Analysis of Nine U.S. Recessions and Three Expansions

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Abstract

Nine U.S. recessions and three expansions are analyzed in this paper using a structural macroeconometric model. With two exceptions and one partial exception, the episodes are predicted well by the model, including the 2008-2009 recession, conditional on the actual values of the exogenous variables. The main exogenous variables are stock prices, housing prices, import prices, exports, and exogenous government policy variables. Monetary policy is endogenous. Fluctuations in stock and housing prices (housing prices after 1995) are important drivers of output fluctuations—large wealth effects on household expenditures. In explaining the 2008-2009 recession detailed financial variables such as credit-constraint variables are not needed for the aggregate predictions. The sluggish recovery after the 2008-2009 recession is explained in large part by sluggish government spending. There is no evidence of secular stagnation.

1 Introduction

Since 1954 there have been nine NBER U.S. recessions, not counting the Pandemic recession, and a number of expansions. This paper analyzes the nine recessions and three expansions. A structural macroeconometric model of the United States, denoted the "US model," is used for the analysis. The main question considered

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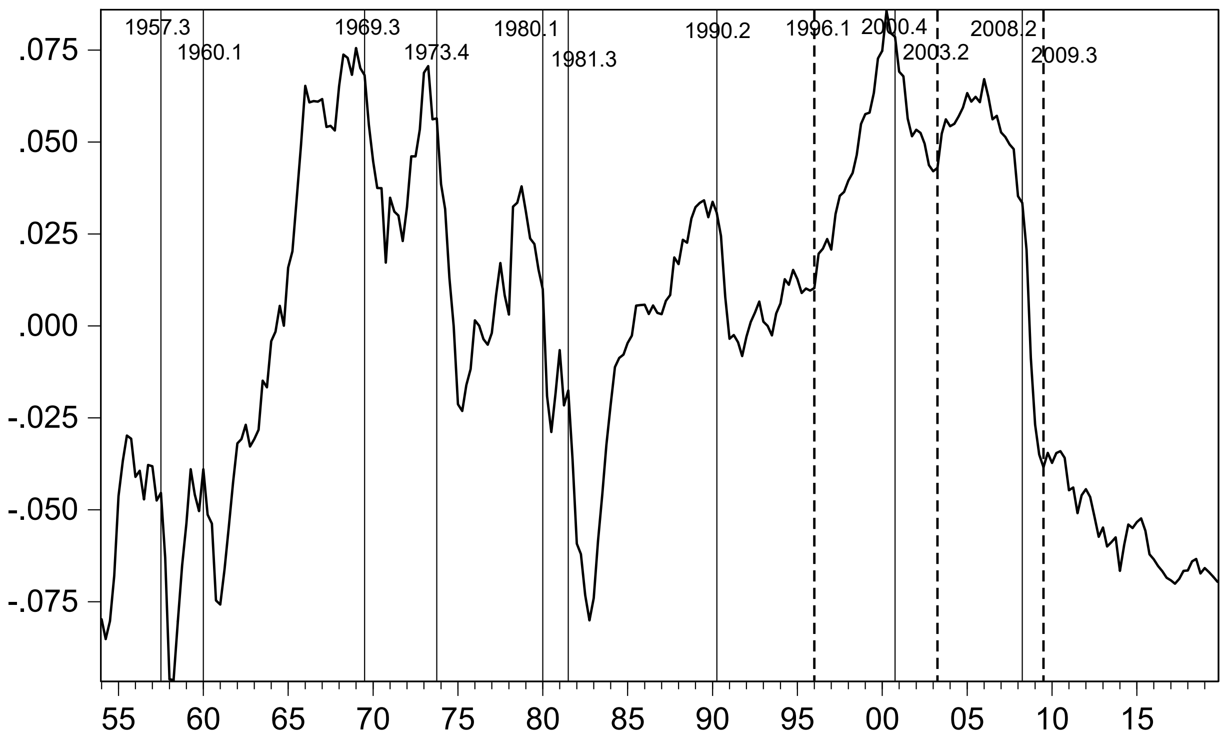
is how much of each episode can be explained by the model, conditional on the actual values of the exogenous variables in the model. The amount not explained is due to shocks to the stochastic equations—the error terms. If a stochastic equation is correctly specified, a shock is random unexplained behavior. If there is misspecification, at least part of the shock is due to the misspecification.

Figures 1-3 plot the episodes of interest. A solid vertical line indicates the quarter before the recession started, and a dotted vertical line indicates the quarter before the expansion started. For Figure 1 the log of real per capita GDP was first regressed on a constant and linear time trend over the 1954.1–2019.4 period. Plotted in Figure 1 are the residuals from this equation. This simply allows one to see better the fluctuations over time. Figure 2 plots the unemployment rate (denoted UR below), and Figure 3 plots the three-month Treasury bill rate (denoted RS below).

An episode is denoted by the year in which it began, "R" for recession and "E" for expansion. As will be seen, the first two recessions, R1954 and R1960, are not well explained, although R1960 was a very mild recession. R1974 is partly explained. Otherwise, the episodes are mostly driven by fluctuations in the exogenous variables as filtered through the US model. Conditional on using the actual values of the exogenous variables, there are not many puzzles. It will be seen that asset price fluctuations are important drivers of output fluctuations; there are strong wealth effects in the model.

A key question for this analysis is which variables in the model to take as exogenous. Population and age distribution variables are. Government spending on goods and services and government transfer payments are if they are not tied to the state of the economy, such as unemployment benefits. These are standard government exogenous variables. Tax rates are also taken to be exogenous. Changes in asset prices—stock prices and housing prices—are also taken to be exogenous. They are largely unpredictable, and there are no structural equations

Figure 1
Log of Real Per Capita GDP
Deviation From Trend
1954.1--2019.4



that can explain them.[1] The two main assets in the US model are net household financial assets and housing assets. More will be said about asset prices later.

Two other important variables are taken to be exogenous for this exercise, U.S. exports and the U.S. import price deflator. These variables are endogenous in my multicountry econometric (MC) model. U.S. exports depend on other countries'

[1]Each year I give one of my classes an assignment to explain the quarterly log change in the S&P 500 index since 1954 using any set of macro variables they want. Nothing sensible is ever found. There may be some explanatory power in predicting future stock prices or stock returns at long horizons. See, for example, Greenwood and Shleifer (2014) and references therein. The lack of explanatory power at short horizons is what is relevant for this paper since it is concerned only with business cycle frequencies.

Figure 2
Unemployment Rate
1954.1--2019.4

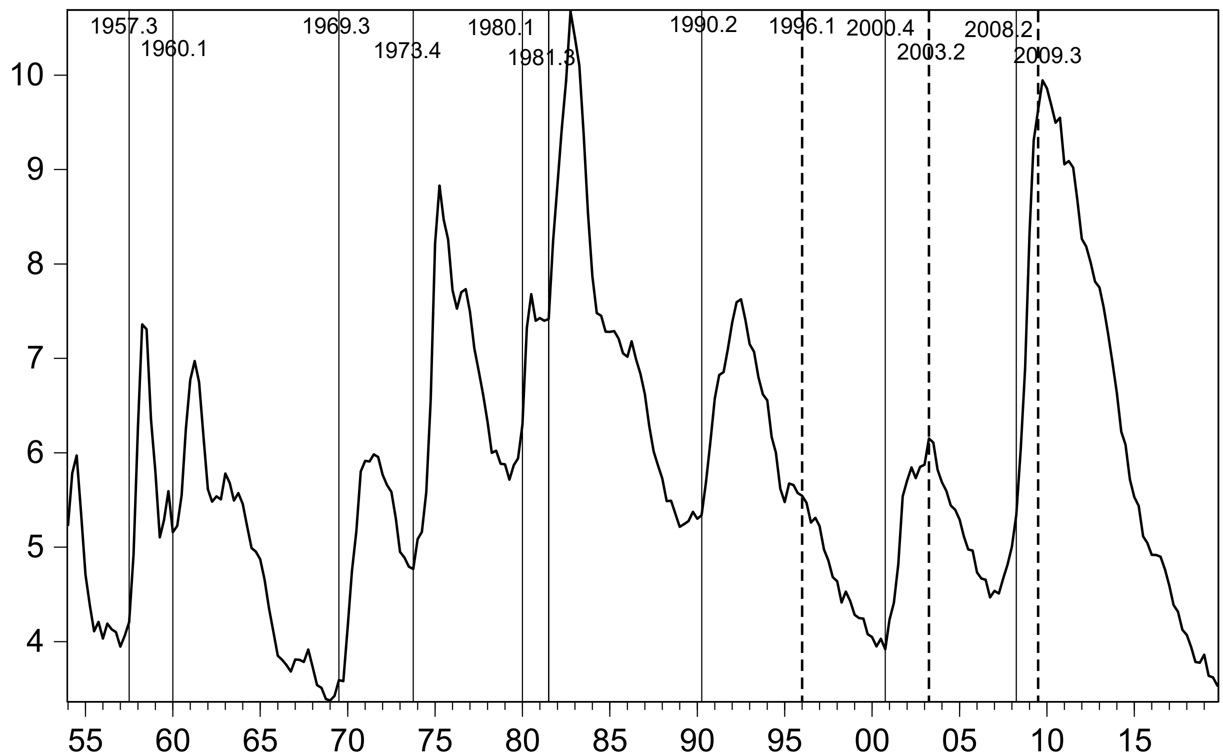
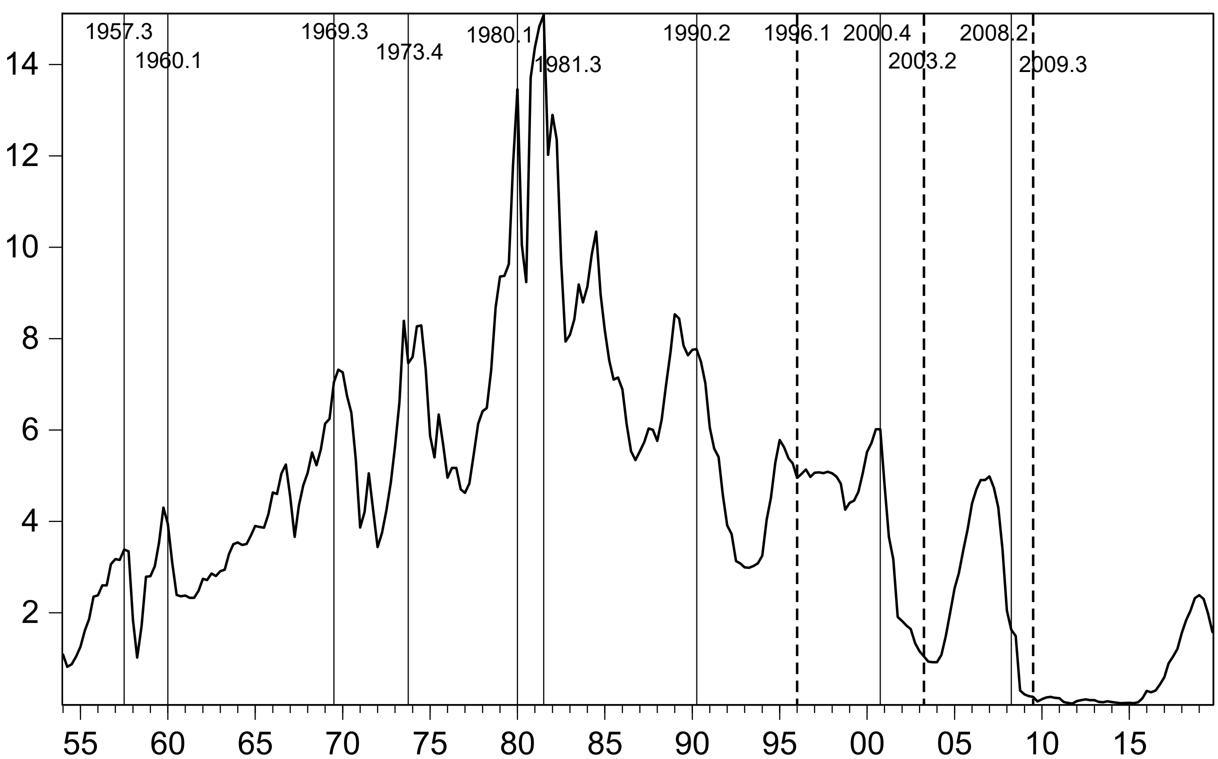


