Yale University

EliScholar – A Digital Platform for Scholarly Publishing at Yale

Cowles Foundation Discussion Papers | Cowles Foundation

3-1-2018

Explaining the Slow U.S.Recovery: 2010–2017

Ray C. Fair

Follow this and additional works at: https://elischolar.library.yale.edu/cowles-discussion-paper-series

 Part of the Economics Commons

Recommended Citation

Fair, Ray C., "Explaining the Slow U.S.Recovery: 2010–2017" (2018). *Cowles Foundation Discussion Papers*. 151.
https://elischolar.library.yale.edu/cowles-discussion-paper-series/151

This Discussion Paper is brought to you for free and open access by the Cowles Foundation at EliScholar – A Digital Platform for Scholarly Publishing at Yale. It has been accepted for inclusion in Cowles Foundation Discussion Papers by an authorized administrator of EliScholar – A Digital Platform for Scholarly Publishing at Yale. For more information, please contact elischolar@yale.edu.

EXPLAINING THE SLOW U.S. RECOVERY: 2010-2017

By

Ray C. Fair

March 2018

COWLES FOUNDATION DISCUSSION PAPER NO. 2124



COWLES FOUNDATION FOR RESEARCH IN ECONOMICS
YALE UNIVERSITY
Box 208281
New Haven, Connecticut 06520-8281

http://cowles.yale.edu/

Explaining the Slow U.S. Recovery: 2010–2017

Ray C. Fair*

March 2018

Abstract

This paper argues that the slow U.S. recovery after the 2008–2009 recession was due to sluggish government spending. The analysis uses a structural macroeconometric model. Conditional on government policy, the errors in predicting output for the 2009.4–2017.4 period are within what one would expect historically. Productivity and labor force participation are endogenous variables in the model, and so their behavior in this period is a consequence of the slow growth rather than a cause.

1 Introduction

U.S. output expanded more slowly after the 2008–2009 recession than might have been expected historically. Why? This paper argues that the slow recovery was due to sluggish government spending. Conditional on government policy, there is no puzzle. A structural macroeconometric model of the United States, denoted the "US model," is used in the analysis. The results show that conditional on the exogenous government policy variables, the errors in predicting output for the 2009.4–2017.4 period are within what one would expect historically.

*Cowles Foundation, Department of Economics, Yale University, New Haven, CT 06520-8281. e-mail: ray.fair@yale.edu; website: *fairmodel.econ.yale.edu*.

To get a quick picture of the argument, Figures 1–3 plot three government spending variables for the 2009.4–2017.4 period. Figure 1 plots federal government purchases of goods in real terms, variable COG in the model. This variable fell from the end of 2010 to the end of 2013 and then remained flat. Figure 2 plots federal transfer payments to households in real terms, variable $TRGHQ$ in the model. Due to the stimulus measures, transfer payments remained high until the fourth quarter of 2010, then fell rapidly to 2012, and then only slowly recovered after that. State and local government spending also contributed to the problem. Figure 3 plots state and local government purchases of goods in real terms, variable COS in the model. This variable fell substantially to 2013 and then only slowly recovered.

Much of the discussion of the sluggish output growth after 2009 has focused on productivity. An important recent paper is Fernald, Hall, Stock, and Watson (2017) (FHSW), who focus on the slow growth of total factor productivity and the decline in labor force participation. However, because of labor and capital hoarding, total factor productivity is endogenous—it depends on output. Also, labor force participation depends on the state of the economy and so is endogenous. Productivity and labor force participation are not exogenous driving forces that explain the disappointing recovery, but rather consequences of whatever the driving forces are. In the US model productivity and labor force participation are endogenous variables. It will be seen that their sluggish behavior is a consequence of the slow recovery caused by exogenous government spending decisions. The US model is briefly discussed in Section 2, and the solutions are discussed in Section 3.

This paper is not the first to point out that sluggish fiscal policy may have contributed to the slow growth after 2009. Eichengreen (2015) cites contractionary U.S. fiscal policy in 2011–2013, although he provides no estimates of the effects on the economy. FHSW (2017, pp. 52–53) point out the sluggish federal and state and local government expenditures following the 2008–2009 recession, but, as noted above, their emphasis is on low productivity growth and declining labor

Figure 1
COG: Federal Government Purchases of Goods
Billions of 2009 Dollars at Quarterly Rates
2009.4--2017.4

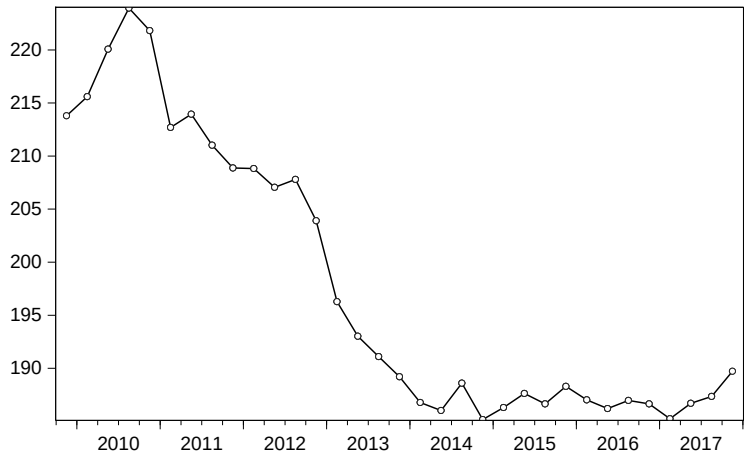


Figure 2
TRGHQ: Federal Government Transfer Payments to Households
Billions of 2009 Dollars at Quarterly Rates
2009.4--2017.4

