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Frugality: Are We Fretting Too Much?
Household Saving and Assets in the United States

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Abstract

Household savings rates in the United States have recently crept up from all-time lows. Some have suggested that a shift toward frugality will hamper GDP growth—the Keynesian "paradox of thrift." We estimate that households compensate for a fall in their asset income by saving more out of their labor income, dollar-for-dollar. In the wake of the crisis, our model predicts that such *primary* savings will increase, but only temporarily and modestly, as household assets stabilize. As savings flows gradually accumulate, they help rebuild corporate net worth and hence firms' capacity to make capital investments. A timely return to pre-crisis levels of capital investment would require that U.S. households save substantially more than the model predicts, starting *now*. Hence, we should fret that our savings rates may be too low.

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I. INTRODUCTION

Beginning in late 2008, as economic activity and asset prices declined, consumer expenditures have plummeted and households have begun to pay down their outstanding credit card debt. Household savings rates in the United States appear to be creeping up from recent all-time lows.

As Box 1 suggests, concerns about the United States savings rate have been widely discussed in the popular and financial press. Some, including Paul Krugman (see Box 1 for all quotes), stress that increases in savings will prolong and deepen the recession, through a Keynesian "paradox of thrift" (POT) channel. By contrast, David Rosenberg and others have suggested that increased savings will be also be an essential part of the recovery, as households struggle to repair their balance sheets. Still others, like Time Magazine's Nancy Gibbs (in a recent cover story), suggest that a "new frugality" may have taken hold in the United States. A change in attitudes, or market conditions, or both, may signal a lasting change in household savings behavior. Some commentators have forecasted that savings rates will soon reach levels not seen for decades.

There seem to be several questions emerging from this discussion: By how much will household savings change? Will our future savings behavior differ from recent historical patterns? Will additional savings prolong the recession or inhibit growth? If so, what should the policy response be?

This paper attempts to address such questions. Retrospectively, we examine the empirical regularities that have jointly linked household net worth, asset returns, and the decision to save. Prospectively, we develop alternative scenarios for savings and net wealth in the coming years (2009 onward). We also examine the impact of savings on private domestic demand so as to clarify POT-related issues.

We use well-established time-series econometrics techniques, including cointegration tests and vector error correction models (VECMs), to examine the long-run behavior of savings and assets in the United States, from 1952 to 2008. [2] We conclude that primary savings (disposable labor income minus consumption) and asset income (rate of return multiplied by stock of assets) cointegrate inversely, on a one-to-one basis.

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[2] Our data on household net worth are quarterly, from the Federal Reserve's *Flow of Funds* database. Papers that were seminal in the development of such techniques include Engle and Granger (1987), Nelson and Plosser (1982), Johansen (1988), and Johansen and Juselius (1990). Our results are consistent with a traditional model of intertemporal optimization – the permanent income hypothesis (PIH).

Box 1. Recent Views on U.S. Savings and the Paradox Of Thrift in the Popular and Financial Press

"...we are at the beginning of a transition period in which our collective spending as a nation will go from roughly 6 or 7 percent more than what we produce to closer to 2 or 3 percent less than we produce, to accommodate an aging population and the need to put away some savings. That's a huge swing, and although it won't necessarily come all at once and may be accomplished through different means, there is no way to accomplish this task by producing more. We're going to have to consume less, which means a temporary reduction in our standard of living."

Steve Pearlstein, *Washington Post*, "Buckle Up, We Haven't Reached Bottom Yet," October 15, 2008.

"The long-feared capitulation of American consumers has arrived… real consumer spending fell at an annual rate of 3.1 percent in the third quarter (of 2008); real spending on durable goods (stuff like cars and TVs) fell at an annual rate of 14 percent….attempts by consumers to do the right thing by saving more can leave everyone worse off. The point is that if consumers cut their spending, and nothing else takes the place of that spending, the economy will slide into a recession, reducing everyone's income. In fact, consumers' income may actually fall more than their spending, so that their attempt to save more backfires—a possibility known as the *paradox of thrift*."

Paul Krugman, "When Consumers Capitulate," *New York Times*, October 31, 2008

"The buy-now/pay-later days are gone. Household debt is contracting at a record rate and the personal savings rate is now on a discernible uptrend. This transition from frivolity towards frugality, as painful as it is, is necessary in order for consumer balance sheets to become more manageable and blaze the trail for the next sustainable economic expansion..."

David Rosenberg, *Financial Times*, January 5, 2009.

"(Consumers) are forgoing spending in an effort to replenish the $10 trillion in collective household wealth they have lost. Consumption patterns may be returning to the lower levels of previous decades."

David M. Smick, "Memo to the Banks: Lend or Else," *Washington Post*, January 12, 2009.

"The underlying malaise is a retreat from debt. The "deleveraging," as household savings grow and the financial services industry sheds debt, will mean that people spend less. Their prudent saving will destroy companies and jobs—Keynes' "paradox of thrift." Nobody can say where the new floor for debt will lie, but just finding it will be painful."

"Fixing Finance," *The Economist*, January 24–30, 2009, p. 20.

"Unlike any other downturn since the 1930s, this one has affected everyone, either the fact of it or the fear of it. Even when prosperity returns, 61 percent predict, they will continue to spend less than they did before."

Nancy Gibbs, "The Great Recession: America Becomes Thrift Nation", *TIME Magazine*, April 15, 2009.

"Paradox of thrift is the idea that you try—everyone tries to increase their savings, so desired savings goes up, thrift being savings, but the act of trying to save pulls down the entire economy, gives you a big recession or maybe even a depression, and total savings do not go up. Maybe they even go down. So everyone trying to save leads to a big slowdown and less savings. That's a paradox."

Simon Johnson, PBS Interview, April 15, 2009.
http://www.pbs.org/newshour/businessdesk/2009/04/in-case-you-missed-it-the-para.html

"... what makes the current experience unique, however, is that those shocks to income and wealth occurred just when rising leverage made consumers most vulnerable... The coming decrease in leverage and increase in saving will mark a sea change in consumer behavior, with critical implications for lenders and financial markets."

Richard Berner/David Cho, "Deleveraging the American Consumer," Morgan Stanley, April 29, 2009.http://www.morganstanley.com/views/gef/archive/2009/20090529-Fri.html

"Americans are not borrowing the way they used to, but the accumulated debt is still there. Over the next many years, Americans will have to save more and borrow less."

David Brooks, "The Great Unwinding" *New York Times*, June 11, 2009.
http://www.nytimes.com/2009/06/12/opinion/12brooks.html?_r=1

"The best guess (and there is little more to go on) is that the U.S. household saving rate will remain at least at its current (Q2 2009) level. …a 5 percentage point decline in the ratio of consumption to disposable income relative to the pre-crisis period…Put simply, 3 percent more of U.S. aggregate demand will have to come from something other than consumption. Will it be from investment? This also seems unlikely….. Less-efficient financial intermediation will affect not only the supply side, but also the demand side. Again, historical evidence from "creditless" recoveries suggests that investment will be weak for a long time."

Olivier Blanchard, "Sustaining a Global Recovery," *Finance and Development*, (Washington D.C.: International Monetary Fund), September 2009;
http://www.imf.org/external/pubs/ft/fandd/2009/09/blanchardindex.htm

Such results help explain why primary savings fell so dramatically over the 2000–06 period. Households were merely responding rationally to perceived increases in their wealth—even while rates of return thereon were, in hindsight, unsustainably high. Likewise, during 2007–08, as the net worth of households fell sharply and rates of return were negative, household saving levels have begun to rebound. Note that an inverse relationship between primary savings and assets (or asset income) is to be expected. Otherwise, the discounted value of financial claims (liabilities) would grow boundlessly, violating the transversality condition. As with any pyramid scheme, a claim whose present value is unbounded will be impossible to redeem.

Assuming that its parameters remain constant, our model suggests that savings will continue to rebound from their recent trough in the coming years. The rebound will be modest: about two and one-quarter percent of GDP. Moreover, the rebound will be only temporary. After peaking in 2011, as household net worth stabilizes, primary savings will then resume its downward trajectory. By the end of the coming decade, household net worth will be only slightly higher than it was at the end of 2008. (This scenario is a cautious one: it assumes rates of return below those of previous decades.)