Figure 3
Three-Month Treasury Bill Rate
1954.1--2019.4



imports, which are endogenous. The import price deflator depends on other countries' export prices, which are endogenous. Both depend on exchange rates, where changes in the rates are largely unpredictable. It is the case, however, that U.S. variables have modest effects on other countries' imports and price of exports. The properties of the US model are not sensitive to whether or not it is imbedded in the MC model. Therefore, as an approximation, U.S. exports and the U.S. import price deflator are taken to be exogenous. They will be denoted EX and PIM, respectively.

Monetary policy is endogenous in the model in that it is explained by an estimated interest rate rule of the Fed—a Taylor rule, although a rule that goes back much before Taylor (1993).[2]

The fact that the model does well in predicting the episodes does not mean it can forecast well, since the exogenous variables cannot necessarily be forecast well. The change in asset prices cannot, and even some government variables are not easy to forecast. Nor necessarily are exports and the import price deflator. In earlier work using the MC model, Fair (2012), I have shown that between about 25 and 37 percent of the forecast error variance of output growth over eight quarters is due to asset price changes, which are unpredictable. This paper is not an exercise in forecasting recessions and expansions, but in explaining them conditional on the exogenous variables. This is a lot of conditioning information. As noted in the next section, not all of the conditioning information is used in the estimation of the coefficients in the model. This is to guard against the possibility that some of the information is endogenous.

The closest research to this paper is the research examining the effects of oil prices on the economy. Hamilton (1983) examined the period 1948–1972 and

[2]The first estimated rule that I am aware of is in Dewald and Johnson (1963), who regressed the Treasury bill rate on a constant, the Treasury bill rate lagged once, real GNP, the unemployment rate, the balance-of-payments deficit, and the consumer price index. The next example can be found in Christian (1968), followed by many others. I added an estimated interest rate rule to my model in 1978—Fair (1978).

found for all but one of the recessions in this period oil price increases preceded the recession, with a lag of about three quarters. He argues that at least some of this was causal. In a later paper Hamilton (2009) argues that oil price increases contributed to the contraction in 2008. This work does not use structural models; the focus is on whether oil prices help explain output contractions. It will be seen that the US model is consistent with Hamilton's story. Oil prices have a positive effect on PIM, especially in the first half of the sample period, and an increase in PIM is contractionary in the model, other things being equal.

Beginning with Mitchell (1927) there is a large literature examining whether contractions are briefer and sharper than expansions. See, for example, McKay and Reis (2008). This paper does not impose any restrictions on recessions and expansions. Each episode is unique, and each is examined separately. A recent paper by Angeletos, Collard, and Dellas (2020) argues for the existence of one main business-cycle driver. They use ten macroeconomic variables in a VAR model. They do not examine individual contractions and expansions, and none of the ten variables are the exogenous variables stressed in this paper. Given Tolstoy's famous quote, their business cycles are like happy families, whereas in this paper each episode is an unhappy family. ("All happy families are alike; each unhappy family is unhappy in its own way.") Given the differences in the episodes outlined in this paper, it does not seem likely that each episode is a happy family.

The results have other implications for the literature. First, aggregate wealth, financial plus housing, appears to be enough to explain most of the 2008-2009 recession. As discussed in Section 5, credit constraints and other measures of financial distress do not appear to add much. Mian and Sufi (2015) stress the household-side credit channel, and Kehoe et al. (2020) examine both the household-side and firm-side credit channels. See the latter for a review of this large literature. Again, what the present results suggest is that analysis of credit channels does not add much to explaining the recession. Aggregate wealth declines are enough.

Second, the slow growth after the 2008-2009 recession is mostly explained by sluggish government spending. Conditional on government spending, there is no puzzle. Related to this is the question of whether the United States economy is in a period of secular stagnation, as argued by Summers (2020). There is no evidence of this in the present results, although direct tests of this hypothesis have not been made.

2 The US Model

The US model is described in detail in a document on my website, "Macroeconometric Modeling: 2018," which will be abbreviated "MM". Most of my past macro research, including the empirical results, is in MM. It includes chapters on methodology, econometric techniques, numerical procedures, theory, empirical specifications, testing, and results. The results in my previous macro papers have been updated through 2017 data, which provides a way of examining the sensitivity of the original results to the use of additional data. It is too much to explain the model in one paper, and I will rely on MM as the reference. Think of MM as the appendix to this paper. In what follows the relevant sections in MM will be put in brackets.

There are 24 stochastic equations and about 100 identities in the US model. The estimation period for the version used here is 1954:1–2019:4 for most equations. The estimation technique is two stage least squares (2SLS) except when there are too few observations to make the technique practical, where ordinary least squares (OLS) is used. The estimation accounts for possible serial correlation of the error terms. The variables used for the first stage regressors are the main exogenous and lagged endogenous variables in the model. Only lagged values of the exogenous variables were used as first stage regressors. For example, no current asset variable is used as a firsts stage regressor. This avoids the possibility that what is taken in the model to be an exogenous variable is in fact contemporaneously correlated with the error term in the equation. Given the stochastic assumptions, the coefficient estimates are consistent.

Each of the stochastic equations has been subject to a number of tests. Lagged values have been added to test for dynamics. The errors have been tested for serial correlation. A time trend has been added to test for trend effects. Two stability tests have been performed: Andrews (2003) end of sample stability test and Andrews and Ploberger (1994) stability test. The results of the tests are summarized in [MM, 3.6.11, 3.7.3]. Not every equation passes every test, but overall the results seem good. A particular specification is not chosen if it does poorly in the tests.

The equations are estimated under the assumption that all variables are trend stationary. If this assumption is violated, the estimated standard errors will be off. One can examine the accuracy of the estimated standard errors based on the asymptotic formulas using the bootstrap procedure. This is done in Fair (2003), with updated results in [MM, 3.9.1]. The asymptotic formulas reject too often, but the errors are not large. The results suggest that little is lost by using the asymptotic formulas.

The modeling methodology is discussed next, followed by an outline of the model.

The Cowles Commission (CC) Approach

The US model follows what I call the Cowles Commission (CC) approach [MM, 1.1]. Theory is used to guide the choice of left-hand-side and right-hand-side variables for the stochastic equations in a model, and the resulting equations are estimated using a consistent estimation technique like 2SLS. Sometimes restrictions are imposed on the coefficients in an equation, and the equation is then estimated with these restrictions imposed. It is generally not the case that all the coefficients in a stochastic equation are chosen ahead of time and thus no estimation done. In this sense the methodology is empirically driven and the data rule. Some argue that models specified using the CC approach are ad hoc, but this is not the case. Behavioral equations of economic agents are postulated and estimated. The CC approach has the advantage of using theory while keeping close to what the data say.

Typical theories for these models are that households behave by maximizing expected utility and that firms behave by maximizing expected profits. The theory that has been used to guide the specification of the US model is discussed in [MM, 3.1]. In the process of using a theory to guide the specification of an equation to be estimated there can be much back and forth movement between specification and estimation. If, for example, a variable or set of variables is not significant or a coefficient estimate is of the wrong expected sign, one may go back to the specification for possible changes. Because of this, there is always a danger of data mining—of finding a statistically significant relationship that is in fact spurious. Testing for misspecification is thus (or should be) an important component of the methodology. There are generally from a theory many exclusion restrictions for each stochastic equation, and so identification is rarely a problem—at least based on the theory used.

The transition from theory to empirical specifications is not always straightforward. The quality of the data is never as good as one might like, so compromises have to be made. Also, extra assumptions usually have to be made for the empirical specifications, in particular about unobserved variables like expectations and about dynamics. There usually is, in other words, considerable "theorizing" involved in this transition process. In many cases future expectations of a variable are assumed to be adaptive—to depend on a few lagged values of the variable itself, and in many cases this is handled by simply adding lagged variables to the equation being estimated. When this is done, it is generally not possible to distinguish partial adjustment effects from expectation effects—both lead to lagged variables being part of the set of explanatory variables [MM, 1.2].

This methodology differs substantially from that behind the specification of DSGE models. For these models the theory is much tighter (more restrictive), rational expectations is assumed, and there is considerable calibration. These differences are discussed in Fair (2019), which also summarizes some of the main results from my macroeconmetric modeling—empirical points that should be taken into account in constructing macro models.

The Equations

An outline of the main estimated equations follows. All the expenditure equations are in real terms. The discussion of the explanatory variables ignores possible lagged dependent variables. A complete discussion of the US model, both the theory and the empirical specifications, is in [MM, 3.2, 3.6].