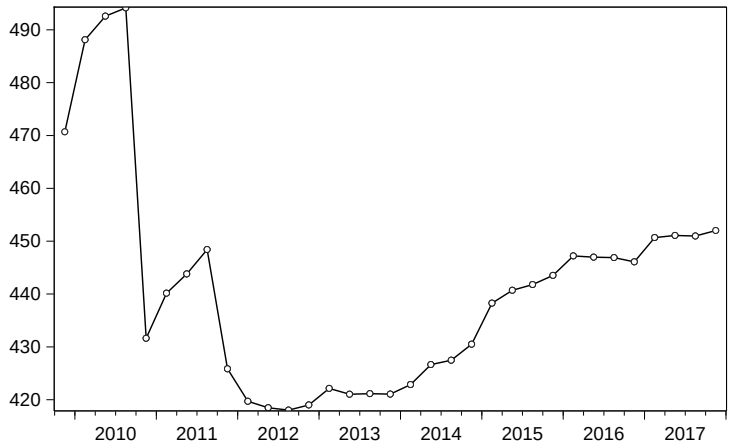
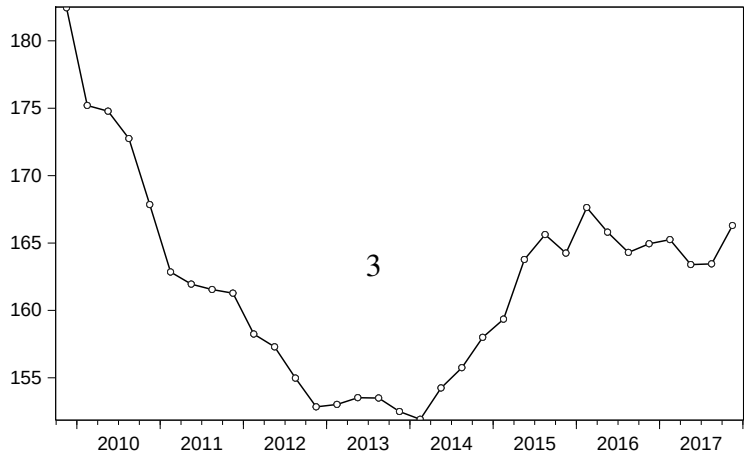


Figure 3
COS: State and Local Government Spending on Goods
Billions of 2009 Dollars at Quarterly Rates
2009.4--2017.4



force participation.[1]

Kydland and Zarazaga (2016) provide an alternative explanation of the slow recovery. Using a calibrated model they argue that fears of a switch to a higher-tax regime after the 2008-2009 account for much of the slow recovery. Baker, Bloom and Davis (2015) show that their measures of uncertainty are high during much of the slow-growth period, arguing that uncertainty may be a cause of slow growth. Hansen and Ohanian (2016) stress productivity shocks and other supply side shocks as causing much of the slow growth, as does Ohanian (2017) in his review of Eichengreen's book.

2 The US Model

The US model uses the methodology of structural macroeconometric modeling, sometimes called the "Cowles Commission" (CC) approach, which goes back at least to Tinbergen (1939). I have gathered my research in macroeconomics in one document, *Macroeconometric Modeling: 2018* (MM), on my website, and this document contains a complete description and listing of the US model. MM is written using the current version of the US model (January 30, 2018), where published results using earlier versions of the model have been updated.[2] The US model is not explained in this paper, and one should think of MM as an appendix to it. When appropriate, I have indicated in this paper in brackets the sections in MM that contain relevant discussion. This paper is thus not self contained. It is too much to try to put all the relevant information in one paper, hence the use of MM as an appendix. The methodology of the CC approach is also discussed and

[1] Some of the comments in the discussion of the FHSW paper argue that more emphasis should have been given to aggregate demand effects in explaining the slow recovery.

[2] Users can work with the US model on line or can download the model and related software to work with it on their own computer. If the model is downloaded, it can be modified and reestimated. Many of the results in MM can be duplicated on line. The US model is a subset of a larger multicountry model, the MC model, but for purposes of this paper the US model has been used alone.

defended in MM [Section 1.1].

In the US model there are three estimated consumption equations, three investment equations, an import equation, four labor supply equations, two labor demand equations, a price equation, a nominal wage equation, two term structure of interest rate equations, and an estimated interest rate rule of the Federal Reserve, among others. In the interest rate rule the Fed is estimated to respond to inflation and unemployment. There are a total of 25 estimated equations and about 100 identities. The unemployment rate is determined by an identity; it equals unemployment divided by the labor force. In the identities all flows of funds among the sectors (household, firm, financial, state and local government, federal government, and foreign) are accounted for. The federal government deficit is determined by an identity, as is the federal government debt. There is an estimated equation determining the interest payments of the federal government as a function of interest rates and the government debt.

The estimation period is 1954:1–2017:4, and the estimation technique is 2SLS. The estimation accounts for possible serial correlation of the error terms. When there is serial correlation, the serial correlation coefficients are estimated along with the structural coefficients. Identification is not a problem in this analysis. Many variables are excluded from each equation. Consistent 2SLS estimation of an equation requires that the first stage regressors be uncorrelated with the error term. Government policy variables and exports are used as first stage regressors in most equations, but always with a lag of one quarter to avoid any possible correlation of the current values of the variables and the error term. (Remember that any serial correlation of the error term has been eliminated in the estimation.)

Table 1 presents the variable notation used in this paper. MM [Section 6] provides a complete description of the variables. It also includes a list of the first stage regressors in each equation. The variables are quarterly time series variables. For ease of notation, time subscripts have not been used here.

