Household Wealth and Macroeconomic Activity: 2008-2013

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Abstract

This paper provides estimates of the effects of the fall in financial and housing wealth in 2008–2009 on overall macroeconomic activity. When the wealth losses are run through a structural macroeconometric model, it is estimated that the fall in wealth contributed about 2.1 percentage points to the rise in the unemployment rate in 2009 and about 3.3 points in 2010. The contribution to the fall in jobs was 3.2 and 6.0 million in the two years. The contribution to the fall in real GDP was 4.5 and 5.4 percent in the two years.

These estimates account for most—but not all—of the recessionary increase in unemployment. The remaining increase in unemployment may have resulted more directly from financial stresses, but little evidence is found for this when the stresses are constrained to operate through consumer expenditures and residential investment. There is evidence that some of the extra unemployment that lower wealth cannot explain is due to fiscal policy and export effects. Distributional effects cannot be accounted for in this study given the use of aggreagate data, but the effects could go either way, since housing wealth decreases may affect low-income consumers more, but financial wealth decreases may affect high-income consumers more.

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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 2008–2010. This paper provides estimates of the effects of the fall in financial and housing wealth in 2008–2009 on macroeconomic activity. When the wealth losses are run through a structural macroeconometric model, it is estimated that the fall in wealth contributed about 2.1 percentage points to the rise in the unemployment rate in 2009 and about 3.3 points in 2010. The contribution to the fall in jobs was 3.2 and 6.0 million in the two years. The contribution to the fall in real GDP was 4.5 and 5.4 percent in the two years.

These estimates account for most—but not all—of the recessionary increase in unemployment. The remaining increase in unemployment may have resulted more directly from financial stresses. However, these stresses do not appear from the results below to explain much of the increase in unemployment when they are constrained to operate through consumer expenditures and residential investment. Financial frictions that run through alternative channels, or the separate effects of fiscal policy and exports, may be responsible for the extra unemployment that lower wealth cannot explain. The separate effects of fiscal policy and exports are estimated below, where both do contribute somewhat to the rise in unemployment in 2009 and 2010.

It may also be that estimated aggregate wealth effects are too small because they don't account for distributional issues, as Mian, Rao, and Sufi (2013) have argued. If the recent wealth losses were concentrated among low-income consumers, who have higher marginal propensities to consume, aggregate wealth effects, as in this paper, will be underestimated. However, more than half of the fall in wealth was financial wealth as opposed to housing wealth, and financial wealth losses are likely to be concentrated among high-income consumers.

There is now an extensive literature on financial frictions—see Brunnermeier and Sannikiov (2014) for citations.[1] This literature is mostly theoretical, and the various financial frictions that are postulated are too abstract to be taken directly to macro data. On the empirical side, 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.

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

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 estimates 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.

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 Loan 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. Section 4 tests various measures of credit conditions. Section 5 then estimates the size of the effect on the economy from the decrease in financial wealth and housing wealth. Section 6 provides further estimates.

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

[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.

counting various transformations of the variables and the trade share variables, is 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. It also includes a list of the first stage regressors in each equation. The discussion in the rest of this paper pertains to the U.S. part of the MC model.

3 The Household 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.

Consumption Equations

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

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

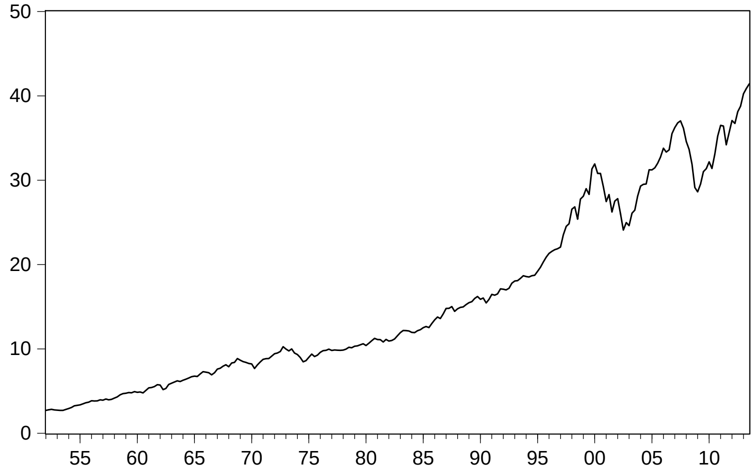


Figure 2
Housing Wealth, AA2, 1952:1--2013:3
Trillions of 2009 Dollars

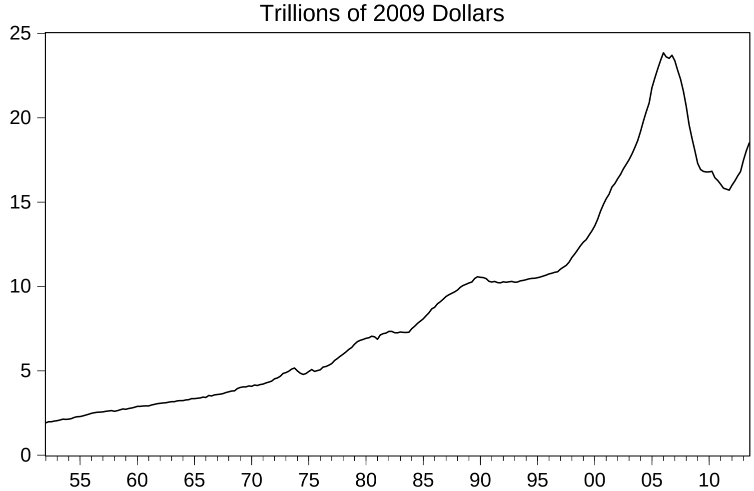


Figure 3
Financial Wealth/Housing Wealth
1952:1--2013:3

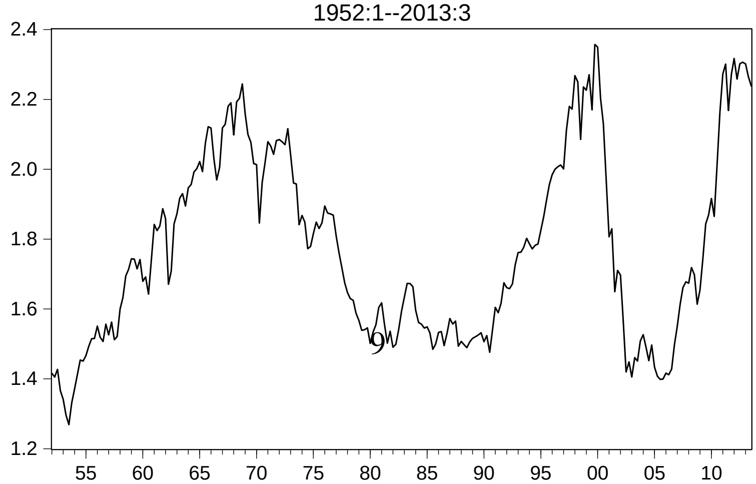


Table 2
Coefficient Estimates for Consumption of Services (CS)
and Consumption of Non Durables (CN)
Left Hand Side Variables are log(CS/POP)
and log(CN/POP)

	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.

variables being variables that affect the decisions.[3]

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 $\lambda = 0.5$

[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.