There are four expenditure equations of the household sector—consumption of services, nondurables, and durables, and housing investment—and the key explanatory variables are disposable income, interest rates, lagged wealth, age distribution variables, and lagged stocks for the durables and housing equations. There are four household labor supply equations—the labor force of males 25-54, females 25-54, all others 16+, and the number of people holding more than one job. The key explanatory variables are the real wage rate, lagged wealth, and the unemployment rate. Lagged wealth has a negative effect on labor supply—a negative income effect. The unemployment rate has a negative effect and is picking up discouraged worker effects.

There are six important stochastic equations of the firm sector. Plant and equipment investment depends on output, lagged excess capital, and interest rates. Production depends on sales and the lagged stock of inventories. The demand for jobs and hours per job depend on output and lagged excess labor. In the two price and wage rate equations the price level depends on the wage rate, the import price deflator, and the unemployment rate. The wage rate and import price deflator are cost variables, and the unemployment rate is the demand variable. The wage rate depends on productivity and the price level. As discussed in the Introduction, the fact that the import price deflator is an explanatory variable in the domestic price equation—the equation determining the price level of the firm sector—is important for the present analysis. The deflator has a positive and highly significant coefficient estimate in the price equation [MM, 3.6.4]. This result is consistent with the idea that when import prices rise firms raise their prices in response to less import competition. Also, prices of inputs that are imported may be higher, which may lead to higher domestic output prices.

As noted in the Introduction, there is an estimated interest rate rule of the Fed. The short term interest rate depends on inflation and the unemployment rate. The Fed is estimated to "lean against the wind." This equation is only estimated through 2008.3, before the zero lower bound. There are two long term interest rates in the model, a bond rate and a mortgage rate. They are affected by the short term rate through estimated term structure equations.

There is an estimated import demand equation, where the level of imports depends on disposable income, lagged wealth, and the domestic price level relative to the import price deflator.

The Wealth Variable

As noted above, lagged wealth appears as an explanatory variable in the household expenditure equations, the labor force equations, and the import equation. The real value of net household wealth, denoted AA, is the sum of household financial wealth and housing wealth:

$$AA = \frac{AH + MH}{PH} + \frac{PKH \cdot KH}{PH} = AA1 + AA2 \tag{1}$$

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. $(AH + MH)/PH$, denoted $AA1$, is thus real financial wealth, and $(PKH \cdot KH)/PH$, denoted $AA2$, is real housing wealth.

Data from the national income and product accunts (NIPA) and the flow of funds accounts (FFA) have been linked in the US model. One of the linking equations is the identity [MM, identity 66, Table A.3 in Appendix A]:

$$AH = AH_{-1} + SH - \Delta MH + CG - DISH \tag{2}$$

where SH is the financial saving of the household sector, CG is the value of capital gains (+) or losses (-) on the financial assets held by the household sector, and $DISH$ is a discrepancy term. If either SH or CG is positive, this increases $AH + MH$, other things being equal. SH is endogenous in the model, determined by an identity, and thus so are AH and AA.[3]

CG, which is constructed from FFA data,, is highly correlated with the change in the S&P 500 stock price index. Stock prices thus affect AH through CG. CG is much more volatile than is SH, and most of the variation in AH is due to variation in CG. In some uses of the US model there is an equation explaining CG, although, not surprisingly, very little of the variance of CG is explained. The left hand side variable of this equation is $CG/(PX_{-1}YS_{-1})$, where YS is a measure of real potential output and PX is a price index. The right hand sider variables are the change in an interest rate and the change in profits. Neither is significant, and the R^2 is 0.016. For the results here this equation was not used, and CG was taken to be exogenous. The average of $CG/(PX_{-1}YS_{-1})$ over the 1954.1–2019:4 period is 0.124. For some of the simulations in Tables 4 and 5, $CG/(PX_{-1}YS_{-1})$ was taken to be 0.124 for each quarter rather than its actual value. This case will be called "SP normal."

The relationship between PKH, the market price of housing, and the deflator for domestic sales in the model, PD, is taken to be exogenous.[4] In other words,

[3]Prior to 2008 there was a demand for money equation explaining MH in the model. This relationship broke down in 2008, and MH is now an erratic variable. The equation has been dropped, and MH is taken to be exogenous. MH is a small fraction of AH. In 2019.4 its value was $1.4 trillion, which compares to $75.1 trillion for AH.

[4]PKH is constructed from nominal housing stock data in the FFA and real housing stock data from the NIPA [MM, Appendix A].

the change in relative housing prices is not explained. More will be said about this when the variable is plotted below.

Household wealth is quantitatively important in the model. A sustained one dollar increase in real financial wealth leads to an increase in real GDP of about 4 cents after two years and about 6 cents after 5 years, other things being equal. The numbers for a sustained one dollar increase in real housing wealth are 6.5 cents after two years and 7.5 cents after 5 years [MM, 5.7.4].[5]

The Import Price Deflator

Regarding Hamilton's (1983) results discussed above, although oil prices are not in the model they do affect the import price deflator, PIM. A property of the model is that when PIM, say, increases, this is contractionary. To see this, let PF denote the price level for the firm sector, which is explained by a stochastic equation. PIM is an explanatory variable in this equation, with a positive coefficient estimate. This price equation plus an estimated nominal wage rate equation have the property than an increase in PF does not result in as large an increase in the nominal wage rate (the nominal wage rate lags the price level), and so the real wage rate falls. This leads to a decrease in real disposable income, which has a negative effect on household expenditures. In addition, the rise in PF leads to a fall in real wealth, which also has a negative effect on household expenditures. There is thus a negative effect on aggregate demand. In the estimated Fed rule the Fed responds positively to the increased inflation but negatively to the drop in aggregate demand (and thus an increase in the unemployment rate). The interest rate could thus go either way depending on the size of the coefficient estimates. An example will be given below.

[5]Only housing wealth appears in the housing investment equation, which is why its effect is larger. I have tested (Fair (2017)) whether financial wealth and housing wealth have different effects in the consumer expenditure equations. The evidence is somewhat mixed, but generally supports just aggregating the two variables. In the housing investment equation only housing wealth is significant.

3 Large Errors in the Stochastic Equations

Before presenting the prediction results, it will be useful to examine the quarters in which there were large residuals in the estimated equations. As noted in the previous section, there are seven aggregate demand equations—three consumption, housing investment, plant and equipment investment, inventory investment, and imports. These equations are estimated for the 1954:1–2019:4 period, 246 observations. For each observation there is an estimated residual. To examine large residuals, the following was done. For each equation and quarter the predicted value of the level of the variable was computed, which was then subtracted from the actual value. This is the estimated residual in levels (some of the equations are in logs). For each quarter there are seven residuals. Summing the first six residuals and subtracting the import residual gives the error in predicting GDP. (The other variables in the GDP identity are exogenous and so have zero residuals.) If the absolute value of the GDP error was greater than 1 percent of the actual value of GDP for the quarter, the quarter was flagged.

Table 1 presents values for the flagged quarters. For each component of GDP the level residual divided by the actual value of GDP is presented. Also presented is the GDP error divided by the actual value of GDP. There are 27 quarters out of 246 that are flagged. The largest GDP error in absolute value is in 1958.1, followed by 1978.2, 1965.1, and 1980.2. 11 of the 27 errors are positive, which means that GDP was larger than predicted. Most of the quarters are before 1990. There are only 8 quarters from 1990 on. This table will be used in the discussion of the predictions.

Table 1
Quarters With Large Residuals
Errors as a Percent of Real GDP

Qtr.	CS	CN	CD	IHH	IKF	IVF	IM	$GDPR$
1957.2	0.00	-0.04	-0.06	-0.07	-0.33	-0.53	0.04	-1.07
1958.1	-0.47	-0.33	-0.16	-0.37	-0.92	-1.54	0.06	-3.84
1958.2	0.21	0.03	-0.06	0.15	0.15	0.70	0.16	1.01
1958.3	0.08	0.22	-0.02	0.19	0.62	0.24	-0.06	1.39
1960.2	0.10	0.11	0.03	-0.53	-0.45	-0.51	0.03	-1.29
1963.4	0.03	-0.29	-0.03	0.11	-0.53	-0.46	-0.14	-1.03
1965.1	0.00	-0.02	0.14	0.11	0.80	0.92	-0.32	2.28
1970.3	0.17	0.13	-0.02	0.15	0.44	0.13	-0.06	1.05
1970.4	-0.22	0.19	-0.25	0.19	-0.74	-0.34	0.04	-1.20
1974.1	-0.45	-0.40	-0.14	-0.13	-0.07	-0.36	-0.19	-1.37
1978.2	0.18	0.04	0.24	0.27	0.67	1.07	0.03	2.44
1978.3	-0.12	0.03	-0.04	-0.04	-0.20	-0.59	0.08	-1.03
1980.2	-0.55	-0.29	-0.31	-0.46	-0.24	-0.58	-0.39	-2.05
1980.3	0.20	-0.17	0.11	0.54	-0.43	0.67	-0.46	1.38
1980.4	0.47	-0.05	0.10	0.17	0.50	0.90	0.15	1.94
1981.3	-0.14	-0.02	0.16	-0.17	0.62	0.60	-0.17	1.22
1982.1	0.04	-0.02	0.15	0.11	-0.71	-0.80	-0.23	-1.01
1982.2	0.00	-0.10	0.05	-0.02	0.28	0.68	-0.21	1.11
1984.2	0.11	0.35	0.08	0.00	0.49	0.30	0.26	1.08
1990.4	-0.42	-0.25	-0.13	-0.06	-0.55	-0.06	-0.38	-1.09
1997.2	0.07	-0.08	-0.07	0.05	0.89	0.37	0.20	1.03
2000.1	0.53	-0.17	0.18	-0.04	-0.62	-0.46	0.52	-1.10
2001.1	-0.05	-0.18	-0.02	-0.05	-0.83	-0.48	-0.21	-1.40
2004.1	-0.03	0.06	0.07	-0.01	-0.18	-0.75	0.19	-1.04
2008.1	-0.02	-0.18	-0.25	-0.10	-0.43	-0.28	-0.04	-1.22
2008.4	-0.05	-0.16	-0.46	-0.14	-0.71	-0.69	-0.65	-1.56
2014.1	-0.15	-0.08	-0.03	-0.02	-0.30	-0.46	0.13	-1.18

CS = service consumption, CN = nondurable consumption,
CD = durable consumption, IHH = housing investment,
IKF = plant and equipment investment, IVF = inventory investment,
IM = imports, $GDPR$ = real GDP,
all in 2012 dollars.

