THE FINANCIAL CRISIS AND MACROECONOMIC ACTIVITY: 2008-2013

By

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March 2014
Revised February 2015

COWLES FOUNDATION DISCUSSION PAPER NO. 1944

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December 2014

Abstract

This paper provides estimates of the effects of the fall in financial and housing wealth in 2008–2009 on overall macroeconomic activity. These effects are large and account for a large fraction of the slowdown in activity. Much of the 2008–2009 recession is estimated to be simply standard wealth effects at work.

1 Introduction

Although there is by now a large literature on the financial crisis and the 2008–2009 recession, there are no estimates as far as I am aware of the size of the effects of the crisis on overall macroeconomic activity, on, say, the unemployment rate in 2008–2009. This paper provides estimates of the effects of the fall in financial and housing wealth in 2008–2009 on macroeconomic activity. It will be seen that these effects are large and account for a large fraction of the slowdown in activity. The results suggest that much of the 2008–2009 recession was simply due to standard wealth effects on household expenditures.

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The extensive literature cited in Brunnermeier and Sannikiov (2014) is theoretical.[1] The various financial frictions that are postulated in this literature are too abstract to be taken directly to macro data. Gilchrist and Zakrajšek (2012) use univariate forecasting equations and VARs to test for the effects of interest rate spreads on various macroeconomic variables. They argue that an increase in their estimate of the excess bond premium reflects shifts in the risk aversion of the financial sector, which leads to a decline in asset prices and a contraction of the supply of credit, which has a negative effect on economic activity. They do not, however, provide estimates of the size of the effects during the 2008–2009 recession. Their excess bond premium variable is examined below. Duygan-Bump, Levkov, and Montoriol-Garriga (2011) test the hypothesis that credit constraints were important in the 2008-2009 recession by examining the financing constraints of small businesses. They also do not provide estimates of the size of the effects during the recession.

The work of Reinhart and Rogoff (2009, 2014) documents the role of financial crises in recessions, arguing, for example, that the subprime crisis in the 2008-2009 recession is not an anomaly in the context of data prior to World War II. This work is descriptive, and no quantitative estimates of the effects of financial crises on economic activity are presented.

Case, Quigley, and Shiller (2012), which is an update of results in Case, Quigley, and Shiller (2005), use data by states to examine housing and financial wealth effects on household spending, where household spending is retail sales. The sample period is 1975:1–2012:2. They find that the effects of housing wealth on spending are larger than the effects of financial wealth on spending. They do not use national income and product accounts (NIPA) data, and there are no esti-

[1] Important early papers in this literature include Bernanke and Gertler (1989), Kiyotaki and Moore (1997), and Bernanke, Gertler, and Gilchrist (1999).

mates of overall effects on the 2008-2009 recession. Some of their estimates are examined below. Zhou and Carroll (2012) also examine wealth effects using state data. They find a strong housing wealth effect, but no financial wealth effect.

Mian, Rao, and Sufi (2013) examine the effects of household wealth on consumption in the 2006-2009 period using consumption and wealth data by zip codes. The data on consumption are constructed using data on auto sales and data from MasterCard Advisors. They also do not use NIPA data, and so obtaining aggregate estimates is limited. Some of their estimates are examined below. Mian and Sufi (2014) examine the effects of changes in housing wealth on employment in the 2007–2009 period using data by counties. Some of their estimates are also examined below.

Carroll, Slacalek, and Sommer (2013) estimate aggregate personal saving equations for the 1966:2–2011:1 period. The find significant coefficient estimates for wealth, for a variable measuring credit constraints (CEA), and for a variable measuring labor income uncertainty ($UnRisk$). CEA is constructed using the question on consumer installment loans from the Federal Reserve's Senior Load Officer Opinion Survey on Bank Lending Practices. CEA is "taken to measure the availability/supply of credit to a typical household through factors other than the level of interest rates." (p. 12) $UnRisk$ is measured "using re-scaled answers to the question about the expected change in unemployment in the Thomson Reuters/University of Michigan Surveys of Consumers." (p. 13) These two variables are examined below.

This paper uses a structural multicountry macroeconometric model, denoted the "MC" model, for the estimates. This model is discussed in Section 2. Financial wealth effects versus housing wealth effects on household expenditures are examined in Section 3 and then again in Section 5. Section 4 tests various measures of credit conditions, and Section 6 examines large shocks during the 2008:1–2013:3

period. Finally, Section 7 estimates what the 2008–2013 economy would have been like had there been no decrease in financial wealth and housing wealth.

2 The MC Model

The MC 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, November 11, 2013* (MM), on my website, and this document contains a complete description and listing of the MC model. MM is written using the current version of the MC model (November 11, 2013), where published results using earlier versions of the model have been updated.[2] The MC 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 defended in MM [1.1].

There are 39 countries in the MC model for which stochastic equations are estimated. There are 25 stochastic equations for the United States and up to 13 each for the other countries. The total number of stochastic equations is 310, and the total number of estimated coefficients is about 1,300. In addition, there are 1,379 bilateral trade share equations estimated, so the total number of stochastic equations is 1,689. The total number of endogenous and exogenous variables, not counting various transformations of the variables and the trade share variables, is

[2] Users can work with the MC 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.

about 2,000. Trade share data were collected for 59 countries, and so the trade share matrix is 59×59.

The estimation periods begin in 1954 for the United States and as soon after 1960 as data permit for the other countries. Data permitting, they end as late as 2013:3. The estimation technique is 2SLS except when there are too few observations to make the technique practical, where ordinary least squares is used. 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.

Table 1 presents the variable notation used in this paper. MM [6] provides a complete description of the variables. The discussion in the rest of this paper pertains to the U.S. part of the MC model.

3 Financial Wealth versus Housing Wealth in Consumer Expenditure Equations

The aggregate U.S. wealth variable in the MC model is:

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

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.

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

Variable	Type	Description
AA	endo	Total net wealth, h, B2009$.
$AA1$	endo	Total net financial wealth, h, B2009$.
$AA2$	endo	Total net housing wealth, h, B2009$.
$AG1$	exog	Percent of 16+ population 26-55 minus percent 16-25.
$AG2$	exog	Percent of 16+ population 56-65 minus percent 16-25.
$AG3$	exog	Percent of 16+ population 66+ minus percent 16-25.
AH	endo	Net financial assets, h, B$.
CD	endo	Consumer expenditures for durable goods, B2009$.
CDA	exog	Peak to peak interpolation of CD/POP.
CG	endo	Capital gains(+) or losses(-) on the financial assets of h, B$.
CN	endo	Consumer expenditures for nondurable goods, B2009$.
$cnst$	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.
CS	endo	Consumer expenditures for services, B2009$.
$DELD$	exog	Physical depreciation rate of the stock of durable goods, rate per quarter.
$DELH$	exog	Physical depreciation rate of the stock of housing, rate per quarter.
$GDPD$	endo	GDP price deflator.
$GDPR$	endo	Gross Domestic Product, B2009$.
IHH	endo	Residential investment, h, B2009$.
$IHHA$	exog	Peak to peak interpolation of IHH/POP.
IKF	endo	Nonresidential fixed investment, f, B2009$.
IM	endo	Imports, B2009$.
IVF	endo	Inventory investment, f, B2009$.
JF	endo	Number of jobs, f, millions.
KD	endo	Stock of durable goods, B2009$
KH	endo	Stock of housing, h, B2009$.
MH	endo	Demand deposits and currency, h, B$.
PD	endo	Price deflator for domestic sales.
PH	endo	Price deflator for CS + CN + CD + IHH inclusive of indirect business taxes.
PIV	endo	Price deflator for inventory investment, adjusted.
PKH	endo	Market price of KH.
POP	exog	Noninstitutional population 16+, millions.

Table 1 (continued)

Variable	Type	Description
$PSI14$	exog	Ratio of PKH to PD.
PX	endo	Price deflator for total sales.
RMA	endo	After tax mortgage rate, percentage points.
RS	endo	Three-month Treasury bill rate, percentage points.
RSA	endo	After tax bill rate, percentage points.
UR	endo	Civilian unemployment rate.
YD	endo	Disposable income, h, B$.
YS	endo	Potential output, B2009$.

- h = household sector.
- f = firm sector.
- B$ = Billions of dollars.
- B2009$ = Billions of 2009 dollars.

Figures 1 and 2 plot $AA1$ and $AA2$, respectively, for the 1952:1–2013:3 period. Figure 3 plots the ratio of $AA1$ to $AA2$. The ratio fluctuates considerably over time, with a range of 1.3 to 2.4. The peak of $AA2$ is in 2006:1 at $23.9 trillion. The peak of $AA1$ is the last quarter at $44.4 trillion. These values are all in 2009 dollars.

Table 2 presents the MC U.S. estimated equations for consumption of services, CS, and consumption of non durables, CN. The equations are in log per capita terms, and the wealth variable enters as $\log(AA/POP)_{-1}$. Two estimation periods are used, 1954:1–2013:3 and 1954:1–2007:4, the latter ending before the crisis. The justification for the specification of these equations is in MM [3.6.3] and this discussion is not repeated here. The equations are taken to be structural equations, with the left hand side variable being a decision variable and the right hand side variables being variables that affect the decisions.[3]

[3]The age variables are designed to pick up age distribution effects—MM [3.6.2]. $cnst2$ is defined in Table 1. It is designed to pick up possible time varying effects—MM [2.3.2]. The lagged dependent variables are picking up dynamic effects. The interest rates are after-tax interest rates.