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. This is discussed at the end of this section.

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

[4]The sixth and seventh explanatory variables in Table 3, namely $DELD \cdot (KD/POP)_{-1} - (CD/POP)_{-1}$ and $(KD/POP)_{-1}$, are picking up partial adjustment effects regarding both the stock of durable goods and the flow—MM [3.6.3]. Similar considerations apply to the third and fourth variables in Table 4 for housing investment. CDA in Table 3 is an exogenous scale parameter for the interest rate. A scale variable is needed because the interest rate has no trend. In Table 4 the scale variable is $IHHA$.

Table 3
Coefficient 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 $DELD \cdot (KD/POP)_{-1} - (CD/POP)_{-1}$
•t-statistics are in parentheses.
•Estimation method is 2SLS.
•Variables are listed in Table 1.

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.

Housing Investment Equation

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) 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

Table 4
Coefficient 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 $DELH \cdot (KH/POP)_{-1} - (IHH/POP)_{-1}$
•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.

equation, but Case, Quigley, and Shiller (2012) do not examine housing investment. They have used many assumptions 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. 1709) that they do not have the statistical power to estimate financial wealth effects because of lack of good data on financial assets by zip codes. Zhou and Carroll (2012), using data by states like Case, Quigley, and Shiller (2012), 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.

Size of the Wealth Effects

A partial equilibrium question is to ask how much household expenditures change when $AA1$ or $AA2$ changes, other things being equal. 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. In this case an increase in $AA1$ of $1,000 billion leads to a sustained increase in total household expenditures of about $40 billion in the long run. So about 4 cents on the dollar. When $AA2$ is increased, the effect is about 5 cents on the dollar, larger because it affects housing investment, which $AA1$ does not.

The roughly 4 percent estimate for $AA1$ 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 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) find 5 to 7 percent effects of housing wealth on consumption (p. 1723), although these effects vary considerably across zip codes. These numbers should be compared to the 4 percent estimate above because Mian, Rao, and Sufi (2013) do not examine housing investment. Their estimated effects are thus somewhat higher than the present ones. This may be due, as discussed in the introduction, to distributional effects that are ignored when using macro data. Zhou and Carroll (2012) find 5 percent effects of housing wealth on consumption (p. 18), again slightly higher than the 4 percent estimate here.

Case, Quigley, and Shiller (2012) test for asymmetrical effects and find that the housing wealth elasticity is estimated to be larger in falling markets than in rising markets.[5] Their estimated elasticities are 0.10 and 0.032, respectively. The result here of 4 cents on the dollar translates into an elasticity of about 0.09, close to the Case, Quigley, and Shiller (2012) elasticity of 0.10 in falling markets.

[5]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.

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. 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.

These residuals were examined for the 2008:1–2013:3 period. There were in fact not huge except for the consumer durables residual for 2008:4, which was negative and 5.3 times its standard error. Consumer durables fell at an annual rate of 25.8 percent in this quarter, much of which was not explained. This error undoubtedly contributes to the rejection of the End test in Table 3. Of the 32 residuals in the four equations for the 2008:1–2009:4 period, only one other was greater than three times its standard error—3.1 for consumer durables in 2009:3. Of the 60 residuals for the 2010:1–2013:3 period, only one was greater than two times its standard error—-2.6 for housing investment in 2010:3. So random shocks do not appear to play a large role in this period.

Structural Stability Post 2007

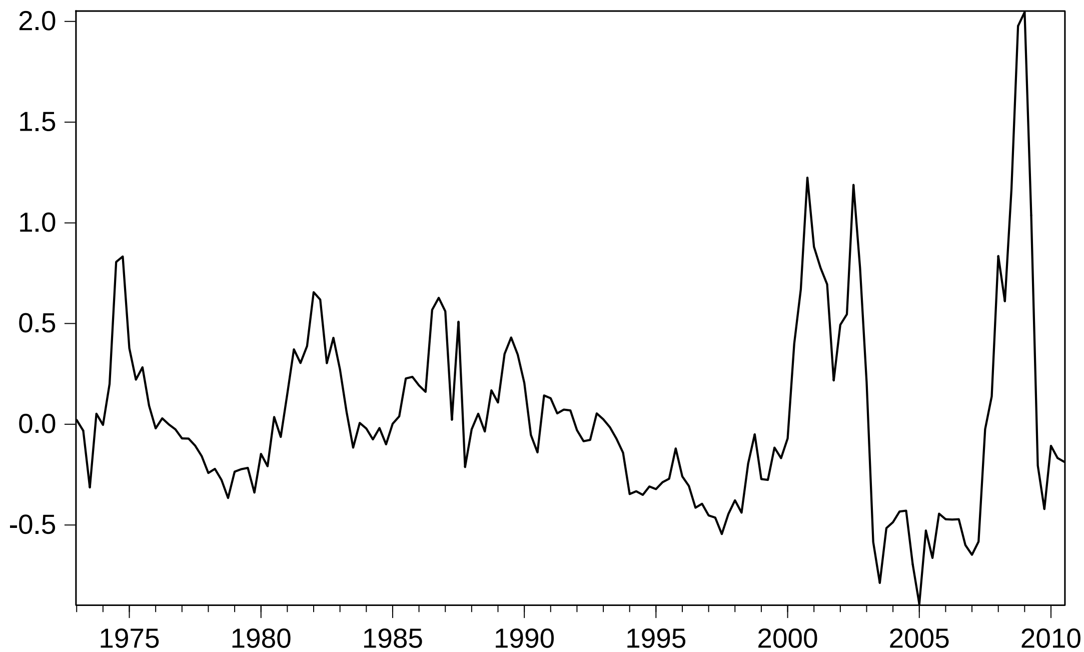
Some of the literature on the financial crisis has focused on possible structural changes that occurred after 2007. In the context of a model like the MC model, the question is whether the coefficients in the structural equations have changed. In particular, has the response to wealth changes changed? There is not much evidence from the above results that the coefficients in the four household expenditure equations have changed. The End test in Tables 2, 3, and 4 does not reject the hypothesis of stability except for consumer durables, which is affected by one large outlier. One can also compare the coefficients on the wealth variable in each equation for the two periods, one ending in 2007:4 and one ending in 2013:3. They are essentially the same for consumption of services and housing investment. For nondurable and durable consumption the coefficient estimate for the longer period is larger, as would be expected if wealth played a larger role after 2007. However, when the hypothesis that the coefficient is the same in the period since 2008:1 as before is tested, it is not rejected for any of the four equations. These are, of course, tests based on aggregate data, and it may be with more refined data some structural changes could be picked up.

4 Testing Measures of Credit Conditions

The household 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
Excess Bond Premium (EBP) 1973:1--2010:3



EBP was chosen after the 2008–2009 recession was known, including the recession in the estimation period is somewhat problematic. 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.

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.

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.

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 household expenditures not captured by the interest rate and wealth variables.[6] This is examined in Section 6.

