Online Appendix for "Shocks and Crashes"*

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This is an online Appendix for "Shocks and Crashes," which appears in NBER's Twenty-eighth Macroeconomics Annual, 2013. The appendix contains a data description, cointegration test results, and a description of standard error calculations for impulse responses and variance decompositions.

Data Description

BLS LABOR SHARE

BLS Labor Share is the share of income paid to labor in the nonfarm business sector. The series is an index normalized to be 100 in 2005. Our source is the Bureau of Labor Statistics.

CONSUMPTION

Consumption is measured as either total personal consumption expenditure or expenditure on nondurables and services, excluding shoes and clothing. The quarterly data are seasonally adjusted at annual rates, in billions of chain-weighted 2005 dollars. The components are chain-weighted together, and this series is scaled up so that the sample mean matches the sample mean of total personal consumption expenditures. Our source is the U.S. Department of Commerce, Bureau of Economic Analysis.

AFTER-TAX LABOR INCOME

After-tax labor income is defined as wages and salaries + transfer payments + employer contributions for employee pensions and insurance - employee contributions for social insurance - taxes. Taxes are defined as [wages and salaries/(wages and salaries + proprietors' income with IVA and Ccadj + rental income + personal dividends + personal interest income)] times personal current taxes, where IVA is inventory valuation and Ccadj is capital consumption adjustments. The quarterly data are in current dollars. Our source is the Bureau of Economic Analysis.

POPULATION

A measure of population is created by dividing real total disposable income by real per capita disposable income. Our source is the Bureau of Economic Analysis.

WEALTH

Total wealth is household net worth in billions of current dollars, measured at the end of the period. A break down of net worth into its major components is given in the table below. Stock market wealth includes direct household holdings, mutual fund holdings, holdings of private and public pension plans, personal trusts, and insurance companies. Nonstock wealth includes tangible/real estate wealth, nonstock financial assets (all deposits, open market paper, U.S. Treasuries and Agency securities, municipal securities, corporate and foreign bonds and mortgages), and also includes ownership of privately traded companies in noncorporate equity, and other. Subtracted off are liabilities, including mortgage loans and loans made under home equity lines of credit and secured by junior liens, installment consumer debt and other. Wealth is measured at the end of the period. A timing convention for wealth is needed because the level of consumption is a flow during the quarter rather than a point-in-time estimate as is wealth (consumption data are time-averaged). If we think of a given quarter's consumption data as measuring spending at the beginning of the quarter, then wealth for the quarter should be measured at the beginning of the period. If we think of the consumption data as measuring spending at the end of the quarter, then wealth for the quarter should be measured at the end of the period. None of our main findings discussed below (estimates of the cointegrating parameters, error-correction specification, or permanent-transitory decomposition) are sensitive to this timing convention. Given our finding that most of the variation in wealth is not associated with consumption, this timing convention is conservative in that the use of end-of-period wealth produces a higher contemporaneous correlation between consumption growth and wealth growth. Our source is the Board of Governors of the Federal Reserve System. A complete description of these data may be found at http://www.federalreserve.gov/releases/Z1/Current/.

PRICE DEFLATOR

The nominal after-tax labor income and wealth data are deflated by the personal consumption expenditure chain-type deflator (2005=100), seasonally adjusted. In principle, one would like a measure of the price deflator for total flow consumption here. Since this variable is unobservable, we use the total expenditure deflator as a proxy. Our source is the Bureau of Economic Analysis.

INVESTMENT

Investment is fixed private investment, seasonally adjusted in chain-weighted 2005 dollars. Our source is the Bureau of Economic Analysis.

INVESTMENT - NONRESIDENTIAL

Nonresidential investment is fixed private non-residential investment, seasonally adjusted in chain-weighted 2005 dollars. Our source is the Bureau of Economic Analysis.

INVESTMENT - EQUIPMENT AND SOFTWARE

Investment in equipment and software is fixed private non-residential investment in equipment and software, seasonally adjusted in chain-weighted 2005 dollars. Our source is the Bureau of Economic Analysis.