4 The Exogenous Variables

Five exogenous variables are of interest to examine before discussing the predictions. These are plotted in Figures 4–8. For all but Figures 6a and 7 the values are deviations from trend, as in Figure 1 for the log of real per capita GDP. The variable in Figure 4 is the log of real government purchases of goods and services per capita, federal and state and local combined. The variation in this variable is large. The variable rises to a peak in the late 1960's, falls to a trough in the late 1970's, rises to the mid 1980's, stays relatively flat until 2010, and then falls sharply after that. The sum of federal and state and local real government purchases of goods and services will be denoted G below. The variable in Figure 5 is the log of the exogenous component of real government transfer payments per capita (unemployment insurance benefits excluded), federal and state and local combined. The spikes are special one time transfers. The variable trended up until the mid 1970's and then has fallen gradually except for increases in the 2008–2009 recession. The sum of real federal and state and local government transfer payments will be denoted TR below.

The variable in Figure 6 is the log of the real value of household wealth per capita, which in the notation in Section 2 if the log of AA per capita. Remember that AA is the sum of financial wealth and housing wealth. Fluctuations in housing wealth are dominated by fluctuations in the market price of housing, denoted PKH in Section 2. Figure 6a plots the ratio of this price to the price deflator for domestic sales, PD. From this figure one can see that housing prices became important beginning in the mid 1990's, rising rapidly to 2006, falling rapidly to 2012, and then rising rapidly again. This means that most of the fluctuations in total wealth in Figure 6 are due to fluctuations in financial wealth prior to 1995. After that, housing wealth fluctuations substantially contribute. In 2019.4, $AA1$, real financial wealth, was \$62.8 trillion and $AA2$, real housing wealth, was \$27.3 trillion, both in 2012 dollars.

Figure 4
Log of Real Per Capita Government Purchases of Goods and Services
Deviation From Trend
1954.1--2019.4

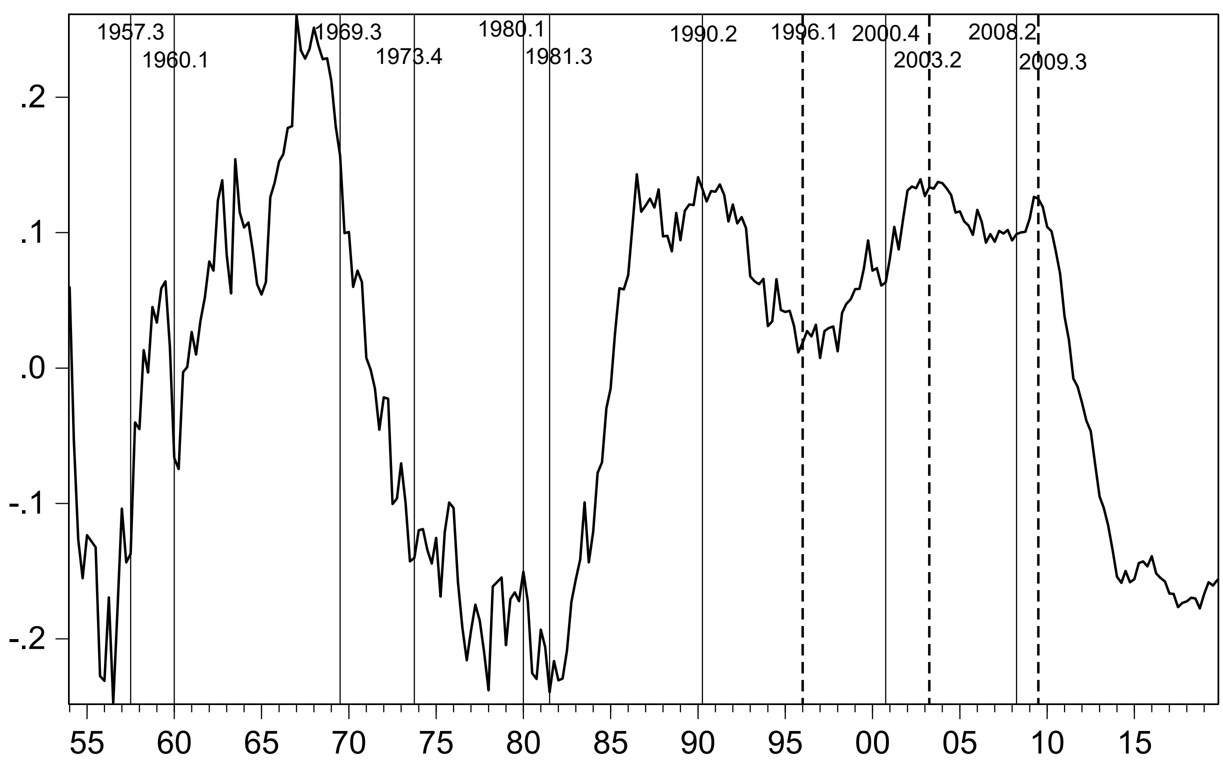


Figure 5
Log of Real Per Capita Government Transfer Payments
Deviation From Trend
1954.1--2019.4

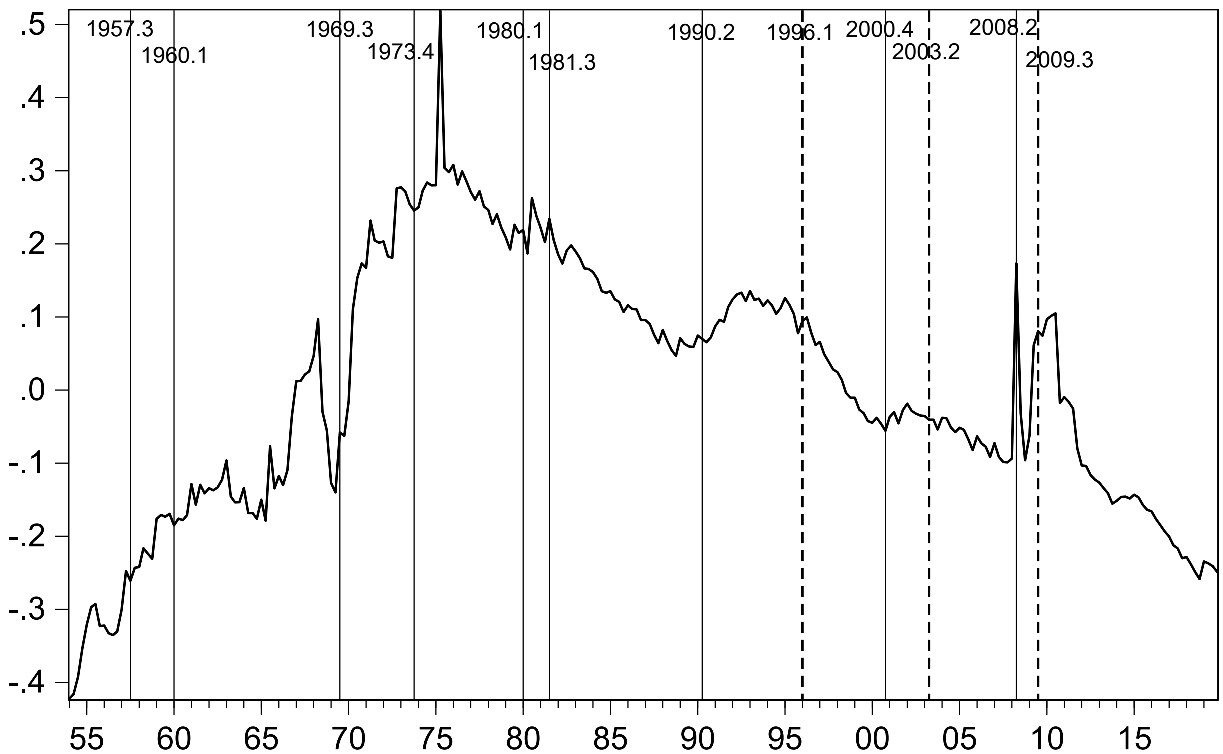


Figure 6
Log of Real Per Capita Household Wealth
Deviation From Trend
1954.1--2019.4

