded in the overall multicountry model, mentioned in footnote 1, because it depends on the export prices of the other countries and on exchange rates, both of which are endogenous except for the export prices of oil exporting countries. For present purposes PIM is taken to be exogenous.

The mean of $\log PIM - \log PIM_{-1}$ over the 1954:1–2009:1 period is 0.00752, which says that the growth rate of PIM has been about 3.0 percent at an annual



rate. For the experiments in this paper the baseline values of PIM were computed using the equation $\log PIM = \log PIM_{-1} + 0.00752$. This captures the average historical behavior of PIM.

A property of the US model is that positive price shocks, like an increase in PIM, are contractionary. If there is a positive price shock, the domestic price level rises faster than does the nominal wage rate, and so, other things being equal, the real wage (and real income) falls. In addition, real wealth falls, other things being equal. Also, in the estimated interest rate rule of the Fed, the Fed is estimated to respond to an increase in inflation, other things being equal, by raising nominal interest rates, which is contractionary.[2] Because an increase in PIM is both inflationary and contractionary, the model, other things being equal, will underpredict inflation and overpredict output when the actual values of PIM are greater than the baseline values.

Figure 5 plots $\log PIM$ for 1954:1–2009:1. PIM grew rapidly between 1970 and 1981 and was essentially flat before and after. PIM is an unusual macroeconomic variable in that most of its change is confined to one period. There were also, however, a fairly large increase between 2007:4 and 2008:3 and a fairly large decrease between 2008:3 and 2009:1.

Exports

Variable EX in the US model is the real value of U.S. exports. It is exogenous in the US model and endogenous when the US model is imbedded in the overall multicountry model. For present purposes it has been taken to be exogenous.

The mean of $\log EX - \log EX_{-1}$ over the 1954:1–2008:4 period is 0.0144, which says that the growth rate of EX has been about 5.8 percent at an annual rate. For the experiments in this paper the baseline values of EX were computed using the equation $\log EX = \log EX_{-1} + 0.0144$. This captures the average historical behavior of EX.

Figure 6 plots $\log(EX/Y^*)$ for 1954:1–2009:1. There is a positive trend in

[2]Consumption in the model responds to nominal, not real, interest rates. I have done extensive tests of nominal versus real interest rates in consumption equations, and nominal interest rates dominate—see Fair (2004, Chapter 3).

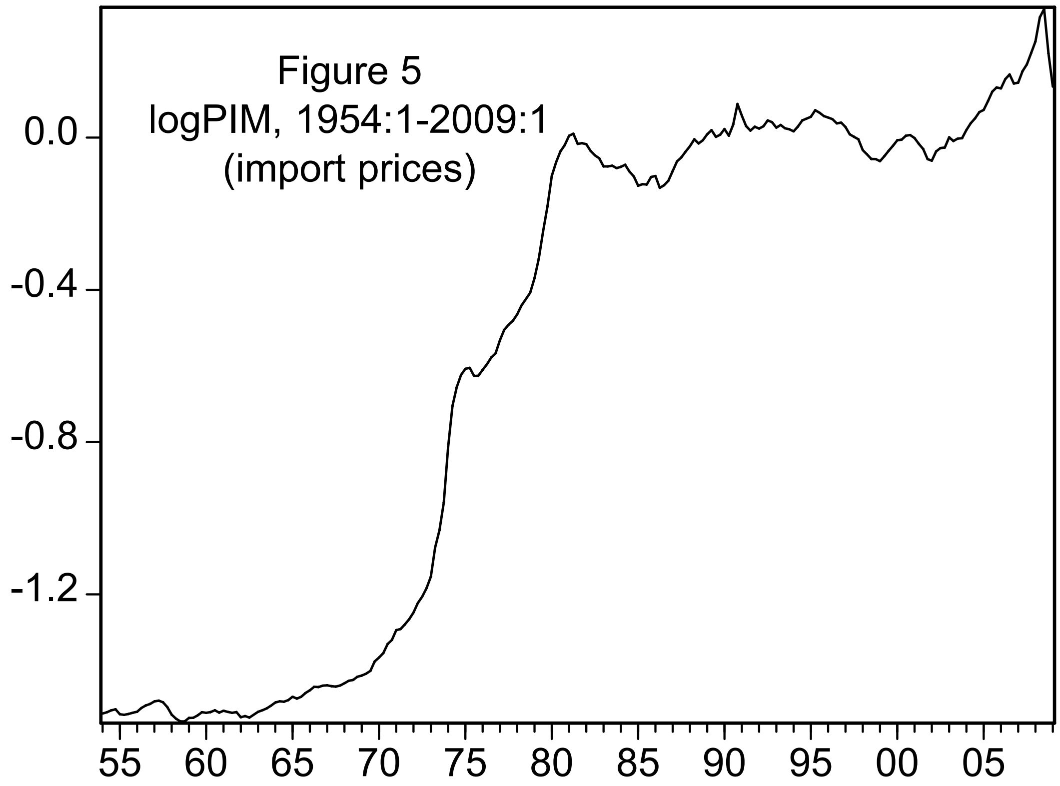


Figure 5
logPIM, 1954:1-2009:1
(import prices)
0.0
-0.4
-0.8
-1.2
55
60
65
70
75
80
85
90
95
00
05

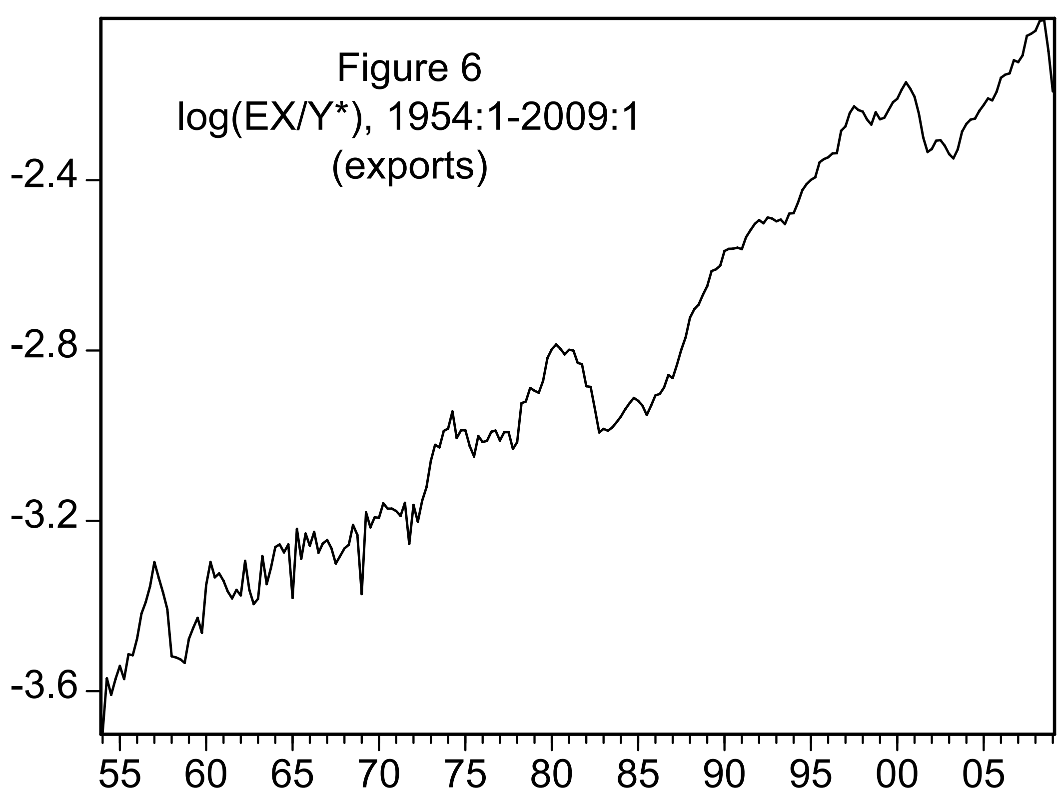


Figure 6
log(EX/Y*), 1954:1-2009:1
(exports)
-2.4
-2.8
-3.2
-3.6
55
60
65
70
75
80
85
90
95
00
05

the ratio of exports to GDP over this period. The periods of noticeable decreases are 1957–1958, 1981–1982, 2000–2001, and 2008:3–2009:1.

Other Exogenous Variables

For all the experiments in this paper actual values have been used for the exogenous variables in the model except for the four variables discussed above. The main exogenous variables are population variables, tax rate and spending variables of the state and local governments and the federal government, and a long run productivity term. The productivity term is computed from peak-to-peak interpolations of output per labor hour. Demographic variables are thus exogenous, and fiscal policy variables are exogenous. Monetary policy, on the other hand, is endogenous because of the estimated interest rate rule of the Fed.

Treating the Four Variables as Exogenous

For none of the forecasts in this paper is there feedback from the economy to equity prices, housing prices, import prices, and exports. Either actual values are used or values from baseline paths. As noted above, there is an equation in the US model explaining CG that has been dropped. Also, in the multicountry model in which the US model is embedded PIM and EX are endogenous. In the estimation of the US model these variables are treated as endogenous (using 2SLS), and so the coefficient estimates are consistent. For the forecasts, however, any feedback has been ignored. Although ignoring feedback has some effect on the results, this effect is likely to be small. For example, in the CG equation the estimated effects of the economy on CG are very small, and the equation explains very little of the variance. In the multicountry model exchange rates have an important effect on PIM, and the estimated exchange rate equations in the model explain little of the variance and have small estimated effects of the economy on exchange rates. Regarding exports, the effect of the U.S. economy on the import demands of other countries is small, and so the feedback of the U.S. economy on EX is small. The fact that the feedback effects of the economy on the four variables are likely to be small is evident from Figures 3–6. It is unlikely that these paths can be explained well using business-cycle macroeconomic variables.

Another way of thinking about Figures 3–6 is to ask whether any time series equations of a few parameters could approximate them well? For example, could one find an equation which would pass structural stability tests for different sub periods? The argument here is that this seems unlikely.

3 The Six Forecasts per Eight-Quarter Period

The Experiments

There are 214 eight-quarter periods within the 1954:1–2009:1 period, and so 214 forecasts were made per each experiment. Results are presented for two variables, the growth rate (at an annual rate) of real GDP over the eight quarters and the inflation rate (at an annual rate) over the eight quarters. The price deflator used in computing the inflation rate is the GDP deflator. Results for all of the eight-quarter periods are presented in Tables A1 and A2 in the appendix. Tables 1 and 2 present a subset of these results—those relating to recessions and booms.

Table 1
Error Components for Output Growth: Selected Observations from Table A1

1	2	3	4	5	6	7	8	9	10
			all	resid	equity	housing	PIM	EX	sum
$t+7$	y_t	$\hat{y}_t$	$\hat{e}_t$	$\hat{e}_{1t}$	$\hat{e}_{2t}$	$\hat{e}_{3t}$	$\hat{e}_{4t}$	$\hat{e}_{5t}$	$\hat{\hat{e}}_t$
Small growth rates (recessions)									
1. 1958.2	-0.20	2.00	2.20	1.56	0.25	0.04	-0.15	0.53	2.23
2. 1961.2	1.66	0.96	-0.70	-0.32	0.22	-0.01	-0.09	-0.45	-0.65
3. 1970.4	0.91	1.18	0.27	-0.57	0.92	0.00	0.07	-0.20	0.22
4. 1975.2	-1.00	3.10	4.10	0.20	0.65	0.23	2.66	0.20	3.94
5. 1983.1	-0.51	1.23	1.73	-0.15	0.44	-0.07	-0.68	2.22	1.76
6. 1991.3	0.76	1.23	0.46	0.32	0.30	0.17	-0.01	-0.34	0.44
7. 2002.2	0.93	2.96	2.03	-0.64	1.01	-0.19	-0.52	2.35	2.01
8. 2009.1	-0.07	4.52	4.60	1.90	0.75	0.60	0.52	0.96	4.74
Large growth rates (booms)									
1. 1956.2	4.97	4.32	-0.64	0.14	-0.25	-0.05	-0.16	-0.23	-0.56
2. 1960.1	6.24	4.19	-2.05	-1.19	-0.21	-0.04	-0.22	-0.30	-1.95
3. 1966.1	6.91	7.21	0.30	0.29	-0.07	0.03	-0.09	0.16	0.33
4. 1973.2	5.87	5.35	-0.51	0.03	-0.25	-0.08	0.36	-0.57	-0.51
5. 1978.4	5.86	5.34	-0.52	-1.04	0.21	-0.14	0.55	-0.11	-0.53
6. 1984.4	6.64	6.35	-0.30	0.35	0.14	-0.01	-0.58	-0.14	-0.25
7. 2000.2	4.63	3.41	-1.23	-0.29	-0.52	-0.08	-0.17	-0.11	-1.16

- $t+7$ = last quarter of eight-quarter prediction period.
- $GDPR$ = real GDP.
- $y_t = 100[(GDPR_{t+7}/GDPR_{t-1})^{.5} - 1]$.
- MAE for the 214 observations: 1.025 for $\hat{e}_t$ and 0.685 for $\hat{e}_{1t}$.
- NBER trough quarters: 1958:2, 1961:1, 1970:4, 1975:1, 1982:4, 1991:1, 2001:4.