Table 1
Variables in the US Model Referred to in this Paper

Variable	Type	Description
AA	endo	Total net financial and housing wealth, h, B2009$.
$cnst$	exog	Constant term.
$cnst2$	exog	0.0 before 1969:1, 0.0125 in 1969:1, 0.0250 in 1969:2, ... , 0.9875 in 1988:3, and 1.0 thereafter.
COG	exog	Purchases of consumption and investment goods, g, B2009$.
COS	exog	Purchases of consumption and investment goods, s, B2009$.
$D593$	exog	1 in 1959:3; 0 otherwise.
E	endo	Total employment, civilian and military, millions.
$GDPD$	endo	GDP price deflator.
HF	endo	Average number of hours paid per job, f, hours per quarter.
HFS	exog	Long-run desired value of HF, computed from peak-to-peak interpolations of HF.
JF	endo	Number of jobs, f, millions.
JG	exog	Number of civilian jobs, g, millions.
$JHMIN$	endo	Number of worker hours required to produce Y, millions, Y/LAM.
JM	exog	Number of military jobs, g, millions.
JS	exog	Number of jobs, s, millions.
KK	endo	Stock of capital, f, B2009$.
$L1$	endo	Labor force of men 25-54, millions.
$L2$	endo	Labor force of women 25-54, millions.
$L3$	endo	Labor force of all others, 16+, millions.
LAM	exog	Amount of output capable of being produced per worker hour, computed from peak-to-peak interpolations of $Y/(JF \cdot HF)$.
LM	endo	Number of"moonlighters": difference between the total number of jobs (establishment data) and the total number of people employed (household survey data), millions.
PH	endo	Price deflator for consumption plus housing investment inclusive of indirect business taxes
POP	exog	Noninstitutional population 16+, millions.
$POP1$	exog	Noninstitutional population of men 25-54, millions.
$POP2$	exog	Noninstitutional population of women 25-54, millions.
$POP3$	exog	Noninstitutional population of all others, 16+, millions.
$PROD$	endo	Output per paid for worker hour ("productivity"), $Y/JF \cdot HF)$.
T	exog	1 in 1952:1, 2 in 1952:2, etc.
$TRGHQ$	exog	Transfer payments (net), g to h, B2009$.
UR	endo	Civilian unemployment rate.
WA	endo	After tax wage rate. (Includes supplements to wages and salaries except employer contributions for social insurance.)
Y	endo	Total production, f, B2009$.

- h = household sector, f = firm sector, g = federal government sector.
- s = state and local government sector.
- B2009$ = Billions of 2009 dollars.

Production Technology

The production function of the firm sector is postulated to be one of fixed proportions in the short run:

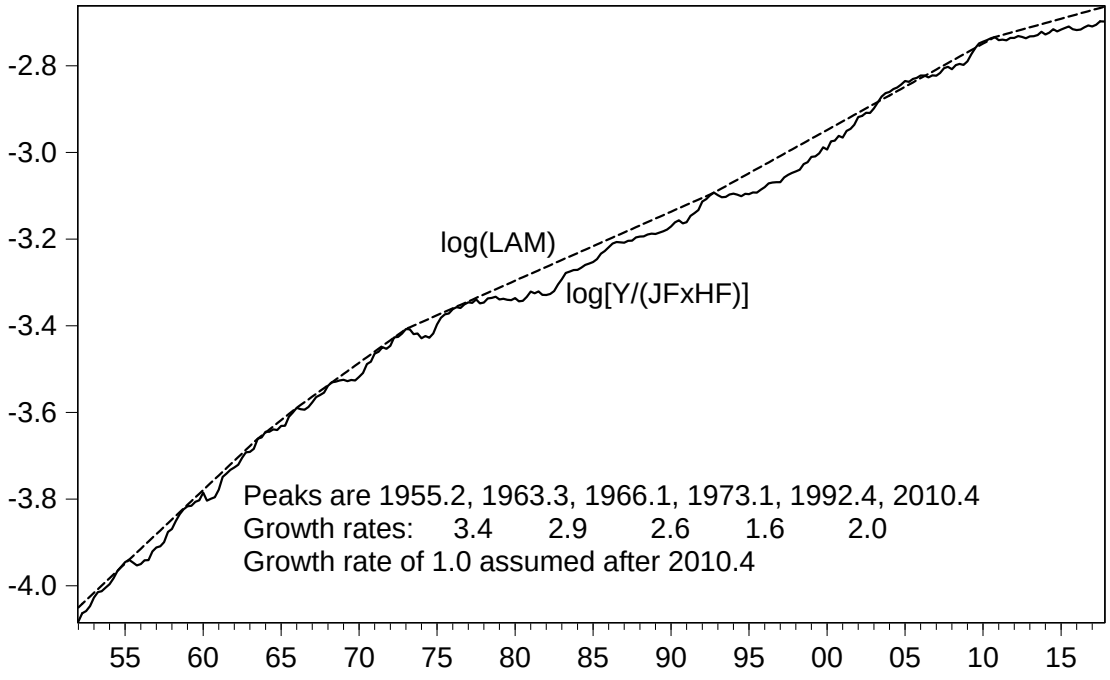
$$Y = \min[LAM \cdot (JF \cdot HF^a), MU \cdot (KK \cdot HK^a)], \tag{1}$$

where Y is production, JF is the number of workers employed, HF^a is the number of hours worked per worker, KK is the capital stock, HK^a is the number of hours each unit of KK is utilized, and LAM and MU are coefficients that may change over time due to technical progress. The variables Y, JF, and KK are observed; the others are not. For example, data on the number of hours paid for per worker exist, HF in the model, but not on the number of hours actually worked per worker, HF^a, unless the two are the same.

If $JF \cdot HF$ is greater than $JF \cdot HF^a$, there is excess labor on hand, i.e., more labor than is needed to produce the level of output of the quarter. Because of adjustment costs, when output falls, firms may not decrease labor hours as much as they could to produce the level of output, which leads to excess labor. Excess labor is measured here from peak-to-peak interpolations of the log of $Y/(JF \cdot HF)$, depicted in Figure 4. The values of the log of LAM lie on the straight lines, where LAM can be thought of as potential productivity. At the peaks it is assumed that $JF \cdot HF$ equals $JF \cdot HF^a$. Given an estimate of LAM for each quarter and given data on Y, Y/LAM, which will be denoted $JHMIN$, is the estimate of the number of worker hours required to produce the output of the quarter.