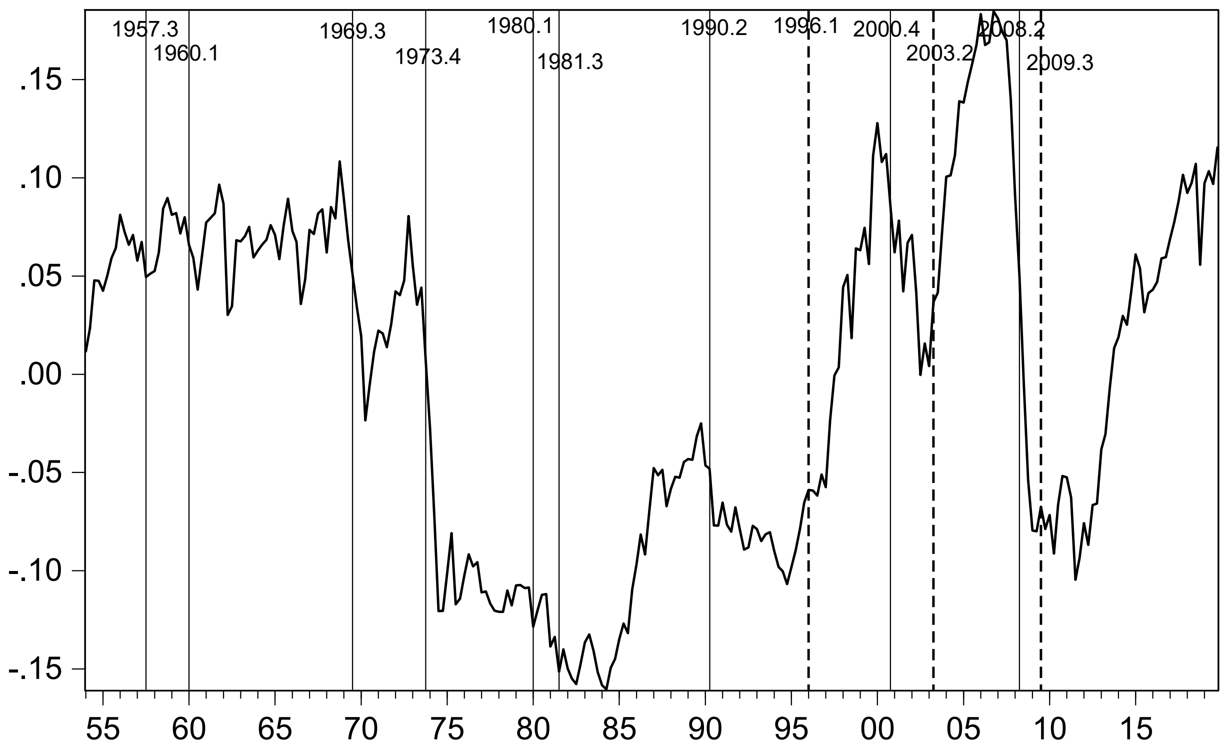


Figure 6a
PKH/PD
1954.1--2019.4

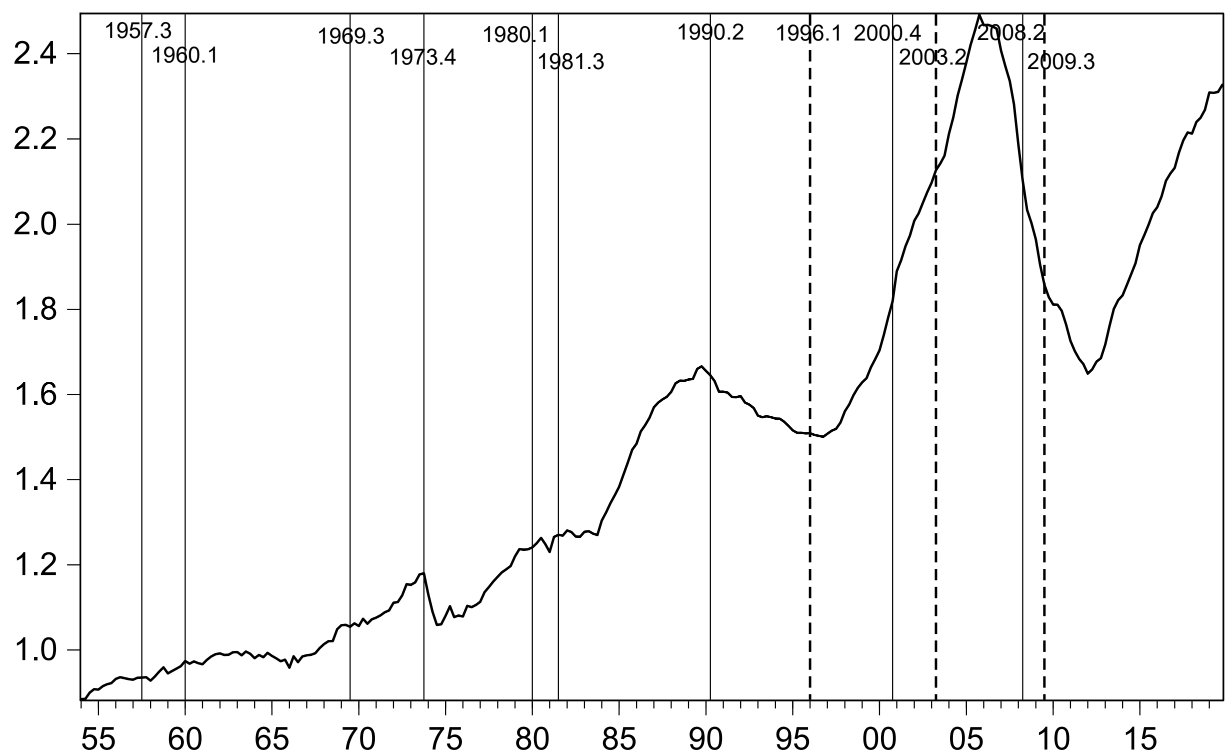


Figure 7
Import Price Deflator/Firm Sector Output Price Deflator
1954.1--2019.4

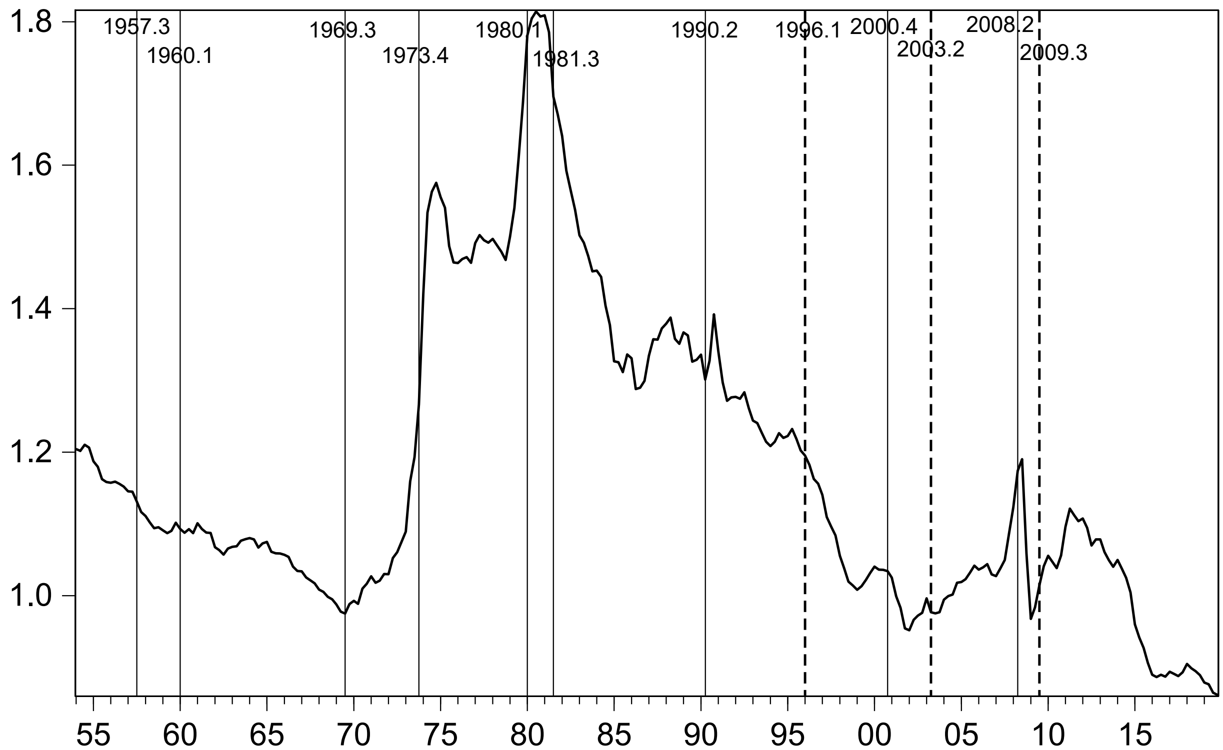
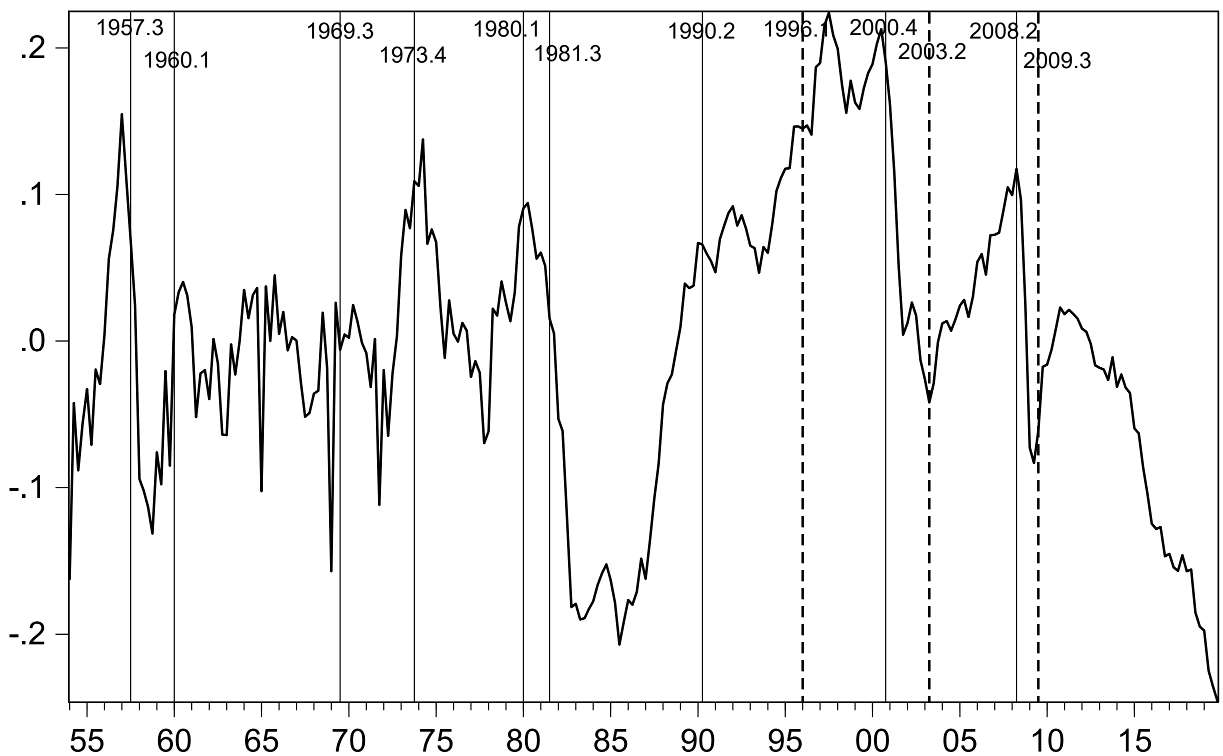


Figure 8
Log of Real Per Capita Exports
Deviation From Trend
1954.1--2019.4



As discussed above, PKH/PD is taken to be exogenous. It is essentially an asset price, and changes in it are largely unpredictable. Looking at Figure 6a, it seems unlikely that a model could be developed that would explain the change in PKH/PD over the 1954.1–2019.4 period. While the ratio is exogenous, PKH is endogenous because PD is. Also, in the definition of $AA2$ both KH and PH are endogenous, and so $AA2$ is endogenous. What is taken as exogenous in the experiments is just the ratio PKH/PD. Likewise $AA1$ is endogenous since AH and PH are. What is taken as exogenous in the experiments is CG in the definition of AH. The log of AA per capita in Figure 6 is thus endogenous. It is plotted here just for reference purposes. Remember, however, that most of its fluctuations are due to fluctuations in CG and PKH/PD, in other words, to unpredictable changes in asset prices. .

The variable in Figure 7 is the import price deflator divided by the price deflator for the firm sector. The plot shows the large increase in import prices, driven by oil prices, in the 1970's, the stagflation years. Since 1980 import prices have mostly fallen relative to the output price deflator. As will be seen, PIM is important in helping to explain R1974, R1980, and R1981. Finally, the variable in Figure 8 is the log of real exports per capita. Exports fell substantially in the early 1980's, rose in the late 1980's to a peak in the late 1990's, and have essentially fallen since then (all this relative to trend).