Column 1 in the tables lists the *last* quarter of the eight-quarter forecast period. Column 2 presents the actual value of the growth rate or the inflation rate. For the first experiment the residuals are set to zero and the baseline values of the four variables are used. Column 3 presents the predicted value from this forecast, and column 4 presents the forecast error—the baseline error.

For the second experiment the residuals are set to zero and the actual values of the four variables are used. Column 5 presents the error from this forecast. This is the error from not knowing the residuals but knowing everything else.

The third experiment the residuals are set to their actual (i.e., estimated) values, baseline values are used for CG, and actual values are used for the other three variables. Column 6 presents the error from this forecast. This is the error from not knowing equity prices. For the fourth experiment the residuals are set to their actual values, baseline values are used for $PSI14$, and actual values are used for the others. Column 7 presents the error from this forecast. This is the error from not knowing housing prices. For the fifth experiment the residuals are set to their actual values, baseline values are used for PIM, and actual values are used for the others. Column 8 presents the error from this forecast. This is the error from not knowing import prices. Finally, for the sixth experiment the residuals are set to their actual values, baseline values are used for EX, and actual values are used for the others. Column 9 presents the error from this forecast. This is the error from not knowing exports. Column 10 is the sum of columns 5 through 9.

The tables show that for each period the value in column 4, the baseline error, is close to the value in column 10, the sum of the five components. The five errors in columns 5 through 9 can thus be considered to be components of the baseline error in column 4. Note also that there is a high degree of serial correlation going down the columns in Tables A1 and A2 because of the overlapping eight-quarter forecast periods.

Mean Absolute Errors

The mean absolute error of the baseline error (column 4) for the 214 observations in Table A1 (eight-quarter growth rate at an annual rate) is 1.025 percentage points. This error is based on not knowing the residuals and not knowing the actual values of the four variables. The mean absolute error of the error in column 5 is 0.685 percentage points. This is the error based on not knowing the residuals but knowing the actual values of the four variables. These mean absolute errors give some idea of how accurate the US model is, but they must be interpreted with caution. The 1.025 error could be either too low or too high regarding what could be expected in a real-time forecasting situation. It is too low in that it is based on coefficients estimated through 2009:1, and in practice the model can only be estimated up to the beginning of the forecast period. It is also too low in that it is based on actual values of all the exogenous variables except the four in question, and in practice one does not know these values exactly. It is too high in that it is based on the baseline values of the four variables, and in practice one may be able to do on average better than this. The 0.685 error, on the other hand, can probably be considered a lower bound for what can be expected in a real-time forecasting situation. It requires knowledge of all the exogenous variables, including the four in question, and is based on coefficients estimated through 2009:1. Whatever the case, the following results are based on knowledge of the coefficients estimated through 2009:1 and on knowledge of all the exogenous variables except the selected four.[3]

The mean absolute error of the baseline error (column 4) for the 214 observations in Table A2 (eight-quarter inflation rate at an annual rate) is 1.130 percentage points. Again, this error is based on not knowing the residuals and not knowing the actual values of the four variables. The mean absolute error of the error in column 5 is 0.720 percentage points.

[3] Also, the latest revised data are used for this work, not the actual data that existed at the time. In addition, the specification of the model is the latest one, which would not have been known, say, at the beginning of 1954.

Results for Output Growth

Table 1 contains selected observations from Table A1. Observations were selected that had the smallest actual growth rates (recessions) and the largest actual growth rates (booms). The recession observations were chosen as follows. The actual growth rates were ranked, and observations were chosen working from the bottom up with the restriction that a previous observation had not been chosen within 12 quarters of the observation in question. In other words, a window of at least 12 quarters was used. The same procedure was followed for booms, working from the top down.

The last quarter for each recession observation in Table 1 is close to the trough quarter of an NBER designated recession, as noted in the footnote to the table. However, the NBER designated two recessions in the early 1980s, 1980:1–1980:3 and 1981:3–1982:4, whereas in this paper this period is considered to be one long recession. The worst eight-quarter period within this overall period ended in 1983:1, which had a growth rate of -0.51 percent, and this is the period used in Table 1. In the following discussion the recessions and booms will be denoted by the last quarter of the eight-quarter period.

Tolstoy said that “Happy families are all alike; every unhappy family is unhappy in its own way.” If we substitute “booms” for “happy families” and “recessions” for “unhappy families,” this summarizes the results in Table 1 fairly well. The recessions are different. Three—1961:2, 1970:4, and 1991:3—are forecast fairly well. The baseline errors are smaller than the mean absolute error. This says that knowing the model, the initial conditions, and the exogenous variables other than the four (again, primarily government policy variables), these three recessions are forecastable. For the 1961:2 and 1991:3 recessions the components are all fairly small. For the 1970.4 recession the equity component of 0.92 percentage points is somewhat offset by the residual component of -0.57.

The baseline errors for the other five recessions vary between 1.73 and 4.60 percentage points. The 1958:2 recession is dominated by the residual component—unexplained shocks to the structural equations. The error in forecasting this recession is thus primarily failure to know the random errors. The PIM component dominates the 1975:2 recession (2.66 percentage points), with the equity component second at 0.65 percentage points. This was a period of sharply rising import prices, which according to the model is contractionary, and not knowing this rise led the model to substantially overpredict output. Also, the stock market was falling, and not knowing this led the model to overpredict. Failure to forecast the 1975:2 recession is thus primarily the failure to forecast import and equity prices.

The 1983:1 and 2002:2 recessions are dominated by the EX component (2.22 and 2.35 percentage points respectively). In both cases this is partly offset by the PIM component (-0.68 and -0.52 percentage points respectively). For the 2002:2 recession the are also two other fairly large offsetting components: 1.01 percentage points for the equity component and -0.64 percentage points for the residual component. The results for the 2002:2 recession are consistent with the results in Fair (2005), which suggest that the sluggish performance of the U.S. economy in this period in spite of expansive monetary and fiscal policies was due in large part to the stock market decline and to exports.

The 2009:1 recession has the largest baseline error (4.60 percentage points), and each of the five components is a noticeable contributor. This is the only recession in which all five contribute in a fairly large way. One might call it a "perfect storm" recession. The percentage points are: 1.90 residual, 0.75 equity, 0.60 housing, 0.52 PIM, and 0.96 EX. This is the only recession in which housing plays a large role. The large residual component could possibly be negative shocks to the demand equations due to borrowing constraints caused by the financial crisis, but there is no way to identify this in the model.[4]

The booms are not as different. Five of the seven (all but 1960:1 and 2000:2) are forecast fairly well in that the baseline errors are smaller than the mean absolute error. The baseline error for the 1960:1 boom is -2.05 percentage points, of which -1.19 is from the residual component. The baseline error for the 2000:2 boom is -1.23 percentage points, of which -0.52 is from the equity component. The results for the 2000:2 boom are consistent with the results in Fair (2004, Chapter 4), which suggest that the rapid growth of the U.S. economy in the last half of the 1990s (the "new economy") was primarily due to the stock market boom. In general, booms are not nearly as problematic as recessions from a forecastability point of view.

The detailed results in Table A1 show that the import price component is most important in the mid 1970s. The equity component is generally modest in size until the mid 1990s. The housing component increases in size from about 2000

[4]Hamilton (2009, p. 40) argues that had there been no oil shock in 2007–2008, the U.S. economy in 2007:4–2008:3 would not have gone into a recession. His results are not based on a structural model, and so they are not directly comparable to the present results. He uses various VAR equations and an equation with GDP growth on the left hand side and on the right hand side four lags of GDP growth and four lags of an oil price increase variable. Also, his period ends in 2008:3 rather than 2009:1 here, and 2008:4 and 2009:1 are extreme in their large negative growth rates in absolute value. The results in Table 1 show that for the 2009:1 recession the import-price component contributes 11 percent (0.52/4.60) to the overall error.

on. These are as expected given the rise in import prices in the 1970s, the stock market volatility beginning in the mid 1990s, and housing price volatility beginning about 2000.

Regarding the Great Depression, Dominguez, Fair, and Shapiro (1988) show that forecasters did not see it coming and that a VAR model using historical data now available also does not forecast it. A structural model was not tried in this paper, and so components of the overall forecast error are not available. The US model cannot be used for this purpose because it is based on data beginning in 1952. In future work, however, it might be interesting to see if a structural model fit through the 1920s and 1930s could determine the components of the overall forecast error.

Results for Inflation

Table 2 contains selected observations from Table A2. Observations were selected that had the largest inflation rates and the smallest inflation rates. The actual inflation rates were ranked, and observations were chosen working from the top down and the bottom up with at least a 12 quarter window. Three large inflation periods (ending in 1971:2, 1975:1, and 1981:1) and four small inflation periods (ending in 1960:4, 1963:3, 1999:1, and 2003:2) were chosen.

The three large inflation periods are all underpredicted, with baseline errors of -2.39, -4.15, and -3.38 percentage points respectively. The first is primarily due to the residual component (-2.49), and the other two are primarily due to the PIM component (-4.17 and -2.77). Not knowing the large increase in PIM between 1970 and 1981 is thus the main reason for underpredicting the large inflation in

Table 2
Error Components for Inflation: Selected Observations from Table A2

1	2	3	4	5	6	7	8	9	10
			all	resid	equity	housing	PIM	EX	sum
$t+7$	y_t	$\hat{y}_t$	$\hat{e}_t$	$\hat{e}_{1t}$	$\hat{e}_{2t}$	$\hat{e}_{3t}$	$\hat{e}_{4t}$	$\hat{e}_{5t}$	$\hat{\hat{e}}_t$
Large inflation rates									
1971.2	5.33	2.95	-2.39	-2.49	0.40	0.01	-0.50	0.08	-2.50
1975.1	9.36	5.21	-4.15	-0.17	0.38	0.06	-4.17	-0.29	-4.18
1981.1	9.61	6.22	-3.38	-0.19	-0.14	-0.01	-2.77	-0.33	-3.45
Small inflation rates									
1960.4	1.18	1.32	0.14	0.35	0.10	0.01	0.23	-0.48	0.21
1963.3	1.13	3.72	2.60	2.04	0.18	0.01	0.47	-0.07	2.63
1999.1	1.19	1.58	0.39	-0.61	-0.29	-0.01	1.40	-0.03	0.46
2003.2	1.83	2.70	0.88	-0.43	0.24	-0.03	0.66	0.47	0.90

- $t+7$ = last quarter of eight-quarter prediction period.
- $GDPD$ = GDP deflator.
- $y_t = 100[(GDPD_{t+7}/GDPD_{t-1})^{.5} - 1]$.
- MAE for the 214 observations: 1.130 for $\hat{e}_t$ and 0.720 for $\hat{e}_{1t}$.

the second and third periods.

Three of the four small inflation periods are forecast fairly well, with baseline errors of 0.14, 0.39, and 0.88 percentage points. The only large error is for 1963:3, with a baseline error of 2.60 percentage points, where 2.04 is from the residual component and 0.47 from the PIM component.