Hours paid per worker, HF, fluctuates much less over the business cycle than does JF. Over time HF has a downward trend. A variable, denoted HFS, was constructed from peak-to-peak interplations of HF. This variable will be called the "desired" number of hours. It is an estimate of the average number of hours firms would want to pay per worker absent business cycle considerations.

Figure 4
Peak-to-Peak Interpolation of the Log of Productivity
1952.1--2017.4



The excess labor variable is then defined to be (in log form) $\log[JF/(JHMIN/HFS)]$. This variable is used in the equations explaining JF and HF below.

A similar procedure is followed in the construction of the model for estimating excess capital—from peak-to-peak interpolations of Y/KK, but in the interests of space this will not be discussed here. (See MM [Section 6.3.9].) The focus here is on labor productivity.

Potential Labor Productivity

The view behind the above specification is that technical progress is primarily embodied in new machines with lower worker/machine ratios. This is approximated by the peak-to-peak interpolations of output per worker hour. In this formulation potential labor productivity is always increasing. It is not cyclical, as is actual productivity. Actual productivity falls when output falls and excess labor is being build up, and it may rise rapidly when output rises and excess labor is being drawn down. The fluctuations in actual productivity are sometimes referred to as "'shocks" in the literature, but this is misleading because they are endogenous. Changes in potential labor productivity can be considered as shocks in this sense, but they are small and always positive.

Figure 4 shows that potential productivity growth was higher in the 1950's and 1960's than since, something that is well known. The growth rate in the two decades ending in 2010 is estimated at 2.0 percent in the figure. Between 1973.1 and 1992.4 it was 1.6 percent, again a well known slow growth. What about since 2010? A peak has probably not been reached by 2017.4, but it clearly looks like there has been a smaller growth rate since 2010. The figure uses 1.0 percent. This is a considerable decline from 2.0 percent, but it may be even lower.

No attempt is made in this paper to try to explain the possible decline in potential productivity growth since 2010. Explaining changes in long-run trends is important, but this is beyond the essentially business cycle considerations of this

paper. An interesting recent paper examining long-run changes in the U.S. employment/population ratio is Abraham and Kearney (2018). Some of the factors that they cite could also affect potential productivity. Schmalensee (2018) shows that there was a large decline in productivity growth between 1990–2000 and 2010–2016 for computers and electronic products, due mostly to sharp slowdowns in the decline of the deflators for these products. These changes are large enough to affect the aggregate productivity numbers. These changes could be due to measurement problems or structural changes in the industries, and they may have an effect on aggregate potential productivity.

For the solutions in Section 3 three assumptions about potential productivity growth since 2010 have been used: 0.5, 1.0, and 1.5 percent. The main point of this paper, namely that the output prediction errors are within what one would expect historically, is not sensitive to these values. It will be seen that predictions of employment and the unemployment rate are sensitive to the use of 1.5 percent—they are not as good.

Labor Demand and Labor Supply Equations

The two labor demand equations explain JF and HF. The four labor supply equations explain the labor force participation of men 25-54, women 25-54, and all others, $L1$, $L2$, and $L3$, and the number of people holding two jobs (moonlighters), JM. The labor demand equations are in Table 2, and the labor supply equations are in Table 3.

The estimated equation for JF is based on the following two equations:

$$\begin{aligned} \log(JF^*/JF_{-1}) = \alpha_0 \log[JF/(JHMIN/HFS)]_{-1} \\ +\alpha_1 \Delta \log Y, \end{aligned} \tag{2}$$

$$\begin{aligned} \log(JF/JF_{-1}) - \log(JF_{-1}/JF_{-2}) = \quad \lambda[\log(JF^*/JF_{-1}) \\ - \log(JF_{-1}/JF_{-2})] + \epsilon, \end{aligned} \tag{3}$$

Table 2
Coefficient Estimates for Jobs (JF) and Hours (HF)

	$\Delta \log JF$	$\Delta \log HF$
cnst	-0.00008	-0.00485
	(-0.11)	(-6.07)
$\log[JF/(JHMIN/HFS)]_{-1}$	-0.0406	-0.0170
	(-3.39)	(-1.69)
$\Delta \log Y$	0.345	0.279
	(4,63)	(5.25)
$\Delta \log JF_{-1}$	0.567	
	(12.61)	
$\log(HF/HFS)_{-1}$		-0.153
		(-5.42)
T		0.00001
		(4.91)
$D593$	-0.0168	
	(-4.74)	
SE	0.00332	0.00268
R^2	0.705	0.318
DW	2.21	2.11

- t-statistics are in parentheses.
- Estimation period is 1954.1–2017.4.
- Estimation method is 2SLS.
- Variables are listed in Table 1: JF = jobs, HF = hours per job, $JHMIN$ = required worker hours, HFS = desired hours per job, Y = output, T = time trend, $D593$ = dummy variable.

where α_0 is negative and the other coefficients are positive. The construction of $JHMIN$ and HFS and the excess labor variable is explained above.

JF^* in equation (2) is interpreted as the number of workers the firm would desire to have on hand in the current quarter if there were no costs of changing employment. The desired change, $\log(JF^*/JF_{-1})$, depends on the amount of excess labor on hand and the change in output. This equation says that the desired

number of workers approaches $JHMIN/HFS$ in the long run if output is not changing. Equation (3) is a partial adjustment equation of the actual number of workers to the desired number.

Combining equations (2) and (3) yields:

$$\Delta \log JF = \lambda\alpha_0 \log[JF/(JHMIN/HFS)]_{-1} + (1-\lambda)\Delta \log JF_{-1} + \lambda\alpha_1 \Delta \log Y + \epsilon. \tag{4}$$

The equation in Table 2 is the estimated version of equation (4). It has a dummy variable, $D593$, added to pick up the effects of a steel strike.