Figure 1
Financial Wealth, AA1, 1952:1--2013:3
Trillions of 2009 Dollars

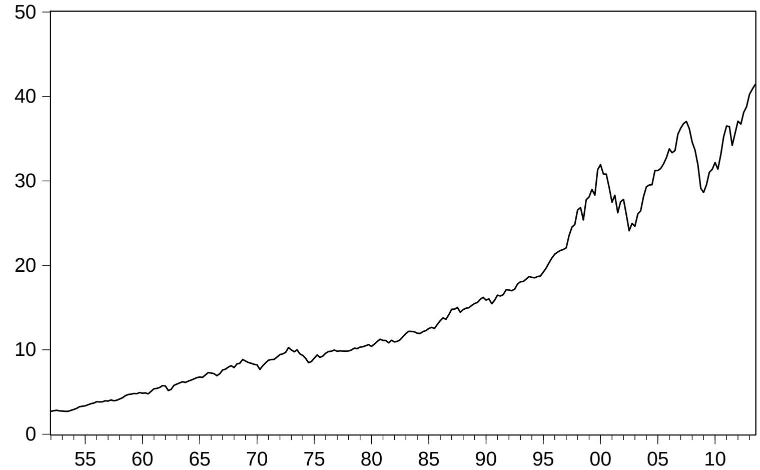


Figure 2
Housing Wealth, AA2, 1952:1--2013:3
Trillions of 2009 Dollars

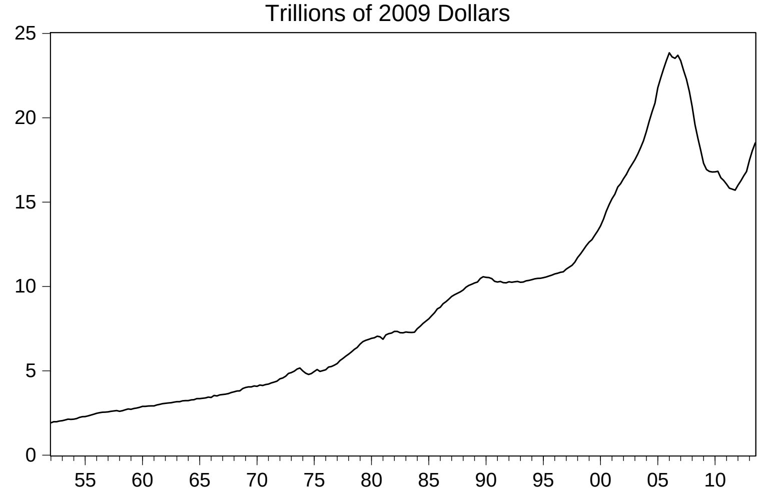


Figure 3
Financial Wealth/Housing Wealth
1952:1--2013:3

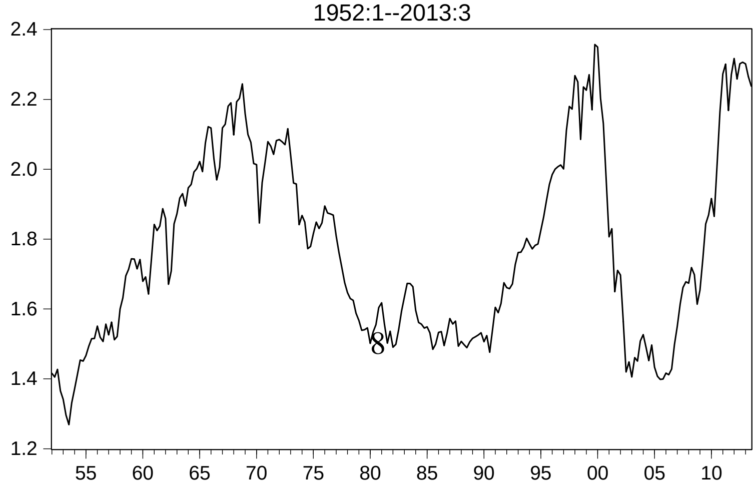


Table 2
Estimates for Consumption of Services (CS) and Consumption of Non Durables (CN)
Left Hand Side Variables are log(CS/POP) and log(CN/POP)

	CS		**CN**	
RHS Variable	**1954:1-2013:3**	**1954:1-2007:4**	**1954:1-2013:3**	**1954:1-2007:4**
cnst2	0.022	0.022	-0.015	-0.015
	(6.60)	(5.94)	(-1.87)	(-1.83)
cnst	-0.134	-0.125	-0.341	-0.256
	(-5.86)	(-3.03)	(-5.04)	(-2.95)
$AG1$	-0.052	-0.077	0.124	0.031
	(-2.10)	(-1.51)	(2.45)	(0.35)
$AG2$	-0.288	-0.269	0.124	0.226
	(-8.43)	(-4.90)	(2.09)	(2.18)
$AG3$	0.247	0.287	-0.310	-0.202
	(4.02)	(3.18)	(-2.61)	(-1.34)
$\log(CS/POP)_{-1}$	0.818	0.810		
	(35.22)	(31.74)		
$\log(CN/POP)_{-1}$			0.740	0.754
			(16.95)	(16.81)
$\Delta\log(CN/POP)_{-1}$			0.214	0.193
			(3.59)	(3.06)
$\log[YD/(POP\cdot PH)]$	0.120	0.129	0.119	0.124
	(5.11)	(4.82)	(3.84)	(3.48)
RSA	-0.00115	-0.00110		
	(-5.08)	(-4.80)		
RMA			-0.00092	-0.00095
			(-1.78)	(-1.82)
$\log(AA/POP)_{-1}$	0.0379	0.0377	0.0480	0.0366
	(6.66)	(4.62)	(4.42)	(2.53)
SE	0.00373	0.00378	0.00658	0.00664
R^2	0.999	0.999	0.999	0.999
DW	1.51	1.58	1.95	1.96
End Test (2007:4)—p-value	0.809	–	0.794	–

•t-statistics are in parentheses.
•Estimation method is 2SLS.
•Variables are listed in Table 1.

The lagged wealth variable, $\log(AA/POP)_{-1}$, is significant in both equations for both periods. The interest rate is significant in the CS equation, but has t-statistics of only -1.78 -1.82 in the CN equation. The End test—Andrews (2003)—is a test of the hypothesis that the coefficients are the same both before and after 2007:4. The p-values are large in both cases, and so the hypothesis is not rejected in either case. This result is consistent with the fact that the coefficient estimates for the two periods are fairly similar.

Remember that AA is equal to $AA1 + AA2$, financial wealth plus housing wealth. The wealth variable enters the equations as $\log(AA/POP)_{-1}$, which assumes that financial and housing wealth have the same effect. This can be tested by using as the wealth variable $\log(\lambda AA1 + (1-\lambda)AA2)_{-1}$ and estimating λ along with the other structural coefficients. The equations are estimated by 2SLS, and so estimating λ is a non linear 2SLS estimation problem, which is straightforward to solve. If the effects are the same, then λ is 0.5.

For the CS and CN equations the estimates of λ for the two periods are the following. The t-statistics in parentheses are for the hypothesis that $\lambda = 0.5$:

		1954:1-2013:3	**1954:1-2007:4**
CS	$\hat{\lambda}$	0.771	0.883
		(2.46)	(1.44)
CN	$\hat{\lambda}$	0.508	0.679
		(0.08)	(0.58)

Although there is slight evidence that financial wealth has a greater weight in the CS equation (but not in the CN equation), with the hypothesis that $\lambda = 0.5$ rejected for the first period (t-statistic of 2.46), the evidence is only slight, and for the rest of the results in this paper the combined AA wealth variable is used in both equations.

Table 3 presents the MC U.S. equation for expenditures on durable goods, CD. The equation is in linear per capita terms. The wealth variable is $(AA/POP)_{-1}$. Again, the justification for the specification of this equation is in MM [3.6.3] and this discussion is not repeated here.[4] The lagged wealth variable is significant for the first estimation period, but only has a t-statistic of 1.33 for the second. The interest rate is significant for both periods. The End test has a p-value of 0.005, so the hypothesis that the coefficients are the same before and after 2007:4 is rejected. It will be seen in Section 6 why this might be so.

Financial versus housing wealth can be tested for durable expenditures by replacing the wealth variable with $(AA1/POP)_{-1}$ and $(AA2/POP)_{-1}$. The results for the two periods are:

	1954:1-2013:3	**1954:1-2007:4**
$(AA1/POP)_{-1}$	0.00043	0.00024
	(2.32)	(1.42)
$(AA2/POP)_{-1}$	0.00106	-0.00022
	(4.06)	(-0.94)
t-statistic for equal coefficients	2.17	0.94

There is slight evidence for the first period that housing has a greater weight, where the hypothesis of equality rejected with a t-statistic of 2.17. For the second period nothing is significant. Because the evidence in favor of housing wealth is slight, as was done for the CS and CN equations, for the rest of the results in this paper the combined AA wealth variable is used in the CD equation.

[4]The sixth and seventh explanatory variables in Table 3 are picking up partial adjustment effects regarding both the stock of durable goods and the flow—MM [3.6.3]. CDA is an exogenous scale parameter for the interest rate. A scale variable is needed because the interest rate has no trend.

Table 3
Estimates for Durable Expenditures (CD)
Left Hand Side Variable is CD/POP

RHS Variable	**1954:1-2013:3**	**1954:1-2007:4**
cnst2	0.062	0.039
	(3.97)	(2.72)
cnst	-0.248	-0.169
	(-3.46)	(-2.09)
$AG1$	0.18	0.02
	(1.60)	(0.12)
$AG2$	2.64	2.92
	(6.27)	(5.37)
$AG3$	-2.35	-2.17
	(-5.50)	(-5.27)
^{a}	0.232	0.271
	(5.10)	(5.45)
$(KD/POP)_{-1}$	-0.0277	-0.0245
	(-6.79)	(-5.89)
$YD/(POP \cdot PH)$	0.0639	0.0704
	(6.21)	(5.76)
$RMA \cdot CDA$	-0.0101	-0.0068
	(-3.96)	-2.83)
$(AA/POP)_{-1}$	0.00063	0.00023
	(3.85)	(1.33)
SE	0.01455	0.01250
R^2	0.207	0.224
DW	1.95	2.20
End Test (2007:4)—p-value	0.005	–

^{a}Variable is $DELD(KD/POP)_{-1} - (CD/POP)_{-1}$
•t-statistics are in parentheses.
•Estimation method is 2SLS.
•Variables are listed in Table 1.

Table 4 presents the MC U.S. equation for housing investment of the household sector, IHH. The equation is similar in form to the CD equation. The wealth variable is $(AA2/POP)_{-1}$, housing wealth, not total wealth. The lagged housing wealth variable is significant for both periods. The hypothesis that the coefficients are the same before and after 2007:4 is not rejected. The coefficient estimates are fairly similar across the two estimation periods.

Regarding housing wealth versus financial wealth in the IHH equation, when $(AA1/POP)_{-1}$ is added to the equation, its t-statistics are 0.67 and 0.04 for the two periods, respectively, and $(AA2/POP)_{-1}$ retains its significance. The t-statistic for the hypothesis that the two coefficients are equal is 2.90 for the first period and 2.71 for the second, so the hypothesis is rejected. The housing wealth variable has thus been used alone in the IHH equation.

The significance of financial wealth in the consumption equations is contrary to results using less aggregate data. As noted in the Introduction, Case, Quigley, and Shiller (2012) (CQS) find stronger effects for housing wealth than for financial wealth on retail sales. In fact, for many of their estimates financial wealth is not significant. In the present case financial wealth is significant in the CS, CN, and CD equations with the exception of the shorter estimation period for the CD equation. As discussed above, there is some evidence that financial wealth is more important in the CS equation and that housing wealth is more important in the CD equation, but the evidence is not very strong. Housing wealth does dominate in the IHH equation, but CQS do not examine housing investment. Many assumptions have been used by CQS to create financial wealth data by state, and their negative results for financial wealth could be at least partly due to measurement error. Mian, Rao, and Sufi (2013) also do not find significant financial wealth effects on consumption, but they point out (p. 20) that they do not have the statistical power to estimate financial wealth effects because of lack of good data on financial assets

Table 4
Estimates for Housing Investment (IHH)
Left Hand Side Variable is IHH/POP

RHS Variable	**1954:1-2013:3**	**1954:1-2007:4**
cnst2	0.137	0.049
	(1.75)	(0.87)
cnst	0.889	0.804
	(4.16)	(5.31)
^{a}	0.379	0.419
	(7.34)	(7.25)
$(KH/POP)_{-1}$	-0.0377	-0.0506
	(-4.51)	(-5.11)
$YD/(POP \cdot PH)$	0.0790	0.1718
	(2.40)	(4.39)
$RMA_{-1} \cdot IHHA$	-0.0259	-0.0242
	(-5.38)	(-4.83)
$(AA2/POP)_{-1}$	0.00368	0.00376
	(3.77)	(2.88)
RHO1	0.626	0.601
	(8.75)	(7.82)
RHO2	0.326	0.287
	(4.68)	(3.88)
SE	0.01542	0.01610
R^2	0.446	0.395
DW	1.99	1.94
End Test (2007:4)—p-value	0.242	–

^{a}Variable is $DELH(KH/POP)_{-1} - (IHH/POP)_{-1}$
•t-statistics are in parentheses.
•Estimation method is 2SLS.
•RHO1 and RHO2 are first and second order serial correlation coefficient estimates.
•Variables are listed in Table 1.

by zip codes. Zhou and Carroll (2012), using data by states like CQS, also find insignificant financial wealth effects but significant housing wealth effects.