However, there are reasons to believe that an era of "new frugality" may have begun: asset losses have been severe, the economic environment is less certain, public sector deficits loom ever larger, and many households have been forced to deleverage. Under alternative "new frugality" scenarios, we impose discrete upward shifts in the savings function, while maintaining the one-to-one relationship with asset income. These more extreme scenarios yield savings levels that are roughly equal to averages during previous eras: the 1990s, 1980s, and as most extreme, 1950s–70s. In all of these scenarios, primary savings will peak in the near term before subsiding. The upward shifts to the savings function are reflected in wealth levels that rebound more quickly.

Should we be fretting about higher savings rates in the future, especially if there is a structural shift in savings—a "new frugality" scenario? Consistent with the POT, such level increase in savings means, by definition, a level decrease in consumption. Then, as household assets rebound, so will consumption—but only gradually so.

On the capital investment side, the story is more complex. As Blanchard (2009, see Box 1) rightly notes, there are reasons to believe that an increase in capital investment will not immediately replace lower consumer demand. Unsold housing inventories are high, capital utilization is low, and the financial system remains wounded. Even so, a boost in savings will stimulate capital expenditures in two other, less well-recognized ways. First, increases in household savings should help compensate for the recent drop in *corporate savings*. Second, savings flows may have even greater impact on investment as they *accumulate*. As savings flows accumulate, firms and banks recapitalize. This permits firms to fund more investment projects, either internally or through leveraged external finance.

Stronger balance sheets (a stock) may facilitate greater capital expenditures (a flow) in the presence of certain financial market frictions and informational asymmetries. Such a stock / flow relationship has been discussed by Fazzari, Hubbard, and Petersen (1988) and Kaplan and Zingles (1997)—at the firm level. We also find a positive relationship between net worth (a *stock*) and investment spending (a *flow*)—*in the aggregate*. [3]

Blanchard (2009) rightly emphasizes that, more than in the past, severe financial frictions portend a "creditless recovery." In this context, new household savings will now be even more essential to repair balance sheets (both household and corporate) and hence replenish financial resources. The impact of stronger balance sheets on investment is a gradual and cumulative process. Thus, in order to return to pre-crisis investment levels within a decade, we would need higher levels of savings than those predicted by our baseline model—starting today. If not, we should fret about too *little* frugality, rather than too much.

The remainder of the paper is organized as follows. In section II, we review several indicators of wealth and saving in the United States. In section III, we review some theoretical linkages between savings and wealth. In section IV, we summarize the results of time-series econometric tests (details in Appendix C). Section V explains the estimation results. In section VI, we present two kinds of forward simulations: stochastic (using the estimated parameters with no modifications) alternative "new frugality" scenarios that feature upward shifts in the savings function. In section VII, we examine the potential effects of increased savings on other private domestic expenditures, namely consumption and fixed capital investment. Our accounting model includes the POT as a special case. SectionVII concludes.

II. Indicators of Household Wealth and Saving in the United States.

The most comprehensive stock measures of assets and liabilities for United States households is the Federal Reserve Board's Flow of Funds database. (Private non-corporate wealth includes both households and non-profit entities.) Table 1 summarizes the evolution of these stocks, in trillions of constant (base year 2000) U.S. dollars, averaged by decade through end-2008 (most recent data point). Table 2 presents these same stocks *in percent of personal disposable income* (including asset and dividend income). Table 3 shows the *difference* between the columns—the increase or decrease in wealth between decades.

Since the 1950s, total gross assets (percent of disposable income) have grown steadily from 535 percent in the 1950s to just over 700 percent for the period 2000–07. By 2008, Q4, this

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[3] These ideas are related to the *financial accelerator* hypothesis; see Bernanke, Gertler, and Gilchrist (1999). We find that total household net worth and the outstanding value of corporate equities cointegrate on a one-to-one basis.

number had fallen to 634 percent. This fall reflects both a decline in the value of real estate (-18.1 percent) and risky private assets (equity shares and mutual funds, -41 percent).

Likewise, total liabilities relative to disposable income have steadily grown since the 1950s, comprised mainly of mortgages (which rose from 30.4 percent of disposable income in the 1950s to about 89 percent in the 2000s) and consumer credit (which rose from 14.4 percent of disposable income in the 1950s to about 25 percent for the 2000–07 period). Comparing Q4 2008 with the average of 2000–07, total liabilities rose by almost 20 percent of disposable income, reflecting mainly a rise in mortgages.

Several alternative net worth calculations are presented. First, total net worth—all assets minus all liabilities—is the most commonly used one (see for example Lettau and Ludvigson (2004), Rudd and Whelan (2006)). It grew between the 1950s and 1960s, fell in the 1970s but grew steadily since then—until 2008. Comparing end–2008 with the average of 2000–2007, net worth has fallen by about 83 percent of disposable income. The second calculation, which excludes consumer durables, nonetheless shows similar movements over the decades, and falls by about 33.5 percent in 2008 when compared to the previous eight years.

The table also shows *financial* net wealth that excludes consumer durables, real estate, and home mortgage liabilities. This measure includes public sector obligations. However, since public obligations entail a future tax burden, the fourth measure of private financial wealth is the difference between private assets and liabilities. Both measures increase during the 1960s, fall in both the 1970s and 1980s, but increase thereafter—until 2008. Then, both of the calculations suggest that household wealth dropped by about 50 percent.

For the analysis in this paper, we focus on the measure of net wealth that includes financial instruments (assets minus liabilities) and real estate (net of mortgage liabilities) but exclude consumer durables. We denote this measure by A_t. The household budget constraint shows the evolution of this variable over time:

$$A_t \equiv (1+\tilde{r}_t)A_{t-1} + Y_t - C_t - T_t \equiv (1+\tilde{r}_t)A_{t-1} + S_t^* \qquad (1)$$

where A_t is a summary measure of net households assets (excluding consumer durables) at market value, $\tilde{r}_t$ is an overall average rate of return, Y_t is labor income, C_t is consumption, T_t is tax revenue, and S_t^* is savings out of labor income: $S_t^* \equiv Y_t - C_t - T_t$. Note that the measure of saving S_t^* explicitly captures household decisions. Borrowing from the fiscal policy literature, we may call S_t^* "primary" saving.

Importantly, $\tilde{r}_t$ is an overall *implicit* rate of return that includes interest and dividend payments $i_t A_{t-1}$ and valuation adjustments to risky assets (equity shares, real estate, etc.). Thus, $\tilde{r}_t A_{t-1} \equiv i_t A_{t-1} + val.\ adj.$ Figure 2 presents an estimate of $\tilde{r}_t$ along with a narrower but more volatile counterpart, the growth rate of the real Standard and Poor's 500 index (including dividends). Much like returns on the real S&P 500, the implicit rate of return on net assets increased steadily until the year 2000. Over the period 1952–79, $\tilde{r}_t$ averaged four percent per year. During the 80's and 90's, that figure rose to almost 8 percent. From 2000–07, $\tilde{r}_t$ averaged just over 6 percent, and for 2007–08, average $\tilde{r}_t$ fell to -8 percent.

Beyond S_t^*, there are broader measures of household savings that are also of interest. The most familiar measure of household saving is the one that comes from the national accounts, namely $S_t^{NA} \equiv Y_t + i_t A_{t-1} - C_t - T_t$. The most comprehensive measure of saving is the change in asset holdings, $S_t = A_t - A_{t-1}$.

Figure 3 shows these three measures of savings, S_t, S_t^*, and ΔA_t as a fraction of disposable labor income, $Y_t^d = Y_t - T_t$. Since ΔA_t is volatile, the trend component of a Hodrick-Prescott filter is instead displayed.

III. An Inverse Relationship between Primary Savings and Asset Income?

We expect to observe an inverse relationship between primary savings S^* and assets A (or asset income $\tilde{r}A$). To justify such a claim, we need only appeal to the intertemporal budget constraint. However, there are certain classes of preferences that will also yield such a relationship; one such class is discussed by Epstein and Zin (1991).