All the variables are significant in the JF equation except the constant term. For example, excess labor is a significant factor in explaining the demand for jobs. The estimate of $1-\lambda$ is .567, and so the implied value of λ is .433. The estimate of $\lambda\alpha_0$ is -.041, and so the implied value of α_0 is -.095. This is the estimate of the size of the effect of excess labor on the desired number of workers.

The ideas behind this employment demand equation and the hours demand equation discussed next go back 50 years to my Ph.D. dissertation, Fair (1969). See also Fair (1985), which shows that the aggregate equations are consistent with the survey results of Fay and Medoff (1985). These two equations have held up remarkably well over the years.

The estimated equation for HF is:

$$\Delta \log HF = \lambda \log(HF_{-1}/HFS_{-1}) + \alpha_0 \log[JF/(JHMIN/HFS)]_{-1} + \alpha_1 \Delta \log Y + \epsilon. \tag{5}$$

The first term on the right hand side of equation (5) is the (logarithmic) difference between the actual number of hours paid for in the previous quarter and the desired number. The reason for the inclusion of this term in the hours equation but not in the employment equation is that, unlike JF, HF fluctuates around a slowly trending level of hours. This restriction is captured by the first term in (5). The other two terms are the amount of excess labor on hand and the current change in output. Both of these terms affect the employment decision, and they should also

affect the hours decision since the two are closely related. The HF equation in Table 2 is the estimated version of equation (5). The estimate of λ is $-.153$, and the estimate of α_0 is $-.017$.

The labor supply equations are consistent with the standard household utility maximization model. Labor supply depends on the real wage and wealth, where the effect of wealth is unambigously negative because it is a pure income effect, but the effect of the real wage can go either way depending on the size of the income and substitution effects. Wealth appears in all three labor force participation equations, but the real wage was only important in the $L3$ equation. The unemployment rate was added to each equation to pick up potential discouraged worker effects. The wealth variable, AA, is the real value of net household financial and housing wealth. Its main fluctuations are from fluctuations in stock price and housing prices. It is discussed in Section 3. The theory is that this variable should have a negative effect on labor supply.

The first equation in Table 3 explains the labor force participation rate of men 25-54. It is in log form and includes as explanatory variables the wealth variable and the unemployment rate. As just noted, the unemployment rate is meant to pick up a discouraged worker effect. The wealth variable has a negative coefficient estimate, as expected, as does the unemployment rate. All the coefficient estimates are significant.

The second equation explains the labor force participation rate of women 25-54. It is in log form and includes as explanatory variables the wealth variable, the unemployment rate, and a time trend. In addition, the constant term and the coefficient of the time trend are assumed to be time varying. (See MM [Section 2.3.2] for the treatment of time varying coefficients.) This is handled by adding $cnst2$ and $cnst2 \cdot T$ as explanatory variables. There is an economically unexplained trend in $L2$, especially in the 1970's, due to social movements, which is the reason the time trend is added. As in the first equation, the wealth variable has a negative coefficient estimate, as does the unemployment rate, although the t-statistic for the

Table 3
Coefficient Estimates for the L1, L2, L3, and LM Equations

	$\log(L1/POP1)$	$\log(L2/POP2)$	$\log(L3/POP3)$	$\log(LM/POP)$
$cnst$	0.0258	-0.0377	0.0414	-0.239
	(3.08)	(-0.97)	(2.10)	(-4.14)
ldv	0.925	0.892	0.973	0.908
	(38.49)	(44.38)	(70.73)	(44.92)
$\log(AA/POP)_{-1}$	-0.00586	-0.01281	-0.01253	
	(-3.10)	(-1.82)	(-2.35)	
UR	-0.0393	-0.1341	-.1282	-1.168
	(-2.73)	(-3.79)	(-3.97)	(-4.31)
$\log(WA/PH)$			0.0161	
			(2.26)	
T		0.00038		
		(6.37)		
$cnst2$		0.0692		
		(5.38)		
$cnst2 \cdot T$		-0.00032		
		(-6.00)		
SE	0.00240	0.00498	0.00521	0.0481
R^2	0.994	0.999	0.987	0.945
DW	2.23	2.22	2.10	2.10

- ldv = lagged dependent variable.
- t-statistics are in parentheses.
- Estimation period is 1954.1–2017.4.
- Estimation method is 2SLS.
- Variables are listed in Table 1.

wealth variable is only -1.82. The time trend is highly significant.

The third equation explains the labor force participation rate of all others 16+. It is also in log form and includes as explanatory variables the real wage, the wealth variable, and the unemployment rate. All the coefficient estimates are significant. The coefficient estimate of the real wage is positive, which suggests that the substitution effect dominates, and the coefficient estimates of the wealth variable and the unemployment rate are negative.

The fourth equation determines the number of moonlighters. It is in log form and includes the unemployment rate as an explanatory variable. The coefficient

estimate of the unemployment rate is negative and significant, which is the discouraged worker effect applied to moonlighters.

The total number of people employed in the economy, denoted E, is equal to the total number of jobs minus the number of moonlighters:

$$E = JF + JG + JM + JS - JM \tag{6}$$

where JG is the number of federal civilian jobs, JM is the number people in the military, and JS is the number of state and local jobs. The unemployment rate, UR, is then

$$UR = \frac{L1 + L2 + L3 - E}{L1 + L2 + L3} \tag{7}$$

3 Solutions of the Model

The model was solved using stochastic simulation as explained in the appendix. This allows standard errors of the predictions to be computed. The solution period is 2009.4–2017.4. The quarter 2009.4 is the first quarter that the recovery began.

This solution uses actual values of the exogenous variables, and so it is not a prediction that could be made in real time. (Also, the solution is not outside the estimation period.) The solution asks the question that, conditional on the exogenous variables, what does the model predict about the recovery?