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 household 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.[7] Whatever information CEA and $UnRisk$ convey, it appears to be captured by variables already in the expenditure equations.

5 What if Financial and Housing Wealth had not Fallen?

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

[6]Note that it could be that EBP affects, say, the labor market, which then affects income. Income is an explanatory variable in the equations, so what is being tested here is whether EBP has independent explanatory power after income has been controlled for.

[7]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.

$AA2$ 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.[8] An increase in $PSI14$ means that housing

[8] PKH is constructed from nominal housing stock data from the U.S. Flow of Funds accounts

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*.[9]

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 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

and real housing stock data from the Bureau of Economic Analysis—MM [Appendix A].

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

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 Figures 5–14. Figures 5 and 6 show the wealth differences. After 8 quarters real financial wealth, $AA1$, is \$7.4 trillion higher and real housing wealth, $AA2$, is \$5.1 trillion higher. These are large differences. By the end of the period, 2013:3, real financial wealth is almost back to its actual value, but real housing wealth is still \$4.3 trillion higher.

Figures 7 and 8 show the effects on the unemployment rate, UR, and jobs, JF. The peak differences are in 2010:3, where the counterfactual unemployment rate is 6.1 versus 9.5 actual and the counterfactual number of jobs is 128.8 million versus 122.6 million actual. Figures 9 and 10 show the effects on real GDP, $GDPR$, and the GDP deflator, $GDPD$. In 2010:3 real GDP is higher by \$762 billion. The GDP deflator is higher by 6.2 percent by the end of the period because of the more robust economy. Figures 11–14 give the plots for the four household expenditure categories. The results for housing investment, IHH, in Figure 14 are striking. In 2009:4 the actual value is \$324 billion and the counterfactual value is \$491 billion, a 52 percent increase.