INVESTMENT - STRUCTURES

Investment in structures is fixed private non-residential investment in structures, seasonally adjusted in chain-weighted 2005 dollars. Our source is the Bureau of Economic Analysis.

Table A.1: Flow of Funds Balance Sheet

Assets	\$200,619	Liabilities	\$41,709
Tangible Assets		Mortgages	\$30,551
Real Estate	\$49,175	Consumer Credit	\$7,447
Other	\$19,389	Other	\$3,860
Financial Assets			
Corporate Equity	\$46,289		
Deposits	\$23,207		
Credit Market Instruments	\$12,865		
Other (incl. pension funds)	\$49,691	*Net Worth*	\$158,909

Notes: Data for the year 2010:Q2. Source: Flow of Funds, Board of Governors of the Federal Reserve. "Other" includes all types of assets (held in or out of pension funds) that are not corporate equity (held directly or indirectly) or credit market instruments. Of these, assets other than corporate equity held indirectly in pension funds and other funds (eg mutual funds) is the largest component. Equity in noncorporate businesses is another large component which includes also the net value of rented homes (tenant occupied housing.).

Cointegration Tests

This appendix presents the results of cointegration tests. Tests for the presence of a unit root in c, a, and y (not reported) are consistent with the hypothesis of a unit root in those series and are available upon request.

We report results below for tests of the null of deterministic cointegration (estimated cointegrating vector eliminates both the deterministic and stochastic trends). The methodology follows Park (1990), Park (1992), Han and Ogaki (1997), and Ogaki and Park (1997). The cointegrating regression is the form: $c_t = cons + \beta_a a_t + \beta_y y_t + \varepsilon_t$. The $H(0,1)$ test statistic tests the hypothesis $\gamma_1 = 0$ in the regression:

$$c_t^* = c + \gamma_1 t + \beta_y y_t^* + \beta_a a_t^* + \varepsilon_t^*, \tag{1}$$

where variables with a "*" denote their transformed values based on the "canonical cointegrating regressions," e.g.,

$$c_t^* = c_t + d_c \varepsilon_t,$$

and similarly for y_t^* and a_t^*. The parameters d_c, etc., are real numbers. Since the cointegrating residual ε_t is stationary, c_t^*, a_t^* and y_t^* are cointegrated with the same cointegrating vector as c_t, a_t and y_t. The parameters d_c etc., are selected so that c_t, etc., are uncorrelated with disturbances of the regression in the long-run, implemented by using the "variable additive method" of Park (1990). These parameters depend on the OLS estimate of the cointegrating vector and the long-run autocovariance function of ε_t, $\Omega = \sum_{i=-\infty}^{\infty} E\left[\varepsilon_t \varepsilon_{t-i}'\right]$. The null hypothesis of deterministic cointegration is a test based on the $H(0,1)$ test statistic of the hypothesis $\gamma_1 = 0$; hence a rejection of $\gamma_1 = 0$ is a rejection of this null. Table A.2 below provides test results for the sample 1952:Q1-2012:Q3. The p-value for the $H(0,1)$ test statistic, reported in parentheses, is the probability of obtaining a value for the statistic at least as extreme as the one observed if the null of cointegration is true. Therefore a rejection of the null at the 5% would be warrented if this value were less than 0.05. The $H(0,1)$ test statistic provides no evidence against the null of deterministic cointegration.

Table A.2: Canonical cointegrating regression results

$\widehat{\beta}_a{}^a$	$\widehat{\beta}_y{}^a$	$H(0,1)^b$
0.1744	0.7309	0.2009
(0.0471)	(0.0526)	(0.6540)

Park and Ogaki's (1991) VAR prewhitening method with Andrew's (1991) automatic bandwidth parameter estimator was used to estimate long-run covariance parameters. The parameters $\widehat{\beta}_a$ and $\widehat{\beta}_y$are estimated cointegrating parameters on a and y, respectively.