Robustness Checks

The above forecasts are based on the US model estimated through 2009:1 and are thus within sample forecasts. As discussed in Section 3, this study is not an attempt to mimic what is known in a real-time forecasting situation. To see whether the above results are sensitive to the estimation of the model through 2009:1, the following check was made. The model was estimated through 1983:2 and used to forecast 1983:3–1985:2. It was then estimated through 1983:3 and used to forecast

1983:4–1985:3. This was repeated to the end, where the last estimate was through 2007:2 and the last forecast was for 2007:3–2009:1. This generates 96 outside sample forecasts. The results are presented in Table 3 for output growth and in Table 4 for inflation. The results in Tables 3 and 4 differ from those in Tables 1 and 2 because the coefficient estimates are different and the estimated residuals are different (being based on different coefficient estimates). The exogenous variable values are the same, including the baseline values. The outside sample forecasts are not forecasts that could have been made in real time. They are simply used here to examine the sensitive of the results to alternative coefficient estimates.

For output growth the mean absolute error for the 96 observations for the outside sample forecasts is 1.048 for the baseline error and 0.759 for the residual component. These compare to 1.078 and 0.622 for the within sample forecasts. For inflation the respective mean absolute errors for the outside sample forecasts are 0.989 and 0.837, which compare to 0.614 and 0.503 for the within sample errors. The output growth errors are thus fairly close, but there is some loss of accuracy for the inflation errors for the outside sample forecasts.

The key question is how different the results in Tables 3 and 4 are from those in Tables 1 and 2. The results are in fact similar. For output growth in Table 3 the 2009:1 recession is still affected by all five components and the 2002:2 recession is still affected most by the EX component and the equity component. The baseline error for the 1991:3 recession is larger (although still smaller than the mean absolute error), with the residual component being the largest. The results for the 2000:2 boom are close, with the largest component continuing to be the equity component. For inflation in Table 4 the results are again similar, with the PIM component being

Table 3
Error Components for Output Growth: Outside Sample Forecasts

1	2	3	4	5	6	7	8	9	10
			all	resid	equity	housing	PIM	EX	sum
$t+7$	y_t	$\hat{y}_t$	$\hat{e}_t$	$\hat{e}_{1t}$	$\hat{e}_{2t}$	$\hat{e}_{3t}$	$\hat{e}_{4t}$	$\hat{e}_{5t}$	$\hat{\hat{e}}_t$
Small growth rates (recessions)									
6. 1991.3	0.76	1.75	0.98	0.80	0.35	0.14	-0.05	-0.27	0.98
7. 2002.2	0.93	3.11	2.18	-0.22	0.92	-0.15	-0.39	2.02	2.18
8. 2009.1	-0.07	5.68	5.75	3.55	0.52	0.43	0.44	0.98	5.93
Large growth rates (booms)									
7. 2000.2	4.63	3.55	-1.08	-0.16	-0.58	-0.08	-0.11	-0.11	-1.05

- $t + 7$ = last quarter of eight-quarter prediction period.
- $GDPR$ = real GDP.
- $y_t = 100[(GDPR_{t+7}/GDPR_{t-1})^{.5} - 1]$.
- MAE for the 96 observations: 1.048 for $\hat{e}_t$ and 0.759 for $\hat{e}_{1t}$.
- NBER trough quarters: 1958:2, 1961:1, 1970:4, 1975:1, 1982:4, 1991:1, 2001:4.

Table 4
Error Components for Inflation: Outside Sample Forecasts

1	2	3	4	5	6	7	8	9	10
			all	resid	equity	housing	PIM	EX	sum
$t+7$	y_t	$\hat{y}_t$	$\hat{e}_t$	$\hat{e}_{1t}$	$\hat{e}_{2t}$	$\hat{e}_{3t}$	$\hat{e}_{4t}$	$\hat{e}_{5t}$	$\hat{\hat{e}}_t$
Small inflation rates									
1999.1	1.19	1.95	0.76	-0.17	-0.43	-0.02	1.44	-0.01	0.81
2003.2	1.83	3.23	1.40	0.10	0.24	-0.04	0.70	0.42	1.43

- $t + 7$ = last quarter of eight-quarter prediction period.
- $GDPD$ = GDP deflator.
- $y_t = 100[(GDPD_{t+7}/GDPD_{t-1})^{.5} - 1]$.
- MAE for the 96 observations: 0.989 for $\hat{e}_t$ and 0.837 for $\hat{e}_{1t}$.

the largest for both periods. The general conclusions are thus not sensitive to the use of within sample forecasts.

Another check is to see if the results are sensitive to the choice of an eight-quarter forecast period. To examine this, the calculations were repeated using a five-quarter period. There are 217 five-quarter periods within the overall 1954:1–2009:1 period. The results for output growth are presented in Table 5. Some

Table 5
Error Components for Output Growth: Five-Quarter Period

1	2	3	4	5	6	7	8	9	10
			all	resid	equity	housing	PIM	EX	sum
$t+4$	y_t	$\hat{y}_t$	$\hat{e}_t$	$\hat{e}_{1t}$	$\hat{e}_{2t}$	$\hat{e}_{3t}$	$\hat{e}_{4t}$	$\hat{e}_{5t}$	$\hat{\hat{e}}_t$
Small growth rates (recessions)									
1. 1958.2	-1.98	1.59	3.57	1.61	0.17	0.01	-0.19	1.93	3.53
2. 1961.2	0.65	1.28	0.63	0.56	0.03	0.04	-0.07	0.09	0.65
3. 1970.4	-0.52	-0.53	-0.02	-0.59	0.61	0.00	0.16	-0.22	-0.05
4. 1975.1	-2.49	3.28	5.77	1.90	0.55	0.36	2.47	0.32	5.59
5. 1982.4	-2.11	0.05	2.16	0.21	0.14	0.02	-0.38	2.15	2.14
6. 1991.2	-0.29	0.78	1.07	0.49	0.21	0.13	0.05	0.12	1.01
7. 2001.3	0.19	2.04	1.85	-0.60	0.71	-0.12	-0.24	2.09	1.84
8. 2009.1	-1.93	4.91	6.84	2.83	1.10	0.42	0.12	2.39	6.86
Large growth rates (booms)									
1. 1955.3	7.33	5.15	-2.18	-1.89	-0.15	-0.04	-0.09	0.04	-2.14
2. 1959.2	8.01	4.83	-3.19	-2.63	-0.22	-0.05	-0.18	-0.07	-3.15
3. 1966.1	8.84	7.87	-0.96	-1.22	0.01	0.06	-0.04	0.22	-0.97
4. 1973.1	7.62	5.69	-1.93	-0.53	-0.17	-0.07	0.25	-1.43	-1.96
5. 1978.2	6.52	4.70	-1.82	-2.00	0.07	-0.11	0.29	-0.09	-1.84
6. 1984.2	8.20	7.63	-0.58	-0.38	0.06	0.03	-0.22	-0.05	-0.55
7. 1999.4	5.00	3.15	-1.85	-0.43	-0.95	-0.06	-0.07	-0.24	-1.75

- $t+4$ = last quarter of five-quarter prediction period.
- $GDPR$ = real GDP.
- $y_t = 100[(GDPR_{t+4}/GDPR_{t-1})^{.8} - 1]$.
- MAE for the 217 observations: 1.306 for $\hat{e}_t$ and 0.963 for $\hat{e}_{1t}$.
- NBER trough quarters: 1958:2, 1961:1, 1970:4, 1975:1, 1982:4, 1991:1, 2001:4.

of the periods are slightly different because they were chosen using the ranking of the five-quarter growth rates rather than the eight-quarter rates. The mean absolute error for the baseline error for the 217 observations is 1.306 percentage points. For the residual component it is 0.963 percentage points.

The results between Tables 1 and 5 are again similar, and no major conclusions are changed. Comparing Table 5 to Table 1, the main change for recessions is that the residual component for the 1975:1 recession has increased and is now the second largest component for this recession. The baseline errors for the 1961:2, 1970:4, and 1991:2 recessions remain smaller than the mean absolute error. For booms the baseline errors and the residual components are all larger in absolute value. Also, the EX component is larger in absolute value for the 1973:1 boom, and the equity component is larger in absolute value for the 1999:4 boom.

4 Ex Ante Forecast Errors

It was mentioned in Section 3 that the mean absolute error for the residual component is likely to be a lower bound on what can be achieved in real-time (ex ante) forecasting situations. It is of interest to see if this is true. Two sets of ex ante forecasts are used for present purposes. The first is from the Survey of Professional Forecasts (SPF), currently run by the Federal Reserve Bank of Philadelphia. Five-quarter-ahead forecasts of real output growth and inflation are available beginning in 1970:2.[5] Median forecasts were used. There are 152 such forecasts given the actual data ending in 2009:1. The second set is on the website mentioned in the introductory footnote. I have made a real-time forecast using the US model each quarter since 1983:3. The forecast horizon is always longer than eight quarters, and so eight-quarter-ahead forecasts are available. There are 96 such forecasts given the actual data ending in 2009:1. There are also 99 five-quarter-ahead forecasts available.

The latest revised actual values of the growth rate and inflation are used for the following results. Results on the website of the Federal Reserve Bank of Philadelphia—Stark (2009)—show that forecasting accuracy is somewhat sensi-

[5] I am indebted to Tom Stark for data on median forecasts of real growth rates prior to 1981:3.

tive to the choice of actual values (first release, second release, latest, etc.). If forecasters are trying to forecast what the economy is actually going to do regarding real growth and inflation and if the latest revised data are the best estimate of what the economy actually did, then the use of the latest revised actual values is justified. The assumption here, given the use of the latest data, is thus that forecasters are trying to forecast reality, not some preliminary estimate of reality. If they are in fact trying to forecast some preliminary estimate, the following results will be at least a little off.

Mean absolute errors (MAEs) are presented in Table 6. Eight-quarter-ahead forecasts are available for the US model within sample (USws), the US model outside sample (USos), and the US model ex ante (USea).[6] For USws and USos there are MAEs for both the baseline error and the residual component. Results for the eight-quarter-ahead forecasts are presented in the top half of Table 6. For output growth the MAEs for USws don't change much in moving from the larger sample period to the common sample period, 1985:2–2009:1. For the common period the MAE for USea of 0.821 is smaller than the MAEs for USws and USos for the baseline error (1.078 and 1.048) and larger for the residual component (0.622 and 0.759). This is what would be expected from the discussion in Section 3.

For inflation there is a large decrease in the MAEs for USws in moving to the common sample period. For the common period the MAE for USea of 0.777 is larger than both MAEs for USws (0.614 and 0.503), but smaller than both MAEs for USos (0.989 and 0.837). Considerable accuracy is lost in moving from USws

[6] Remember that the outside sample forecast are not ex ante forecasts. They were not made in real time and are based on actual or baseline values of the exogenous variables.

Table 6
Mean Absolute Errors—Percentage Points

	Eight-quarter growth rate (annual rate)				Eight-quarter inflation rate (annual rate)			
	USws	USos	USea		USws	USos	USea	
1955:4–2009:1	1.025	–	–		1.130	–	–	
214 obs.	(0.685)				(0.720)			
1985:2–2009:1	1.078	1.048	0.821		0.614	0.989	0.777	
96 obs.	(0.622)	(0.759)			(0.503)	(0.837)		
	Five-quarter growth rate (annual rate)				**Five-quarter inflation rate (annual rate)**			
	USws	USos	USea	SPFea	USws	USos	USea	SPFea
1955:1–2009:1	1.306	–	–	–	1.045	–	–	–
217 obs.	(0.963)				(0.801)			
1971:2–2009:1	1.343	–	–	1.274	0.929	–	–	0.988
152 obs.	(0.883)				(0.669)			
1984:3–2009:1	1.279	1.334	1.000	1.124	0.602	1.015	0.698	0.724
99 obs.	(0.804)	(1.043)			(0.583)	(0.892)		

- USws = within sample forecasts.
- USos = outside sample forecasts.
- USea = ex ante forecasts, US model.
- SPFea = ex ante forecasts, median SPF forecasts.
- Values for USws and USos not in parentheses are MAEs for baseline error.
- Values for USws and USos in parentheses are MAEs for residual component.

to USos, and USea is in between these two. These inflation comparisons have the disadvantage that the common period does not include any of the period of the large increases in PIM, and in this sense it is not a representative sample.