Figure 5
Total Real Net Financial Wealth (AA1)
Actual and Counterfactual

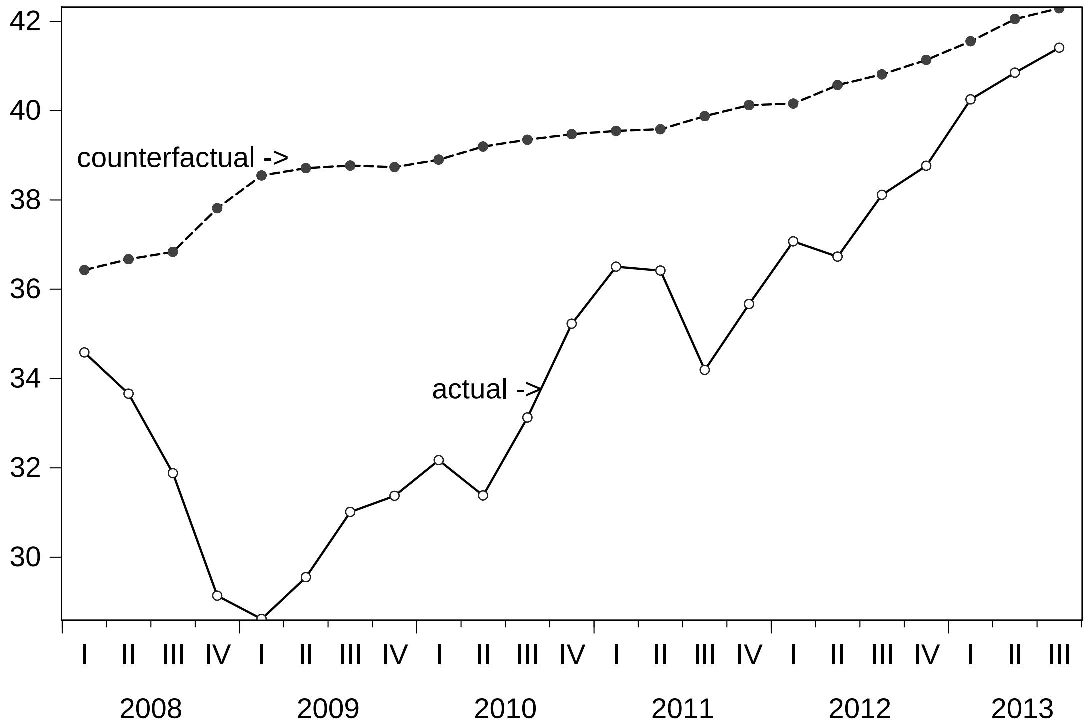


Figure 6
Total Real Net Housing Wealth (AA2)
Actual and Counterfactual

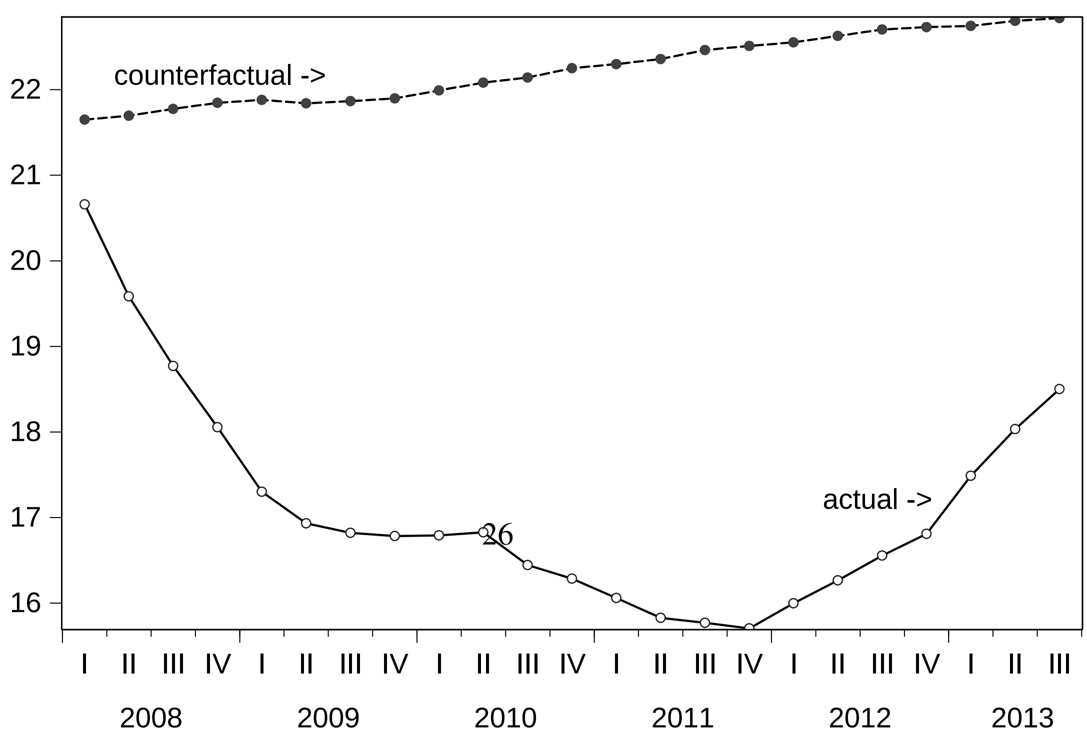


Figure 7
Unemployment Rate (UR)
Actual and Counterfactual

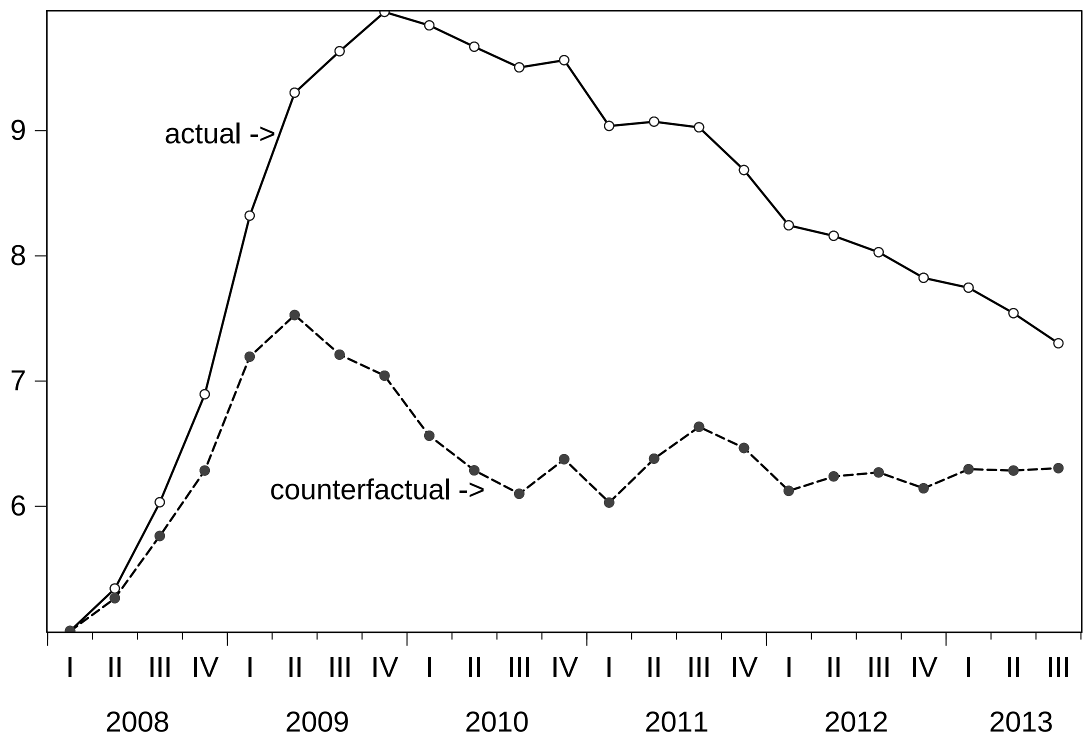


Figure 8
Number of Firm Sector Jobs (JF)
Actual and Counterfactual

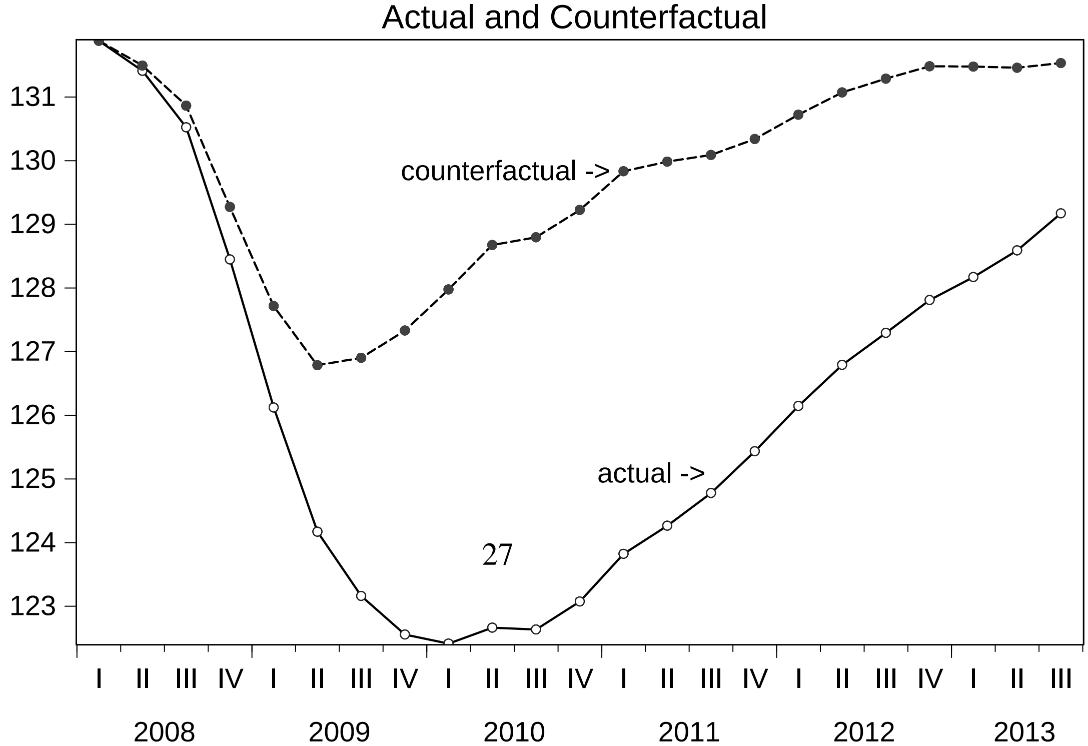


Figure 9
Real GDP (GDPR)
Actual and Counterfactual

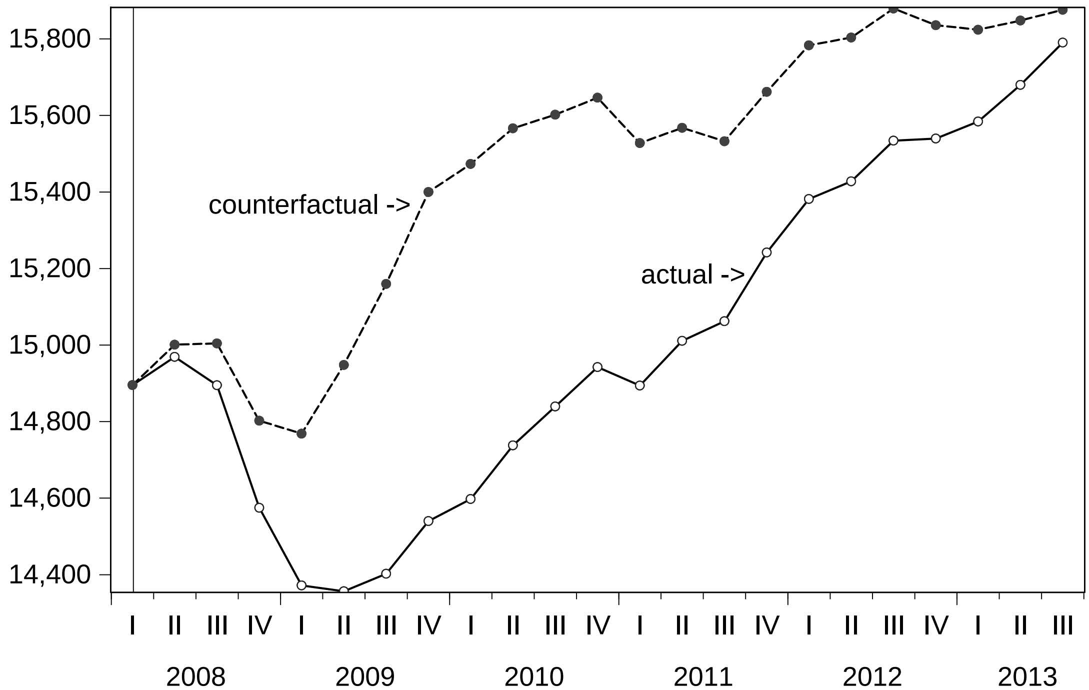


Figure 10
GDP Deflator (GDPD)
Actual and Counterfactual

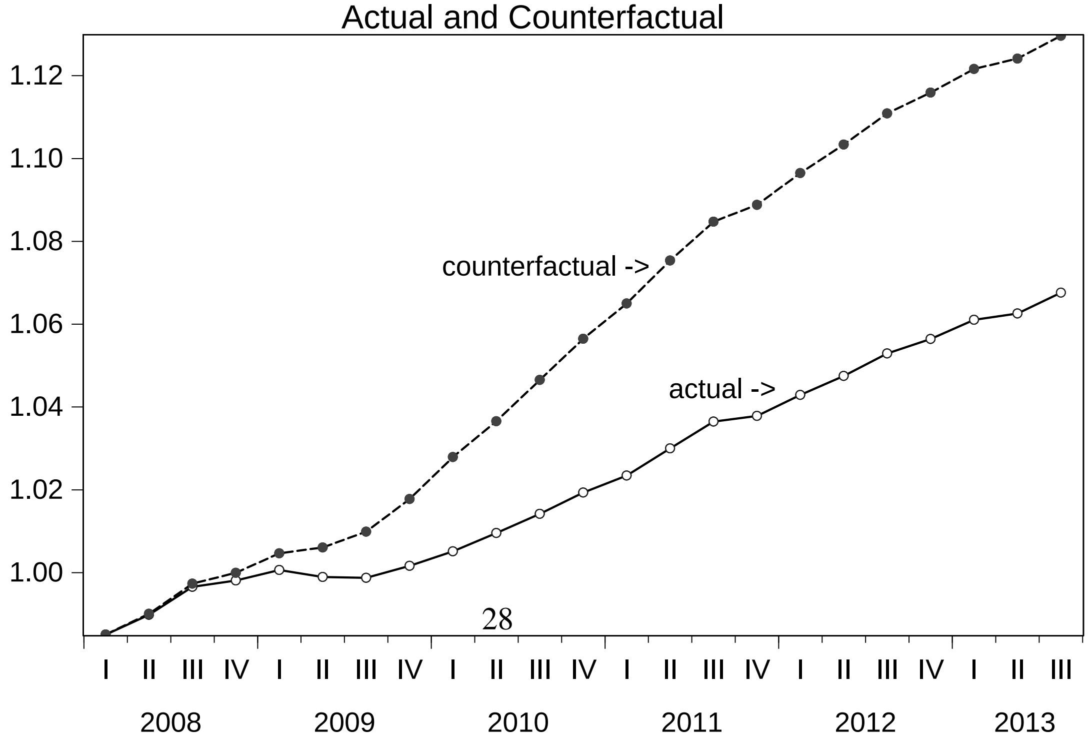


Figure 11
Consumption of Services (CS)