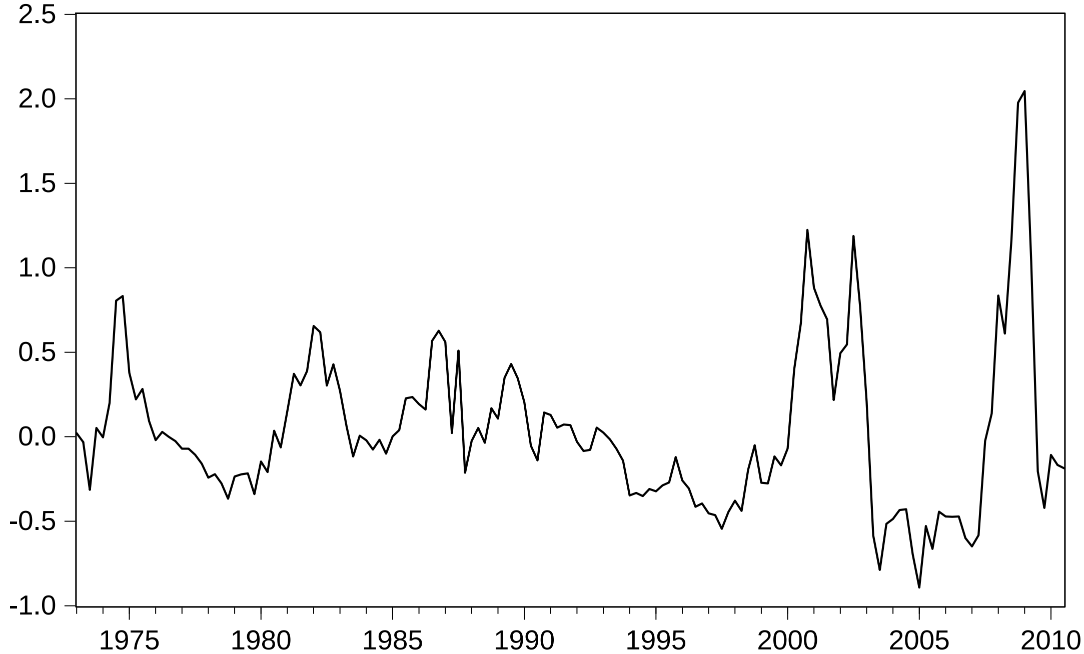
If constructing financial wealth by zip codes or states leads to larger measurement errors than constructing housing wealth by zip codes or states, then this could explain the insignificance of financial wealth versus housing wealth. The present results using aggregate data are quite strong regarding the overall significance of financial wealth. It would be hard, for example, to explain the boom in the U.S. economy in the last half of the 1990s without considering the huge increase in financial wealth in this period from the boom in the stock market.

4 Testing Measures of Credit Conditions

The consumer expenditure equations in Tables 2–4 do not have explanatory variables measuring credit conditions other than interest rates and wealth. It is of interest to see if other measures might add to the explanatory power. Possible candidates are various interest rate spreads. Stock and Watson (2003) review of the use of interest rate spreads to forecast various macroeconomic variables. Interest rate spreads may incorporate credit conditions not captured in the interest rate and wealth variables. This is straightforward to test by simply adding spread variables to the equations and seeing if they are significant. As noted in the Introduction, Gilchrist and Zakrajšek (2012) create their own interest rate spread variable, an excess bond premium, denoted EBP, and test its predictive power. Figure 4 plots EBP for the period for which data exist, 1973:1–2010:3. The large values during the 2008-2009 recession are evident, and there are also large values in the 2000-2002 period.

When testing the interest rate spread variables, two estimation periods were used, one ending in 2007:4 and one ending in 2013:3 (or 2010:3 for EBP). Since

Figure 4
EBP 1973:1--2010:3



EBP was chosen after the 2008–2009 recession was known, there may be data mining issues for estimation periods including the recession. This is not an issue for the wealth variable used in this paper, since it first appeared in the model 30 years ago—Fair (1984). Table 5 presents results for two spread variables, the BAA/AAA bond spread and EBP. For each equation estimates are presented for the interest rate, the wealth variable, and the spread. The BAA/AAA bond spread is not close to being significant in any of the equations. Although not shown in the table, the same was true for the spread between the AAA bond rate and the 10-year government bond rate.

Table 5
Testing Interest Rate Spreads

		Interest Rate	Wealth_{-1}	Spread_{-1}	EBP_{-1}
CS	1954:1–2007:4	-0.00110	0.0377	-0.00028	
		(-4.79)	(4.62)	(-0.30)	
	1954:1–2013:3	-0.00116	0.0369	-0.00089	
		(-5.14)	(6.38)	(-1.17)	
	1973:4–2007:4	-0.00151	0.0509		0.00031
		(-5.33)	(4.79)		(0.27)
	1973:4–2010:3	-0.00156	0.0525		-0.00107
		(-5.55)	(5.49)		(-1.41)
CN	1954:1–2007:4	-0.00100	0.0365	0.00026	
		(-1.67)	(2.52)	(0.13)	
	1954:1–2013:3	-0.00079	0.0475	-0.00076	
		(-1.38)	(4.35)	(-0.50)	
	1973:4–2007:4	-0.00121	0.0404		-0.00371
		(-2.31)	(2.56)		(-2.05)
	1973:4–2010:3	-0.00119	0.0445		-0.00494
		(-2.29)	(3.13)		(-3.96)
CD	1954:1–2007:4	-0.00834	0.00031	0.00983	
		(-3.13)	(1.72)	(1.30)	
	1954:1–2013:3	-0.01012	0.00063	0.00024	
		(-3.72)	(3.64)	(0.06)	
	1973:4–2007:4	-0.01013	0.00022		-0.00729
		(-3.17)	(0.99)		(-1.30)
	1973:4–2010:3	-0.01357	0.00058		-0.01682
		(-3.84)	(2.70)		(-4.59)
IHH	1954:1–2007:4	-0.0243	0.00368	0.00216	
		(-4.79)	(2.76)	(0.16)	
	1954:1–2013:3	-0.0269	0.00361	-0.00373	
		(-5.66)	(3.71)	(-0.40)	
	1973:4–2007:4	-0.0259	0.00281		-0.01105
		(-4.96)	(2.02)		(-1.19)
	1973:4–2010:3	-0.0270	0.00395		-0.01531
		(-5.65)	(3.35)		(-2.13)

•Spread is BAA-AAA.
•Estimation method is 2SLS.
•See Tables 2–4 for the interest rate and wealth variables per equation.
•Spread is multiplied by CDA for CD equation. Similarly for EBP.
•Spread is multiplied by $IHHA$ for IHH equation. Similarly for EBP.

Regarding EBP, it is not significant for the period ending before the recession except for the CN equation, where the t-statistic is -2.05. For the period through the recession it is not significant in the CS equation, but it is in the three others. Adding EBP does not affect the significance of any of the interest rate and wealth variables. They are all significant expect for the wealth variable in the CD equation for the periods ending before the recession. 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. But it could be that EBP is capturing some effects on consumer expenditures not captured by the interest rate and wealth variables. This is examined in Section 8.

Another possible measure of credit conditions is the CEA variable of Carroll, Slacalek, and Sommer (2013), which was mentioned in the Introduction. It was tried (lagged one quarter) in the four consumer expenditure equations for two estimation periods: 1966:2–2007:4 and 1966:2–2011:1. In none of the eight regressions was it significant, and so there is no evidence that it has independent explanatory power. The labor income uncertainty variable, $UnRisk$, was also tried (lagged one quarter), and it was only significant in the CN equation, with t-statistics of -2.45 and -2.28 for the two periods, respectively. There is thus little support for this variable.[5] Whatever information CEA and $UnRisk$ convey, it appears to be captured by variables already in the expenditure equations.

5 Estimated Effects of Changes in Financial and Housing Wealth

Before considering the 2008–2009 recession, it will be useful to examine the size of the wealth effect in the MC model. How much do household expenditures change

[5]For the CD equation $UnRisk$ was multiplied by CDA and for the IHH equation it was multiplied by $IHHA$. This was not done for CEA because it has a trend.

when $AA1$ or $AA2$ changes? The size of this wealth effect depends on what is held constant. If the complete MC model is used, then an increase in $AA1$ or $AA2$ increases U.S. household expenditures, which then leads to a multiplier effect on output and at least some increase in inflation. Given the estimated interest rate rule in the model, the Fed responds to the expansion by raising interest rates, which slows down the expansion, and so on. The rest of the world also responds to what the United States is doing, which then feeds back on the United States. The size of the wealth effect with nothing held constant thus depends on many features of the MC model, not just the properties of the U.S. household expenditure equations.

One can focus solely on the properties of the household expenditure equations by taking income and interest rates to be exogenous. The following experiment was performed. The variables $YD/(POP \cdot PH)$, RSA, RMA, $AA1$, and $AA2$ were taken to be exogenous, which isolates the four household expenditure equations from the rest of the model. The estimated residuals were then added to the stochastic equations and taken to be exogenous. This means that when the model is solved using the actual values of all the exogenous variables, a perfect tracking solution is obtained. The actual values are thus the base values. For the first experiment $AA1$, financial wealth, was increased by $1000 billion in each quarter from the base case, and the model was solved for the 2005:1–2012:4 period. The difference for a given quarter between the predicted value of a variable and the actual value is the estimated effect of the $AA1$ change on that variable for that quarter.

The effects on total consumption expenditures ($CS + CN + CD + IHH$) by quarters are presented in Table 6. After four quarters expenditures have risen $22.0 billion, and after eight quarters they have risen $33.3 billion. The increases then level off at about $40 billion. The effect of a sustained increase in wealth on consumption expenditures is thus estimated to be about 4 percent per year ignoring any feedback effects.