In undiscounted terms, a household's asset holdings may grow without bound. However, over an infinite horizon, the *present value* of such assets cannot grow boundlessly. This basic anchor on asset accumulation is the transversality condition. [4] To satisfy that condition, it is sufficient that primary savings S^* and asset income $\tilde{r}A$ move inversely. To show this, assume first that the rate of return is fixed: $\tilde{r} \equiv \bar{r}$. Assume also a savings function that

[4] The transversality condition illustrates that pyramid schemes are unsustainable, since it is impossible to redeem a claim whose present value is infinite. Likewise, the transversality condition suggests that the present value of tangible assets (real estate) must be bounded; otherwise, it would be possible to obtain a collateralized loan against such assets whose value was infinite.

includes a constant term, $S_t^* = \kappa + \tilde{\sigma}\bar{r}A_{t-1}$. In this case, the limiting present value of assets over an infinite horizon is:

$$\lim_{t\to\infty} \frac{A_t}{(1+\bar{r})^t} = \{A_0(1+\bar{r}(1+\tilde{\sigma}))^t + \kappa\sum_{j=0}^{t-1}(1+\bar{r}(1+\tilde{\sigma}))^j\}/(1+\bar{r})^t \tag{2}$$

For transversality to hold (present value tends to zero) it is both necessary and sufficient that $\bar{r}(1+\tilde{\sigma}) < \bar{r}$ or equivalently $\bar{r}\tilde{\sigma} < 0$. Hence a negative relationship between primary savings and asset income ensures that the transversality condition holds. The analysis extends to variable rates of return. Assume that $\tilde{r}_t$ fluctuates about a fixed mean $\bar{r}$: $\tilde{r}_t \equiv \bar{r} + \varepsilon_t$, $\varepsilon_t \sim N(0, sd^e)$. Even when $\tilde{r}_t$ is used in place of $\bar{r}$, the previous analysis holds since the probability limit of the error term is $\underset{t\to\infty}{plim}\, \varepsilon_t = 0$.

An important special case is that of $\tilde{\sigma} = -1$. This implies that, at the margin, primary savings S^* and asset income $\tilde{r}_t A_{t-1}$ are *inversely related on a one-to-one basis*. The undiscounted value of assets grows over time since j and hence $j\kappa$ both grow over time, but transversality is nonetheless satisfied.

Variable interest rates yield an important property discussed in Epstein and Zin (1991). Their preference setup suggests that the ratio of consumption to assets C/A will vary over time. In our setup, this must be so since $C_t \equiv Y_t^d - S_t^* \equiv Y_t^d - \kappa - \tilde{\sigma}\tilde{r}_t A_{t-1}$. Our formulation thus permits the *time-varying* consumption/asset relationship (a "Pigou effect") that they also derive.

Our setup can be reconciled with that of Lettau and Ludvigson (2004). They derive a long-run (cointegrating) relationship between consumption, disposable income, and wealth, namely $C_t + b_y Y_t^d + b_a A_{t-1} = error_t$, where the vector of cointegrating coefficients is $[1, b_y, b_a]$ and the error term is stationary. In our setup, $b_y = -1$ and the *average* value of b_a is $\tilde{\sigma}\bar{r}$.

IV. The Estimated Relation Between Primary Saving and Asset Income

Later in the paper, we will attempt to forecast the likely paths of primary savings and household net wealth over the medium term. To do so, we must first assess the historical relationships underlying these variables. At the heart of our analysis is a vector error correction (VECM) system:

$$\Delta\mathbf{X}_t = \pi_0 + \pi\mathbf{X}_{t-1} + \sum_{i=1}^{p-1}\Gamma_i\Delta\mathbf{X}_{t-i} + e_t \tag{3}$$

where $\mathbf{X}_t$ is a (3×1) vector that includes primary saving, asset income, and (log) disposable labor income, $\mathbf{X}_\mathbf{t}^{'} \equiv [Y_t^d, S_t^*, \tilde{r}A_{t-1}]$, and $\boldsymbol{\pi}$ is a (3×3) matrix whose rank determines the number of cointegrating vectors. Using well-known methods developed by Engle and Granger (1987), Johansen (1988, 1991), and Johansen and Juselius (1990), we uncover long-run equilibrium cointegrating relationships between the variables, short-run dynamic error-correction coefficients, and impulse response functions from VECM (3) (or variants thereof). Through a sequence of tests detailed in Appendix C, we find that primary savings *S^* and asset income $\tilde{r}A$ cointegrate inversely on a one-to-one basis*. That is, $S^* + \tilde{r}A + \kappa \equiv \Delta A$ is stationary. Such a relationship is considered to be a long-run equilibrium. Our procedures then point to a specific *error correction* mechanism: households eliminate their savings disequilibria exclusively by adjusting their primary savings S^*, rather than the other variables. Such disequilibria are eliminated gradually over time.

In the spirit of Hendry's (1986) *general-to-specific* philosophy, the above sequence of hypothesis tests permit a restricted simplification of VECM (3):

$$\Delta \mathbf{X}_t = \mathbf{b_0} + \sum_{i=1}^{p-1} \mathbf{b_i} \Delta \mathbf{X}_{t-i} + \mathbf{b_s} \mathbf{I} \Delta A_{t-1} + e_t \tag{3'}$$

where $\boldsymbol{\alpha}$ is a (*3 x 1*) vector of error correction coefficients. The term $\boldsymbol{\alpha}\Delta A_{t-1}$ summarizes the *error-correction* mechanism: it tells us how each of the elements of $\mathbf{X}$ respond to deviations from the equilibrium path of asset accumulation $S^* + \tilde{r}A \equiv \Delta A$—the result of our cointegration tests. (Our tests also reveal that this term will only be significant in the second equation—the one for S^*.)

Estimation details of VECM (3′) are presented in Appendix C, Table A.4. Impulse response functions (IRFs) from VECM (3′) that show us how the variables of the model respond in the short run to innovations are shown in Figure 4. The responses of ΔY^d are of interest. Note that there is a small but significant positive response to innovations in ΔS^*. This is one of our key findings regarding the paradox of thrift (POT). While a negative response might be interpreted as favorable evidence for the POT, we find the reverse: This result is inconsistent with the POT. Instead, it suggests that innovations to savings are intermediated through the economy, resulting in higher expenditures.

The response of ΔS^* are also of interest. First, note that innovations in ΔY^d bring about a small significant response of ΔS^* (impulse responses with error bands excluding zero). This suggests that a small fraction — about 4 percent; see Table A.4 for details — of (temporary) innovations to income are saved, consistent with the Permanent Income Hypothesis (PIH). Note also that the initial response of ΔS^* to innovations of $\Delta \tilde{r}A$ are first positive and then negative. This initial response, while inconsistent with the long-run response, suggests that households are "return chasers," at least in the very short run.

Finally, there is a significant positive impact of shocks to ΔrA. This result is also inconsistent with the POT. Rather, it suggests that more asset accumulation (due to higher returns) stimulates more spending and hence more income.[5]

V. Prospective Analysis: Alternative Scenarios for Savings and Assets

As we have previously stressed, one of our main goals in this paper is to forecast the likely paths of primary savings and household net wealth over the medium term, in light of the recent drop in asset values and consumer expenditures. We do so by first simulating an econometric model whose parameters remain unchanged from the estimated ones.

We recognize that models *can* change: we may have entered an era of "new frugality." However, some have expressed uncertainty as to how just how frugal we will be. For example, Blanchard (2009) states that we have "little more to go on" than a "best guess" about savings. Echoing such uncertainty, we also introduce exogenous structural shifts to the savings function. In this way, we incorporate alternative educated "guesses" into our savings projections. However, our savings projections are still anchored to theory -- the permanent income hypothesis and present value boundedness. since we continue to incorporate the feedback effect of rebounding assets (and asset income) on primary savings. As discussed above, we confirm that this effect is negative.