The main exogenous variables are government policy variables, population and age distribution variables, exports, and the price of imports. Three of the main government spending variables have been plotted in Figures 1–3.

A key variable in the US model is AA, the total real net financial and housing wealth of the household sector. It appears in the three labor force participation equations in Table 3. It is also an important explanatory variable in the three consumption equations and the housing investment equation in the model (lagged one quarter). There are large estimated wealth effects in the equations. Changes in AA are primarily affected by changes in stock prices and changes in housing

prices. AA is also affected by the saving of the household sector, but most of the fluctuations in AA are due to capital gains or loses on stocks and housing.

$\log(AA/POP)$ is plotted in Figure 5 for the 1990.1–2017.4 period. Figure 5 shows that since 1995 there have been huge fluctuations in financial and housing wealth, which is well known. What is important for present purposes is that AA has risen substantially since 2010—primarily because of rising stock prices. In the solution of the model the change in stock prices and the change in housing prices have been taken to be exogenous. This means that most of the fluctuations in AA in Figure 5 are exogenous. The solution thus takes into account the increase in wealth in the period. Had smaller values of AA been used, the recovery would have been predicted to be slower. In practice changes in AA are, of course, largely unpredictable, since changes in stock prices and housing prices are largely unpredictable.[3]

Fed behavior has also been taken to be exogenous. There is an estimated interest rate rule in the model, and this equation has been dropped. The solution is thus conditional on actual Fed behavior, which kept interest rates low during this period.

Finally, the potential productivity variables, LAM and MUH, have been taken to be exogenous. As discussed in Section 2, an important question is what has been the growth rate of LAM since 2010? Figure 4 uses 1.0 percent, and this has been used as the base case. However, solutions have also been run using 0.5 percent and 1.5 percent to examine the sensitivity of the results to these changes.

For each variable of interest, the growth rate over the 33 quarter interval has been computed and put at an annual rate. For the unemployment rate the predicted value in the last quarter has been used. Results are presented in Table 4 for 11

[3]There is actually a lot of macro information in Figure 5, at least from the perspective of the US model. The results in Fair (2004) show that most of the boom in the U.S. economy in the last half of the 1990s was due to the increase in AA—the wealth effect at work. The results in Fair (2005) show that much of the sluggish economy in the 2000.4–2004.3 period was due to the fall in AA. Finally, the results in Fair (2017) show that much of the 2008-2009 recession was due to the huge fall in AA. In this latter case much of the fall in AA was from the huge decline in housing prices.

Figure 5
log(AA/POP): Log of Real Net Household Wealth Per Capita
1990.1--2017.4

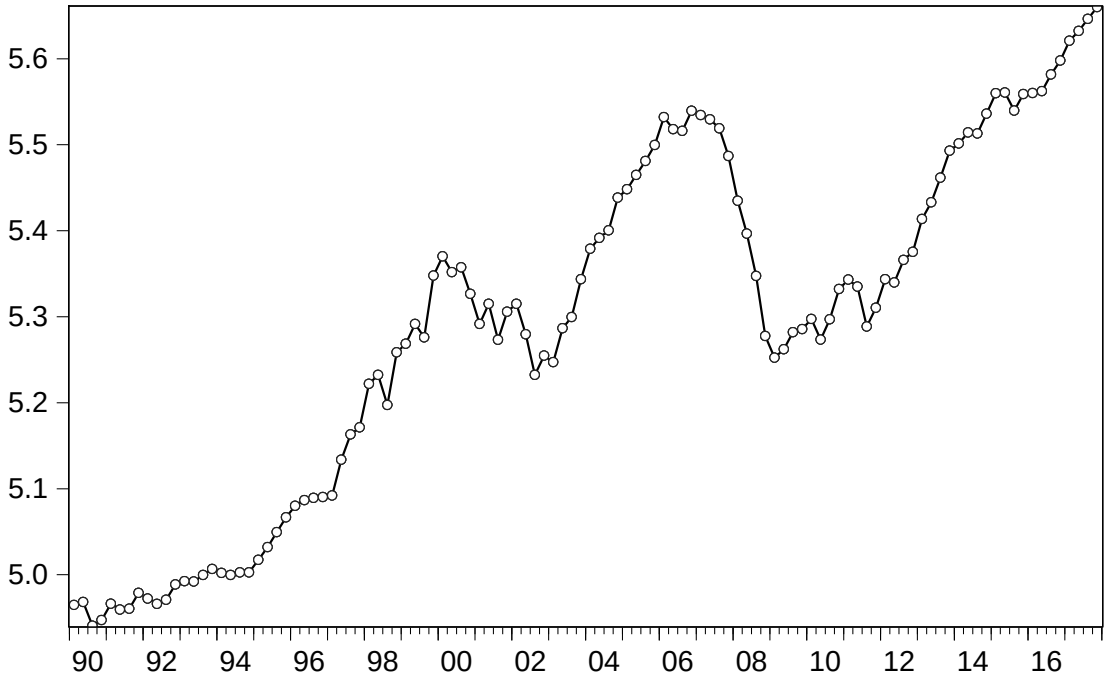


Table 4
Predictions from the Model

		$g(LAM) = 1.0$			$g(LAM) = 0.5$		$g(LAM) = 1.5$	
	Actual	**Pred.**	**Error**	**SE**	**Pred.**	**Error**	**Pred.**	**Error**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y	2.55	2.76	0.21	0.234	2.73	0.18	2.78	0.23
JF	1.54	1.39	-0.15	0.316	1.62	0.08	1.24	-0.30
HF	0.25	0.32	0.07	0.074	0.32	0.07	0.31	0.06
$PROD$	0.74	1.03	0.29	0.231	0.87	0.13	1.31	0.57
$L1$	-0.13	-0.15	-0.02	0.089	-0.13	0.00	-0.19	-0.06
$L2$	-0.11	-0.10	0.01	0.166	-0.01	0.10	-0.19	-0.08
$L3$	1.43	1.26	-0.17	0.297	1.36	-0.07	1.15	-0.28
LM	4.22	4.54	0.32	1.857	5.31	1.09	3.69	-0.53
E	1.13	0.97	-0.16	0.232	1.13	0.00	0.79	-0.34
UR	4.09	4,82	0.73	1.078	4.10	0.01	5.62	1.53
$GDPD$	1.65	1.71	0.06	0.256	1.82	0.17	1.58	-0.07