Table 6
Effects on $CS + CN + CD + IHH$ of a Change in $AA1$ of 1000

	Year							
Quarter	2005	2006	2007	2008	2009	2010	2011	2012
1	0.0	26.2	34.4	36.3	39.0	41.4	41.8	41.6
2	8.9	29.2	35.1	36.9	39.9	41.6	41.5	41.4
3	16.3	31.5	35.6	37.3	40.7	41.9	41.4	41.3
4	22.0	33.3	35.9	38.0	41.1	42.1	41.5	40.9

• Units are billions of 2009 dollars

Table 7
Effects on $CS + CN + CD + IHH$ of a Change in $AA2$ of 1000

	Year							
Quarter	2005	2006	2007	2008	2009	2010	2011	2012
1	0.0	56.1	59.9	53.7	50.4	49.0	47.2	45.7
2	23.7	59.2	58.5	52.6	50.2	48.6	46.5	45.4
3	39.7	60.5	56.9	51.5	50.0	48.3	46.0	45.1
4	50.0	60.7	55.2	50.8	49.5	47.9	45.9	44.5

• Units are billions of 2009 dollars

The increase in $AA1$ does not affect housing investment, IHH, because it does not appear in the housing investment equation. So in Table 6 IHH is unchanged. If $AA2$ instead of $AA1$ is changed, this changes all four categories of expenditures because $AA2$ appears in all four equations. Results of increasing $AA2$ by $1000 billion are presented in Table 7. In this case the expenditures peak at about $60 billion rather than $40 billion, although the effects wear off faster.[6]

The roughly 4 percent estimate in Table 6 is consistent with results from other approaches. The size of the wealth effect is discussed in Ludvigson and Steindel (1999), where they conclude (p. 30) that "a dollar increase in wealth likely

[6]The main reason the effects wear off faster is that when housing investment is stimulated, the housing stock increases, which over time is a drag on new housing investment. (In Table 4 the coefficient estimate for KH/POP_{-1} is negative.)

leads to a three-to-four-cent increase in consumption in today's economy," although they argue that there is considerable uncertainty regarding this estimate. Their approach is simpler and less structural than the present one, but the size of their estimate is similar. Starr-McCluer (1998) uses survey data to examine the wealth effect, and she concludes that her results are broadly consistent with a modest wealth effect.

Mian, Rao, and Sufi (2013) (MRS) find 5 to 7 percent effects of housing wealth on consumption (p. 30), although these effects vary considerably across zip codes. These numbers should be compared to the numbers in Table 6 because MRS do not examine housing investment, and so their estimated effects are somewhat higher than the present ones. Zhou and Carroll (2012) find 5 percent effects of housing wealth on consumption (p. 18), slightly higher than the estimates in Table 6.

CQS test for asymmetrical effects and find that the housing wealth elasticity is estimated to be larger in falling markets than in rising markets.[7] Their estimated elasticities are 0.10 and 0.032, respectively. How do these compare with the present results? Take Table 6. Excluding housing investment, $CS + CN + CD$ at the beginning of 2005 was about $9.4 trillion. Housing wealth, $AA2$, was about $21.8 trillion. If one takes the change in consumption expenditures to be $40 billion, then the housing wealth elasticity is (40/9400)/(1000/21800) = 0.09. So this elasticity is close to the CQS elasticity in falling markets of 0.10.

6 Estimated Shocks: 2008:1–2013:3

If the 2SLS coefficient estimates of the equations in Tables 2–4 are consistent, then consistent estimates of the residuals (actual minus predicted) are available.

[7] No attempt was made in the present study to estimate asymmetrical effects. It is unlikely using aggregate data that any such effects could be estimated even if they exist.

If credit-condition effects during the 2008–2009 recession have not been captured well by the wealth and interest rate variables in the equations, then one would expect the residuals on average to be negative and large in absolute value during the recession. Table 8 presents residuals that are larger than one standard deviation in absolute value for the 2008:1–2013:3 period, where the main emphasis is on the recessionary period 2008:1–2009:4.

The residuals are not huge except for the CD residual for 2008:4, which is negative and 5.3 times its standard error. CD fell at an annual rate of 25.8 percent in this quarter, much of which was not explained. The error undoubtedly contributes to the rejection of the End test in Table 3. Of the 17 large residuals for the consumer expenditure equations (equations 1–4) for 2008:1–2009:4, 14 are negative. Consumer durable expenditures are hit the hardest. Two of the three large residuals for housing investment are actually positive. For the other three demand equations, there are 10 large residuals for the 2008:1–2009:4 period, of which 6 are negative.

Although 14 of the 17 large residuals for the consumer expenditure equations are negative, only 4 of the 14 are greater than two standard errors. There is thus clearly some of the recession not captured by the equations, but much of it has been.[8] Quantitative estimates of how much has been captured are presented in the next section.

[8] How does the inclusion of EBP in the four consumer expenditure equations affect the residuals? Consider the 1973:4–2010:3 estimation period. For the four equations without EBP_{-1} added, there are 13 large residuals, of which 10 are negative, for the 2008:1–2009:4 period. (In Table 8 there are 17 large residuals, with 14 negative. The difference is due to the different estimation period. The estimation period when EBP_{-1} is added is considerably shorter.) When EBP_{-1} is added, there are 10 large residuals, of which 6 are negative. The (negative) residual for the CD equation for 2008:4 is 4.9 times its standard error without EBP_{-1} added and 3.8 times when it is added. Quantitative estimates of how much EBP contributes to explaining the recession are presented in the Section 8.

Table 8
Large Absolute-Value Residuals
100(Actual - Predicted)/Standard Error

	Equation						
	1	2	3	4	12	11	27
2008:1		-1.2	-2.4	-1.8		-1.6	
2008:2	-1.2		-1.0				
2008:3	-1.0	-2.1	-1.6	1.9			
2008:4		-2.1	-5.3		-3.2	-1.9	1.1
2009:1	-1.2					-1.4	3.5
2009:2		-1.3	-1.1		2.5		2.0
2009:3			3.1	2.5		-1.6	
2009:4			-1.3				-1.3
2010:1							-1.1
2010:2			1.1				-1.8
2010:3	1.1			-2.6	1.3	1.2	-1.6
2010:4	1.1	1.3	1.1				
2011:1					-1.1	-1.3	
2011:2			-1.7				
2011:3			-1.0		2.7		
2011:4			1.2			1.0	
2012:1				-1.3			
2012:2			-1.4	-1.3			
2012:3							
2012:4	-1.2			-1.2	1.2		
2013:1					-2.1		
2013:2							
2013:3	-1.9		1.9				

Estimation period is 1954:1–2013:3
Equation 1: Service consumption (CS)
Equation 2: Nondurable consumption (CN)
Equation 3: Durable consumption (CD)
Equation 4: Housing investment (IHH)
Equation 12: Nonresidential fixed investment (IKF)
Equation 11: Inventory investment (IVF)
Equation 27: −Imports (IM)

7 What if Financial and Housing Wealth had not Fallen in 2008–2009?

Real financial wealth, $AA1$, and real housing wealth, $AA2$, are plotted in Figures 1 and 2. From 2007:4 to 2009:4 $AA1$ fell by $4.79 trillion. From 2010 on it recovered well, with a small dip in the middle of 2011. From 2007:4 to 2009:4 $AA2$ fell by $4.77 trillion, but unlike $AA1$, it had not recovered well by 2013:3. Say these two variables from 2008:1 on had instead behaved normally according to historical experience? What would the macroeconomy have looked like? An answer to this question using the MC model is as follows. The period examined is 2008:1–2013:3.

First, the variable AH, which is in the definition of $AA1$, is the nominal value of net financial assets of the household sector. It is determined by an 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, MH is its holdings of demand deposits and currency, CG is the value of capital gains (+) or losses (-) on the financial assets held by the household sector (almost all of which is the change in the market value corporate stocks held by the household sector), and $DISH$ is a discrepancy term. CG is constructed from data from the U.S. Flow of Funds accounts. It is highly correlated with the change in the S&P 500 stock price index. Stock prices thus affect AH through CG. There is an equation explaining CG in the model, 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 potential output and PX is a price index. For the experiment in this section the equation for CG was dropped and $CG/(PX_{-1}YS_{-1})$ was taken in each quarter to be its average over the 1954:1–2007:4 period, which is 0.12623.

Second, the relationship between PKH, the market price of housing, and the deflator for domestic sales in the model, PD, is

$$PKH = PSI14 \cdot PD \tag{3}$$

where PSI14 is taken to be exogenous.[9] An increase in $PSI14$ means that housing prices are rising relative to overall prices. For the experiment $PSI14$ was taken in each quarter to be its value in 2007:4, which is 2.0.

Third, the estimated shocks that occurred during the 2008:1–2013:3 period—the estimated residuals—were assumed to be the same in the new regime. In the estimation these shocks are assumed to be iid.[10]

Fourth, Fed behavior, as reflected in the values of the three-month Treasury bill rate, RS, was assumed to be the same in the new regime. In the model there is an estimated interest rate rule explaining Fed behavior, and this equation has been dropped from the model for the experiment. The rule is a leaning against the wind rule, and so if it were retained, the Fed would be predicted to increase RS from its base values in the more robust economy. For simplicity it seemed best not to compound the effects of wealth changes and interest rate changes, and so RS is taken to be exogenous.

For the experiment the estimated residuals were added to the model for the 2008:1–2013:3 period and taken to be exogenous. This means that when the model is solved with no changes in the exogenous variables, there is a perfect tracking solution. Then the two wealth changes were made and the model was solved—the entire MC model, not just the U.S. part. For each endogenous variable and each quarter, the difference between its solution value and its actual value is

[9] PKH is constructed from nominal housing stock data from the U.S. Flow of Funds accounts and real housing stock data from the Bureau of Economic Analysis—MM [Appendix A].

[10] As mentioned in Section 2, serial correlation has been removed from the shocks by the estimation of serial correlation coefficients.

the estimated effect of the wealth changes on the variable. Because the entire MC model is solved, all the endogenous variables are affected, but the following discussion focuses only on U.S. variables.

Using stochastic simulation and reestimation, standard errors of the estimated effects can be estimated, and this was done. The exact procedure for doing this is discussed in the appendix. Some of the estimated standard errors are reported below. In an experiment like this the main uncertainty comes from changes in the coefficient estimates as new sets of residuals are drawn. The additive error terms wash out because a new set of residuals is the same for both the base simulation and the simulation with the wealth changes.

To summarize, the experiment consists of having U.S. stock prices grow at historical rates, of having housing prices grow at the same rate as overall prices, of using the same shocks, and of having no change in the historical values of the short term interest rate (which are mostly zero). The experiment corresponds to large increases in financial and housing wealth because in reality both U.S. stock prices and housing prices fell dramatically.

Results are presented in Tables 9–11 and Figures 5–14. Table 9 shows the effects on $AA1$ and $AA2$. After 8 quarters financial wealth is \$7.36 trillion higher and housing wealth is \$5.12 trillion higher. These are, of course, huge differences. By the end of the period, 2013:3, financial wealth is about back down to its actual value, but housing wealth is still \$4.33 trillion higher. The estimated standard errors (SE) on the differences are small, but not zero. They are not zero because $AA1$ and $AA2$ depend on more than just $CG/(PX_{-1}YS_{-1}$ and $PSI14$, respectively, which are constant. See equation (1).