Results for the five-quarter-ahead forecasts are presented in the bottom half of Table 6, where the ex ante forecasts from SPF are added (SPFea). There is now a common sample period for USws versus SPFea of 1971:2–2009:1. Again, for output growth the MAEs for USws don't change much in moving across the three sample periods. For the first common period the MAE of 1.274 for SPFea is in between the two MAEs for USws, 1.343 and 0.883. This is also true for the second common period for both USws and USos (1.124 for SPFea versus 1.279 and 0.804 for USws and 1.334 and 1.043 for USos). The MAE for USea is 1.000, and it also fits this pattern. So again, these results are as expected from the discussion in Section 3, namely that the ex ante MAEs are in between the baseline error MAEs and the residual component MAEs. Comparing the accuracy of the two ex ante forecasts for the five-quarter-ahead forecasts and the common sample period, the MAE for USea is slightly smaller than that for SPFea (1.000 versus 1.124).

For inflation there is a large decrease in the MAEs for USws in moving from the first common period to the second. For the first common period the MAE for SPFea is larger than both MAEs for USws. This is also true for the second common period. For USos, on the other hand, the MAE for SPFea is smaller than both MAEs for USos. The same is true for the MAE for USea. Again, the MAE for USea is slightly smaller than the MAE for SPFea (0.698 versus 0.724).

Overall, the results for the growth rate are what would be expected, namely that the accuracy of errors from ex ante forecasts is likely to be between that from baseline errors and that from residual errors. This is not true for inflation, but the common sample period may be a problem.

5 Conclusion

In the US model equity prices, housing prices, import prices, and exports have important effects on the economy. If these variables are not forecast well for a particular period, the model's forecast for the period, other things being equal, will not be accurate. This paper compares forecasts from the model using actual values of the four variables versus using values from simple baseline paths. The baseline error for a period can be separated into five components: not knowing each of the four variables and not knowing the residuals. Can recessions and booms be forecast using only baseline values for the four variables and zero residuals? The answer is yes for some recessions and most booms. When the answer is no for a recession, the reason or reasons vary by recession. The relative sizes of the five components vary across recessions; there is no common pattern. The recession of 2009:1 is perhaps the most interesting in that each of the five components is large: a perfect storm.

The analysis in this paper requires the use of a structural model. The model must explain, for example, the effects of the four variables on the economy. Some key effects in the US model are wealth effects in the consumption equations and the effect of the import price variable in the price equation. An important property of the overall model is that an increase in the price of imports is contractionary, other things being equal.

The fact that there is no common pattern across recessions may explain why single-equation exercises do not yield stable results. One would not expect there to be stable single-equation forecasting relationships given the present results. The macro economy is more complicated than this.

Table A1
Error Components for Output Growth

1	2	3	4	5	6	7	8	9	10
			all	resid	equity	housing	PIM	EX	sum
$t+7$	y_t	$\hat{y}_t$	$\hat{e}_t$	$\hat{e}_{1t}$	$\hat{e}_{2t}$	$\hat{e}_{3t}$	$\hat{e}_{4t}$	$\hat{e}_{5t}$	$\hat{\hat{e}}_t$
1955.4	4.59	2.82	-1.77	-1.10	-0.18	0.00	-0.08	-0.32	-1.67
1956.1	4.60	2.88	-1.72	-0.38	-0.23	-0.04	-0.15	-0.81	-1.62
1956.2	4.97	4.32	-0.64	0.14	-0.25	-0.05	-0.16	-0.23	-0.56
1956.3	4.33	4.62	0.29	1.41	-0.13	-0.03	-0.18	-0.67	0.40
1956.4	4.15	4.11	-0.04	1.07	-0.13	-0.02	-0.19	-0.67	0.06
1957.1	2.99	3.64	0.64	1.80	-0.17	-0.03	-0.08	-0.77	0.75
1957.2	2.03	2.58	0.54	1.85	-0.02	-0.02	-0.05	-1.12	0.63
1957.3	1.85	1.66	-0.20	0.54	0.10	0.00	-0.05	-0.74	-0.15
1957.4	1.05	0.90	-0.14	0.49	0.15	0.00	-0.05	-0.65	-0.06
1958.1	-0.10	1.53	1.63	1.52	0.33	0.02	-0.07	-0.14	1.67
1958.2	-0.20	2.00	2.20	1.56	0.25	0.04	-0.15	0.53	2.23
1958.3	1.00	2.86	1.86	0.92	0.23	0.04	-0.22	0.91	1.89
1958.4	1.34	3.69	2.35	0.92	0.33	0.03	-0.28	1.29	2.29
1959.1	1.99	3.08	1.08	-0.50	0.10	0.01	-0.35	1.75	1.01
1959.2	3.45	3.91	0.45	-0.73	0.11	0.02	-0.39	1.37	0.38
1959.3	2.91	2.62	-0.29	-0.76	-0.16	0.01	-0.39	1.00	-0.28
1959.4	3.64	2.72	-0.92	-1.04	-0.26	0.00	-0.33	0.73	-0.89
1960.1	6.24	4.19	-2.05	-1.19	-0.21	-0.04	-0.22	-0.30	-1.95
1960.2	5.67	3.67	-2.00	-0.93	-0.16	-0.03	-0.13	-0.60	-1.86
1960.3	4.55	3.42	-1.12	-0.28	0.07	-0.01	-0.08	-0.76	-1.05
1960.4	2.69	2.37	-0.33	0.54	0.19	0.01	-0.06	-0.93	-0.25
1961.1	2.03	2.55	0.52	1.13	0.22	-0.04	-0.10	-0.63	0.59
1961.2	1.66	0.96	-0.70	-0.32	0.22	-0.01	-0.09	-0.45	-0.65
1961.3	2.52	1.47	-1.05	-0.75	0.12	0.00	-0.12	-0.28	-1.02
1961.4	3.38	2.38	-1.00	-0.46	0.17	0.01	-0.17	-0.53	-0.98
1962.1	3.16	3.26	0.10	0.08	-0.11	0.03	-0.16	0.26	0.10
1962.2	3.98	3.80	-0.19	-0.31	-0.18	0.00	-0.19	0.49	-0.18
1962.3	4.38	3.73	-0.65	-0.35	-0.33	0.00	-0.22	0.27	-0.63
1962.4	5.19	5.97	0.78	0.54	0.04	-0.01	-0.20	0.44	0.81
1963.1	5.56	6.57	1.01	0.61	0.30	-0.03	-0.23	0.34	0.98
1963.2	5.23	6.30	1.06	1.10	0.23	-0.01	-0.21	-0.05	1.06
1963.3	5.37	6.75	1.38	1.45	0.25	0.01	-0.18	-0.09	1.43
1963.4	4.71	6.72	2.01	1.84	0.36	0.03	-0.18	-0.06	1.98
1964.1	4.94	5.73	0.79	0.94	0.21	0.03	-0.07	-0.30	0.81
1964.2	4.98	5.64	0.66	1.12	-0.54	0.03	-0.06	0.13	0.67
1964.3	5.21	5.17	-0.04	0.88	-0.50	0.03	-0.02	-0.39	0.01
1964.4	5.22	5.62	0.40	1.21	-0.05	0.05	-0.03	-0.71	0.46
1965.1	5.82	5.60	-0.22	0.21	-0.01	0.05	-0.05	-0.40	-0.20
1965.2	5.87	6.37	0.50	0.41	0.00	0.04	-0.05	0.11	0.50
1965.3	5.95	5.83	-0.12	0.18	0.05	0.06	-0.06	-0.31	-0.08
1965.4	6.80	6.76	-0.05	0.29	-0.10	0.05	-0.07	-0.15	0.02

Table A1
Error Components for Output Growth

1	2	3	4	5	6	7	8	9	10
			all	resid	equity	housing	PIM	EX	sum
$t+7$	y_t	$\hat{y}_t$	$\hat{e}_t$	$\hat{e}_{1t}$	$\hat{e}_{2t}$	$\hat{e}_{3t}$	$\hat{e}_{4t}$	$\hat{e}_{5t}$	$\hat{\hat{e}}_t$
1966.1	6.91	7.21	0.30	0.29	-0.07	0.03	-0.09	0.16	0.33
1966.2	6.48	6.38	-0.10	-0.12	-0.07	0.06	-0.09	0.12	-0.09
1966.3	6.11	6.32	0.21	0.20	-0.02	0.05	-0.06	0.05	0.23
1966.4	6.39	7.57	1.18	0.89	0.08	0.07	-0.05	0.18	1.17
1967.1	5.57	6.81	1.24	1.88	0.16	0.05	-0.08	-0.80	1.21
1967.2	4.87	7.54	2.68	2.22	0.02	0.03	-0.04	0.46	2.68
1967.3	4.23	6.18	1.95	1.79	0.20	0.00	-0.05	0.03	1.98
1967.4	3.38	5.79	2.40	1.64	0.32	0.00	-0.09	0.49	2.36
1968.1	3.19	4.97	1.79	1.60	0.11	-0.04	-0.12	0.23	1.78
1968.2	3.88	4.53	0.66	0.41	-0.06	0.00	-0.16	0.48	0.68
1968.3	3.89	3.54	-0.35	0.36	-0.43	-0.04	-0.13	-0.02	-0.26
1968.4	3.69	2.92	-0.77	-0.30	-0.33	-0.03	-0.15	0.07	-0.73
1969.1	4.05	3.42	-0.63	-0.68	-0.17	-0.04	-0.13	0.42	-0.60
1969.2	4.19	3.82	-0.37	0.05	-0.26	-0.06	-0.09	0.05	-0.31
1969.3	4.10	3.41	-0.69	-0.02	-0.17	-0.08	-0.05	-0.29	-0.62
1969.4	3.47	2.66	-0.80	-0.29	-0.07	-0.07	-0.03	-0.25	-0.71
1970.1	2.33	0.61	-1.72	-1.07	-0.28	-0.06	-0.01	-0.20	-1.62
1970.2	1.57	0.30	-1.27	-1.06	0.18	-0.05	0.00	-0.28	-1.21
1970.3	1.67	0.73	-0.94	-1.32	0.38	-0.06	0.04	0.01	-0.95
1970.4	0.91	1.18	0.27	-0.57	0.92	0.00	0.07	-0.20	0.22
1971.1	1.51	-0.41	-1.92	-1.64	0.80	0.02	0.13	-1.35	-2.03
1971.2	1.65	1.69	0.04	-1.20	0.66	0.02	0.20	0.22	-0.10
1971.3	1.74	2.04	0.30	-0.43	0.48	0.00	0.26	-0.07	0.24
1971.4	2.12	3.13	1.01	0.13	0.27	0.01	0.18	0.30	0.90
1972.1	3.11	3.66	0.55	0.04	0.04	-0.02	0.21	0.21	0.49
1972.2	4.22	3.34	-0.89	-1.10	-0.60	0.00	0.23	0.49	-0.98
1972.3	4.26	4.28	0.02	-0.03	-0.43	-0.05	0.19	0.30	-0.02
1972.4	5.68	6.29	0.61	0.48	-0.25	-0.05	0.23	0.15	0.56
1973.1	5.55	5.53	-0.03	0.13	-0.12	-0.06	0.19	-0.17	-0.04
1973.2	5.87	5.35	-0.51	0.03	-0.25	-0.08	0.36	-0.57	-0.51
1973.3	5.17	4.78	-0.39	0.08	-0.35	-0.09	0.52	-0.54	-0.38
1973.4	5.52	4.32	-1.19	-0.01	-0.16	-0.11	0.73	-1.72	-1.27
1974.1	4.14	4.57	0.43	0.55	0.00	-0.09	1.05	-1.12	0.38
1974.2	3.08	3.06	-0.02	0.31	0.03	-0.09	1.41	-1.79	-0.13
1974.3	2.09	3.11	1.02	0.07	0.23	-0.01	1.97	-1.29	0.97
1974.4	1.07	4.17	3.10	0.59	0.78	0.12	2.45	-1.02	2.92
1975.1	-0.79	3.37	4.16	0.66	0.72	0.17	2.79	-0.37	3.98
1975.2	-1.00	3.10	4.10	0.20	0.65	0.23	2.66	0.20	3.94
1975.3	0.10	4.75	4.65	0.28	0.85	0.32	2.66	0.33	4.45
1975.4	0.28	5.22	4.94	0.89	0.46	0.36	2.28	0.71	4.70