A. Forward Simulations

Below, we develop a model designed for simulating savings and assets. This model retains several key elements of VECM (3′). At the same time, the modified model explicitly includes the budget constraint, so as to include the non-linear dynamics of savings and asset accumulation. The model's equations are:

$$\Delta Y_t^d = b_{y0} + \sum_{i=1}^{I} b_{yyi} \Delta Y_{t-i}^d + \sum_{i=1}^{I} b_{ysi} \Delta S_{t-i}^* + \sum_{i=1}^{I} b_{yri} \Delta \tilde{r}_{t-i+1} A_{t-i} + error_{yt} \tag{4a}$$

$$\Delta S_t^* = b_{s0} + \sum_{i=1}^{I} b_{syi} \Delta Y_{t-i}^d + \sum_{i=1}^{I} b_{ssi} \Delta S_{t-i}^* + \sum_{i=1}^{I} b_{sri} \Delta \tilde{r}_{t-i+1} A_{t-i} + b_{se} \Delta A_{t-1} + error_{st} \tag{4b}$$

[5] Note that the Choleski ordering includes some standard elements. Disposable income appears first. Production decisions, and hence labor income, are assumed to be fixed prior to the period. Savings appears second. While somewhat less standard, this assumption is reasonable: household decisions may be modified than firms' production decisions (within the period), as they respond to changes in disposable income. Asset income is third, since both the implicit rate of return and the stock of assets reflect decisions that have occurred within the period.

$$\tilde{r}_t = b_{r0} + \sum_{i=1}^{I} b_{ryi}\Delta Y^d_{t-i} + \sum_{i=1}^{I} b_{rsi}\Delta S^*_{t-i} + \sum_{i=1}^{I} b_{rri}\tilde{r}_{t-i} + error_{rt} \tag{4c}$$

$$S^*_t \equiv S^*_{t-1} + \Delta S^*_t \tag{4d}$$

$$A_t \equiv (1+\tilde{r}_t)A_{t-1} + S^*_t + \hat{\kappa} \tag{4e}$$

Equation (4a) describes the short-run behavior of the (logarithmic change in) disposable labor income, ΔY^d. This equation is similar to the first one in VECM (3′). However, consistent with our previous tests (Appendix C, table A.3.), we do not include an error-correction term, since disequilibria in asset accumulation ($\Delta A = S^* + \tilde{r}A_{t-1}$) do not have a significant impact on ΔY^d. In this equation, the ad-hoc "paradox of thrift" terms are the b_{ysi}. Equation (4b) expresses the change in primary savings in a way that is consistent with VECM (3) and our hypothesis tests. In addition to lagged values of $\Delta\mathbf{X}_t' \equiv [\Delta Y^d_t, \Delta S^*_t, \Delta\tilde{r}_t A_{t-1}]$, the equation includes the error-correction term $b_{se}\Delta A_{t-1}$. Recall that the long-run equilibrium (cointegrating) relationship may be written $S^* + \tilde{r}A = const + error$. Therefore, the system is out of equilibrium if $\Delta A = S^* + \tilde{r}A$ deviates from its long-run equilibrium value (a constant mean that is reflected in b_{S0}). To ensure that asset accumulation returns to its equilibrium path after a shock, $b_{Se} > 0$.

Equation (4c) explains the implicit rate of return $\tilde{r}$; this variable is stationary, so no error-correction term is required. Equation (4d) is an identity that integrates up to obtain the *level* of primary saving S^*. Finally, equation (4e) (identical to budget constraint (1)) permits us to replicate the non-linear dynamics inherent in asset accumulation; a simple linear econometric model cannot capture such a law of motion in this way. Unlike VECM (3′), where $\tilde{r}A$ is forecast, this term is instead computed from results of system (4a)-(4e). Note also the exogenous shift in the savings function, namely $\hat{\kappa}$. In our initial "no structural break" scenarios, $\hat{\kappa} = 0$. Then, under our alternative "new frugality" scenarios, we consider alternative values of $\hat{\kappa} > 0$. Importantly, note that in simulation, the effects of $\hat{\kappa} > 0$ will feed back into the savings equations (4b) and (4d). More asset accumulation (higher values of $\hat{\kappa}$) imply higher asset income. This, in turn will reduce the forecast of primary savings from equation (4b). Estimations of equations (4a), (4b), and (4c) are presented in Table 4.

B. Stochastic Simulation (No Change to Parameters)

Forward stochastic simulations are presented for 2009–18, assuming that $\hat{\kappa} = 0$—no parametric shift. [6] Figure 5 presents the median value (close to the mean, not shown) and the 95th, 75th , 25th and 10th percentiles. For the mean/median case, primary savings peaks in 2011 at about -$262 billion *in each quarter*. Note that primary savings S^* troughed in the fourth quarter of 2007—about -$330 billion per quarter. On an annualized basis, the increase in primary savings from trough to peak is about $272 billion—about 2.3 percent of 2008 U.S. GDP (about $11.625 trillion in constant 2000 dollars). Thereafter, primary savings is forecast to fall gradually, reaching $284 billion in 2018, a value comparable to those observed during 2005–06.

Probabilistically, there is a 10 percent chance that this shift in savings (2011 versus 2007) will be $92 billion per year *or less*—about 0.8 percent of 2008 GDP; there is a 25 percent chance that this shift will be $178 billion per year *or less*—about 1.5 percent of 2008 GDP; there is a 75 percent chance that this shift will be $370 billion per year or less—about 3.1 percent of 2008 GDP; and a 95 percent chance that this shift will be $442 billion per year or less—about 3.8 percent of 2008 GDP.

We also assess prospective increases in net wealth by the end of 2018—see the lower part of Figure 5. For the mean case (median somewhat lower) net wealth (*A*) reaches a value of about $39 trillion by 2018—a slight increase over household net worth at the end of 2008 (about $38.5 trillion in constant 2,000 dollars). Net worth may fall. Probabilistically, there is a 10 percent chance assets may *fall* by 31.2 percent or more; there is a 25 percent chance that net worth will fall by 18 percent or more. Net worth may also rise: there is a 25 percent chance (75th percentile) that net worth will increase by 19.8 percent or more; there is a 10 percent chance (90th percentile) that net worth will increase by 43.2 percent or more.

Note that the charts display interesting asymmetries. For primary saving, the 90th percentile line appears to converge toward a maximum value (about -$200 billion), whereas the 10th percentile line appears to drop without bound. For net wealth, the 90th percentile appears to growth without bound, while the 10th percentile appears to continue falling, but at a decreasing rate. These asymmetries are easily explained by differences in the rate of return across draws. Simulations (available from the authors) show that draws with higher end-period wealth and lower average primary saving rates are those with higher rates of return. For draws with lower average rates of return, the decline of net wealth is attenuated because households save more.

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[6] All simulations are carried out in the Regression Analysis of Time Series (RATS) package; there were 1000 random draws. In all simulations, the rate of return $\tilde{r}$ converges to (about) 4% -- lower than in recent years.

C. Alternative "New Frugality" Scenarios: Structural Shifts In The Model

> "We are going back to the days of *Leave it to Beaver*…caution and prudence will be the order of the day."
>
> David Rosenberg, quoted in Bloomberg, March 2, 2009. [7]

The above simulations suggest that, on average, the coming increase in (primary) savings will be relatively modest and short-lived assuming no change in the model's parameters. Model parameters *can* change, however. There are several reasons to believe that an era of "new frugality" may induce shifts in parameter values:

First, households have suffered severe losses in their net wealth. In and of itself, the severity of such losses may signal a parametric shift. Moreover, households may perceive that the lower rates of return will persist. *Second,* economic uncertainty has risen. Prior to the crisis, there was a widely-held view that a "great moderation" began sometime in the early 1980s (see, for example, Bernanke (2004), Blanchard and Simon (2001), and others).
While it is only speculative, the crisis of 2008 may have ushered in a discrete increase in macroeconomic volatility. [8]

Third, consumers are deleveraging, voluntarily or otherwise. Many consumers appear to have reached their upper limits for credit card or home equity debt and are now forced to pay back. As they expect access to such credit to be more limited in the future, households may seek instead to rebuild their collateral. For further details on household attitudes regarding deleveraging, see Gallup Poll of June 17, 2009.[9]

Fourth, there seems to be more awareness that prospective federal budget deficits will reach record levels in the years to come. This is confirmed in a recent Gallup Poll (June 8, 2009).[10]

Our calculations (available from the authors) suggest that there were discrete downward shifts in the level of primary savings in the early 1980s— coinciding with the onset of the "great moderation"—as well as the early 1990s and in the early 21st century. Thus, as

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[7] *Leave it to Beaver* was a popular television show that debuted in 1957.
www.bloomberg.com/apps/news?pid=20601087&sid=au8LMpzli7.k&refer=home

[8] Tests due to Bai, Lumsdaine, and Stock (1998) indicate that a discrete downward shift in macroeconomic volatility took place sometime between 1982 and 1984. Accordingly, Tanner (1997) found evidence favoring a discrete downward shift in household saving (national accounts measure) shortly thereafter.