- Dynamic stochastic simulation for 2009.4–2017.4.
- Values are growth rates over the 33 quarters at an annual rate except for UR.
- The UR value is the prediction for 2017.4.
- Values are mean values from the stochastic simulation, 2000 trials.
- SE = estimated standard error of the prediction.
- SE roughly the same for $g(LAM) = 0.5$ and 1.5.
- Variables are listed in Table 1.

variables. The first column lists the actual values and the second column lists the predicted values. The prediction error is in the third column and the estimated standard error of the prediction in the fourth column.

With one exception the predicted values are within one standard error of the actual values. The exception is productivity, where the error is 0.29 and the standard error is 0.231. Output growth is overpredicted—2.76 percent versus 2.55 percent actual—but not by much. Job growth is underpredicted—1.39 percent versus 1.54 percent, although hours growth is overpredicted—0.32 percent versus 0.25 percent. The net effect of these is that productivy growth was overpredicted—1.03

percent versus 0.74 percent—because output was overpredicted and employment was underpredicted. The labor force participation variables were predicted well. One reason for the predictions of sluggish labor force growth is the increase in the wealth variable, AA. The unemployment rate at the end of the period was predicted to be 4,82 percent, which compares to the actual value of 4.09 percent. This error is primarily due to the fact that job growth was underpredicted. But again these are all within a standard error.

In column (5), where the growth rate of LAM is lowered to 0.5 percent, the predicted value of output is little affected, but the growth rate of jobs is now larger. In this run there is less excess labor since potential productivity is less, which leads firms to hire more—remember that excess labor has a negative effect on employment demand. For this run the predicted value of the unemployment rate at the end of the period is essentially perfect—4.10 percent versus 4.09 percent.

When the growth rate of LAM is increased to 1.5 percent in column (7), output growth is again little affected, but the growth rate of jobs is now lower because excess labor is larger. The predicted unemployment rate at the end is 5.62 percent versus 4.09 percent actual. The larger unemployment rates in this run lead the predicted values of the labor supply variables to be smaller because of the discouraged worker effect. This run is the least accurate of the three for the employment variables.

An important point about the results in Table 4 is that output growth is not sensitive to assumptions about potential productivity. Output growth is accurately predicted in all three cases. Job growth and the unemployment rate are fairly well predicted in the first two cases, but if potential productivity really grew at 1.5 percent, the model noticeably underpredicts job growth and overpredicts the unemployment rate.

Finally, to give a little more detailed picture of the results, Figures 6–8 plot for the 2009.4–2017.4 period the actual and predicted values of output, productivity, and the unemployment rate along with one standard error bands. The predicted

values are for the growth rate of LAM of 1.0 percent. For the most part the actual values are within the error bands. Output was underpredicted in the first half and overpredicted in the second. Productivity was overpredicted beginning about 2013 by about a standard error. The unemployment rate was generally overpredicted, but quite accurate from 2015 on.

4 Conclusion

This paper has attempted to provide a casual explanation of the slow output growth after the 2008–2009 recession, namely sluggish government spending. According to the model, conditional on wealth, monetary policy, and fiscal policy, output grew about as expected during this period. On the plus side were the larger than average rise in wealth and easy monetary policy. On the minus side was the sluggish government spending. The net effect was a sluggish recovery.

The puzzle regarding the relationship between output and the unemployment rate is not a puzzle unless the growth rate of potential productivity is about 1.5 percent or greater. More time is needed before one has a good estimate of this rate since 2010. Although for present purposes, essentially business cycle analysis, the assumption of exogenous potential labor productivity growth is unlikely to bias the results much, an important area of research is to explain why potential productivity growth may have slowed.