Actual and Counterfactual

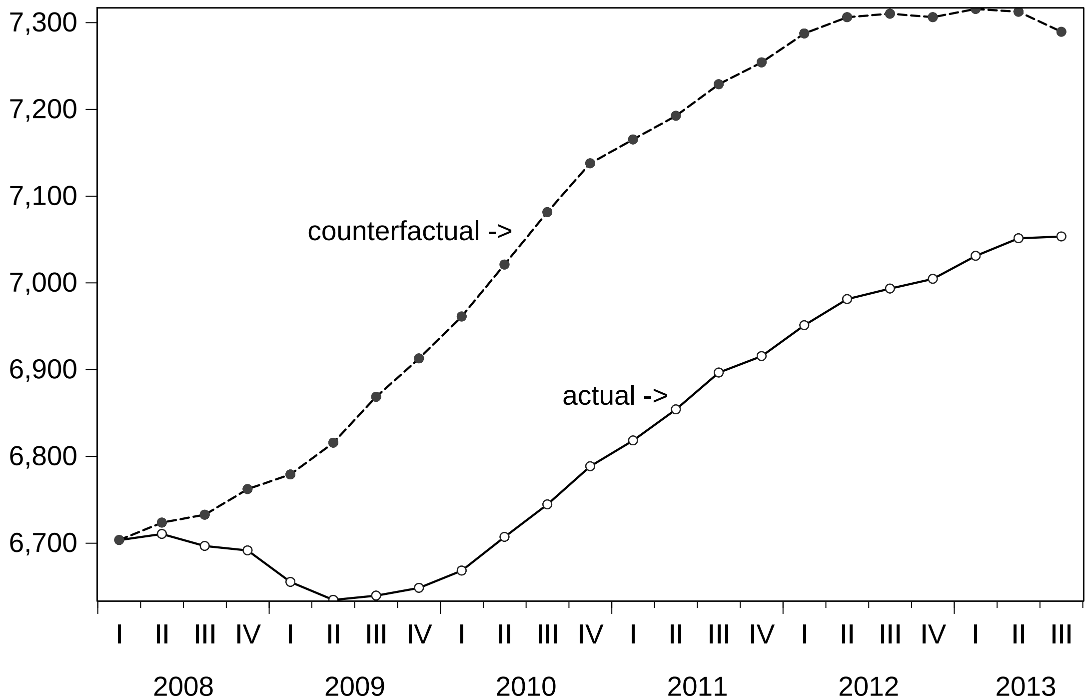


Figure 12
Consumption of Non Durables (CN)
Actual and Counterfactual

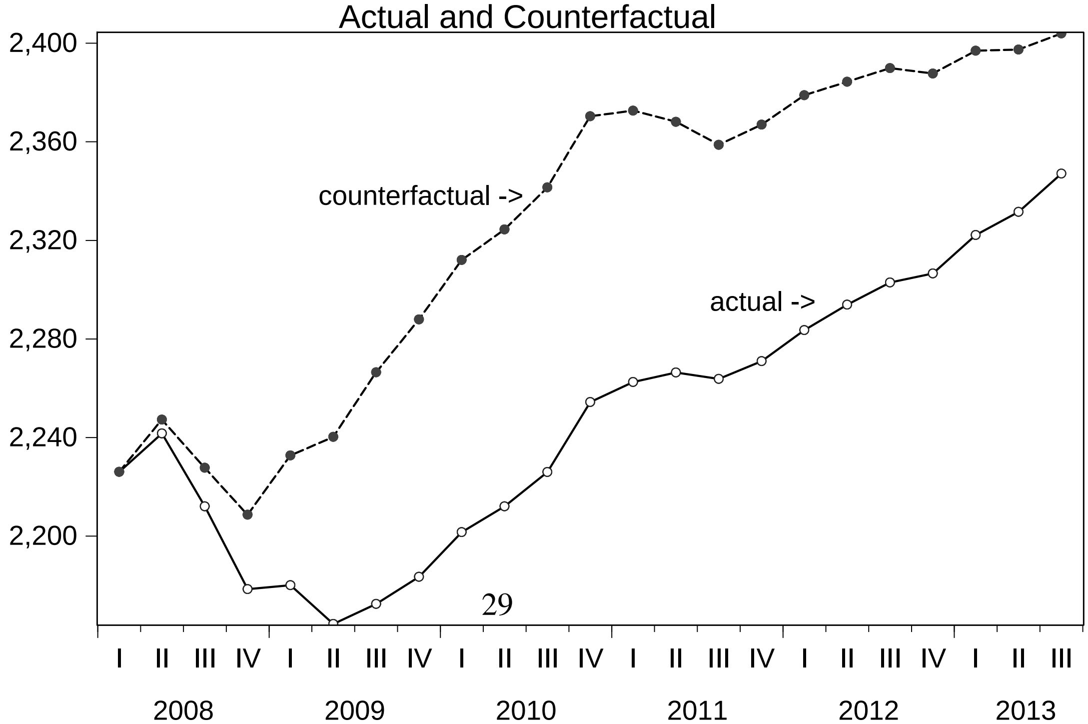


Figure 13
Consumption of Durables (CD)
Actual and Counterfactual

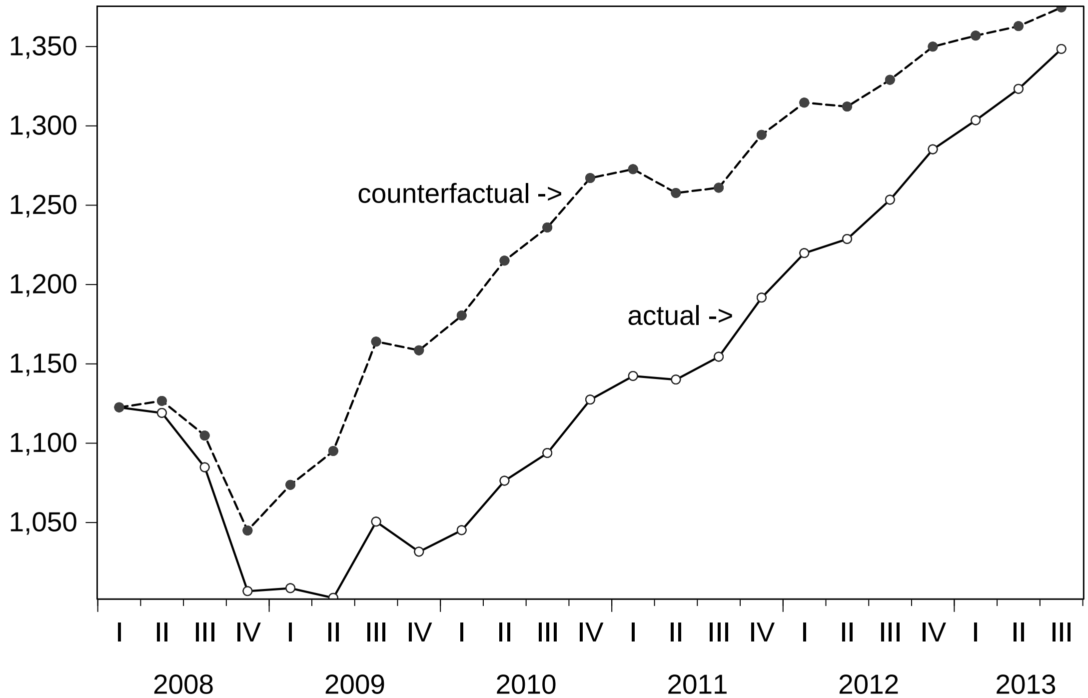


Figure 14
Housing Investment (IHH)
Actual and Counterfactual

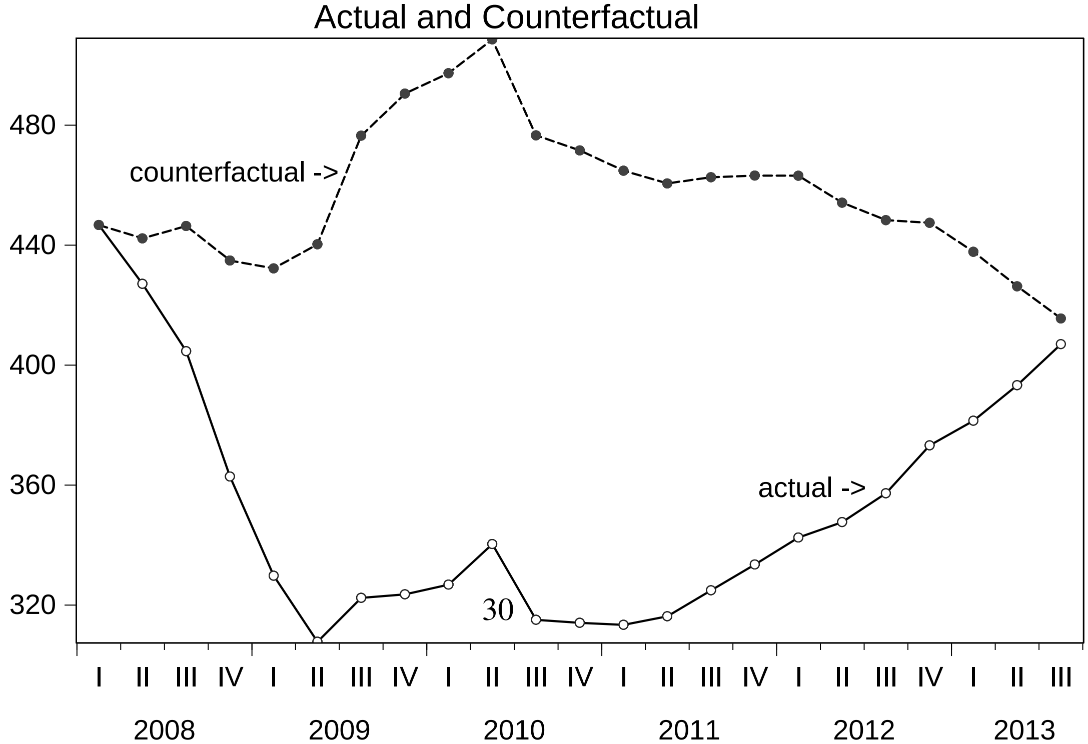


Table 6 presents summary results for the unemployment rate (UR), jobs (JF), and real GDP ($GDPR$). The variable's actual average value for the year (the last three quarters for 2013) is given first. Row 1 is then the difference between the counterfactual value and the actual value. The values in parentheses below the differences are the estimated standard errors discussed above. (Ignore rows 2, 3, and 4 for now.) For example, in 2010 the actual value of the unemployment rate was 9.64 percent and the counterfactual value was 3.31 percentage points lower than this. The estimated standard error of this difference was 0.37 percentage points. This relative small standard error is a common result—see MM [3.9.2]. As discussed above, when the uncertainty is only from the coefficient estimates, as here, it tends to be small. For jobs the increase in jobs in 2010 was 5.97 million (with a standard error of 0.72 million). Real GDP was 5.4 percent higher in 2010.