[a]Standard errors are in parentheses.

[b]χ^2 test statistic with one degree of freedom for the deterministic cointegration restriction. P-values are in parentheses.

Standard Errors for Impulse Response Functions and Variance Decompositions

This appendix explains the computation of 95% confidence intervals for the impulse response functions and variance decompositions given in the text in response to the structural disturbances. The confidence intervals are generated from a bootstrap as described in Gonzalo and Ng (2001). The procedure is as follows. First, the cointegrating vector is estimated, and conditional on this estimate, the remaining parameters of the VECM are estimated. The fitted residuals from this VECM, $\widehat{e}_t$, are obtained and a new sample of data is constructed using the initial VECM parameter estimates by random sampling of $\widehat{e}_t$ with replacement. Given this new sample of data, all the parameters are reestimated, holding fixed the number of cointegrating vectors, and the impulse responses and variance decompositions stored. This is repeated 5,000 times. The empirical 95% confidence intervals are evaluated from these 5,000 samples of the bootstrapped impulse response functions and variance decompositions are presented below.

Table A.3: Impulse Response Function with 90% Confidence Intervals

Horizon			Consumption			
h	Prod. Shock		Fact. Shares Shock		Risk Aversion Shock	
1	0.401	(0.371, 0.424)	0.000	(0.000, 0.000)	0.000	(0.000, 0.000)
2	0.696	(0.600, 0.770)	0.044	(-0.011, 0.093)	0.177	(0.108, 0.234)
4	0.725	(0.618, 0.831)	0.016	(-0.056, 0.078)	0.172	(0.097, 0.237)
8	0.731	(0.628, 0.852)	-0.011	(-0.096, 0.064)	0.149	(0.075, 0.220)
16	0.735	(0.633, 0.868)	-0.034	(-0.132, 0.056)	0.128	(0.056, 0.207)
∞	0.761	(0.650, 1.041)	-0.171	(-0.386, 0.004)	0.006	(0.000, 0.113)
Horizon			Labor Income			
h	Prod. Shock		Fact. Shares Shock		Risk Aversion Shock	
1	0.353	(0.264, 0.434)	0.788	(0.717, 0.838)	0.000	(0.000, 0.000)
2	0.684	(0.533, 0.821)	0.725	(0.623, 0.808)	0.154	(0.061, 0.242)
4	0.715	(0.558, 0.878)	0.701	(0.591, 0.790)	0.154	(0.064, 0.241)
8	0.721	(0.568, 0.895)	0.677	(0.558, 0.773)	0.134	(0.052, 0.220)
16	0.725	(0.575, 0.907)	0.657	(0.526, 0.765)	0.115	(0.040, 0.203)
∞	0.748	(0.601, 1.045)	0.534	(0.316, 0.718)	0.005	(0.000, 0.096)
Horizon			Net Worth			
h	Prod. Shock		Fact. Shares Shock		Risk Aversion Shock	
1	0.546	(0.396, 0.712)	-0.006	(-0.199, 0.166)	2.035	(1.847, 2.160)
2	0.834	(0.503, 1.262)	-0.423	(-0.812, -0.098)	2.369	(1.925, 2.681)
4	0.915	(0.583, 1.575)	-0.791	(-1.377, -0.268)	2.054	(1.434, 2.545)
8	0.976	(0.626, 1.852)	-1.108	(-1.866, -0.380)	1.770	(1.036, 2.444)
16	1.029	(0.646, 2.102)	-1.382	(-2.265, -0.470)	1.526	(0.742, 2.370)
∞	1.341	(0.669, 4.454)	-3.012	(-5.232, -1.172)	0.067	(0.001, 1.487)

Notes: This table reports impulse response functions of consumption, labor income and net worth. Bootstrapped 90% confidence intervals are in parentheses. The sample spans the fourth quarter of 1951 to the third quarter quarter of 2012.

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