Table A1
Error Components for Output Growth

1	2	3	4	5	6	7	8	9	10
			all	resid	equity	housing	PIM	EX	sum
$t+7$	y_t	$\hat{y}_t$	$\hat{e}_t$	$\hat{e}_{1t}$	$\hat{e}_{2t}$	$\hat{e}_{3t}$	$\hat{e}_{4t}$	$\hat{e}_{5t}$	$\hat{\hat{e}}_t$
1976.1	1.84	4.77	2.92	0.19	0.32	0.20	1.21	0.79	2.70
1976.2	2.08	3.81	1.73	-0.20	0.03	0.07	0.35	1.29	1.55
1976.3	2.82	3.30	0.48	0.33	-0.41	-0.02	0.05	0.50	0.45
1976.4	3.39	3.43	0.04	-0.03	-0.40	-0.03	-0.06	0.61	0.09
1977.1	4.64	4.71	0.07	-0.22	-0.17	0.00	-0.10	0.66	0.17
1977.2	5.28	4.79	-0.49	-0.71	-0.01	0.05	0.00	0.21	-0.46
1977.3	5.33	4.70	-0.63	-0.55	-0.24	-0.04	0.27	-0.06	-0.63
1977.4	4.64	4.62	-0.02	-0.80	-0.12	-0.07	0.42	0.52	-0.04
1978.1	3.65	3.56	-0.09	-0.94	0.06	-0.11	0.44	0.41	-0.14
1978.2	5.28	4.12	-1.16	-1.87	0.12	-0.07	0.48	0.10	-1.24
1978.3	5.54	4.25	-1.29	-2.01	0.14	-0.12	0.48	0.12	-1.40
1978.4	5.86	5.34	-0.52	-1.04	0.21	-0.14	0.55	-0.11	-0.53
1979.1	5.33	4.39	-0.93	-0.77	0.02	-0.14	0.43	-0.48	-0.94
1979.2	4.36	3.94	-0.42	-0.38	0.01	-0.11	0.39	-0.39	-0.47
1979.3	3.81	2.71	-1.10	-0.94	-0.08	-0.11	0.58	-0.56	-1.11
1979.4	3.96	3.32	-0.65	0.05	-0.17	-0.10	0.84	-1.32	-0.70
1980.1	3.96	3.89	-0.08	0.56	-0.30	-0.09	1.19	-1.46	-0.10
1980.2	0.94	2.96	2.02	1.54	-0.22	-0.08	1.46	-0.64	2.05
1980.3	0.36	2.24	1.88	1.06	-0.17	-0.07	1.81	-0.74	1.89
1980.4	0.63	1.87	1.25	-0.07	-0.28	-0.08	2.05	-0.43	1.20
1981.1	1.54	2.16	0.61	-0.68	-0.29	-0.01	2.14	-0.56	0.61
1981.2	1.10	1.11	0.01	-1.06	-0.32	0.02	2.00	-0.64	-0.01
1981.3	1.34	0.70	-0.64	-1.75	-0.27	0.01	1.57	-0.19	-0.64
1981.4	0.56	0.30	-0.26	-1.75	-0.22	0.00	1.11	0.53	-0.33
1982.1	-0.42	-0.62	-0.20	-1.47	-0.30	0.00	0.39	1.04	-0.34
1982.2	0.87	0.16	-0.71	-2.27	-0.08	0.01	0.07	1.40	-0.87
1982.3	0.76	1.84	1.08	-0.67	0.19	0.02	-0.19	1.64	0.99
1982.4	-0.12	1.92	2.03	0.12	0.42	-0.02	-0.38	1.85	1.99
1983.1	-0.51	1.23	1.73	-0.15	0.44	-0.07	-0.68	2.22	1.76
1983.2	1.00	2.49	1.49	-0.39	0.34	0.03	-0.85	2.40	1.52
1983.3	1.38	2.30	0.92	-0.60	0.05	0.05	-0.66	2.11	0.94
1983.4	3.06	3.25	0.19	-1.27	0.08	0.04	-0.78	2.09	0.16
1984.1	4.93	4.35	-0.58	-1.12	-0.13	0.08	-0.82	1.41	-0.58
1984.2	5.54	5.05	-0.49	-0.93	-0.19	0.07	-0.69	1.28	-0.46
1984.3	6.26	5.18	-1.07	-0.92	-0.08	0.01	-0.61	0.54	-1.06
1984.4	6.64	6.35	-0.30	0.35	0.14	-0.01	-0.58	-0.14	-0.25
1985.1	6.48	6.34	-0.14	0.22	0.26	-0.03	-0.45	-0.13	-0.14
1985.2	5.75	5.62	-0.13	0.22	0.41	-0.07	-0.52	-0.14	-0.10
1985.3	5.54	4.51	-1.03	-0.59	0.35	-0.14	-0.60	0.01	-0.96
1985.4	4.87	4.33	-0.54	-0.15	0.31	-0.21	-0.55	0.10	-0.49

Table A1
Error Components for Output Growth

1	2	3	4	5	6	7	8	9	10
			all	resid	equity	housing	PIM	EX	sum
$t+7$	y_t	$\hat{y}_t$	$\hat{e}_t$	$\hat{e}_{1t}$	$\hat{e}_{2t}$	$\hat{e}_{3t}$	$\hat{e}_{4t}$	$\hat{e}_{5t}$	$\hat{\hat{e}}_t$
1986.1	4.36	4.28	-0.08	0.53	0.08	-0.18	-0.61	0.13	-0.04
1986.2	3.68	3.67	0.00	0.78	-0.08	-0.18	-0.70	0.18	0.00
1986.3	3.67	4.32	0.65	1.31	-0.10	-0.18	-0.56	0.20	0.66
1986.4	3.50	4.84	1.33	1.98	-0.14	-0.18	-0.44	0.17	1.40
1987.1	3.37	4.59	1.22	1.77	-0.15	-0.19	-0.21	0.01	1.24
1987.2	3.49	3.79	0.30	1.13	-0.21	-0.15	-0.17	-0.24	0.37
1987.3	3.16	2.72	-0.44	0.90	-0.42	-0.11	-0.06	-0.66	-0.34
1987.4	3.66	3.22	-0.43	0.78	-0.22	-0.08	-0.11	-0.72	-0.35
1988.1	3.42	3.29	-0.13	0.99	-0.10	-0.07	-0.01	-0.85	-0.04
1988.2	3.87	3.50	-0.37	0.51	-0.05	-0.03	0.34	-1.13	-0.36
1988.3	3.65	2.43	-1.22	-0.16	-0.19	-0.03	0.40	-1.23	-1.20
1988.4	4.07	2.69	-1.38	-0.60	0.03	-0.02	0.41	-1.20	-1.38
1989.1	4.25	2.51	-1.75	-0.81	0.31	-0.01	0.26	-1.50	-1.75
1989.2	4.03	2.16	-1.87	-0.82	0.28	0.00	0.12	-1.47	-1.89
1989.3	3.92	2.22	-1.70	-0.84	0.34	0.01	0.08	-1.33	-1.75
1989.4	3.16	1.09	-2.07	-0.70	-0.14	0.00	-0.01	-1.18	-2.03
1990.1	3.50	1.89	-1.61	-0.43	-0.13	-0.01	-0.07	-0.90	-1.53
1990.2	2.98	1.30	-1.68	-0.40	-0.14	0.02	-0.21	-0.85	-1.58
1990.3	2.71	1.38	-1.33	-0.18	-0.18	0.03	-0.09	-0.85	-1.27
1990.4	1.65	0.95	-0.70	0.06	-0.04	0.05	-0.05	-0.66	-0.65
1991.1	0.88	1.35	0.47	0.87	0.09	0.07	-0.07	-0.48	0.48
1991.2	0.88	1.04	0.16	0.28	0.16	0.10	-0.14	-0.21	0.20
1991.3	0.76	1.23	0.46	0.32	0.30	0.17	-0.01	-0.34	0.44
1991.4	0.87	1.31	0.43	0.39	0.32	0.20	-0.09	-0.42	0.40
1992.1	0.81	0.87	0.05	0.13	0.12	0.17	-0.22	-0.16	0.04
1992.2	1.17	1.13	-0.04	-0.05	0.07	0.13	-0.11	-0.15	-0.11
1992.3	1.66	1.23	-0.43	0.28	-0.24	0.11	-0.33	-0.22	-0.40
1992.4	2.61	1.97	-0.64	0.49	-0.06	0.07	-0.87	-0.24	-0.62
1993.1	2.93	2.68	-0.25	0.43	0.09	0.10	-0.58	-0.26	-0.21
1993.2	2.86	3.39	0.53	0.72	-0.02	0.10	-0.31	0.08	0.57
1993.3	2.87	3.75	0.87	0.71	-0.02	0.09	-0.20	0.30	0.89
1993.4	3.32	4.40	1.08	0.76	0.13	0.10	-0.31	0.38	1.06
1994.1	3.31	4.31	1.00	0.75	-0.03	0.13	-0.28	0.42	1.00
1994.2	3.49	4.07	0.59	0.81	-0.13	0.10	-0.35	0.17	0.60
1994.3	3.27	3.79	0.52	0.98	-0.14	0.10	-0.48	0.07	0.54
1994.4	3.31	3.25	-0.06	0.40	0.05	0.09	-0.40	-0.19	-0.05
1995.1	3.39	3.54	0.15	0.67	0.10	0.05	-0.22	-0.45	0.14
1995.2	3.22	3.90	0.68	1.35	0.06	0.05	-0.23	-0.53	0.70
1995.3	3.37	3.53	0.15	1.11	0.04	0.07	-0.08	-0.95	0.19
1995.4	3.06	3.59	0.53	1.32	0.04	0.07	-0.04	-0.85	0.54