[9] http://www.gallup.com/poll/120938/Americans-Deleveraging-One-Three-Reduced-Debt.aspx

[10] http://www.gallup.com/poll/120770/Obama-Rated-Highest-as-Person-Lowest-Deficit-Spending.aspx

alternative scenarios, we consider cases wherein primary savings return to their levels during the 1990s ($\hat{\kappa} = \$100$ billion / quarter in real 2000 \$U.S.), the 1980s, ($\hat{\kappa} = \$185$), and the period that includes 1950s–70s ($\hat{\kappa} = \$280$). These scenarios are summarized in Table 5 and Figure 6 (upper and lower). Note that the model includes a critical feedback mechanism: positive values of $\hat{\kappa}$ are reflected in the right hand side of equation (4b). Note also that we report simulations for primary savings that include the shift term, namely $S^* + \hat{\kappa}$.

The "no shift" scenario $\hat{\kappa} = \$0$ is identical to the median of the stochastic simulation above. Savings to rise from the 2007 trough to a peak in early 2011, a peak to trough difference of about \$66 billion per quarter, or about 2.3 percent of 2008 GDP. Casual inspection suggests that this level of savings is similar to those experienced quite recently-in the early years of the 21st century.

Afterwards, savings fall. Note also that wealth continues to fall under this scenario until about 2011, and then gradually rises to just under \$39 trillion by 2018—about 0.5 percent above its real value at end 2008. Hence, if left unmodified, the model predicts an increase in savings that is modest and only temporary.

Consider next the "new frugality" scenarios that imply larger and more persistent increases in savings than otherwise. Under the 1990s scenario ($\hat{\kappa} = \$100$ billion / quarter), there is also a savings cycle. The models' own dynamics suggests that savings will rise from its trough in 2007 to a peak in early 2011 by about \$161 billion per quarter–about 5.5 percent of 2008 GDP. These are levels of saving comparable (in real dollar terms) to those seen in the mid-1990s. By 2018, asset levels reach \$43 trillion—about 12.5 percent more than the level at end-2008.

Under the 1980s scenario ($\hat{\kappa} = \$185$), the model's dynamics imply that savings will rise and peak in early 2011 by about \$241 billion per quarter—about 8.25 percent of 2008 GDP–a level dollar level comparable to those of the mid-1980s. Under this scenario, net worth reaches \$47 billion–about 23 percent more than the level at end-2008, and close to their mid-2005 levels.

Finally, under the most extreme 1950s–70s scenario ($\hat{\kappa} = \$280$), the trough to peak change in savings is about \$331 billion per quarter–just under 11.5 percent of 2008 GDP–to dollar levels not seen since the mid-1950s. Under this scenario, net worth reaches \$51 trillion—about 35 percent more than the level at end-2008, and close to the peak of mid-2007.

Under all three "new frugality" scenarios, there are substantial adjustments to private savings. But, in all cases, they are temporary. As assets rise, savings fall from their peak levels from early 2011, gradually back to less elevated levels. Even under the most extreme 1950s–70s scenario, savings return to levels of the 1990s by 2018.

VI. Pleasant Pigovian Accounting? Further Reflections on the Paradox of Thrift

Will additional savings increase or decrease output, as the POT indicates? To address this question, we develop a simple accounting framework that includes both a Keynesian multiplier and impacts of wealth accumulation on domestic private consumption and capital formation. The model is then supplemented with simulations of these two macroeconomic aggregates. These simulations help us to quantify the impacts of saving on these aggregates, and hence, evaluate the POT.

A. An Illustrative Model

Consider two economies: i = N (non-frugal), F (frugal). Economy i is described by several equations. First, gross domestic product GDP is the sum of private consumption C^i plus other elements of domestic demand Z^i_{dom} and external demand Z^i_{ext}. The other elements of domestic demand include government expenditures G and fixed capital investment FC.

Government expenditures G are autonomous and identical in both economies. External demand (net exports) is written $Z^i_{ext} = X - \mu^* Y_t^{di} + \sigma_m A^i_{t-1}$ where X is gross exports of goods and services (exogenous), $0 < \mu < 1$ and $\sigma_m < 0$ are marginal propensities to import out of income and wealth, respectively. Since output is assumed to be non-storable, inventory movements play no role in this framework.

The consumption function is:

$$C^i_t = \beta^* Y^{di}_t - \sigma A^i_{t-1} - \kappa^i \tag{5}$$

where $0 < \beta^* \leq 1$, $\sigma \leq 0$, $\kappa^N = 0$ and $\kappa^F = \kappa > 0$. Assets in economy i evolve according to:

$$A^N_t = A^N_{t-1}(1+r) + \kappa^i \tag{6}$$

If initial assets are equal ($A^N_0 = A^F_0$), in any period t > 0, if $\kappa > 0$ then $A^N_t > A^F_t$. The dynamics of consumption are easily seen from equations (5) and (6). Consumption will initially fall when saving rises. As household assets rebound, so will consumption–but only gradually so.

A critical question is whether the resources represented by κ are made available to another economic sector, either domestic or external. We assume that a fraction $0 \leq \lambda \leq 1$ is available in other sectors; the fraction $(1-\lambda)$ might be placed "under a mattress." In that sense, we may think of λ as a coefficient that summarizes the efficiency of the financial system. If there is a "credit crunch" (a queue of good projects that remain without financing by an inefficient financial system), $\lambda < 1$.

Extra savings may be used by foreigners, but analysis of that question is left to an appendix. We focus instead on the intermediation of household savings to domestic investment in fixed capital, FC.

For several reasons, the idea that additional savings will be placed in a mattress or burned in an incinerator (low λ) is a naïve caricature. Additional savings *flows* from households represent resources that can be channeled towards capital formation. Such flows may be channeled directly to firms through additional purchases of equity shares, either directly or indirectly (through pensions or mutual funds; as of end-2008, equity holdings totaled about $10 trillion in constant 2000 dollars). Less directly, households might free up banking system resources by increasing deposits (about six trillion dollars) or amortizing their liabilities (total about $11 trillion, of which about eight and a half trillion dollars are mortgage related). Alternatively, savers may purchase government bonds (about $1.8 trillion as of end-2008) or tangible assets (about $20 trillion, of which real estate is $17 trillion).

Additional flows from households may be important to replace another important source of funding for capital investment projects that has recently decreased: *corporate saving*. [11] As authors like Myers and Majluf (1984) and Fama and French (2002) have stressed, such flows represent the lowest-cost alternative in a 'pecking order' of funding sources. The data in Figure 7 suggests that, in recent years, corporate and household savings have been negatively related. (From 1980 through 2008, the relationship is statistically significant and cointegrating; the coefficient is close to minus one. Results are available on request.)

Household saving data by themselves may not provide an adequate picture of the domestic resource flows associated with new capital formation. For example, corporate saving peaked in 2006 at about $460 billion (constant $ 2,000) per year. By end-2008, that annualized flow fell by about $289 billion. Over that same period, households boosted their saving by about $167 billion—a substantial amount, but not enough to fully compensate.

However, there is also reason to believe that there should be a positive relationship between the *stock* of accumulated savings and the *flow* of capital expenditures. Household purchases contribute to firm's collateral value (holdings of financial assets) and hence its net worth. Informational asymmetries between firms and investors will give rise to a wedge between the firms' cost of capital and the risk-free rate of return. As the collateral value of firms rises (and hence its net worth), the cost of capital falls; hence investment expenditures will

[11] More correctly, corporate savings equals undistributed corporate profits plus inventory valuation adjustment plus capital consumption allowance.

increase. Of course, some portion the asset accumulation will be foreign. However, in this paper, we emphasize the domestic linkages, appealing to Feldstien and Horioka's (1980) observation that domestic savings and investment are highly correlated—a home bias.

These ideas have been explored at the level of the firm in several papers, including Fazzari, Hubbard, and Petersen (1988) and Kaplan and Zingales (1997). These ideas are also related to the *financial accelerator* hypothesis; see for example Bernanke, Gertler, and Gilchrist (BGG,1999).

We believe such ideas may also be relevant *in the aggregate*. Data in support of this argument are shown in Figure 8, which plots household net wealth (*stock*) against real flows of private investment, both total and non-residential. Casual observation indicates that there is a high degree of correlation between net wealth and both measures of investment (although some what more so for the total measure that includes housing).