Table 10 is the key table. It shows the effects of the changes on the unemployment rate, UR, and private sector jobs, JF. The peak differences are in 2010:3, where the predicted unemployment rate is 6.10 versus 9.50 actual and the predicted

Table 9
Actual and Predicted Values of
Financial Wealth (AA1) and
Housing Wealth (AA2)
(trillions of 2009 Dollars)

	AA1				AA2			
Qtr.	**Act.**	**Pred.**	**Dif.**	**SE**	**Act.**	**Pred.**	**Dif.**	**SE**
2008.1	34.58	36.43	1.84	0.01	20.66	21.65	0.99	0.00
2008.2	33.66	36.67	3.01	0.02	19.58	21.70	2.11	0.00
2008.3	31.88	36.83	4.96	0.04	18.77	21.77	3.00	0.01
2008.4	29.14	37.81	8.68	0.07	18.05	21.85	3.79	0.01
2009.1	28.62	38.55	9.93	0.10	17.30	21.88	4.58	0.02
2009.2	29.55	38.71	9.16	0.13	16.93	21.84	4.91	0.03
2009.3	31.01	38.77	7.76	0.15	16.82	21.87	5.05	0.04
2009.4	31.37	38.73	7.36	0.18	16.78	21.90	5.12	0.05
2010.1	32.17	38.90	6.73	0.20	16.79	21.99	5.20	0.07
2010.2	31.38	39.19	7.81	0.24	16.83	22.08	5.26	0.08
2010.3	33.13	39.35	6.22	0.25	16.44	22.14	5.70	0.09
2010.4	35.23	39.47	4.25	0.28	16.28	22.25	5.97	0.10
2011.1	36.50	39.54	3.04	0.32	16.06	22.30	6.24	0.11
2011.2	36.42	39.58	3.17	0.33	15.83	22.36	6.53	0.11
2011.3	34.19	39.87	5.68	0.36	15.77	22.46	6.69	0.12
2011.4	35.67	40.12	4.45	0.36	15.70	22.51	6.81	0.14
2012.1	37.07	40.15	3.08	0.40	16.00	22.55	6.56	0.14
2012.2	36.73	40.57	3.84	0.39	16.26	22.63	6.36	0.15
2012.3	38.11	40.81	2.70	0.40	16.55	22.70	6.15	0.16
2012.4	38.76	41.13	2.37	0.40	16.81	22.73	5.92	0.17
2013.1	40.25	41.55	1.30	0.41	17.49	22.75	5.26	0.19
2013.2	40.85	42.05	1.20	0.42	18.03	22.80	4.77	0.19
2013.3	41.41	42.29	0.89	0.41	18.50	22.84	4.33	0.19

Table 10
Actual and Predicted Values of
the Unemployment Rate (UR) and
Private Sector Jobs (JF)
(percentage points and millions of jobs)

	UR				JF			
Qtr.	**Act.**	**Pred.**	**Dif.**	**SE**	**Act.**	**Pred.**	**Dif.**	**SE**
2008.1	5.00	5.00	0.00	0.00	131.88	131.88	0.00	0.00
2008.2	5.34	5.27	-0.08	0.02	131.41	131.49	0.08	0.02
2008.3	6.03	5.76	-0.27	0.05	130.52	130.86	0.34	0.06
2008.4	6.89	6.28	-0.61	0.11	128.45	129.27	0.83	0.12
2009.1	8.32	7.19	-1.13	0.19	126.12	127.72	1.59	0.22
2009.2	9.30	7.53	-1.78	0.24	124.17	126.78	2.61	0.37
2009.3	9.63	7.21	-2.42	0.31	123.16	126.90	3.74	0.52
2009.4	9.95	7.04	-2.91	0.33	122.56	127.33	4.78	0.65
2010.1	9.84	6.56	-3.28	0.37	122.42	127.97	5.56	0.75
2010.2	9.67	6.29	-3.38	0.41	122.66	128.67	6.01	0.76
2010.3	9.50	6.10	-3.41	0.39	122.63	128.79	6.16	0.74
2010.4	9.56	6.37	-3.19	0.40	123.08	129.23	6.15	0.78
2011.1	9.04	6.03	-3.01	0.38	123.82	129.83	6.01	0.74
2011.2	9.07	6.38	-2.69	0.38	124.27	129.98	5.72	0.73
2011.3	9.03	6.63	-2.39	0.34	124.78	130.09	5.31	0.69
2011.4	8.68	6.46	-2.22	0.34	125.44	130.34	4.90	0.70
2012.1	8.24	6.12	-2.12	0.33	126.15	130.72	4.57	0.73
2012.2	8.16	6.24	-1.92	0.33	126.79	131.07	4.28	0.67
2012.3	8.03	6.27	-1.76	0.31	127.29	131.29	3.99	0.65
2012.4	7.82	6.14	-1.68	0.29	127.81	131.48	3.67	0.67
2013.1	7.74	6.30	-1.45	0.30	128.17	131.48	3.30	0.67
2013.2	7.54	6.28	-1.26	0.29	128.59	131.46	2.87	0.66
2013.3	7.30	6.30	-1.00	0.28	129.17	131.53	2.36	0.67

Table 11
Actual and Predicted Values of
real GDP (GDPR) and
the GDP Deflator (GDPD)
(billions of 2009 dollars and 2009 = 1.0)

	GDPR				GDPD			
Qtr.	**Act.**	**Pred.**	**Dif.**	**SE**	**Act.**	**Pred.**	**Dif.**	**SE**
2008.1	14895.3	14895.4	0.1	0.1	0.985	0.985	0.000	0.000
2008.2	14969.1	15000.9	31.8	4.6	0.990	0.990	0.000	0.000
2008.3	14895.0	15004.3	109.3	14.5	0.997	0.997	0.001	0.000
2008.4	14574.6	14802.1	227.5	28.4	0.998	1.000	0.002	0.000
2009.1	14372.1	14768.2	396.1	44.0	1.001	1.005	0.004	0.001
2009.2	14356.9	14948.1	591.2	68.0	0.999	1.006	0.007	0.001
2009.3	14402.5	15159.6	757.1	86.7	0.999	1.010	0.011	0.002
2009.4	14540.2	15399.7	859.5	95.5	1.002	1.018	0.016	0.003
2010.1	14597.7	15473.1	875.4	99.7	1.005	1.028	0.023	0.003
2010.2	14738.0	15566.4	828.4	92.8	1.010	1.037	0.027	0.004
2010.3	14839.3	15601.7	762.4	88.9	1.014	1.047	0.032	0.005
2010.4	14942.4	15646.4	704.0	83.7	1.019	1.056	0.037	0.006
2011.1	14894.0	15527.6	633.6	82.4	1.023	1.065	0.042	0.006
2011.2	15011.2	15567.6	556.4	76.2	1.030	1.075	0.045	0.007
2011.3	15062.1	15532.5	470.4	81.0	1.036	1.085	0.048	0.008
2011.4	15242.0	15661.7	419.7	73.8	1.038	1.089	0.051	0.008
2012.1	15381.4	15783.1	401.7	74.9	1.043	1.096	0.054	0.009
2012.2	15427.6	15803.5	375.9	74.1	1.047	1.103	0.056	0.010
2012.3	15534.0	15879.4	345.4	73.8	1.053	1.111	0.058	0.010
2012.4	15539.6	15835.8	296.2	75.0	1.056	1.116	0.059	0.010
2013.1	15583.9	15823.6	239.7	70.6	1.061	1.122	0.061	0.010
2013.2	15679.6	15847.9	168.3	69.9	1.063	1.124	0.062	0.010
2013.3	15790.1	15876.0	85.9	72.1	1.068	1.130	0.062	0.011

number of jobs is 128.79 million versus 122.63 million actual. The standard errors are small relative to the size of the differences. This is a common result—see MM [3.9.2]. When the uncertainty is only from the coefficient estimates, as here, it tends to be small.

Table 11 shows the effects on real GDP, $GDPR$, and the GDP deflator, $GDPD$. In 2010:1 real GDP is higher by $875.4 billion. The GDP deflator is higher by 6.2 percent by the end of the period because of the more robust economy. The standard errors are again relatively small.

To get the big picture, Figures 5–14 plot the six variables in Tables 9–11 plus the three consumption variables and housing investment, CS, CN, CD, and IHH. Figure 6 for housing wealth, $AA2$, shows the small recovery after the initial fall. The results for housing investment, IHH, in Figure 14 are striking. In 2009:4 the actual value is $323.6 billion and the predicted value is $490.5 billion, a 52 percent increase.

The main conclusion from the overall results is that much of the recession and slow recovery from the recession was do to the fall in financial and housing wealth from what wealth would have been had it behaved according to historical norms. It is clear, however, that not all of the recession has been explained. The unemployment rate in the new case still rises, from 5.00 percent in 2008:1 to a peak of 7.53 percent in 2009:2. Some of this increase is likely due to financial effects not captured in the interest rate and wealth variables in the four household expenditure equations in the model. This issue is taken up in the next section.

Remember that this experiment takes the wealth changes to be exogenous—actually $CG/(PX_{-1}YS_{-1})$ and $PSI14$ to be exogenous. Households respond to the changes after they have taken place. The wealth changes are not explained. Also, the fall in housing prices before 2008, which likely triggered the future wealth changes, is not explained. Looking at the plots in Figures 1 and 2 from,