5 Predicting the Twelve Episodes

Recessions

Results for the nine recessions are in Table 2, and results for the three expansions are in Table 3. For each episode the errors in the stochastic equations were set to zero and the model was solved for the relevant period. This is a dynamic simulation. Differences between the actual values and the predicted values are errors. Results for real GDP (in 2012 dollars), $GDPR$, the unemployment rate, UR, and the three month Treasury bill rate, RS, are presented in the tables.

Consider the first recession, R1957. The prediction was for three quarters, beginning in 1957.4. Actual values of all variables were used for 1957.3 and back, and actual values of the exogenous variables were used for the three quarters. Table 2 shows that the predicted value of $GDPR$ was \$3,014 billion for 1957.4, which is 1.0 percent higher than the actual value of \$2,984 billion. For UR the predicted value was 4.4 percent, which is 0.5 percentage points lower than the actual value of 4.9 percent. For RS the predicted value was 3.3 percent, which is equal to the actual value. For the other two quarters the $GDPR$ errors were both 3.8 percent, the UR errors were -1.8 and -3.1 percentage points respectively, and the RS errors were 1.6 and 2.8 percentage points respectively. The last row of numbers for this recession contains the changes from the quarter before the recession started, 1957.3, and the last quarter of the recession, 1958.2. For $GDPR$ the actual change was -3.0 percent and the predicted change was 0.8 percent. For UR the actual change was 3.2 percentage points and the predicted change was 0.0. For RS the actual change was -2.4 percentage points and the predicted change was 0.4. The same format holds for all the other episodes in Tables 2 and 3. The following discussion will focus on the totals.

For R1957 the period was predicted to be one of sluggish growth, 0.8 percent, but the actual growth was much lower at -3.0 percent. UR rose, and it was predicted not to. Given that the actual values of the exogenous variables were used, this says

Table 2
Predictions of the Nine Recessions

		$GDPR$			UR			RS	
Qtr.	Act.	Pred.	%Err.	Act.	Pred.	Err.	Act.	Pred.	Err.
R1957									
1957.3	3015.			4.2			3.4		
1957.4	2984.	3014.	1.0	4.9	4.4	-0.5	3.3	3.3	-0.0
1958.1	2906.	3016.	3.8	6.3	4.4	-1.8	1.8	3.4	1.6
1958.2	2925.	3038.	3.8	7.4	4.2	-3.1	1.0	3.8	2.8
Total	-3.0	0.8		3.2	0.0		-2.4	0.4	
R1960									
1960.1	3276.			5.2			3.9		
1960.2	3258.	3281.	0.7	5.2	5.2	0.0	3.1	3.5	0.4
1960.3	3274.	3304.	0.9	5.5	5.2	-0.3	2.4	3.5	1.1
1960.4	3232.	3308.	2.4	6.3	5.2	-1.0	2.4	3.7	1.3
1961.1	3254.	3326.	2.2	6.8	5.2	-1.6	2.4	3.7	1.4
Total	-0.7	1.5		1.6	0.0		-1.6	-0.2	
R1969									
1969.3	4968.			3.6			7.0		
1969.4	4944.	4943.	0.0	3.6	4.1	0.5	7.3	6.9	-0.4
1970.1	4936.	4940.	0.1	4.2	4.7	0.5	7.3	6.1	-1.2
1970.2	4944.	4956.	0.2	4.7	5.1	0.4	6.8	5.6	-1.2
1970.3	4989.	4972.	-0.4	5.2	5.6	0.4	6.4	5.3	-1.1
1970.4	4936.	4963.	0.6	5.8	5.8	0.0	5.4	5.3	-0.1
Total	-0.7	-0.1		2.2	2.2		-1.7	-1.8	
R1974									
1973.4	5728.			4.8			7.5		
1974.1	5679.	5751.	1.3	5.1	5.0	0.0	7.6	6.8	-0.8
1974.2	5692.	5787.	1.7	5.2	5.3	0.1	8.3	7.2	-1.1
1974.3	5638.	5774.	2.4	5.6	5.7	0.1	8.3	7.7	-0.6
1974.4	5616.	5749.	2.4	6.6	6.2	-0.3	7.3	7.3	0.0
1975.1	5548.	5754.	3.7	8.2	6.6	-1.6	5.9	6.9	1.1
1975.2	5588.	5776.	3.4	8.8	6.9	-1.9	5.4	6.8	1.4
Total	-2.4	0.8		4.1	2.2		-2.1	-0.7	

Table 2 (continued)
Predictions of the Nine Recessions

	$GDPR$			UR			RS		
Qtr.	Act.	Pred.	%Err.	Act.	Pred.	Err.	Act.	Pred.	Err.
R1980									
1980.1	6838.			6.3			13.5		
1980.2	6697.	6783.	1.3	7.3	6.7	-0.6	10.0	12.3	2.3
1980.3	6689.	6743.	0.8	7.7	7.6	-0.1	9.2	11.7	2.5
Total	-2.2	-1.4		1.4	1.3		-4.2	-1.7	
R1981									
1981.3	6978.			7.4			15.1		
1981.4	6902.	6894.	-0.1	8.2	8.0	-0.3	12.0	14.1	2.1
1982.1	6795.	6820.	0.4	8.8	8.7	-0.1	12.9	16.0	3.1
1982.2	6826.	6771.	-0.8	9.4	9.5	0.1	12.4	14.8	2.4
1982.3	6800.	6693.	-1.6	9.9	10.4	0.4	9.7	11.2	1.5
1982.4	6802.	6659.	-2.1	10.7	10.9	0.3	7.9	9.2	1.3
Total	-2.5	-4.6		3.3	3.5		-7.2	-5.9	
R1990									
1990.2	9392.			5.3			7.8		
1990.3	9398.	9401.	0.0	5.7	5.7	0.0	7.5	7.3	-0.2
1990.4	9313.	9402.	1.0	6.1	6.1	0.0	7.0	6.8	-0.3
1991.1	9269.	9433.	1.8	6.6	6.3	-0.3	6.1	6.1	0.1
Total	-1.3	0.4		1.2	1.0		-1.7	-1.6	
R2001									
2000.4	13260.			3.9			6.0		
2001.1	13223.	13395.	1.3	4.2	3.9	-0.3	4.8	5.9	1.1
2001.2	13300.	13385.	0.6	4.4	4.0	-0.4	3.7	6.0	2.4
2001.3	13245.	13312.	0.5	4.8	4.3	-0.5	3.2	5.7	2.6
2001.4	13281.	13254.	-0.2	5.5	4.8	-0.7	1.9	5.2	3.3
Total	0.2	-0.1		1.6	0.9		-4.1	-0.8	
R2008									
2008.2	15752.			5.3			1.6		
2008.3	15667.	15740.	0.5	6.0	5.7	-0.3	1.5	2.0	0.6
2008.4	15328.	15505.	1.2	6.9	6.4	-0.5	0.3	1.8	1.5
2009.1	15156.	15213.	0.4	8.3	7.3	-1.0	0.2	1.2	1.0
2009.2	15134.	15089.	-0.3	9.3	8.1	-1.2	0.2	0.2	0.1
Total	-3.9	-4.2		4.0	2.8		-1.5	-1.4	

Table 3
Predictions of the Three Expansions

	$GDPR$			UR			RS		
Qtr.	Act.	Pred.	%Err.	Act.	Pred.	Err.	Act.	Pred.	Err.
E1996									
1996.1	10818.			5.5			5.0		
1996.2	10998.	10969.	-0.3	5.5	5.3	-0.1	5.0	4.8	-0.2
1996.3	11097.	11069.	-0.3	5.3	5.3	0.0	5.1	4.8	-0.4
1996.4	11212.	11214.	0.0	5.3	5.2	-0.2	5.0	4.8	-0.2
1997.1	11285.	11358.	0.6	5.2	5.2	0.0	5.1	4.5	-0.6
1997.2	11472.	11465.	-0.1	5.0	5.1	0.1	5.1	4.3	-0.8
1997.3	11616.	11612.	0.0	4.9	4.9	0.0	5.1	4.4	-0.6
1997.4	11716.	11710.	-0.1	4.7	4.8	0.1	5.1	4.4	-0.7
1998.1	11833.	11790.	-0.4	4.6	4.7	0.1	5.1	4.3	-0.7
1998.2	11942.	11932.	-0.1	4.4	4.6	0.2	5.0	4.3	-0.7
1998.3	12092.	12034.	-0.5	4.5	4.5	0.0	4.8	4.3	-0.5
1998.4	12287.	12182.	-0.9	4.4	4.5	0.1	4.3	4.3	0.1
1999.1	12403.	12296.	-0.9	4.3	4.3	0.0	4.4	4.5	0.1
1999.2	12499.	12424.	-0.6	4.2	4.2	0.0	4.5	4.7	0.2
1999.3	12662.	12556.	-0.8	4.2	4.1	-0.1	4.7	4.7	0.0
1999.4	12878.	12677.	-1.6	4.1	4.0	0.0	5.0	4.7	-0.3
2000.1	12924.	12798.	-1.0	4.0	3.4	-0.6	5.5	5.5	0.0
2000.2	13161.	12897.	-2.0	3.9	3.3	-0.6	5.7	5.8	0.0
Total	21.7	19.2		-1.6	-2.2		0.8	0.8	
Total,ar	(4.7)	(4.2)							
E2003									
2003.2	13752.			6.2			1.0		
2003.3	13985.	13900.	-0.6	6.1	6.1	0.0	0.9	1.3	0.4
2003.4	14146.	14036.	-0.8	5.8	5.9	0.1	0.9	1.7	0.8
2004.1	14221.	14186.	-0.2	5.7	5.5	-0.2	0.9	2.2	1.3
2004.2	14330.	14318.	-0.1	5.6	5.1	-0.5	1.1	2.6	1.5
2004.3	14465.	14413.	-0.4	5.4	4.9	-0.5	1.5	2.8	1.3
2004.4	14610.	14492.	-0.8	5.4	4.8	-0.6	2.0	3.1	1.1
2005.1	14772.	14638.	-0.9	5.3	4.5	-0.8	2.5	3.6	1.1
2005.2	14840.	14779.	-0.4	5.1	4.3	-0.8	2.9	4.0	1.1
2005.3	14972.	14872.	-0.7	5.0	4.1	-0.8	3.4	4.2	0.9
2005.4	15067.	14943.	-0.8	5.0	4.1	-0.8	3.8	4.3	0.5
2006.1	15267.	15064.	-1.3	4.7	3.9	-0.8	4.4	4.4	0.0
Total	11.0	9.5		-1.4	-2.2		3.4	3.4	
Total,ar	(3.9)	(3.4)							