The correlation appears to be especially strong for the early 21st century. We also note that the net worth (outstanding shares) of *firms* is related to that of *households*: we find that the two cointegrate on a one-to-one basis over the entire 1952–2008 period (results available from the authors), potentially reflecting the home bias discussed above.

Thus consider a simple functional for fixed capital investment:

$$FC_t^i = \overline{FC} + \delta[\lambda\kappa^i + \varphi A_{t-1}^i] \tag{7}$$

where δ is the fraction of savings flows that are directed towards domestic, rather than foreign, $(0 \le \delta \le 1)$ uses and φ captures the credit constraint / financial accelerator effect discussed above $(\varphi > 0)$.

Gross domestic product (GDP) for economy *i* is written:

$$Y_t^i = \frac{1}{(1-\beta+\mu)}[-(1-\lambda\delta)\kappa^i + (\delta\varphi - \sigma^{tot})A_{t-1}^i + \overline{FC} + X + G] \tag{8}$$

where $0 < \beta < 1$ and $0 < \mu < 1$ are the gross marginal propensities to consume and import of GDP. Consider now a formal definition of the paradox of thrift (POT), which holds if: [12]

[12] An alternative notion of the POT, as Simon Johnson (see Box 1) has suggested, is that aggregate savings increases by less than the level downward shift in the consumption function (κ). This is true for an open economy, since:

(continued)

$$Y_t^N - Y_t^F > 0 \tag{9}$$

Using expression (8), we can obtain the difference between GDPs in the two economies:

$$Y_t^N - Y_t^F = \frac{1}{(1-\beta+\mu)}[(1-\lambda\delta)\kappa - \sigma^{tot}[A_{t-1}^N - A_{t-1}^F] + \delta\varphi[A_{t-1}^N - A_{t-1}^F]] \tag{10}$$

We may now see that validity of the POT depends on three factors. *First,* $[(1-\lambda\delta)\kappa$ may be thought of as an offset flow factor: it tells us the degree to which reduced consumption in the frugal economy is offset by extra domestic capital formation. At one extreme, if all new savings are fed into an "incinerator" $(\lambda = 0)$ then GDP in the non-frugal economy will exceed that in the frugal economy by $(1-\lambda\delta)\kappa/(1-\beta+\mu)$. At another extreme, if all additional savings are channeled toward domestic capital formation, $(\delta\lambda = 1)$ there will be no effect of extra savings on demand in the frugal economy. *Second*, $-\sigma^{tot}[A_{t-1}^N - A_{t-1}^F]$ captures the differential stock effect on consumption across the two economies. For t>0, $-\sigma^{tot}[A_{t-1}^N - A_{t-1}^F] < 0$. *Third*, $\varphi\delta[A_{t-1}^N - A_{t-1}^F]$ captures the differential stock effect on capital investment (the cash constraint / financial accelerator effect) in the two economies. For t>0, $\varphi\delta[A_{t-1}^N - A_{t-1}^F] < 0$. The validity of the POT hence depends on the relative strengths of the flow effect against the two stock effects. The POT holds if:

$$(1-\lambda\delta)\kappa > \sigma^{tot}[A_{t-1}^N - A_{t-1}^F] - \delta\varphi[A_{t-1}^N - A_{t-1}^F] \tag{11}$$

Finally, as a naïve caricature, note that the POT *always* holds if $\lambda = \sigma^{tot} = \varphi = 0$.[13]

$$\frac{1+\mu}{1-\beta+\mu} < 1$$

Paradoxically, the more open the economy is (higher μ) the lower the potential impact of an increase in κ will be.

[13] The term λ may be interpreted in terms of a standard IS/LM model. For example, fixed capital formation is sensitive to the economy-wide interest rate, we might think also of an LM curve whose slope is 1/($(1-\lambda)$. The case of $\lambda = 1$ would imply a *vertical* LM curve. Note also that $(1-\lambda)$ might be reflected in inventory buildup. However, since we assume output to be non-storable, inventory accumulation is ruled out. As we discuss below, the savings flow κ is effectively destroyed if both σ and λ are equal to zero.

B. Prospective Paths for Consumer Expenditures

We augment system (4a)-(4e) with the following equation for household consumption:

$$\Delta C_t = b_{c0} + \sum_{i=1}^{I} b_{cci}\Delta C_{t-i} + \sum_{i=1}^{I} b_{csi}\Delta S^*_{t-i} + \sum_{i=1}^{I} b_{cri}\Delta rA_{t-i} + b_{ce}\Delta A_{t-1} + error_{ct} \qquad (12)$$

This equation is analogous to savings equation (4b); the estimated b_{ce} error correction term significant and positive, somewhat larger than in savings equation, confirming that consumption responds to past departures from the equilibrium change in assets. Note that the shift in the consumption function $-\hat{\kappa}$ is immediately reflected in the alternative scenarios. Note also that higher values of $\hat{\kappa}$ are associated with consumption trajectories whose slope is somewhat greater. This is, of course, a consequence of the fact that, for higher values of $\hat{\kappa}$, net wealth is being accumulated more rapidly.

However, as the simulations shown in Figure 9 suggest, this effect is only gradual: by the end of the forecast horizon, under all structural shift scenarios $\hat{\kappa} > 0$, consumption remains lower than under the no-shift scenario $\hat{\kappa} = 0$.

C. Capital Investment

Next, we append the following investment equations to the simulation model:

$$\Delta FC_t = b_{f0} + \sum_{i=1}^{I} b_{ffi}\Delta FC_{t-i} + \sum_{i=1}^{I} b_{fyi}\Delta Y^d_{t-i} + \sum_{i=1}^{I} b_{fai}\Delta A_{t-i} + \sum_{i=1}^{I} b_{fri}\tilde{r}_{t-i} + error_{ft} \qquad (13a)$$

$$FC_t \equiv FC_{t-1} + \Delta FC_t \qquad (13b)$$

where FC denotes fixed capital formation. While the estimated equation includes residential capital, an equation with non-residential capital only yielded similar results. Estimation details, including F-tests for variable exclusion, are provided in Table 7. The results suggest that both comprehensive savings (ΔA) and the implicit rate of return $(\tilde{r})$ are positively and significantly related to investment expenditures. [14] The coefficients on ΔA, namely b_{fai} should be interpreted as the *wealth constraint* or *financial accelerator* coefficients. They indicate that an increment to wealth will affect capital investment FC—above and beyond

[14] We can reject the null hypothesis that all coefficients on ΔA are zero (exclusion) but only at the 90 percent level. However, this significance level rises considerably if $\tilde{r}$ is omitted. This makes sense, since the two variables may carry similar information.

the impacts of other factors, including inertial factors from past investment, disposable income (a measure of consumer purchasing power) and the rate of return on investment.

As before, we conduct stochastic simulations–simulations with random shocks, unchanged parameters). Results are shown in Figure10. For the mean/median case, investment expenditures *FC* reach about $420 billion per quarter in 2018–about 10 percent less than the 2006 peak $470 billion. Will investment expenditures ever return to this peak level, and if so, when? The figure indicates that there is a 25 percent chance that, by 2018 *FC* will be $470 billion per quarter or more. More optimistically, there is a 10 percent chance that *FC* will reach or exceed that value by 2014.

We also conduct simulations that incorporate the "new frugality" parametric shifts discussed previously: savings levels comparable to the 1990s, the 1980s, and the 1950s–70s. Figure 11 suggests that capital formation will respond to changes in savings flows, but only gradually. Initially, those extra savings would not be directed to domestic capital investment.[15]

Thus, in the no shift scenario, investment *FC* increases only marginally above its end-2008 levels. By contrast, under the most extreme 1950s–70s scenario, investment returns to values that are close to recent highs, but only by 2018. These simulations thus illustrate that increases in savings, when accumulated, can yield non-trivial changes in the flow of investment. The figure also suggests that, unless rates of return exceed those generated by the model, more savings than those predicted by the unmodified model will be required for investment levels to return to their peak levels of the 2005–07 period.

VII. Summary, Conclusions, and Directions for Future Work

In the dictionary, the first definition of "fret" as a verb is "to feel or express worry, annoyance, discontent, or the like."[16] Are we fretting too much about frugality? If "fretting" precludes a structured analysis, the answer is "yes."