Figure 5
AA1, Actual and Predicted

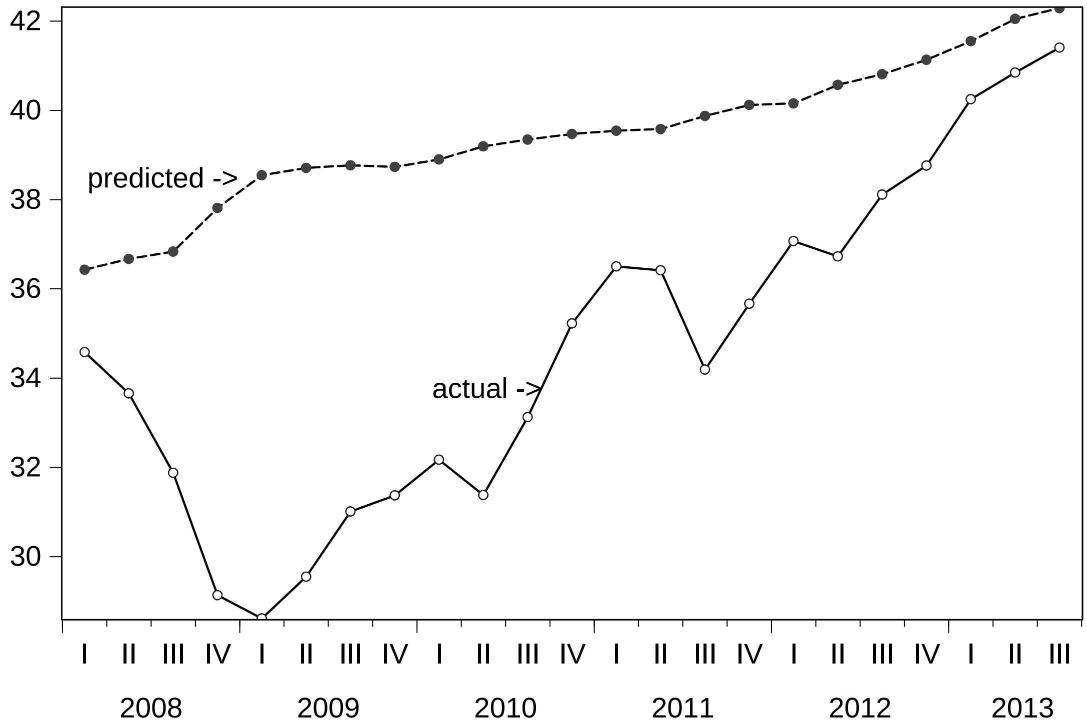


Figure 6
AA2, Actual and Predicted

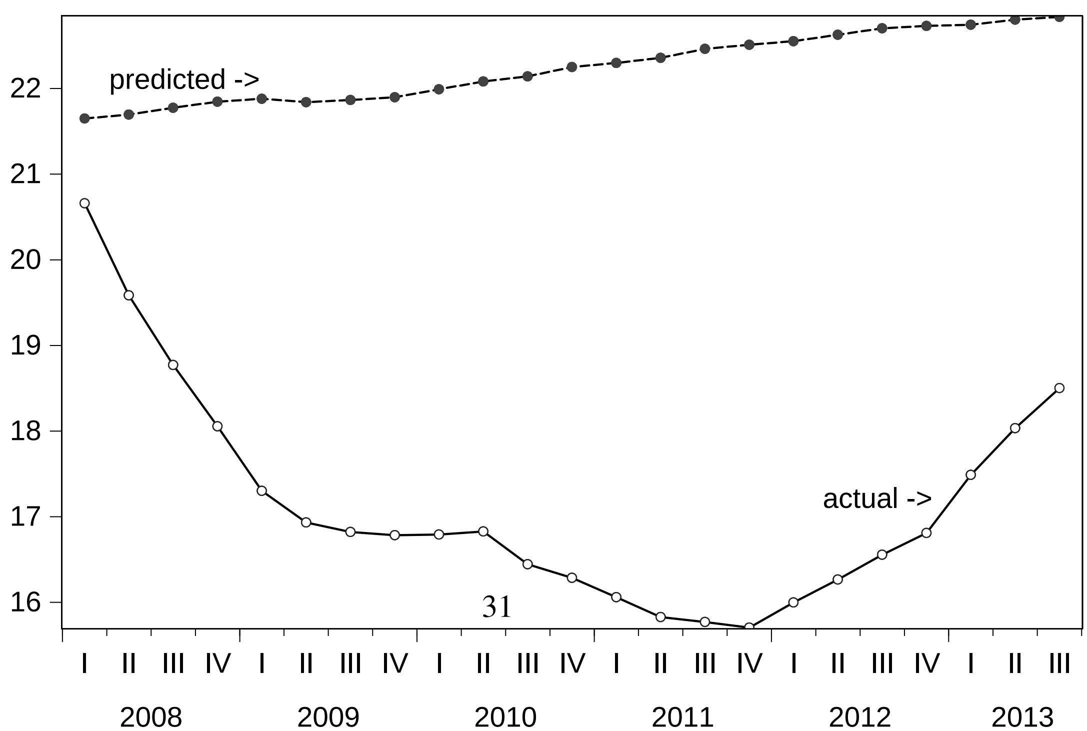


Figure 7
UR Actual and Predicted

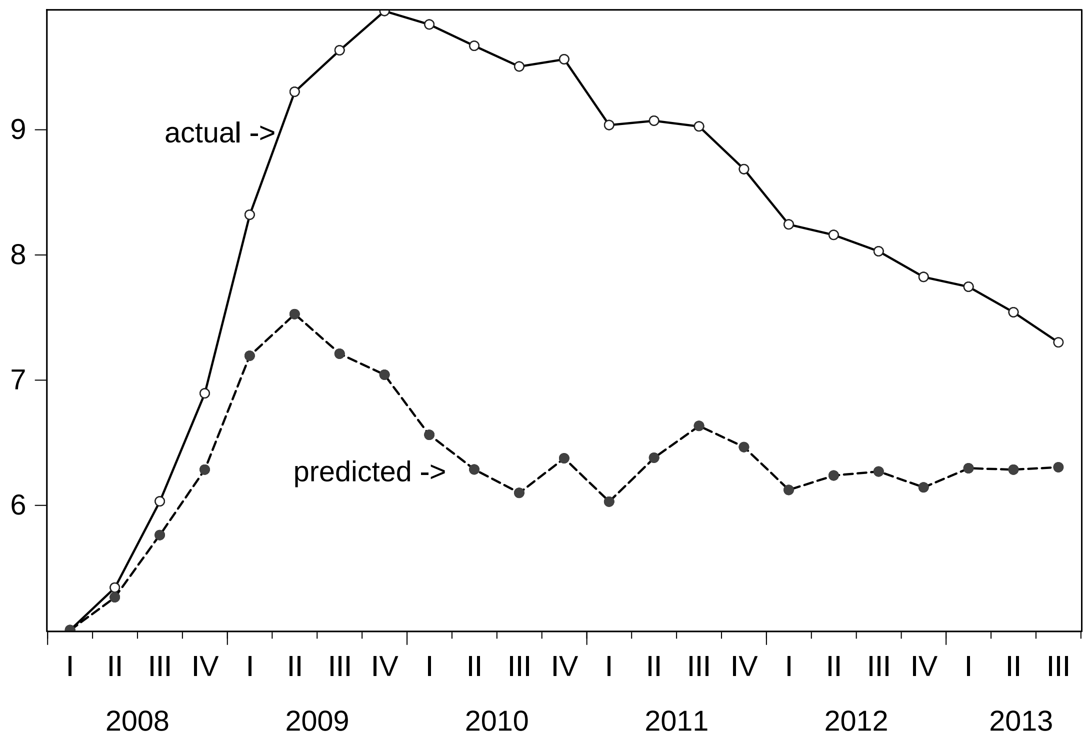


Figure 8
JF Actual and Predicted

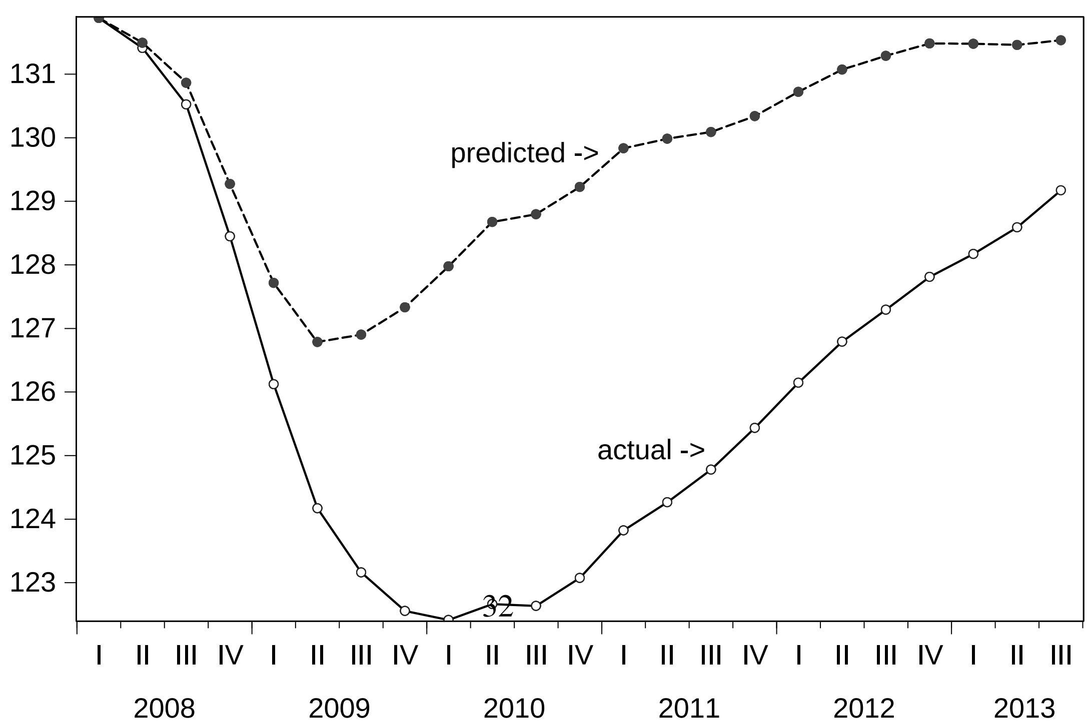


Figure 9
GDPR Actual and Predicted

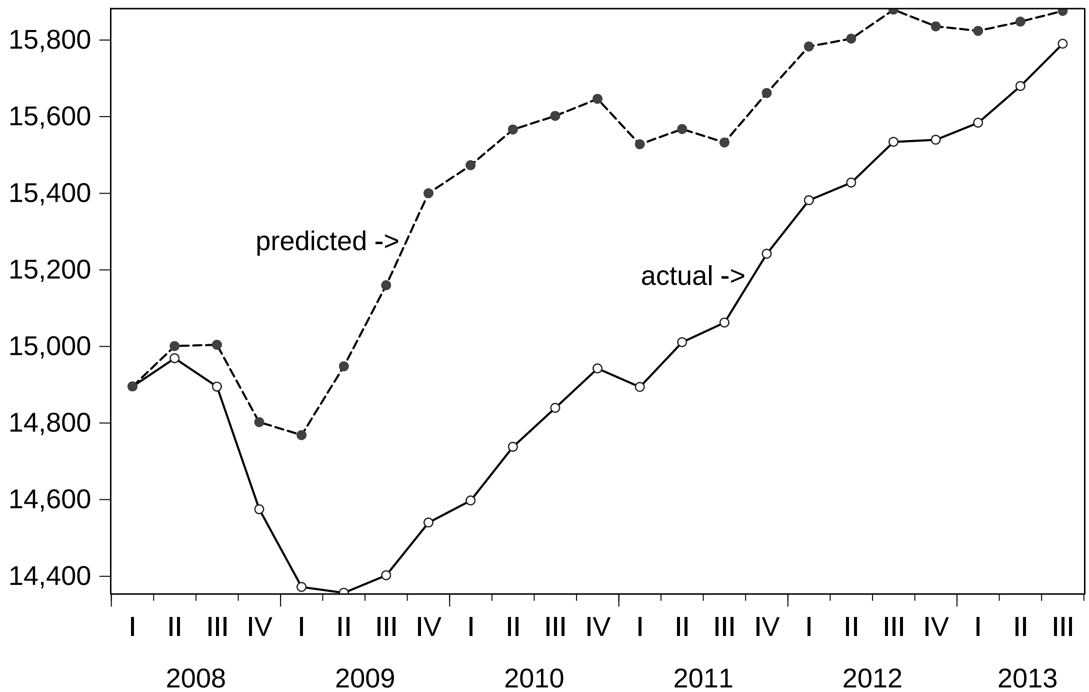


Figure 10
GDPD Actual and Predicted

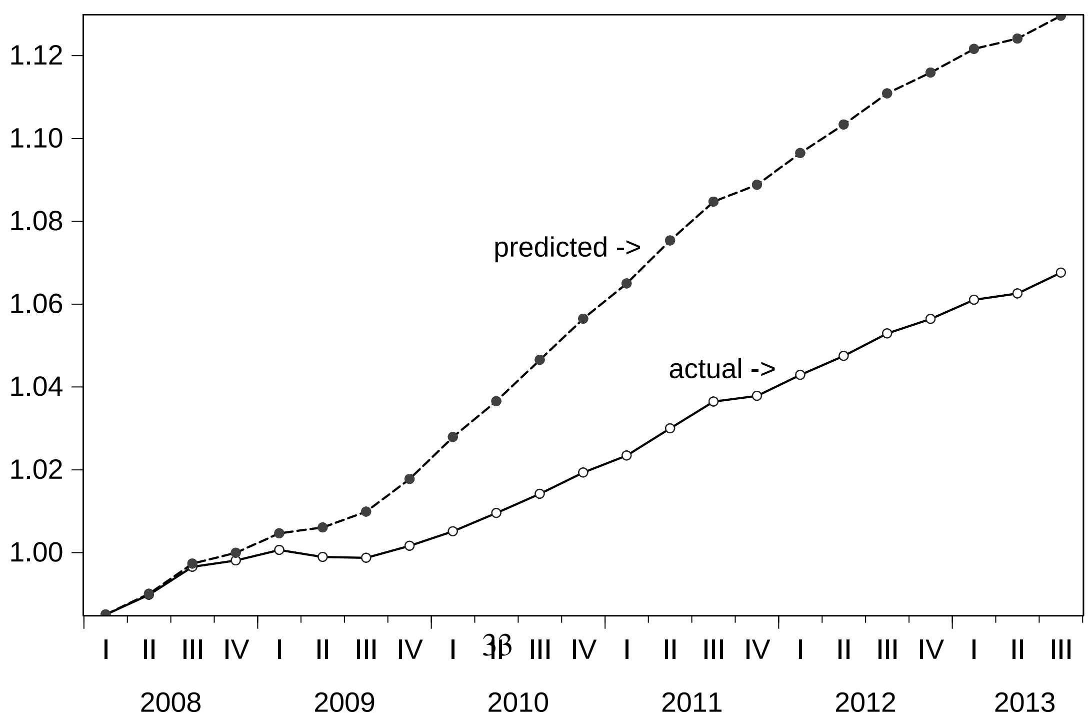


Figure 11
CS Actual and Predicted

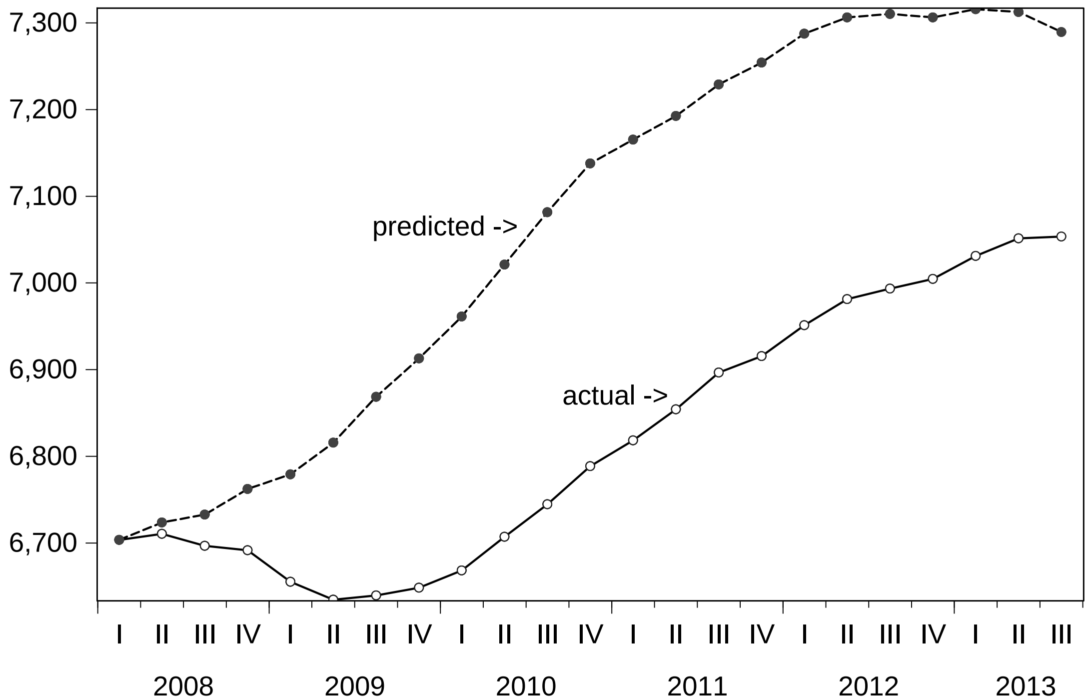


Figure 12
CN Actual and Predicted

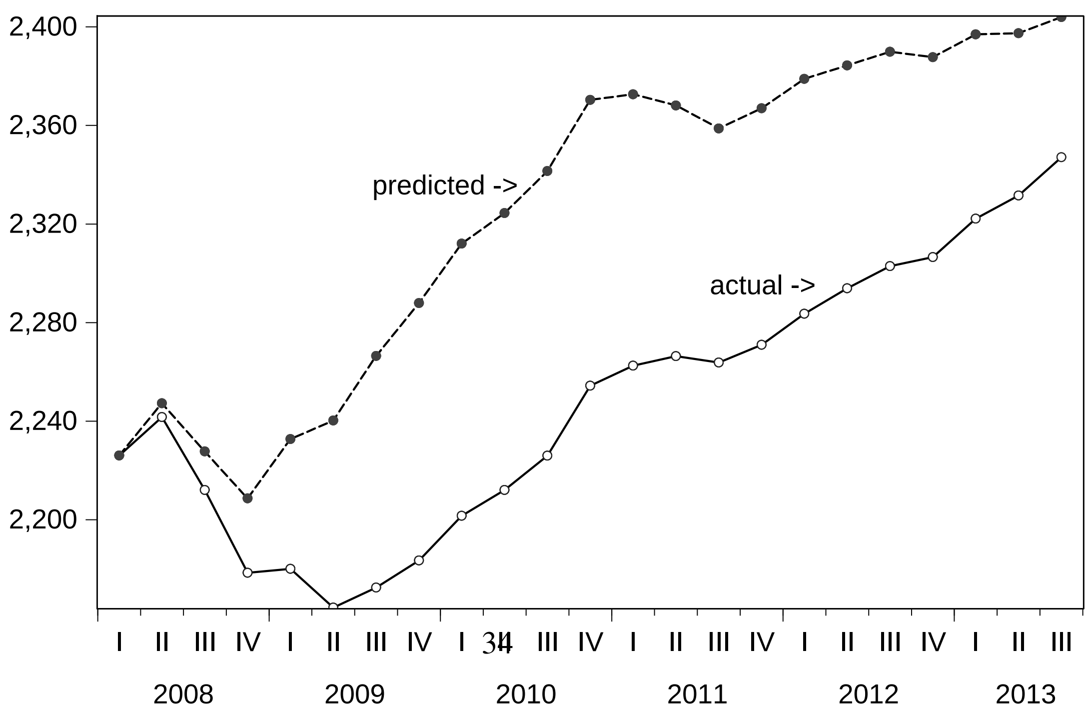


Figure 13
CD Actual and Predicted

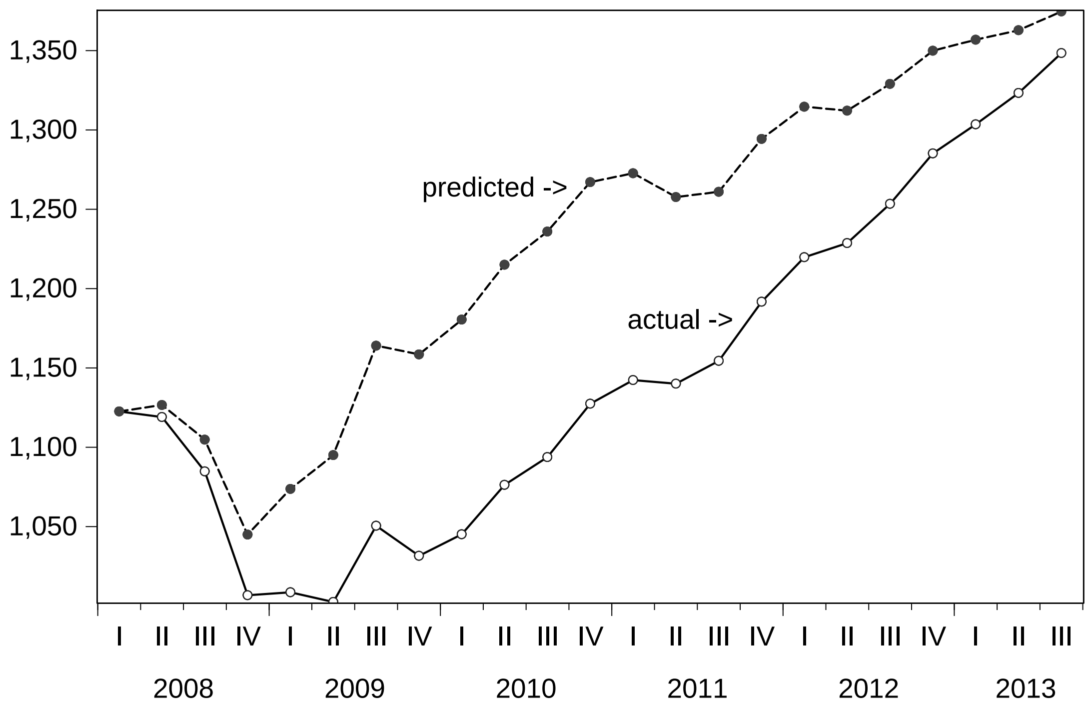