Table 3 (continued)
Predictions of the Three Expansions

	GDPR			*UR*			*RS*		
Qtr.	Act.	Pred.	%Err.	Act.	Pred.	Err.	Act.	Pred.	Err.
E2009									
2009.3	15189.			9.6			0.2		
2009.4	15356.	15340.	-0.1	9.9	9.6	-0.3	0.1	0.0	-0.1
2010.1	15415.	15378.	-0.2	9.9	9.5	-0.4	0.1	0.0	-0.1
2010.2	15557.	15435.	-0.8	9.7	9.2	-0.5	0.1	0.0	-0.1
2010.3	15672.	15466.	-1.3	9.5	9.3	-0.2	0.2	0.0	-0.2
2010.4	15751.	15526.	-1.4	9.5	9.3	-0.3	0.1	0.0	-0.1
2011.1	15713.	15561.	-1.0	9.1	9.1	0.0	0.1	0.4	0.3
2011.2	15825.	15596.	-1.5	9.1	9.1	0.0	0.0	0.8	0.7
2011.3	15821.	15616.	-1.3	9.0	9.1	0.1	0.0	0.5	0.5
2011.4	16004.	15656.	-2.2	8.7	9.2	0.5	0.0	0.6	0.5
2012.1	16130.	15733.	-2.5	8.3	9.1	0.8	0.1	0.7	0.6
2012.2	16199.	15786.	-2.5	8.2	9.1	0.9	0.1	0.5	0.5
2012.3	16221.	15830.	-2.4	8.0	9.0	1.0	0.1	0.1	0.0
2012.4	16239.	15866.	-2.3	7.8	9.0	1.2	0.1	0.0	0.0
2013.1	16383.	15898.	-3.0	7.8	9.0	1.3	0.1	0.3	0.2
2013.2	16403.	15950.	-2.8	7.5	9.0	1.5	0.1	0.2	0.1
2013.3	16532.	16012.	-3.1	7.3	9.0	1.8	0.0	0.0	0.0
2013.4	16664.	16153.	-3.1	7.0	8.9	1.9	0.1	0.1	0.1
2014.1	16616.	16299.	-1.9	6.6	8.6	2.0	0.0	0.5	0.4
2014.2	16842.	16495.	-2.1	6.2	8.2	2.0	0.0	0.6	0.6
2014.3	17047.	16696.	-2.1	6.1	7.9	1.8	0.0	0.8	0.8
2014.4	17143.	16876.	-1.6	5.7	7.5	1.7	0.0	1.1	1.1
2015.1	17278.	17042.	-1.4	5.5	7.1	1.6	0.0	1.1	1.1
2015.2	17406.	17236.	-1.0	5.4	6.7	1.3	0.0	1.3	1.2
2015.3	17463.	17374.	-0.5	5.1	6.5	1.4	0.0	1.5	1.5
2015.4	17469.	17463.	0.0	5.0	6.4	1.4	0.1	1.4	1.3
Total	15.0	15.0		-4.6	-3.2		-0.1	1.2	
Total,ar	(2.3)	(2.3)							

ar = annual rate

that the information in the exogenous variables (as filtered through the model) do not suggest negative growth. The recession is thus primarily due to shocks to the stochastic equations, which are unexplained. Table 1 shows that the main shocks were in 1958.1. There were negative and fairly large shocks to the seven consumption and investment equations (and essentially a zero shock to the import equation). If the actual errors are used in the stochastic equations for 1958.1, but zero errors otherwise, the predictions are much better. $GDPR$ is predicted to fall by 2.1 percent over the period (versus -3.0 actual), and UR is predicted to fall by 3.5 percentage points (versus 3.2 actual). Because of the more sluggish economy, the Fed is predicted to lower RS by 2.2 percentage points, compared to the actual lowering of 2.4 percentage points. This is thus an accurate prediction, and so it can be said that much of the recession was due to unexplained aggregate demand shocks in 1958.1.

R1960 was a fairly mild recession, and the predictions are not as far off as they are for R1957. The four quarters were predicted to be sluggish, 1.5 percent growth, and the actual growth was -0.7 percent. Regarding shocks to the stochastic equations, Table 1 shows negative shocks to the three investment equations in 1960.2. If the actual errors are used for this quarter, but zero errors otherwise, $GDPR$ is predicted to rise by only 0.4 percent rather than 1.5 percent without these errors, and UR is predicted to rise by 0.5 percentage points rather than not at all. Both of these are closer to the actual values. So some of this (mild) recession was due to unexplained investment shocks in 1960.2.

The next recession, R1969, was also mild, and it was predicted well. When a recession is predicted well, one can ask whether there are large fluctuations in any of the key exogenous variables that contributed to the contraction. From Figure 4 G noticeably fell, and from Figure 6 AA fell. To examine the effects of this, a simulation was run in which for the five quarters the capital gains ratio discussed in Section 2, $CG/(PX_{-1}YS_{-1})$, was taken to be its historical average of 0.124 and government purchases of goods and services, G, was taken to be equal to its value in 1969.3. In other words, no G decreases and no stock price decreases (SP normal). For this simulation the actual values of the residuals were added to the stochastic equations and taken to be exogenous. This means that if a prediction is made using actual values of all the exogenous variables, a perfect tracking solution results. The two exogenous variable changes were made and the model was solved. The difference between the predicted value and the actual value for a particular variable and quarter is the estimated effect of the changes on the variable.

Results are presented in Table 4 for $GDPR$, UR, and RS for all five quarters. For $GDPR$ the values are percent changes from the actual values, and for UR and RS the values are percentage point changes. Also presented are the average changes over the five quarters. For example, $GDPR$ is on average 1.1 percent higher. If one sums the absolute changes in $GDPR$ over the five quarters and divides this by the sum of the five levels of $GDPR$, this would be roughly 1.1 percent because the five levels are fairly similar. So the 1.1 percent is a good metric to use to measure the overall effect of the exogenous variable changes. The result is thus that had G not fallen and had stock prices been normal rather than falling, $GDPR$ would have been on average 1.1 percent higher. The average unemployment rate would have been 0.4 percentage points lower, and the average bill rate would have been 0.5 percentage points higher. This mild recession is thus at least partly due to falling stock price and and falling government purchases of goods and services.[6]

R1974 is a stagflation recession. Table 2 shows that over the six quarters $GDPR$ fell by 2.4 percent. The model predicted a sluggish period with $GDPR$ rising only 0.8 percent. UR rose 4.1 percentage points and was predicted to rise by 2.2 points. Some of this recession was thus predicted, but not all. Figure 7 shows that the import price deflator, PIM, was high during this period, which in the model, as discussed above, is inflationary and contractionary. Although

[6]For this experiment PKH/PD was not changed. As can be seen in Figure 6a, this variable only becomes important in the mid 1990's.

Table 4
Estimated Exogenous Variable
Contributions to the Recessions

	$GDPR$ new/act.	UR new-act.	RS new-act.
R1969: SP normal & G flat			
1969.4	0.5	-0.1	0.1
1970.1	0.8	-0.2	0.3
1970.2	1.1	-0.4	0.5
1970.3	1.4	-0.6	0.7
1970.2	1.6	-0.8	0.9
$\sum/5$	1.1	-0.4	0.5
R1974: SP normal & PIM flat			
1974.1	0.1	-0.0	-0.6
1974.2	0.4	-0.1	-1.3
1974.3	0.9	-0.3	-1.5
1974.4	1.6	-0.6	-1.3
1975.1	2.4	-1.0	-1.0
1975.2	3.0	-1.3	-0.7
$\sum/6$	1.4	-0.6	-1.1
R2001: SP normal & EX flat			
2001.1	0.1	-0.0	0.0
2001.2	0.6	-0.2	0.2
2001.3	1.4	-0.5	0.4
2001.4	2.1	-0.8	0.8
$\sum/4$	1.1	-0.4	0.4
R2008: SP normal & PKH/PD flat &EX flat			
2008.3	0.0	-0.0	-0.0
2008.4	1.2	-0.4	0.3
2009.1	3.2	-1.1	1.1
2009.2	4.7	-1.9	1.8
$\sum/4$	2.3	-0.9	0.8

not shown in the table, the actual percentage change in the GDP deflator over the six quarters was 14.7 percent. The prediction from the model was close at 15.6 percent, driven by the high values of PIM. Figure 6 shows that there was a fall in AA during this period. This is partly from a fall in nominal stock prices and partly from the increase in the price level. This fall in AA contributed to the contraction. Regarding interest rates, in this case of high inflation and rising unemployment the Fed's response could go either way. Table 2 shows that the Fed initially increased the interest rate (through 1974.3) and then began lowering it. The predicted values from the estimated Fed rule captured this pattern. The Fed thus initially contributed to the contraction. So part of this recession is explained by the high values of PIM and the fall in AA. Regarding unexplained shocks, Table 1 shows that there was one quarter of large negative shocks, 1974.1. If the actual errors are used for this quarter, but zero errors otherwise, the predicted GDP growth is -0.2 percent versus 0.8 percent with zero errors. UR rises by 2.7 points rather than 2.2 points. Part of this recession is thus also due to unexplained negative errors in 1974.1.

It is interesting to see how much of the R1974 recession is due to the rise in PIM and the fall in wealth. In a manner similar to that done for R1969, a simulation was run in which PIM was taken to be its value in 1973.4 and $CG/(PX_{-1}YS_{-1})$ was taken to be 0.124. In other words, no import price increases and no stock price decreases. The results are presented in Table 4. $GDPR$ is on average 1.4 percent higher, UR is on average 0.6 points lower, and RS is on average 1.1 points lower. Not shown in the table but the predicted percentage change in the GDP deflator over the 6 quarters is 9.4 percent, which compares to the actual value of 14.7 percent. This reflects the effects of not having PIM rise. The lower inflation led to lower predictions of RS through the estimated Fed rule.

The remaining five recessions are predicted fairly well, including R2008, sometimes called the Great Recession. One does not have to rely on unexplained shocks to explain them. For the most part the recessions are explained by the exogenous variables as filtered through the model.

For R1980 the main culprit is the high values of PIM (Figure 7), which are contractionary. For R1981 the values of PIM are also high, although falling, which led to high inflation values and high values of RS (the Fed's reaction), both actual and predicted.[7] Exports also fell during the period (Figure 8), which contributed to the contraction.

R1990 was a mild recession. There are no large changes in the exogenous variables in this period, although AA did fall somewhat (Figure 6). In this recession there are thus no one or two exogenous variables that stand out as the main causes.