To see how much of the effects are from financial wealth versus housing wealth, an experiment was run in which only real housing wealth, $AA2$, was changed. Results are presented in row 2 in Table 6. In 2010 the unemployment rate difference was 1.44 percentage points, compared to 3.31 percentage points when both wealths were changed. In general the housing effects are a little less than half, although near the end of the period they are relatively somewhat larger because, as seen in Figures 5 and 6, housing wealth did not come back like financial wealth did.

6 Other Possible Effects

EBP

Figure 7 shows that the unemployment rate still rose somewhat in 2008 and 2009 even after accounting for the fall in financial and housing wealth. One question is whether other financial effects can be picked up? Various measures of credit

Table 6
Summary Results of Four Counterfactual Experiments

		2008	2009	2010	2011	2012	2013
Unemployment Rate (UR)							
	UR^a	5.82	9.30	9.64	8.95	8.06	7.53
1) $AA1$ and $AA2$	$\hat{UR} - UR^a$	-0.24	-2.06	-3.31	-2.58	-1.87	-1.24
	SE	(0.04)	(0.26)	(0.37)	(0.36)	(0.31)	(0.27)
2) $AA2$ only	$\hat{UR} - UR^a$	-0.12	-0.90	-1.44	-1.31	-1.12	-0.73
3) Exports	$\hat{UR} - UR^a$	0.00	-0.87	-0.85	-0.17	0.09	-0.01
Sum of rows 1 and 3	$\hat{UR} - UR^a$	-0.24	-2.93	-4.16	-2.75	-1.78	-1.25
4) Policy	$\hat{UR} - UR^a$	-0.17	-0.74	-1.14	-0.45	0.49	1.10
Jobs (JF)							
	JF^a	130.57	124.00	122.70	124.58	127.01	128.64
1) $AA1$ and $AA2$	$\hat{JF} - JF^a$	0.31	3.18	5.97	5.49	4.13	2.84
	SE	(0.05)	(0.44)	(0.72)	(0.69)	(0.65)	(0.66)
2) $AA2$ only	$\hat{JF} - JF^a$	0.18	1.47	2.66	2.74	2.47	1.80
3) Exports	$\hat{JF} - JF^a$	-0.07	1.65	2.14	1.11	0.46	0.44
Sum of rows 1 and 3	$\hat{JF} - JF^a$	0.24	4.83	8.11	6.60	4.59	3.28
4) Policy	$\hat{JF} - JF^a$	0.33	1.55	2.61	1.87	0.17	-1.37
Real GDP (GDPR)							
	$GDPR^a$	14833.5	14417.9	14779.4	15052.3	15470.7	11773.4
1) $AA1$ and $AA2$	$\hat{GDPR}/GDPR^a$	0.6	4.5	5.4	3.5	2.3	1.2
	SE	(0.08)	(0.52)	(0.57)	(0.50)	(0.47)	(0.45)
2) $AA2$ only	$\hat{GDPR}/GDPR^a$	0.3	2.0	2.4	2.0	1.6	0.8
3) Exports	$\hat{GDPR}/GDPR^a$	-0.0	2.4	1.4	0.3	0.1	0.3
Sum of rows 1 and 3	$\hat{GDPR} - GDPR^a$	0.6	6.9	6.8	3.8	2.4	1.5
4) Policy	$\hat{GDPR}/GDPR^a$	0.6	2.0	2.3	0.6	-0.8	-2.1

- Experiment 1) compares the actual values of the endogenous variables to a counterfactual scenerio in which neither $AA1$ (real financial wealth) nor $AA2$ (real housing wealth) is allowed to decline during the recessions.
- The counterfactual in Experiment 2) changes only real housing wealth from its actual path.
- The counterfactual in Experiment 3) is one in which exports do not decline.
- The counterfactual in Experiment 4) is one in which state and local and federal government expenditures grow smoothly.
- ^{a} Actual value.
- ˆCounterfactual value.
- The year 2013 includes only the first three quarters of the year.
- Differences for real GDP are percents.
- Standard errors are only presented for the first experiment.

conditions were tested in Section 4. From these 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.

First, the main experiment, changing $AA1$ and $AA2$, 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 Table 7. These results differ somewhat from those in row 1 in Table 6 because of the different estimation period for the four household expenditure equations. But it is the same experiment otherwise. The prediction period ends in 2010:3, since this is the end of the EBP data.

Then the main experiment was run again, this time using the fourth of each of the four expenditure equations in Table 5 in place of the regular expenditure equations. For this experiment $AA1$, $AA2$, and EBP were changed. One can see from Figure 4 that the value of EBP in 2007:2 was quite low. This value (-0.5828) was used for 2007:3 on. 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 also presented in Table 7.

Table 7 shows that in 2009 the fall in the unemployment rate was 2.46 percentage points without EBP changed and 2.86 percentage points with it changed. For jobs the respective numbers are 3.99 million and 4.89 million. For 2010 the change in EBP has little effect on the results. The reason for this small effect can be seen in Figure 4, which shows that EBP dropped sharply in 2009:3. The stimulative effects from the lower values of EBP in the experiment are thus much less after this. In general, EBP is economically important in 2009, but not much

Table 7
Experiment 1 with EBP

		2008	2009	2010
Unemployment Rate (UR)				
	UR^a	5.82	9.30	9.67
$AA1$ and $AA2$ changed	$\hat{UR} - UR^a$	-0.29	-2.46	-3.81
$AA1$, $AA2$, and EBP changed	$\hat{UR} - UR^a$	-0.45	-2.86	-3.72
Jobs (JF)				
	JF^a	130.57	124.00	122.57
$AA1$ and $AA2$ changed	$\hat{JF} - JF^a$	0.41	3.99	7.06
$AA1$, $AA2$, and EBP changed	$\hat{JF} - JF^a$	0.72	4.89	7.22