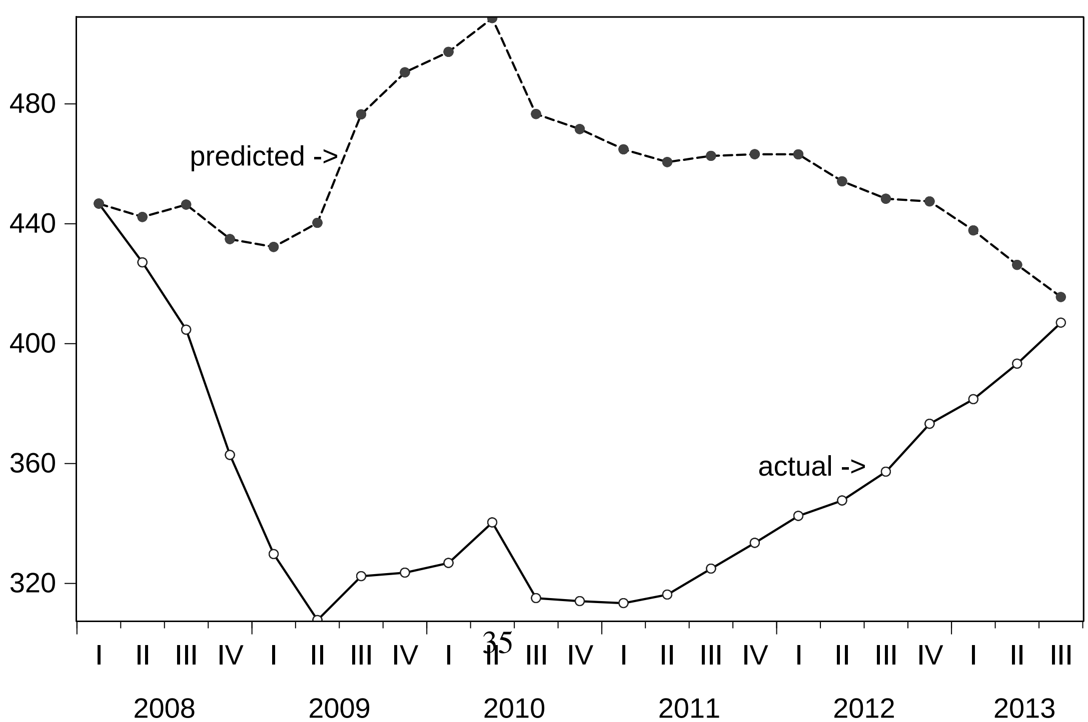


Figure 14
IHH Actual and Predicted



say, 1995 on, it seems unlikely that the changes in these series could be explained econometrically using macro variables. The changes in $AA1$ and $AA2$ are largely unpredictable. In other words, it is unlikely that estimated equations for $AA1$ and $AA2$ could be obtained that would have picked up the changes that occurred since, say, 1995.[11] The experiment is thus conditional on the wealth changes. Conditional on the changes, conditional on the shocks being the same, and conditional on Fed behavior being the same, it answers the question of what the economy would have been like had the wealth changes been at historical values.