Table A1
Error Components for Output Growth

1	2	3	4	5	6	7	8	9	10
			all	resid	equity	housing	PIM	EX	sum
$t+7$	y_t	$\hat{y}_t$	$\hat{e}_t$	$\hat{e}_{1t}$	$\hat{e}_{2t}$	$\hat{e}_{3t}$	$\hat{e}_{4t}$	$\hat{e}_{5t}$	$\hat{\hat{e}}_t$
1996.1	2.90	2.07	-0.83	0.23	-0.16	0.06	-0.01	-0.96	-0.84
1996.2	3.07	1.77	-1.30	-0.09	-0.36	0.06	-0.10	-0.78	-1.26
1996.3	3.21	1.66	-1.55	-0.34	-0.44	0.05	-0.24	-0.48	-1.45
1996.4	3.21	1.45	-1.76	-0.21	-0.52	0.04	-0.32	-0.64	-1.65
1997.1	3.47	1.70	-1.77	-0.05	-0.46	0.04	-0.40	-0.78	-1.66
1997.2	4.16	2.20	-1.95	0.17	-0.41	0.03	-0.62	-1.05	-1.89
1997.3	4.38	2.77	-1.61	0.26	-0.35	0.03	-0.64	-0.88	-1.58
1997.4	4.38	3.16	-1.22	0.67	-0.35	0.02	-0.64	-0.89	-1.18
1998.1	4.59	3.27	-1.32	0.69	-0.42	0.02	-0.72	-0.85	-1.28
1998.2	4.08	2.79	-1.30	0.71	-0.57	0.00	-0.78	-0.60	-1.24
1998.3	4.25	2.68	-1.56	0.46	-0.75	-0.01	-0.79	-0.42	-1.51
1998.4	4.43	2.94	-1.49	0.08	-0.74	-0.04	-0.92	0.19	-1.43
1999.1	4.47	2.89	-1.58	-0.10	-0.85	-0.06	-0.89	0.37	-1.53
1999.2	4.11	2.83	-1.28	-0.62	-0.56	-0.07	-0.76	0.77	-1.23
1999.3	4.07	3.22	-0.84	-0.43	-0.45	-0.08	-0.71	0.87	-0.80
1999.4	4.60	3.02	-1.58	-0.84	-0.52	-0.09	-0.63	0.56	-1.52
2000.1	4.16	3.45	-0.71	-0.27	-0.30	-0.08	-0.31	0.35	-0.62
2000.2	4.63	3.41	-1.23	-0.29	-0.52	-0.08	-0.17	-0.11	-1.16
2000.3	3.97	2.30	-1.67	0.18	-1.16	-0.08	0.00	-0.47	-1.53
2000.4	3.46	2.56	-0.90	-0.02	-0.64	-0.09	0.04	-0.13	-0.84
2001.1	2.96	1.89	-1.07	-0.27	-0.55	-0.11	0.10	-0.19	-1.02
2001.2	2.70	2.10	-0.60	-0.46	-0.17	-0.13	0.01	0.20	-0.55
2001.3	1.92	1.52	-0.41	-0.86	-0.22	-0.15	-0.13	0.97	-0.39
2001.4	1.23	2.13	0.91	-1.10	0.75	-0.18	-0.27	1.68	0.88
2002.1	1.44	3.20	1.76	-0.78	1.14	-0.20	-0.46	2.08	1.78
2002.2	0.93	2.96	2.03	-0.64	1.01	-0.19	-0.52	2.35	2.01
2002.3	1.28	3.93	2.65	-0.30	1.10	-0.16	-0.61	2.59	2.62
2002.4	1.05	3.62	2.57	-0.01	0.87	-0.15	-0.62	2.46	2.53
2003.1	1.26	3.47	2.21	-0.01	0.59	-0.15	-0.52	2.32	2.21
2003.2	1.54	3.07	1.53	-0.78	0.93	-0.14	-0.34	1.90	1.56
2003.3	2.64	2.44	-0.19	-1.42	0.43	-0.12	-0.21	1.15	-0.18
2003.4	2.77	2.78	0.01	-1.07	0.69	-0.13	0.01	0.46	-0.03
2004.1	2.80	2.86	0.06	-0.82	0.54	-0.13	0.09	0.28	-0.04
2004.2	2.96	2.59	-0.37	-0.51	-0.04	-0.15	0.01	0.30	-0.40
2004.3	3.11	2.42	-0.69	-0.06	-0.67	-0.16	0.03	0.20	-0.66
2004.4	3.41	2.76	-0.65	0.16	-0.57	-0.18	0.10	-0.12	-0.61
2005.1	3.64	2.36	-1.27	0.30	-0.79	-0.23	0.03	-0.49	-1.18
2005.2	3.53	2.11	-1.42	0.01	-0.55	-0.24	0.16	-0.77	-1.38
2005.3	3.08	1.22	-1.87	-0.68	-0.53	-0.25	0.22	-0.57	-1.81
2005.4	2.91	2.12	-0.79	-0.31	-0.29	-0.26	0.34	-0.22	-0.75

Table A1
Error Components for Output Growth

1	2	3	4	5	6	7	8	9	10
			all	resid	equity	housing	PIM	EX	sum
$t+7$	y_t	$\hat{y}_t$	$\hat{e}_t$	$\hat{e}_{1t}$	$\hat{e}_{2t}$	$\hat{e}_{3t}$	$\hat{e}_{4t}$	$\hat{e}_{5t}$	$\hat{\hat{e}}_t$
2006.1	3.15	1.79	-1.36	-0.69	-0.34	-0.28	0.28	-0.29	-1.32
2006.2	3.05	1.17	-1.88	-0.96	-0.48	-0.27	0.26	-0.36	-1.82
2006.3	2.69	0.58	-2.11	-0.97	-0.65	-0.23	0.27	-0.44	-2.02
2006.4	2.56	1.25	-1.31	-0.42	-0.41	-0.17	0.20	-0.46	-1.26
2007.1	2.19	0.72	-1.47	-0.61	-0.50	-0.08	0.18	-0.42	-1.42
2007.2	2.46	0.87	-1.59	-0.77	-0.52	0.02	0.06	-0.37	-1.58
2007.3	2.57	0.64	-1.93	-0.69	-0.46	0.10	-0.03	-0.79	-1.88
2007.4	2.38	1.07	-1.31	-0.21	-0.46	0.16	0.01	-0.79	-1.28
2008.1	1.89	1.75	-0.14	0.27	-0.29	0.22	0.17	-0.54	-0.17
2008.2	1.91	1.74	-0.17	0.34	-0.34	0.26	0.26	-0.68	-0.16
2008.3	1.74	2.56	0.82	0.96	-0.13	0.35	0.43	-0.76	0.85
2008.4	0.73	4.00	3.27	1.74	0.31	0.50	0.66	0.10	3.30
2009.1	-0.07	4.52	4.60	1.90	0.75	0.60	0.52	0.96	4.74

• See notes to Table 1.

Table A2
Error Components for Inflation

1	2	3	4	5	6	7	8	9	10
			all	resid	equity	housing	PIM	EX	sum
$t+7$	y_t	$\hat{y}_t$	$\hat{e}_t$	$\hat{e}_{1t}$	$\hat{e}_{2t}$	$\hat{e}_{3t}$	$\hat{e}_{4t}$	$\hat{e}_{5t}$	$\hat{\hat{e}}_t$
1955.4	1.77	0.89	-0.88	-0.79	-0.11	0.01	0.28	-0.15	-0.76
1956.1	2.15	1.01	-1.14	-0.76	-0.15	-0.02	0.44	-0.50	-0.99
1956.2	2.40	2.02	-0.38	-0.56	-0.16	-0.03	0.46	-0.01	-0.30
1956.3	2.91	3.51	0.60	0.64	-0.08	-0.02	0.47	-0.31	0.70
1956.4	3.05	3.68	0.63	0.62	-0.09	-0.01	0.46	-0.26	0.72
1957.1	3.49	4.22	0.73	1.08	-0.16	-0.02	0.27	-0.34	0.83
1957.2	3.63	4.25	0.62	1.28	-0.04	-0.01	0.20	-0.75	0.68
1957.3	3.56	3.27	-0.28	0.01	0.05	-0.01	0.19	-0.49	-0.24
1957.4	3.02	2.97	-0.05	0.37	0.09	-0.01	0.23	-0.65	0.04
1958.1	3.03	4.16	1.13	1.03	0.22	0.01	0.31	-0.42	1.15
1958.2	2.92	5.29	2.37	1.64	0.17	0.02	0.49	0.09	2.41
1958.3	2.62	4.95	2.33	1.24	0.14	0.03	0.64	0.32	2.36
1958.4	2.69	6.00	3.31	1.55	0.27	0.02	0.76	0.65	3.26
1959.1	2.05	4.86	2.81	0.62	0.10	0.01	0.86	1.13	2.73
1959.2	1.70	4.35	2.65	0.62	0.11	0.01	0.95	0.88	2.58
1959.3	1.57	3.64	2.07	0.51	-0.08	0.01	0.91	0.73	2.07
1959.4	1.73	2.98	1.25	0.15	-0.17	0.00	0.76	0.52	1.27
1960.1	1.41	0.80	-0.61	-0.83	-0.15	-0.02	0.51	-0.03	-0.52
1960.2	1.41	0.12	-1.29	-1.23	-0.14	-0.02	0.37	-0.15	-1.16
1960.3	1.27	0.74	-0.53	-0.41	0.02	0.00	0.25	-0.32	-0.47
1960.4	1.18	1.32	0.14	0.35	0.10	0.01	0.23	-0.48	0.21
1961.1	1.18	2.51	1.33	1.33	0.13	-0.03	0.30	-0.35	1.39
1961.2	1.27	1.58	0.30	0.21	0.15	-0.01	0.30	-0.30	0.34
1961.3	1.28	1.43	0.16	-0.01	0.09	0.00	0.37	-0.26	0.18
1961.4	1.27	1.88	0.60	0.45	0.15	0.00	0.47	-0.44	0.63
1962.1	1.38	2.81	1.44	0.91	-0.05	0.02	0.49	0.06	1.44
1962.2	1.24	2.55	1.31	0.52	-0.10	0.00	0.52	0.34	1.29
1962.3	1.20	1.81	0.62	0.16	-0.26	0.01	0.61	0.13	0.64
1962.4	1.19	2.52	1.33	0.66	-0.03	-0.01	0.54	0.18	1.35
1963.1	1.19	2.71	1.52	0.64	0.15	-0.02	0.59	0.12	1.48
1963.2	1.19	3.10	1.90	1.21	0.13	-0.01	0.53	0.04	1.90
1963.3	1.13	3.72	2.60	2.04	0.18	0.01	0.47	-0.07	2.63
1963.4	1.35	4.68	3.33	2.53	0.31	0.01	0.45	-0.01	3.30
1964.1	1.16	3.53	2.37	1.99	0.21	0.02	0.24	-0.08	2.37
1964.2	1.27	3.14	1.88	1.78	-0.36	0.01	0.21	0.22	1.87
1964.3	1.33	2.18	0.86	1.26	-0.35	0.01	0.10	-0.14	0.88
1964.4	1.41	2.91	1.51	1.77	-0.04	0.02	0.15	-0.36	1.55
1965.1	1.56	2.61	1.06	1.26	0.00	0.03	0.18	-0.38	1.08
1965.2	1.68	3.21	1.54	1.18	0.01	0.02	0.19	0.14	1.53
1965.3	1.78	2.69	0.92	0.88	0.04	0.03	0.21	-0.21	0.96
1965.4	1.71	2.58	0.87	0.77	-0.06	0.03	0.24	-0.05	0.93

Table A2
Error Components for Inflation

1	2	3	4	5	6	7	8	9	10
			all	resid	equity	housing	PIM	EX	sum
$t+7$	y_t	$\hat{y}_t$	$\hat{e}_t$	$\hat{e}_{1t}$	$\hat{e}_{2t}$	$\hat{e}_{3t}$	$\hat{e}_{4t}$	$\hat{e}_{5t}$	$\hat{\hat{e}}_t$
1966.1	1.90	3.07	1.17	0.83	-0.03	0.01	0.29	0.10	1.19
1966.2	2.18	2.69	0.51	0.14	-0.03	0.03	0.26	0.13	0.52
1966.3	2.51	2.87	0.36	0.15	-0.01	0.02	0.18	0.02	0.37
1966.4	2.74	3.36	0.62	0.24	0.02	0.04	0.19	0.12	0.61
1967.1	2.70	4.01	1.31	1.46	0.07	0.03	0.25	-0.52	1.29
1967.2	2.76	4.96	2.20	1.84	-0.03	0.02	0.14	0.23	2.21
1967.3	3.06	5.00	1.94	1.75	0.11	0.00	0.18	-0.09	1.95
1967.4	3.30	5.81	2.51	1.76	0.23	0.01	0.28	0.20	2.47
1968.1	3.55	5.29	1.74	1.22	0.12	-0.03	0.34	0.08	1.73
1968.2	3.66	4.82	1.16	0.49	0.00	0.01	0.42	0.27	1.19
1968.3	3.62	3.96	0.34	0.27	-0.27	-0.02	0.39	0.04	0.40
1968.4	3.87	3.68	-0.19	-0.39	-0.21	-0.01	0.38	0.07	-0.16
1969.1	4.19	3.72	-0.46	-0.78	-0.08	-0.02	0.35	0.08	-0.45
1969.2	4.57	4.01	-0.56	-0.72	-0.13	-0.03	0.26	0.10	-0.51
1969.3	4.80	3.83	-0.97	-0.85	-0.09	-0.04	0.18	-0.12	-0.91
1969.4	4.92	3.51	-1.40	-1.29	-0.04	-0.03	0.10	-0.06	-1.33
1970.1	5.07	3.17	-1.90	-1.53	-0.24	-0.03	0.05	-0.06	-1.81
1970.2	5.24	2.96	-2.28	-2.19	0.05	-0.03	0.00	-0.06	-2.23
1970.3	5.14	3.05	-2.10	-2.13	0.13	-0.04	-0.16	0.10	-2.10
1970.4	5.09	3.86	-1.23	-1.50	0.49	0.00	-0.21	-0.04	-1.26
1971.1	5.32	2.24	-3.08	-2.41	0.44	0.01	-0.39	-0.84	-3.20
1971.2	5.33	2.95	-2.39	-2.49	0.40	0.01	-0.50	0.08	-2.50
1971.3	5.11	2.66	-2.45	-2.20	0.33	0.00	-0.58	-0.04	-2.50
1971.4	4.81	3.07	-1.74	-1.59	0.22	0.01	-0.46	0.01	-1.81
1972.1	4.91	2.58	-2.34	-2.01	0.09	-0.01	-0.51	0.05	-2.38
1972.2	4.51	1.85	-2.66	-2.01	-0.33	0.01	-0.58	0.17	-2.74
1972.3	4.60	2.97	-1.63	-1.08	-0.24	-0.02	-0.48	0.16	-1.67
1972.4	4.62	3.43	-1.19	-0.67	-0.13	-0.02	-0.57	0.16	-1.23
1973.1	4.47	3.31	-1.16	-0.73	-0.03	-0.02	-0.50	0.10	-1.17
1973.2	4.59	2.97	-1.62	-0.59	-0.10	-0.03	-0.88	-0.03	-1.62
1973.3	5.07	2.99	-2.08	-0.67	-0.19	-0.04	-1.15	-0.03	-2.08
1973.4	5.71	3.13	-2.59	-0.34	-0.09	-0.05	-1.53	-0.63	-2.64
1974.1	5.87	3.27	-2.60	-0.06	-0.03	-0.04	-2.14	-0.36	-2.63
1974.2	6.78	2.77	-4.01	-0.46	-0.04	-0.05	-2.82	-0.75	-4.13
1974.3	7.82	3.15	-4.66	-0.62	0.05	-0.02	-3.46	-0.68	-4.73
1974.4	8.69	4.57	-4.13	-0.16	0.42	0.04	-3.91	-0.63	-4.25
1975.1	9.36	5.21	-4.15	-0.17	0.38	0.06	-4.17	-0.29	-4.18
1975.2	9.27	5.74	-3.53	-0.15	0.35	0.11	-3.79	-0.05	-3.53
1975.3	9.17	6.49	-2.68	0.26	0.56	0.19	-3.60	-0.07	-2.66
1975.4	9.09	7.45	-1.64	0.62	0.32	0.23	-3.04	0.26	-1.61