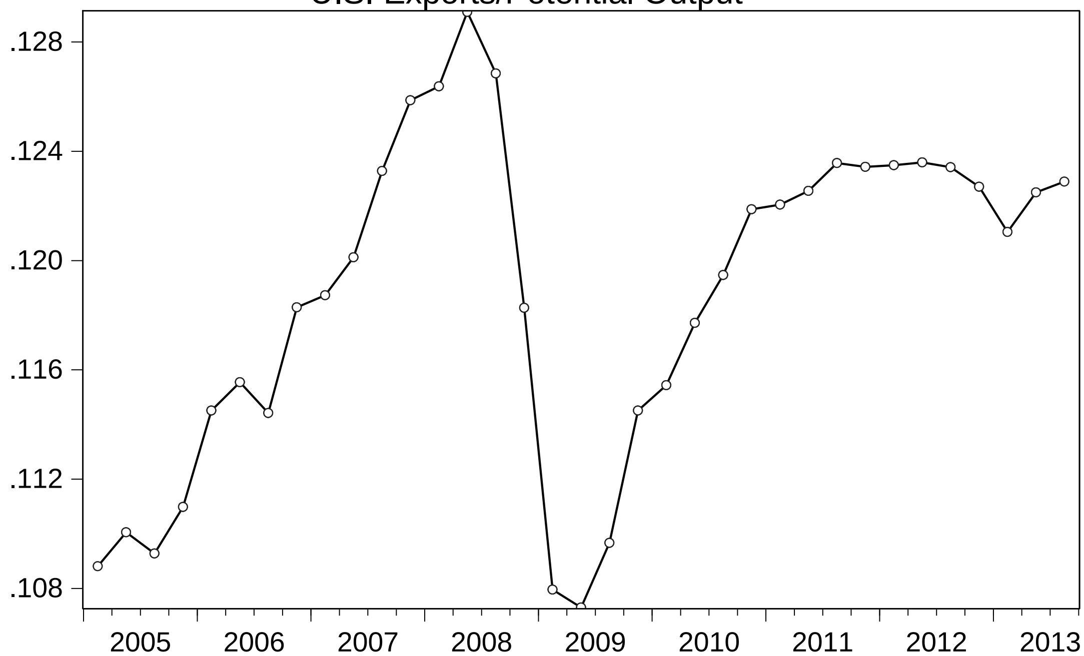
• ^{a} Actual value.
• ˆ Counterfactual value.
• 2010 is for the first three quarters.

otherwise.

Exports

The fall in financial and housing wealth in 2008–2009 was a world wide phenomenon. (This is documented in Fair (2014).) In the MC model there are no wealth variables in the household expenditure equations for the other countries (primarily because of data limitations), and so experiments like the ones done in this paper for the United States cannot be done for the other countries. If they could and the fall in wealth was turned off for the other countries, this would increase U.S. exports because of the more robust economies of the other countries. Figure 15 presents a plot of U.S. exports as a percent of potential output for the 2005:1–2013:3 period. The fall of exports in 2008 is dramatic. Some of this fall is likely due to negative wealth effects in the other countries, although it is not possible to estimate how much.

Figure 15
U.S. Exports/Potential Output



To estimate the effect of the fall in U.S. exports, the following experiment was run. The ratio of exports to potential GDP in 2007:4 was 0.1259, and this ratio was assumed to remain unchanged throughout the prediction period. This is an unnatural experiment in the MC model because U.S. exports are endogenous—imports of all the other countries. What was done was to assume that the change in exports all went to countries outside of the countries in the model. This is rough, but the aim is simply to get a rough idea of the export effect. No other changes were made, including no change in U.S. financial and housing wealth. This is an experiment purely to estimate the export effect.

Results are presented in row 3 in Table 6. In 2009 the unemployment rate is 0.87 percentage points lower, and in 2010 it is 0.85 percentage points lower. The increase in jobs in the two years is 1.65 and 2.14 million, respectively, and real

GDP is higher by 2.4 and 1.4 percent, respectively. Overall, there are non trivial effects from the fall in exports in these two years. The export effects are modest after 2010 because actual exports recovered to normal values, as can be seen from Figure 15.

Rows 1 and 3 in Table 6 are roughly additive, and so the estimated fall in the unemployment rate in 2010 from the fall in wealth and exports is 3.31 + 0.85 = 4.16. The actual unemployment rate was 9.64, and the fall of 4.16 takes it down to 5.48. If all of the fall in U.S. exports was from the fall in world wide wealth, this is what the model estimates the unemployment rate would have been had there been no fall in wealth. It is of course, only a lower bound.

Policy Effects

Another interesting question is how much government policy variables affected the economy during this period. There were large fluctuations in both federal and state and local government variables. The final experiment performed here assumes that six government variables behaved normally from 2008:1 on rather than do whatever they did. The first variable is federal government purchases of goods. It rose in 2008–2010 and then fell after that. For the experiment the ratio of real purchases of goods to potential output was assumed to be the same throughout the period as it was in 2007:4. The second is state and local government purchases of goods. It was fairly flat in 2008–2009 and began falling in 2010. As was done for federal purchases, for the experiment the ratio of real state and local purchases of goods to potential output was assumed to be the same throughout the period as it was in 2007:4.

The third variable is federal transfer payments to households. This is the main variable affected by the stimulus bills. It rose substantially in 2008–2010 and then fell substantially after that. Again, for the experiment the ratio of real transfer payments to potential output was assumed to be the same as it was in 2007:4. The fourth variable is state and local transfer payments to households. It in fact fell substantially in 2008 and 2009 before beginning to rise in 2010. It was treated like federal transfer payments for the experiment.

Two tax-rate variables were used. There is an aggregate federal personal income tax rate variable in the model. It was somewhat erratic in this period, with two very low values in 2009:1 and 2010:4. For the experiment its value was taken to be the value in 2007:4. There is also an aggregate payroll tax variable in the model. It was fairly flat except in 2011 and 2012, where it was lower due to the payroll tax cut. For the experiment its value was taken to be the value in 2007:4.

The policy experiment is thus to assume that these six main government spending and tax variables behaved smoothly during the period. Comparing this run with what actually happened shows the net effect on the economy from the government changes that in fact took place. For this experiment, like for the export experiment, no other changes were made. The aim is to isolate the government effects.

Results are presented in row 4 in Table 6. There is little effect in 2008. The peak effect is in 2010, where the unemployment rate is 1.14 percentage points lower, the number of jobs is 2.61 million higher, and real GDP is 2.3 percent higher. By 2012 the effect is negative, due to the fact that some of the government spending variables began falling in 2010.

7 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, not only decreases in housing wealth but also decreases in financial wealth through falling stock prices.

Table 6 gives a sense of the various effects at work on the economy in the 2008–2013 period. What stands out is the importance of the wealth effects, especially if at least some of the export effect is attributed to international wealth effects. Financial wealth and housing wealth contributed roughly equally. Table 7 shows that the excess bond premium variable of Gilchrist and Zakrajšek (2012) contributed a little.

In testing in Section 3 for different effects from financial wealth versus housing wealth in the consumption equations, the evidence is mixed but not very strong. Equal effects are roughly supported. For the housing investment equation, only housing wealth is significant. In testing in Section 4 for various measures of credit conditions, only the excess bond premium variable of Gilchrist and Zakrajšek (2012) is possibly significant. The stability tests discussed at the end of Section 3 do not suggest that there were large structural changes after 2007, at least using aggregate data.

Finally, remember that the wealth experiments in this paper take the wealth changes 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, 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.[10] The wealth

[10] 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.

experiments are thus conditional on the wealth changes.

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.[11] 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.[12]

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.

Each trial of the bootstrap procedure is as follows. First, 239 error vectors are

[11] 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.

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

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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