8 Other Experiments

Can any more of the recession be picked up? In particular, can any other financial effects be picked up? Various measures of credit conditions were tested in Section 4. From the results, the only possible candidate of interest is the EBP variable of Gilchrist and Zakrajšek (2012). Table 5 shows that it is significant in three of the four expenditure equations when they are estimated through the recessionary period. It is possible, however, that EBP is essentially a dummy variable for the 2008–2009 period, chosen after the fact. But if it is picking up actual effects, the following experiment is of interest.

The experiment is as follows. First, the main experiment was rerun with the four household expenditure equations estimated for the 1973:4–2010.3 period, which is the period used when EBP_{-1} is added to the equations. The results for the unemployment rate and jobs are presented in the top half of Table 12. These results differ somewhat from those in Table 10 because of the different estimation period for the four consumer expenditure equations. Second, the fourth of each

[11] Regressions of $CG/(PX_{-1}YS_{-1})$ and $\log PSI14 - \log PSI14_{-1}$ on lagged values of numerous macroeconomic variables for the 1954:1–2013:3 period yield nothing of interest, as expected.

Table 12
Actual and Predicted Values of
the Unemployment Rate (UR) and
Private Sector Jobs (JF)
(percentage points and millions of jobs)

Regular Version

		UR			JF	
Qtr.	**Act.**	**Pred.**	**Dif.**	**Act.**	**Pred.**	**Dif.**
2008.1	5.00	5.00	0.00	131.88	131.88	0.00
2008.2	5.34	5.25	-0.09	131.41	131.52	0.11
2008.3	6.03	5.70	-0.33	130.52	130.97	0.45
2008.4	6.89	6.15	-0.75	128.45	129.53	1.08
2009.1	8.32	6.95	-1.37	126.12	128.18	2.06
2009.2	9.30	7.16	-2.15	124.17	127.50	3.33
2009.3	9.63	6.74	-2.90	123.16	127.86	4.70
2009.4	9.95	6.52	-3.42	122.56	128.45	5.90
2010.1	9.84	6.04	-3.80	122.42	129.17	6.76
2010.2	9.67	5.82	-3.85	122.66	129.85	7.19
2010.3	9.50	5.70	-3.80	122.63	129.90	7.26

EBP Added

		UR			JF	
Qtr.	**Act.**	**Pred.**	**Dif.**	**Act.**	**Pred.**	**Dif.**
2008.1	5.00	4.97	-0.04	131.88	131.95	0.06
2008.2	5.34	5.13	-0.22	131.41	131.74	0.33
2008.3	6.03	5.50	-0.54	130.52	131.36	0.84
2008.4	6.89	5.86	-1.03	128.45	130.08	1.64
2009.1	8.32	6.58	-1.74	126.12	128.94	2.82
2009.2	9.30	6.70	-2.60	124.17	128.46	4.28
2009.3	9.63	6.28	-3.35	123.16	128.88	5.72
2009.4	9.95	6.21	-3.74	122.56	129.31	6.76
2010.1	9.84	5.93	-3.91	122.42	129.69	7.28
2010.2	9.67	5.93	-3.74	122.66	130.00	7.34
2010.3	9.50	5.97	-3.53	122.63	129.71	7.08

of the four expenditure equations in Table 5 was used in place of the regular expenditure equations in the model. One can see from Figure 4 that the value of EBP in 2007:2 was quite low. For the experiment this value (-0.5828) was used for 2007:3 on. The rest of the experiment was unchanged. The prediction period was taken to end in 2010:3, since this is the end of the EBP data. So this is an experiment in which wealth doesn't fall and the excess bond premium doesn't rise. The results for the unemployment rate and jobs are presented in the bottom half of Table 12.

Comparing the two sets of results in Table 12, for the version with EBP added UR peaks in 2009:2 at 6.70 versus 7.16 for the regular version. The actual value of UR in this quarter was 9.30, and so roughly the wealth variables lowered it by 2.15 and EBP lowered it by 0.45 more. Figure 4 shows that EBP dropped sharply in 2009:3, which means in the experiment that the stimulative effects from the lower values of EBP are much less. In 2010:3 the predicted unemployment rate for the regular version is 5.70 versus 9.50 actual, and for the version with EBP added the predicted unemployment rate is actually higher at 5.97. In general, EBP is economically important in 2009, but not much otherwise.

Finally, it is of interest to compare the results for jobs in Table 10 with results in Mian and Sufi (2014) (MS). Using estimates for the non-tradeable sector obtained from county data and making some assumptions to aggregate to the entire economy, they estimate that the the fall in housing wealth accounted for 55 percent of the fall in employment between 2007 and 2009. For comparison purposes the above experiment was run with only housing wealth ($AA2$) changed. The results for JF are presented in Table 13. Also presented is the actual value of JF for 2007:4. The decline in JF between 2007:4 and 2009:4 was 9.56 million. If housing wealth had not fallen, the estimate is that the decline would have been 2.12 million less, or 7.44 million. 2.12 million is 22 percent of 9.56 million, which is much smaller

Table 13
Only AA2 Changed
Actual and Predicted Values
of Private Sector Jobs (JF)
(millions of jobs)

		JF	
Qtr.	**Act.**	**Pred.**	**Dif.**
2007.4	132.11		
2008.1	131.88	131.88	0.00
2008.2	131.41	131.46	0.05
2008.3	130.52	130.72	0.20
2008.4	128.45	128.90	0.46
2009.1	126.12	126.94	0.82
2009.2	124.17	125.43	1.25
2009.3	123.16	124.87	1.71
2009.4	122.56	124.67	2.12

than the 55 percent estimate of MS. In Table 13, 55 percent would be a fall in JF of 5.36 million due to the fall in housing, which seems high. It may be that some of the assumptions made by MS in moving from the non-tradeable sector results to the aggregate estimates are not realistic. Or it may be that they have overestimated the employment response in the non-tradeable sector.[12]

[12]The employment data used by MS are not the same as the data for JF, and MS use annual changes, not fourth-quarter to fourth-quarter changes. They have a fall in employment between 2007 and 2009 of 5.3 percent, whereas the fall in JF between 2007:4 and 2009:4 in Table 13 is 7.2 percent. The different data might explain part of the 22 versus 55 percent difference.

9 Conclusion

A standard view of the 2008-2009 financial crisis is that for a variety of reasons, some doing with lack of regulations and some with excessive risk taking, housing prices rose to unsustainable levels between 2002 and 2006. When they started to fall, this set off a chain reaction that led to the financial crisis.[13] The trigger was thus a fall in housing wealth. The results in this paper suggest that much of the effect of the financial crisis on macroeconomic activity can be picked up through financial and housing wealth effects on household expenditures. Some of the recession, at least in 2009, not captured by the wealth variables can be captured by the excess bond premium variable of Gilchrist and Zakrajšek (2012), although this variable was created ex post and is only significant ex post. In general much of the 2008-2009 recession is estimated to be simply standard wealth effects at work.

[13]There is some evidence that my wife, Sharon Oster, is the cause of the financial crisis. She was a graduate student with Chip Case at Harvard in the 1970s, and after we were married she introduced Chip to me, which led to our collaborating on an economics text. At some point Chip was interested in finding someone to work with him on housing prices, and I introduced Chip to Bob Shiller. Out of this came the Case-Shiller housing price index. This index for the first time provided financial firms with good data on changes in housing prices. At the time of its release the index had more or less increased every year, and financial firms may have (ex post incorrectly) extrapolated this trend into the future, making mortgage loans under this assumption. Hence the boom in prices and then the collapse. So had Sharon not introduced me to Chip, none of this would have happened.

Appendix

Computing Standard Errors

There are 1,689 estimated equations in the MC model, of which 1,379 are trade share equations. The estimation period for the United States is 1954:1–2013:3. The estimation periods for the other countries begin as early as 1962:1 and end as late as 2013:2. The estimation period for most of the trade share equations is 1966:1–2012:4. For each estimated equation there are estimated residuals over the estimation period. Let $\hat{u}_t$ denote the 1689-dimension vector of the estimated residuals for quarter t.[14] Most of the estimation periods have the 1972:1–2007:4 period—144 quarters– in common, and this period is taken to be the "base" period. These 144 observations on $\hat{u}_t$ are used for the draws in the stochastic-simulation procedure discussed below.[15]

The solution period used to create new data is 1954:1–2013:3—239 quarters. For a given set of coefficient estimates and error terms, the model can be solved dynamically over this period. Equations enter the solution as data become available. For example, for the period 1954:1–1959:4 only the equations for the United States are used. The links from the other countries to the United States are shut off, and the U.S. variables that these links affect are taken to be exogenous. By 1972 almost all the equations are being used.

[14]There is a mixture of quarterly and annual equations in the MC model. For equations estimated using annual data, the error is put in the first quarter of the year with zeros in the other three quarters (which are never used). 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. As discussed in the text, the draws are by year—four quarters at a time.

[15]If an estimation period does not include all of the 1972:1–2007:4 period, zero errors are used for the missing quarters.

Each trial of the bootstrap procedure is as follows. First, 239 error vectors are drawn with replacement from the 144 vectors in the base period. (Each vector consists of 1,689 errors.) Using these errors and the coefficient estimates based on the actual data, the model is solved dynamically over the 1954:1–2013:3 period. Using the solution values as the new data set, the 1,689 equations are reestimated. Given these new coefficient estimates and the new data, the experiment in Section 7 is performed for the 2008:1–2013:3 period. The estimated effects are recorded. This is one trial. The procedure is then repeated, say, N times. (Note that the coefficient estimates used to generate the new data on each trial are the estimates based on the actual data.) This gives N values of each estimated effect, from which measures of dispersion can be computed. For the results in Section 7 the number of trials was 100. There were no solution failures for any trial.

The measure of dispersion used in the tables (denoted SE) is as follows. Rank the N values of a given multiplier by size. Let m_r denote the value below which r percent of the values lie. The measure of dispersion is $(m_{.8413} - m_{.1587})/2$. For a normal distribution this is one standard error.

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