We have attempted to begin a more structured discussion about potential increases in household savings in the aftermath of the 2007–09 financial crisis. Our econometric tests suggest that the relationship between household primary savings and net wealth is negative in a way that is consistent with the economy's long-run intertemporal budget constraint. For this reason, we should expect that savings will rise in the aftermath of a severe market downturn.

[15] Instead, the trade balance would rise, government spending would increase, or inventories would rise.

[16] This definition is from www.dictionary.com.

By how much will savings increase? With no change in the parameters, our model suggests an increase in savings that is only modest and temporary. Under alternative scenarios, if we boost the level of savings, we still expect to see a cyclical pattern, with savings starting to decrease in the medium term—as household asset levels begin to recuperate.

Some, including Blanchard (2009), have concluded that increased flows of household savings will not immediately be met by an increase in investment. Instead, domestic demand will probably remain sluggish for some time. We agree. As the same time, economic analyses of the post-crisis recovery run the risk of “fretting” about flow impact of saving (demand reducing) while not properly considering the stimulating impacts of balance sheet repair—the accumulation of savings flows. Our paper suggests that assessments and/or forecasts of the post-crisis economy (US or global) should account for this dynamic in some way.

More than any specific forecast, we hope that our paper has made a contribution by highlighting the importance of this dynamic and setting the stage for further research. The linkages between macroeconomic and financial variables discussed in this paper might also be simulated in general equilibrium model. Likewise, our analysis should be expanded to encompass external savings and global imbalances (beyond our brief discussion in Appendix D). And, an analysis of intertemporal fiscal implications would be especially important in light of the current global surge in public sector debt.

References

Ahmed, S. and Rogers, J.H., 1995, "Government Budget Deficits and Trade Deficits: Are Present Value Constraints Satisfied in Long-Term Data?" *Journal of Monetary Economics*, Vol. 36, n2 (November), pp. 351–74.

Bai, J., R.L. Lumsdaine and J.H. Stock, 1998, Testing for and Dating Common Breaks in Multivariate Time Series, *Review of Economic Studies* 65, pp. 395–432.

Bernanke, Ben S., Mark Gertler, and Simon Gilchrist, 1999, "The Financial Accelerator in a Quantitative Business Cycle Framework," in: J. B. Taylor & M. Woodford (ed.), *Handbook of Macroeconomics,* (Amsterdam: Elsevier), Edition 1, Vol. 1, Chapter 21, pp. 1341–93 .

Blanchard, Olivier, 2009, "Sustaining a Global Recovery," *Finance and Development*, September, (Washington D.C.: International Monetary Fund), http://www.imf.org/external/pubs/ft/fandd/2009/09/blanchardindex.htm

_______ and John Simon, 2001, "The Long and Large Decline in U.S. Output Volatility," *Brookings Papers on Economic Activity* (2001, issue. 1, pp. 135-64)

Bohn, H., 1991, "Budget Balance Through Revenue or Spending Adjustments—Some Historical Evidence for the United States," *Journal of Monetary Economics* Vol. 27, n3 (June), 333–59.

Corsetti, G. and Roubini, N., 1991, "Fiscal Deficits, Public Debt, and Government Solvency—Evidence from OECD Countries," *Journal of the Japanese and International Economies* Vol. 5, n4 (December), pp. 1264–73.

Engle, Robert F, and Clive W. J. Granger, 1987, "Co-integration and Error Correction: Representation, Estimation, and Testing," *Econometrica,* Vol. 55, issue 2, pp.251–76.

Epstein, Larry G. and Stanley Zin, 1991, "Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: An Empirical Analysis Preview," Journal of Political Economy, Vol. 99, issue 2 (April), pp. 263–86.

Fama, E. and K. French. "Testing Trade-Off and Pecking Order Predictions About Dividends and Debt", *Review of Financial Studies*, Vol. 15 (2002), 1–33.

Fazzari, Steven, R. Glenn Hubbard, and Bruce Petersen, 1988, "Financing Constraints and Investment," *Brookings Papers on Economic Activity*, Vol.1, pp. 141–95.

Feldstein, Martin and Charles Horioka, 1980, "Domestic Saving and International Capital Flows", *Economic Journal* 90, pp. 314–29.

Hakkio, Craig S. and Mark Rush, 1991, “Is the Budget Deficit "Too Large?" *Economic Inquiry* v29, n3 (July), pp. 429–45.

Hendry, David F., 1986, “Econometric Modeling with Cointegrated Variables: An Overview,” *Oxford Bulletin of Economics and Statistics*, Vol. 48, 3, pp 201–12.

Johansen, Soren, 1988, "Statistical analysis of cointegration vectors," *Journal of Economic Dynamics and Contro*l, Vol. 12(2-3), pp. 231–54.

_____, 1991, “Estimation and Hypothesis Testing of Cointegrating Vectors in Gaussian Vector Autoregressive Models,” *Econometrica* 59, pp. 1551–80.

Johansen, Soren and Katarina Juselius, 1990, "Maximum Likelihood Estimation and Inference on Cointegration—With Applications to the Demand for Money," Oxford Bulletin of Economics and Statistics, Department of Economics, University of Oxford, Vol. 52(2), (May), pp. 169–210.

Kaplan, Steven, and Luigi Zingales, 1997, “Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints?” *Quarterly Journal of Economics*, Vol. 112, pp.159–216.

Lettau, Mark and Sydney Ludvigson, 2004, “Understanding Trend and Cycle in Asset Values: Reevaluating the Wealth Effect on Consumption,” *American Economic Review*, Vol. 94, 1 (March), pp. 276–99.

Myers, Stewart and Nicholas S. Majluf, 1984, "Corporate Financing and Investment Decisions when Firms have Information that Investors Do Not Have", *Journal of Financial Economics,* Vol. 13, No. 2 (June), pp. 187–221.

Quintos, C.E., 1995, “Sustainability of the Deficit Process with Structural Shifts,” *Journal of Business & Economic Statistics* v13, n4 (October): 409–17.

Rudd, Jeremy and Karl Whelan, 2006, “Empirical Proxies for the Consumption–Wealth Ratio,” *Review of Economic Dynamics*, Vol. 9, pp. 34–51.

Svensson, Lars E. O. and Assaf Razin, 1983, “The Terms of Trade and the Current Account: The Harberger-Laursen-Metzler Effect,” *Journal of Political Economy*, February, Vol. 91, issue. 1, pp. 97–125.

Tanner, Evan, 1995, “Intertemporal Solvency and Indexed Debt: Evidence from Brazil, 1976-1991,"*Journal of International Money and Finance,* August 1995, Vol. 14, issue 4, pp. 549–73.

_____, 1997, "Shifts in US Savings: Long-Run Asset Accumulation versus Consumption Smoothing," *Applied Economics*, Vol. 29, issue 8 (August), pp. 989–99.

_____ and Peter Liu, 1994, "Is the Budget Deficit 'too Large"?: Some Further Evidence," *Economic Inquiry* 32, pp. 511–18.

Telatar, E., Bolatoglu, N. and Telatar, F., 2004, "A New Approach on Testing the Behaviour of the Governments Towards Sustainability of Fiscal Policy in a Small-open and Politically Instable Economy," *Applied Economics Letters* Vol. 11, n5 (April), pp. 333–36.

Trehan, Bharat and Carl E. Walsh, 1990, "Seigniorage and Tax Smoothing in the United States, 1914–1986," *Journal of Monetary Economics,* Vol. 25, n1 (January), pp. 97–112.

_____, 1991, "Testing Intertemporal Budget Constraints: Theory and Applications to U.S. Federal Budget and Current Account Deficits," *Journal of Money, Credit, and Banking*, Vol. 23, n2 (May), pp. 206–23.

Appendix A. Data Definitions

All data were obtained through the Haver Analytics Database. Codes are available on request. *All variables were deflated by the GDP deflator, base year 2000=100.*

1. Disposable Labor Income (Y^d): Disposable Income minus interest receipts minus interest payments. (US National Income and Product Accounts, Disposition of Personal Income).