Table A2
Error Components for Inflation

1	2	3	4	5	6	7	8	9	10
			all	resid	equity	housing	PIM	EX	sum
$t+7$	y_t	$\hat{y}_t$	$\hat{e}_t$	$\hat{e}_{1t}$	$\hat{e}_{2t}$	$\hat{e}_{3t}$	$\hat{e}_{4t}$	$\hat{e}_{5t}$	$\hat{\hat{e}}_t$
1976.1	8.68	7.96	-0.72	0.17	0.24	0.13	-1.64	0.31	-0.79
1976.2	7.99	8.30	0.30	-0.02	0.07	0.04	-0.61	0.68	0.17
1976.3	7.17	7.46	0.29	0.43	-0.24	-0.02	-0.16	0.25	0.26
1976.4	6.56	6.99	0.43	0.23	-0.26	-0.02	0.17	0.36	0.48
1977.1	6.14	6.50	0.37	0.02	-0.08	0.00	0.18	0.34	0.46
1977.2	6.17	6.09	-0.09	-0.22	0.02	0.04	0.01	0.09	-0.06
1977.3	5.88	5.43	-0.45	0.30	-0.15	-0.02	-0.50	-0.10	-0.47
1977.4	6.08	5.78	-0.30	0.32	-0.10	-0.03	-0.68	0.14	-0.34
1978.1	6.26	6.02	-0.24	0.35	0.01	-0.05	-0.72	0.11	-0.30
1978.2	6.66	5.50	-1.16	-0.62	0.05	-0.02	-0.77	0.12	-1.25
1978.3	6.80	5.04	-1.76	-1.28	0.06	-0.05	-0.79	0.17	-1.89
1978.4	6.96	5.37	-1.60	-0.95	0.13	-0.06	-0.87	0.12	-1.63
1979.1	7.03	5.43	-1.59	-0.71	0.02	-0.07	-0.74	-0.12	-1.62
1979.2	7.56	6.05	-1.51	-0.67	0.03	-0.05	-0.78	-0.12	-1.59
1979.3	8.07	5.37	-2.70	-1.41	-0.02	-0.05	-1.05	-0.21	-2.74
1979.4	7.94	5.30	-2.64	-0.50	-0.07	-0.04	-1.47	-0.62	-2.71
1980.1	8.29	5.10	-3.19	-0.42	-0.17	-0.05	-1.88	-0.74	-3.25
1980.2	8.50	6.31	-2.19	0.39	-0.13	-0.04	-2.17	-0.20	-2.15
1980.3	8.83	6.25	-2.59	0.35	-0.08	-0.04	-2.44	-0.33	-2.55
1980.4	9.17	6.24	-2.93	0.20	-0.15	-0.05	-2.76	-0.23	-2.98
1981.1	9.61	6.22	-3.38	-0.19	-0.14	-0.01	-2.77	-0.33	-3.45
1981.2	9.30	6.23	-3.07	-0.01	-0.17	0.01	-2.50	-0.47	-3.14
1981.3	9.09	6.13	-2.95	-0.71	-0.14	0.01	-1.88	-0.31	-3.03
1981.4	9.03	6.35	-2.68	-1.53	-0.14	0.00	-1.26	0.13	-2.80
1982.1	8.60	6.44	-2.16	-1.90	-0.23	0.00	-0.51	0.32	-2.32
1982.2	8.06	5.44	-2.62	-3.16	-0.11	0.01	-0.08	0.54	-2.80
1982.3	7.61	7.12	-0.49	-1.53	0.06	0.02	0.31	0.56	-0.58
1982.4	6.72	7.58	0.85	-0.56	0.21	-0.01	0.58	0.58	0.81
1983.1	5.80	7.24	1.44	-0.59	0.24	-0.05	1.00	0.83	1.43
1983.2	5.24	7.13	1.89	-0.50	0.20	0.01	1.17	0.98	1.86
1983.3	4.81	6.14	1.33	-0.59	0.05	0.02	0.95	0.91	1.34
1983.4	4.26	5.06	0.80	-1.36	0.08	0.02	1.04	1.00	0.78
1984.1	4.20	4.72	0.52	-1.20	-0.05	0.04	1.08	0.66	0.53
1984.2	4.02	4.22	0.20	-1.29	-0.11	0.03	0.90	0.70	0.23
1984.3	3.70	3.28	-0.42	-1.48	-0.09	0.01	0.84	0.35	-0.38
1984.4	3.48	3.78	0.30	-0.48	0.02	0.00	0.84	-0.01	0.37
1985.1	3.64	3.82	0.18	-0.56	0.09	0.00	0.71	-0.04	0.20
1985.2	3.51	3.75	0.23	-0.60	0.18	-0.02	0.79	-0.08	0.27
1985.3	3.25	3.07	-0.17	-1.02	0.17	-0.05	0.88	-0.08	-0.09
1985.4	3.19	3.62	0.44	-0.37	0.16	-0.08	0.81	-0.02	0.50

Table A2
Error Components for Inflation

1	2	3	4	5	6	7	8	9	10
			all	resid	equity	housing	PIM	EX	sum
$t+7$	y_t	$\hat{y}_t$	$\hat{e}_t$	$\hat{e}_{1t}$	$\hat{e}_{2t}$	$\hat{e}_{3t}$	$\hat{e}_{4t}$	$\hat{e}_{5t}$	$\hat{\hat{e}}_t$
1986.1	2.81	3.63	0.82	0.03	0.05	-0.06	0.84	0.03	0.88
1986.2	2.64	3.62	0.99	0.04	-0.02	-0.07	0.99	0.06	1.00
1986.3	2.53	3.44	0.91	0.09	-0.02	-0.07	0.81	0.10	0.92
1986.4	2.57	3.76	1.18	0.49	-0.04	-0.07	0.68	0.16	1.22
1987.1	2.38	3.64	1.26	1.02	-0.05	-0.08	0.30	0.06	1.25
1987.2	2.37	3.17	0.80	0.78	-0.08	-0.06	0.21	-0.02	0.83
1987.3	2.53	2.86	0.33	0.75	-0.19	-0.05	0.06	-0.18	0.40
1987.4	2.58	3.41	0.83	1.00	-0.08	-0.03	0.17	-0.17	0.90
1988.1	2.75	3.68	0.94	1.18	-0.03	-0.03	0.05	-0.16	1.00
1988.2	2.97	2.99	0.02	0.89	-0.03	-0.02	-0.53	-0.28	0.03
1988.3	3.25	2.61	-0.63	0.44	-0.14	-0.01	-0.57	-0.34	-0.62
1988.4	3.25	2.50	-0.75	0.17	-0.04	-0.01	-0.55	-0.33	-0.76
1989.1	3.45	2.85	-0.60	0.19	0.13	0.00	-0.39	-0.50	-0.58
1989.2	3.67	3.23	-0.43	0.11	0.13	0.00	-0.21	-0.48	-0.44
1989.3	3.65	3.38	-0.27	0.09	0.21	0.00	-0.13	-0.48	-0.31
1989.4	3.63	3.21	-0.42	0.09	-0.05	0.00	0.02	-0.45	-0.39
1990.1	3.81	3.83	0.03	0.24	-0.04	0.00	0.13	-0.26	0.07
1990.2	3.91	4.06	0.14	0.14	-0.05	0.01	0.37	-0.25	0.22
1990.3	3.80	3.65	-0.15	0.15	-0.09	0.01	0.12	-0.29	-0.10
1990.4	3.80	3.72	-0.07	0.30	-0.06	0.01	-0.01	-0.27	-0.02
1991.1	3.82	4.16	0.33	0.44	0.00	0.01	0.15	-0.24	0.36
1991.2	3.66	3.88	0.22	-0.05	0.04	0.02	0.31	-0.07	0.25
1991.3	3.65	3.78	0.12	-0.09	0.12	0.06	0.12	-0.11	0.10
1991.4	3.58	3.90	0.33	0.03	0.15	0.08	0.17	-0.13	0.30
1992.1	3.29	3.62	0.34	-0.23	0.08	0.07	0.39	0.01	0.31
1992.2	2.96	2.94	-0.01	-0.30	0.06	0.05	0.13	-0.02	-0.08
1992.3	2.73	2.95	0.22	-0.09	-0.12	0.04	0.45	-0.05	0.24
1992.4	2.62	3.33	0.71	-0.25	-0.05	0.02	1.11	-0.10	0.73
1993.1	2.41	2.58	0.16	-0.50	0.03	0.03	0.82	-0.17	0.22
1993.2	2.36	2.49	0.12	-0.30	-0.01	0.03	0.49	-0.04	0.17
1993.3	2.23	2.51	0.28	-0.09	-0.01	0.03	0.36	0.01	0.31
1993.4	2.22	3.04	0.81	0.08	0.08	0.03	0.51	0.10	0.80
1994.1	2.21	3.43	1.22	0.55	0.01	0.05	0.48	0.12	1.20
1994.2	2.16	3.36	1.20	0.60	-0.05	0.04	0.54	0.07	1.20
1994.3	2.26	3.38	1.12	0.37	-0.08	0.03	0.68	0.12	1.13
1994.4	2.23	3.00	0.77	0.08	0.01	0.03	0.59	0.06	0.77
1995.1	2.16	2.54	0.38	0.02	0.03	0.01	0.36	-0.04	0.38
1995.2	2.06	2.91	0.85	0.57	0.02	0.01	0.35	-0.08	0.87
1995.3	2.08	2.81	0.73	0.75	0.03	0.02	0.20	-0.23	0.77
1995.4	2.05	3.24	1.18	1.17	0.05	0.02	0.13	-0.19	1.19