R2001 was also mild. In this case there is a fall in AA (Figure 6) and a large fall in exports (Figure 8). The fall in AA is only financial wealth since relative housing prices rose (Figure 6a). For this recession it is interesting to see how much of the recession is due to the fall in exports and stock prices. A simulation was run in which for all four quarters EX was taken to be its value in 2000.4 and $CG/(PX_{-1}YS_{-1})$ was taken to be 0.124. In other words, no export decline and no stock price decreases. The results are presented in Table 4. $GDPR$ is on average 1.1 percent higher, UR is on average 0.4 points lower, and RS is on average 0.4 points higher. This recession is thus at least partly due to falling exports and falling stock prices. This conclusion is the same as that in Fair (2005) using the entire MC model, namely that wealth effects and export effects dominate this period.

R2008, sometimes called the "Great Recession," is predicted well. The two exogenous variables that stand out in this period are AA (Figure 6) and EX (Figure 8), both falling substantially. In this case the fall in AA is partly due to a fall in relative housing prices (Figure 6a). To see the effects of falling AA and EX, a simulation was run in which for all four quarters EX was taken to be its value in 2008.2, $CG/(PX_{-1}YS_{-1})$ was taken to be 0.124, and PKH/PD was taken to be its value in 2008.2. In other words, no export decline, no stock price decreases, and no housing price decreases. The results are presented in Table 4, and they are

[7] The actual percentage change in the GDP deflator over the 6 quarters is 7.1 percent, and the predicted change is 6.1 percent.

large. $GDPR$ is on average 2.4 percent higher, UR is on average 0.9 points lower, and RS is on average 0.8 points higher. In 2009.2 the predicted value of $GDPR$ is 4.7 percent higher, and the predicted value of UR is 1.9 points lower. As was the case for R2001, R2008 is at least partly due to falling exports and falling wealth, in this case both financial and housing wealth. This conclusion is the same as that in Fair (2017) using the entire MC model, namely that wealth effects and export effects dominate this period.

Note that in predicting R2008 no use has been made of credit constraint variables and the like. In Fair (2017) I have added the corporate AAA/BBB spread and the 10-year government/corporate AAA spread to the four household expenditure equations, and none of the spreads tried were significant. I also tried two variables from Carroll, Slacalek, and Sommer (2013), one measuring credit constraints and one measuring labor income uncertainty, and these were not significant. I also tried the excess bond premium (EBP) variable from Gilchrist and Zakrajšek (2012). This variable has a large spike in the 2008–2009 recession. It is not significant when the estimation period ends in 2007.4, but it is for the period ending in 2010.3. The evidence for EBP is thus mixed, depending on how much weight one puts on possible data mining, since it was created after the recession was known. In general there appears to be little independent information in spreads and other measures of financial difficulties not in the wealth variable AA.

Expansions

The predictions for the three expansions are presented in Table 3. All three are predicted well. The growth rate at an annual rate over each period is presented. For E1996 it is 4.7 percent actual and 4.2 percent predicted. For E2003 it is 3.9 percent actual and 3.4 percent predicted. For E2009 it is 2.3 percent actual and 2.3 percent predicted.

For E1996 and E2003 the story is mostly asset price increases. In Figure 6 AA

rose substantially in both cases, and Figure 6a shows that housing wealth increases contributed. To examine wealth effects for E1996 a simulation was run in which for all 18 quarters $CG/(PX_{-1}YS_{-1})$ was taken to be 0.124 and PKH/PD was taken to be its value in 1996.1. In other words, no unusual stock price increases and no relative housing price increases. The results are presented in Table 5. $GDPR$ is on average 1.1 percent lower, UR is on average 0.6 points higher, and RS is on average 0.7 points lower. For 2002.2 the predicted value of $GDPR$ is 2.8 percent lower and the predicted value of UR is 1.5 points higher. This expansion was thus driven by wealth increases. This conclusion is the same as that in Fair (2004) using the entire MC model, namely that wealth effects dominate this period.

A similar experiment was run for E2003. A simulation was run in which for all 11 quarters $CG/(PX_{-1}YS_{-1})$ was taken to be 0.124 and PKH/PD was taken to be its value in 2003.2. In other words, no unusual stock price increases and no relative housing price increases. The results are presented in Table 5, and they are large. $GDPR$ is on average 3.4 percent lower, UR is on average 1.9 points higher, and RS is on average 1.9 points lower. In 2006.1 the predicted value of $GDPR$ is 5.4 percent lower and the predicted value of UR is 3.2 points higher. Again, an expansion driven by wealth increases.

The expansion E2009 has been consider a puzzle in having fairly low growth rates. The economy did not come rapidly out of the recession. In this case it is not due to AA declines because it rose, including housing wealth (Figures 6 and 6a). It is the case, however, that both G in Figure 4 and TR in Figure 5 noticeably fell. According to the model, these declines offset some of the stimulus from the increase in wealth. To examine this, a simulation was run in which for all 25 quarters G was taken to be its value in 2009.3 and TR was taken to be its value in 2009.3. In other words, no decline in these variables, although no increases either. The results are presented in Table 5. $GDPR$ is on average 1.1 percent higher, UR is on average 0.4 points lower, and RS is on average 0.6 points higher. The sluggish expansion is thus due in part to sluggish values of government spending,

Table 5
Estimated Exogenous Variable Contributions to the Expansions

	$GDPR$ new/act.	UR new-act.	RS new-act.
E1996: SP normal & PKH/PD flat			
1996.2	0.0	0.0	0.0
1996.3	0.0	0.0	0.0
1996.4	0.0	0.0	0.0
1997.1	0.0	0.0	0.0
1997.2	0.0	0.0	0.0
1997.3	-0.2	0.1	-0.1
1997.4	-0.4	0.2	-0.2
1998.1	-0.7	0.4	-0.4
1998.2	-1.1	0.6	-0.6
1998.3	-1.5	0.8	-0.8
1998.4	-1.7	0.9	-1.0
1999.1	-1.9	1.1	-1.2
1999.2	-2.0	1.2	-1.3
1999.3	-2.1	1.2	-1.4
1999.4	-2.3	1.3	-1.5
2000.1	-2.5	1.4	-1.7
2000.2	-2.8	1.5	-1.9
$\sum/17$	-1.1	0.6	-0.7
E2003: SP normal & PKH/PD flat			
2003.3	0.0	0.0	0.0
2003.4	-0.7	0.3	-0.2
2004.1	-1.6	0.7	-0.7
2004.2	-2.5	1.2	-1.1
2004.3	-3.4	1.7	-1.5
2004.4	-4.0	2.1	-2.0
2005.1	-4.5	2.5	-2.5
2005.2	-4.8	2.8	-2.9
2005.3	-5.1	3.0	-3.2
2005.4	-5.3	3.1	-3.4
2006.1	-5.4	3.2	-3.6
$\sum/11$	-3.4	1.9	-1.9

Table 5 (continued)
Estimated Exogenous Variable
Contributions to the Expansions

	$GDPR$ new/act.	UR new-act.	RS new-act.
E2009: G flat & TR flat			
2009.4	0.0	0.0	0.0
2010.1	0.0	0.0	0.0
2010.2	-0.2	0.0	0.0
2010.3	-0.2	0.1	-0.1
2010.4	0.1	0.0	0.0
2011.1	0.5	-0.1	0.1
2011.2	0.9	-0.3	0.3
2011.3	1.2	-0.4	0.4
2011.4	1.3	-0.5	0.5
2012.1	1.4	-0.6	0.6
2012.2	1.5	-0.6	0.7
2012.3	1.5	-0.7	0.7
2012.4	1.6	-0.7	0.8
2013.1	1.8	-0.7	0.9
2013.2	1.8	-0.8	0.9
2013.3	1.8	-0.8	0.9
2013.4	1.9	-0.7	0.9
2014.1	2.0	-0.8	1.0
2014.2	1.9	-0.8	1.0
2014.3	1.7	-0.7	1.0
2014.4	1.5	-0.6	0.9
2015.1	1.3	-0.5	0.8
2015.2	1.1	-0.4	0.7
2015.3	0.9	-0.3	0.6
2015.4	0.8	-0.2	0.5
$\sum/11$	1.1	-0.4	0.6

government transfer payments, and exports. This conclusion about government spending and transfer payments is the same as that in Fair (2018a).

6 Conclusion

The following is a summary of the 12 episodes. All are well predicted by the US model conditional on the exogenous variables except for R1957, R1960, and part of R1974. SP denotes stock prices, which accounts for most of the fluctuations in financial wealth. PKH/PD is the relative price of housing, which accounts for most of the fluctuations in housing wealth. PIM is the import price deflator, which is influenced by oil prices. G is total government purchases of goods and services, TR is the exogenous component of total government transfer payments, and EX is exports.

1. R1957: Unexplained demand shocks in 1958.1.
2. R1960: Mild. Unexplained investment shocks in 1960.2.
3. R1969: Mild. Falling SP and G.
4. R1974: Partly unexplained demand shocks in 1974.1. Partly high values of PIM and falling SP.
5. R1980: High values of PIM.
6. R1981: High values of PIM and falling EX.
7. R1990: Mild. No salient exogenous variables.
8. E1996: Rising SP and PKH/PD.
9. R2001: Mild. Falling SP and EX.
10. E2003: Rising SP and PKH/PD.
11. R2008: Falling SP, PKH/PD, and EX. .
12. E2009: Sluggish expansion. Falling G and TR.

It is clear that one of the main driving forces is the change in asset prices, stock prices before 1995 and both stock prices and housing prices since. More detailed financial variables are not needed for the aggregate predictions. Import prices played an important role in the 1970's and early 1980's. Export declines were also important in a number of the recessions.

The effects of the exogenous variables on the economy are filtered through the US model. Misspecifications in the model will affect the accuracy of the effects. The fact that the model does well in predicting most of the episodes is support for it. If it were a poor approximation, one would expect more of a need to explain the fluctuations using the shocks to the stochastic equations. The model has been extensively tested, and in general it does well [MM, 3.6, 3.9, 3.10].

Finally, it is clear that the current pandemic recession is not due to fluctuations in the exogenous variables considered in this paper. There are huge shocks to some of the stochastic equations. For example, consumption of services in the second quarter of 2020 was much less than predicted by the stochastic equation for consumption of services. This is due in part to government mandated closures and in part to behavioral changes caused by health risks. This is a classic example of structural change, at least temporarily, which a macro model like the US model is not equipped to handle. There are no past pandemic observations to use.

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