Figure 6
Actual and Predicted Y and Standard Error Bands
2009.4--2017.4

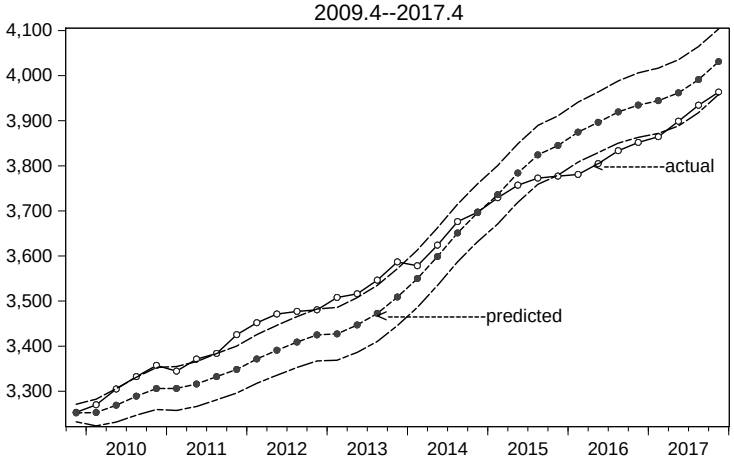


Figure 7
Acltual and Predicted PROD and Standard Error Bands
2009.4--2017.4

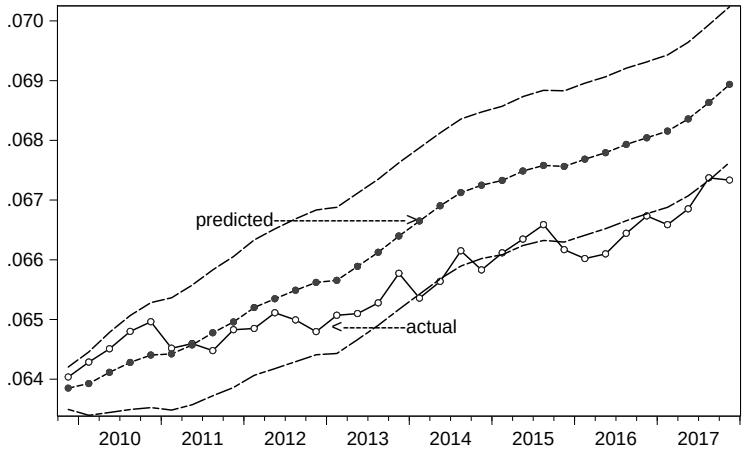
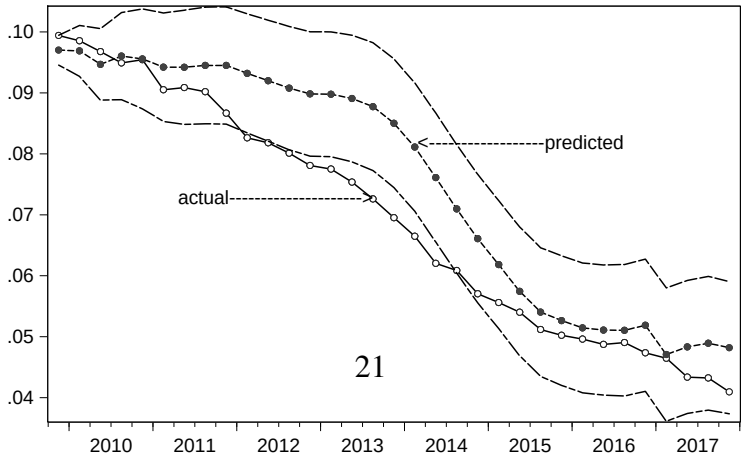


Figure 8
Actual and Predicted UR and Standard Error Bands
2009.4--2017.4



Appendix
Computing Standard Errors

There are 25 estimated equations in the US model, but two of these have been dropped for purposes of this paper—the capital gains equation and the Fed rule. This gives 23 equations. The estimation period is 1954.1–2017.4, 256 quarters. For each estimated equation there are 256 estimated residuals. Let $\hat{u}_t$ denote the 23-dimension vector of the estimated residuals for quarter t, $t = 1, ..., 256$.[4]

The solution period is 2009.4–2017.4, 33 quarters. The model was solved 2,000 times for this period. Each trial is as follows. First, 33 error vectors are drawn with replacement from the 256 error vectors $\hat{u}_t$, $t = 1, ..., 256$. These errors are added to the equations and the model is solved dynamically for the 2009.4–2017.4 period. The predicted values are recorded. This is one trial. This procedure is then repeated 2,000 times, which gives 2,000 predicted values of each variable. The mean and standard error are then computed for each variable. See MM [Sections 2.6 and 2.7] for more details.

[4]If the initial estimate of an equation suggests that the error term is serially correlated, the equation is reestimated under the assumption that the error term follows an autoregressive process (usually first order). The structural coefficients in the equation and the autoregressive coefficient or coefficients are jointly estimated (by 2SLS). The $\hat{u}_t$ error terms are after adjustment for any autoregressive properties, and they are taken to be iid for purposes of the draws.

References

[1] Abraham, Katherine G., and Melissa S. Kearney, 2018, "Explaining the Decline in the U.S. Employment-to-Population Ratio: A Review of the Evidence," NBER Working Paper 24333, February.

[2] Baker, Scott R., Nicholas Bloom, and Steven J. Davis, 2015, "Measuring Economic Policy Uncertainty," NBER Working Paper 21633.

[3] Eichengreen, Barry, 2015, *Hall of Mirrors: The Great Depression, the Great Recession, and the Uses and Misuses of History*, Oxford University Press.

[4] Fair, Ray C., 1969, *The Short-Run Demand for Workers and Hours*. North-Holland Publishing Co.

[5] Fair, Ray C., 1985, "Excess Labor and the Business Cycle," *The American Economic Review*, 239–245.

[6] Fair, Ray C., 2004, "Testing for a New Economy in the 1990s," *Business Economics*, January, 43–53.

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

[8] Fair, Ray C., 2017, "Household Wealth and Macroeconomic Activity: 2008–2013," *Journal of Money, Credit and Banking*, March-April, 495–523.

[9] Fair, Ray C., 2018, *Macroeconometric Modeling: 2018*, *fairmodel.econ.yale.edu/mmm2/mm2018.pdf*.

[10] Fay, Jon A., and James L. Medoff, 1985, "Labor and Output Over the Business Cycle: Some Direct Evidence," *The American Economic Review*, 75, 638–655.

[11] Fernald, John G., Robert E. Hall, James H. Stock, and Mark W. Watson, 2017, "The Disappointing Recovery of Output after 2009," *Brookings Papers on Economic Activity*, Spring, 1–81.

[12] Hansen, Gary D., and Lee F. Ohanian, 2016, "Neoclassical Models in Macroeconomics," NBER Working Paper 22122, March.

[13] Kydland, Finn E., and Carlos E.J.M. Zarazaga, 2016, "Fiscal Sentiment and the Weak Recovery from the Great Recession: A Quantitative Exploration," *Journal of Monetary Economics*, 79, 109–125.

[14] Ohanian, Lee E., 2017, "The Great Recession in the Shadow of the Great Depression: A Review Essay on *Hall of Mirrors: The Great Depression, the Great Recession, and the Uses and Misuses of Hostory*, by Barry Eichengren, *Journal of Economic Literature*, 55, 1583–1601.

[15] Schmalensee, Richard, 2018, "The Collapse of Labor Productivity Growth in U.S. Manufacturing After 2010," February.