Table A2
Error Components for Inflation

1	2	3	4	5	6	7	8	9	10
			all	resid	equity	housing	PIM	EX	sum
$t+7$	y_t	$\hat{y}_t$	$\hat{e}_t$	$\hat{e}_{1t}$	$\hat{e}_{2t}$	$\hat{e}_{3t}$	$\hat{e}_{4t}$	$\hat{e}_{5t}$	$\hat{\hat{e}}_t$
1996.1	2.05	1.74	-0.31	-0.06	-0.01	0.02	0.02	-0.27	-0.32
1996.2	2.04	1.95	-0.09	0.05	-0.09	0.02	0.19	-0.24	-0.07
1996.3	1.87	1.77	-0.10	-0.26	-0.11	0.02	0.45	-0.13	-0.03
1996.4	1.90	1.79	-0.12	-0.32	-0.17	0.01	0.53	-0.11	-0.05
1997.1	1.91	1.68	-0.22	-0.50	-0.16	0.01	0.65	-0.16	-0.15
1997.2	1.81	2.03	0.22	-0.39	-0.14	0.01	1.00	-0.20	0.29
1997.3	1.74	2.20	0.46	-0.33	-0.11	0.01	1.02	-0.10	0.50
1997.4	1.67	2.23	0.56	-0.19	-0.08	0.01	1.03	-0.17	0.60
1998.1	1.49	2.28	0.79	0.01	-0.08	0.01	1.14	-0.23	0.84
1998.2	1.37	2.08	0.71	-0.10	-0.11	0.00	1.25	-0.28	0.75
1998.3	1.40	1.81	0.41	-0.29	-0.17	0.00	1.27	-0.34	0.47
1998.4	1.31	1.98	0.67	-0.41	-0.21	-0.01	1.42	-0.06	0.74
1999.1	1.19	1.58	0.39	-0.61	-0.29	-0.01	1.40	-0.03	0.46
1999.2	1.29	1.51	0.22	-0.90	-0.17	-0.01	1.21	0.14	0.27
1999.3	1.29	1.84	0.55	-0.66	-0.12	-0.02	1.13	0.25	0.59
1999.4	1.34	1.66	0.32	-0.68	-0.14	-0.03	1.01	0.20	0.37
2000.1	1.67	1.68	0.02	-0.63	-0.02	-0.02	0.56	0.18	0.06
2000.2	1.80	1.77	-0.03	-0.31	-0.06	-0.02	0.34	0.05	0.00
2000.3	1.88	1.23	-0.65	-0.22	-0.35	-0.02	0.07	-0.05	-0.57
2000.4	1.91	1.69	-0.22	-0.02	-0.15	-0.02	-0.04	0.03	-0.19
2001.1	2.11	1.24	-0.87	-0.33	-0.19	-0.02	-0.18	-0.12	-0.85
2001.2	2.34	1.89	-0.44	-0.12	-0.11	-0.03	-0.01	-0.14	-0.42
2001.3	2.35	1.82	-0.53	-0.39	-0.22	-0.03	0.21	-0.08	-0.51
2001.4	2.39	2.66	0.28	-0.34	0.10	-0.04	0.52	0.02	0.27
2002.1	2.12	3.20	1.08	-0.08	0.23	-0.04	0.85	0.12	1.09
2002.2	2.08	2.89	0.81	-0.67	0.25	-0.04	0.89	0.38	0.80
2002.3	2.01	3.49	1.48	-0.42	0.32	-0.04	1.05	0.58	1.48
2002.4	2.08	3.51	1.43	-0.47	0.22	-0.03	1.08	0.62	1.42
2003.1	2.07	3.33	1.26	-0.26	0.08	-0.03	0.88	0.59	1.26
2003.2	1.83	2.70	0.88	-0.43	0.24	-0.03	0.66	0.47	0.90
2003.3	1.90	1.99	0.09	-0.55	0.05	-0.03	0.41	0.23	0.11
2003.4	1.92	1.61	-0.31	-0.56	0.20	-0.03	-0.03	0.09	-0.32
2004.1	2.20	1.50	-0.70	-0.85	0.25	-0.02	-0.23	0.12	-0.74
2004.2	2.49	1.68	-0.81	-1.06	0.11	-0.03	-0.04	0.18	-0.83
2004.3	2.59	1.56	-1.03	-0.97	-0.12	-0.02	-0.07	0.17	-1.02
2004.4	2.71	1.50	-1.21	-0.92	-0.10	-0.03	-0.24	0.07	-1.21
2005.1	2.82	1.89	-0.93	-0.58	-0.20	-0.04	0.02	-0.07	-0.88
2005.2	2.92	2.06	-0.86	-0.15	-0.13	-0.05	-0.33	-0.18	-0.84
2005.3	3.17	2.21	-0.96	-0.11	-0.13	-0.04	-0.48	-0.18	-0.95
2005.4	3.37	2.30	-1.06	-0.23	-0.04	-0.04	-0.69	-0.04	-1.05

Table A2
Error Components for Inflation

1	2	3	4	5	6	7	8	9	10
			all	resid	equity	housing	PIM	EX	sum
$t+7$	y_t	$\hat{y}_t$	$\hat{e}_t$	$\hat{e}_{1t}$	$\hat{e}_{2t}$	$\hat{e}_{3t}$	$\hat{e}_{4t}$	$\hat{e}_{5t}$	$\hat{\hat{e}}_t$
2006.1	3.34	2.39	-0.96	-0.31	-0.04	-0.05	-0.56	0.00	-0.97
2006.2	3.22	2.54	-0.68	-0.01	-0.07	-0.05	-0.53	-0.01	-0.68
2006.3	3.28	2.71	-0.57	0.27	-0.14	-0.06	-0.55	-0.07	-0.55
2006.4	3.14	3.28	0.14	0.68	-0.06	-0.06	-0.37	-0.04	0.15
2007.1	3.17	3.11	-0.06	0.51	-0.09	-0.03	-0.38	-0.05	-0.05
2007.2	3.15	3.53	0.39	0.75	-0.10	-0.01	-0.21	-0.05	0.37
2007.3	2.84	3.60	0.77	0.98	-0.08	0.01	-0.02	-0.09	0.80
2007.4	2.71	3.60	0.88	1.14	-0.08	0.02	-0.07	-0.12	0.90
2008.1	2.59	3.95	1.36	1.78	-0.04	0.03	-0.37	-0.05	1.35
2008.2	2.37	3.87	1.51	2.10	-0.11	0.02	-0.42	-0.07	1.52
2008.3	2.51	3.69	1.19	2.04	-0.11	0.04	-0.60	-0.15	1.22
2008.4	2.31	3.66	1.34	2.27	-0.03	0.07	-0.83	-0.16	1.33
2009.1	2.14	3.72	1.58	2.22	0.03	0.09	-0.55	-0.25	1.54

• See notes to Table 2.

The US versus DSGE Models

I have argued elsewhere that a model like the US model is a better approximation of the economy than are currently popular dynamic stochastic general equilibrium (DSGE) models. The most extensive discussion is in Fair (2007, Section 2). Table A3 is a slightly modified version of Table 2 in this paper; it summarizes some of the main points.

The reference in the last point in Table A3 presents a comparison in terms of outside sample root mean squared errors of the US model and three models in the DSGE tradition. This comparison is based on results in Ireland (2004), Del Negro, Schorfheide, Smets, and Wouters (2006), and Fair (2004). The results show that the US model is much more accurate, especially regarding real output. This is perhaps not surprising since DSGE models leave out many first order effects and are based on assumptions like labor market clearing and rational expectations that do not seem realistic. As listed in Table A3, first order effects that are usually left out of DSGE models include 1) no disaggregation of demand into consumption and investment components, 2) usually no government and foreign sectors, 3) no stock effects and wealth effects, and 4) usually no wage equation. The US model disaggregates demand into three categories of consumption, three categories of investment, and imports. Exports are endogenous in the MC model. Both federal and state and local governments are in the US model. Lagged stock effects play a major role: durable goods stock, housing stock, capital stock, inventory stock. Wealth effects are very important, as has been seen in this paper.

Most DSGE models have the feature that a positive price shock with the nominal interest rate held constant is explosive or indeterminate. This property has important implications for monetary policy. In the US model, on the other hand, a positive price shock is contractionary, as discussed in Section 2 of this paper. This feature seems strongly supported by the data in the tests that I have done. If true, then DSGE models that have the opposite feature are likely to be misleading for most monetary policy analyses.

The US model is completely estimated and has been extensively tested—see Fair (2004, Chapter 2). Not all tests yield positive results, but overall the model seems to be a reasonable approximation. In particular the model does fairly well on coefficient stability tests. If the Lucas critique were a problem, it seems likely that more stability hypotheses would be rejected. Also, the Lucas critique is not a problem if expectations are not rational, and tests that I have performed of the rational expectations hypothesis—again see Fair (2004, Chapter 2)—are not generally supportive of the hypothesis. The US model has the feature that all flows of funds among the sectors are accounted for.

Micro theory is behind the specification of household and firm behavior. The estimated equations are meant to be approximations to decision equations that result from optimization problems. Theory is used to decide what is on the left hand and right hand sides of the estimated equations. People using the DSGE methodology don't like this way of using theory because it is not as tight as that used in DSGE work. It is considered ad hoc. But my view is that this is exactly the way theory should be used. Any more restrictive or rigorous use of theory is likely to push beyond what the data can tell us. Macroeconomic data are highly aggregated, and there is a limit to what one can expect to learn from the data.

Table A3
DSGE Models versus the US Model

Property	DSGE Models	US Model
Intertemporal optimization?	Yes.	Yes.
Rational expectations?	Yes.	No.
Imperfect competition?	Yes.	Yes.
Costly price adjustment?	Yes.	No.
Estimation.	Parameters of the theoretical model are calibrated or estimated.	The theoretical model is used to guide the specification of the econometric model, which is then estimated. No calibration for econometric model.
Demand disaggregation.	One aggregate demand equation.	Three consumption equations: services, nondurables, durables; three investment equations: nonresidential fixed, residential, inventory; import demand equation.
Government sector?	Usually not.	Yes.
Foreign sector?	Usually not.	Yes.
Stock effects?	No.	Yes, on durable consumption, residential investment, nonresidential fixed investment, inventory investment.
Wealth effects?	No.	Yes, on the three categories of consumption.
Wage equation?	Usually not.	Yes, separately estimated wage and price equations.
Real versus nominal interest rate effects.	Real effects imposed.	Tested, where nominal interest rates generally dominate.
Effects of a positive price shock with the nominal interest rate held constant.	Explosive or indeterminate.	Contractionary.
Lucas critique a problem?	No.	Not under the assumptions about expectations.
Long run tradeoff between inflation and output?	No.	Lack of tradeoff not tested because of limited data. Relationship likely to be nonlinear.
Accuracy.	See Table 1, Fair (2007).	See Table 1, Fair (2007).

References

[1] Chauvet, Marcelle, and Simon Potter, 2005, "Forecasting Recessions Using the Yield Curve," *Journal of Forecasting*, 24, 77–103.

[2] Del Negro, Marco, Frank Schorfheide, Frank Smets, and Raf Wouters, 2006, "On the Fit of New-Keynesian Models," March.

[3] Dominguez, Kathryn M., Ray C. Fair, and Matthew D. Shapiro, 1988, "Forecasting the Depression: Harvard Versus Yale," *The American Economic Review*, 595–612.

[4] Fair, Ray C., 2004, *Estimating How the Macroeconomy Works*. Cambridge, MA: Harvard University Press.

[5] Fair, Ray C., 2005, "Policy Effects in the Post Boom U.S. Economy,"*Topics in Macroeconomics*, Vol 5, Iss. 1, Article 19.

[6] Fair, Ray C., 2007, "Evaluating Inflation Targeting Using a Macroeconometric Model," *e*conomics - The Open-Access, Open-Assessment E-Journal.

[7] Hamilton, James D., 2009, "Causes and Consequences of the Oil Shock of 2007-2008," NBER Working Paper No. 15002, May.

[8] Ireland, Peter N., 2004, "A Method for Taking Models to the Data," *Journal of Economic Dynamics and Control*, 28, 1205–1226.

[9] Rudebusch, Glenn D., and John C. Williams, 2008, "Forecasting Recessions: The Puzzle of the Enduring Power of the Yield Curve," Working Paper 2007-16, Federal Reserve Bank of San Francisco, JUly.

[10] Stark, Tom, 2009, "Error Statistics for the Survey of Professional Forecasters for Real GNP/GDP," February, 19.

[11] Stock, James, H., and Mark W. Watson, 2003, "Forecasting Output and Inflation: The Role of Asset Prices," *Journal of Economic Literature*, 61, 788–829.