2. Labor (Primary) Savings (S^*): Disposable Income minus consumption net of interest receipts plus interest payments.

3. Total Net Worth (A) = Total Assets minus Consumer Durables minus Total Liabilities.

4. Implicit asset income (residual) $\tilde{r}_t A_{t-1} = A_t - A_{t-1} - S^*$.

5. Implicit rate of return: $\tilde{r}_t = [A_t - A_{t-1} - S^*] / A_{t-1}$

Appendix B. Assessing Transversality: Primary Savings and the Level of Assets

Assume that households channel their labor income to savings in some proportion σ of their net asset holdings, $S_t^* = \kappa + \sigma A_{t-1}$, $\kappa \geq 0$. We also assume for simplicity a fixed rate of return ($\tilde{r}_t \equiv \bar{r}$). This assumption will be modified later but it does not affect the essentials of the analysis. Over an infinite horizon, the present value of asset holdings is:

$$\lim_{t\to\infty} \frac{A_t}{(1+\bar{r})^t} = \{A_0(1+\bar{r}+\sigma)^t + \kappa\sum_{j=0}^{t-1}(1+\bar{r}+\sigma)^j\} / (1+\bar{r})^t \qquad \text{(A1)}$$

where A_0 is the initial stock of net assets (assumption: $A_0 > 0$.) Satisfaction of the transversality (or "no Ponzi Game") condition implies that the denominator $(1+\bar{r})^t$ go to infinity more quickly than the numerator. Thus, the necessary and sufficient condition to satisfy transversality is $(1+\bar{r}+\sigma) < (1+\bar{r})$.

However, this is a relatively weak condition: so long as $(1+\bar{r}+\sigma) > 1$, the undiscounted stock of net assets will increase boundlessly–even while the discounted value remains bounded. For the "borderline" case of $(1+\bar{r}+\sigma) = 1$, if $\kappa = 0$, assets remain constant at $A_t = A_0$, while if $\kappa > 0$ assets are unbounded.

A more restrictive case is $0 < (1+\bar{r}+\sigma) < 1$. In this case, we have:

$$\lim_{t\to\infty} \frac{A_t}{(1+\bar{r})^t} = [\kappa \frac{(1+\bar{r}+\sigma)}{(\bar{r}+\sigma)}] / (1+\bar{r})^t \qquad \text{(A2)}$$

Here, assets are bounded in both discounted and undiscounted terms. [17]Thus, to satisfy transversality, primary savings must be negatively related to asset holdings, but within certain bounds, namely $-1 < \sigma < 0$.

A familiar way to empirically address such issues would be through the use of *cointegration* methods. For example, testing for the cointegration of S^* and A would yield an estimate of σ. Such tests not new. For example, tests similar to those discussed here have been applied to assess the sustainability of government budget deficits (Hakkio and Rush (1991), Bohn (1991), Corsetti and Roubini (1991), Trehan and Walsh (1990, 1991), Tanner and Liu (1994), Ahmed and Rogers (1995), Quintos (1995), Telatar and others (2005)).

Appendix C. Estimation Details

The analysis in the body of the paper suggests that we should expect to see a negative relationship between primary savings and asset income in the long-run. Prior to directly testing this hypothesis, we must first conduct standard augmented Dickey-Fuller (ADF) unit-root tests on both the levels and first differences of the relevant variables. The results are presented in Table A.1. We cannot reject the null hypothesis of a unit root for all of the following variables in levels: $S^*, \tilde{r}A, Y^d$. However, we reject the null of a unit root for the first differences: $\Delta S^*, \Delta\tilde{r}A, \Delta Y^d$. This suggests the primary saving, asset income, and (log) disposable labor income are all non-stationary and integrated of order one in levels, or I (1). Note also that our results suggest that (net) assets are I (1) in levels, but the implicit rate of return $\tilde{r}$ is stationary.

1. Model Setup

We may now investigate economically meaningful linear combinations of the I (1) series—primary saving, asset income, and disposable labor income—that are stationary or I (0). These are *cointegrating* relationships. To do so, we use the Johansen (1988, 1991) and Johansen and Juselius (1990) maximum likelihood procedure. We begin by specifying a vector auto-regression (VAR) system:

$$\mathbf{X}_t = \boldsymbol{\pi}_0 + \sum_{i=1}^{p} \boldsymbol{\pi}_i \mathbf{X}_{t-i} + \mathbf{e}_t \tag{A3}$$

[17] Svensson and Razin (1983) note that the existence of a target level of wealth presumes that households' rate of time preference increases with the level of wealth.

where $\mathbf{X}_t$ is a (3×1) vector that includes primary saving, asset income, and (log) disposable labor income, $\mathbf{X}_t' \equiv [Y_t^d, S_t^*, \tilde{r}A_{t-1}]$, and the $\boldsymbol{\pi}_i s$ are (3×3) matrices of coefficients on lags of $\mathbf{X}_t$. Note that since disposable labor income is also a variable of interest, we include in our analysis. As Hendry's (1986) general-to-specific approach advocates, we will test whether this variable belongs to the cointegration space and also whether it is important for the short run dynamics. For convenience, we now add and subtract various lags of $\mathbf{X}_t$ so as to obtain the VAR in its vector error correction (VECM) form:

$$\Delta \mathbf{X}_t = \pi_0 + \pi \mathbf{X}_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta \mathbf{X}_{t-i} + e_t \qquad \text{(A4)}$$

$$where \quad \Gamma_i = -(\pi_{i+1} + \cdots + \pi_p) \quad i = 1, \cdots, p-1 \qquad and \qquad \pi = \left(\sum_{i=1}^{p} \pi_i \right) - I.$$

As per the Johansen procedure, the presence of cointegrating relationships is reflected in the *rank* of the $\boldsymbol{\pi}$ matrix. If there are <u>no</u> cointegrating relationships amongst the variables in $\mathbf{X}_t$, the rank of $\boldsymbol{\pi}$ will be zero. In this case, the model may be simply estimated in first differences. It will be informative about short-run (but not long-run) relationships. At the other extreme, if $rank(\boldsymbol{\pi}) = 3$, then the original series are not I(1), but in fact I(0); modeling in differences is unnecessary.

Of greater interest is the intermediate case of $0 < rank(\boldsymbol{\pi}) < 3$. If $rank(\boldsymbol{\pi}) = 1$, there is one cointegrating relationship amongst the variables. If $rank(\boldsymbol{\pi}) = 2$, there are two such relationships.

Test results for the existence of cointegration (the Johansen test) are presented in the upper part of Table A.2. As we will show, our tests strongly suggest that the rank of $\boldsymbol{\pi}$ is one—that there is *one* cointegrating relationship amongst these variables. Each line presents relevant statistics for null hypotheses H_0 that $rank(\boldsymbol{\pi})$ is *r*, for *r=0,1,2,3* (leftmost column). The statistics are, from left to right: Eigen value, log likelihood for rank, trace test (with p-value) and max-Eigen value (with p-value). [18] The null hypothesis of no cointegration (*r = 0*) is strongly rejected at the 1 percent significance level across both test statistics. The trace

[18] Recall that the trace statistic tests the null hypothesis that there are at most *r* cointegrating vectors against the alternative that there are more than *r* vectors, whereas the Max-Eigenvalue statistic tests the null that there are *r* cointegrating vectors against the alternative that *r+1* exist.

statistic cannot reject the null hypothesis of at most one cointegrating vector against the alternative that more than one vector exist. Also, the max-Eigen value statistic cannot reject the null hypothesis of one cointegrating vector against the alternative that two vectors exist. *We therefore conclude that there is one cointegrating relation among the variables*.

2. Coefficient Estimates: Long-Run and Short-Run

According to the Johansen procedure, if $0 < rank(\boldsymbol{\pi}) \equiv r < 3$, then the matrix $\boldsymbol{\pi}$ can be expressed as the outer product of two full column rank $(3 \times r)$ matrices $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ where $\boldsymbol{\pi} = \boldsymbol{\alpha\beta}'$. This implies that there are $(3-r)$ unit roots in $\boldsymbol{\pi}\mathbf{X}$. The VECM model can thus be rewritten as:

$$\Delta\mathbf{X}_t = \boldsymbol{\pi}_0 + \boldsymbol{\alpha\beta}'\mathbf{X}_{t-1} + \sum_{i=1}^{p-1}\boldsymbol{\Gamma}_i\Delta\mathbf{X}_{t-i} + \mathbf{e}_t \qquad \text{(A5)}$$

The decomposition $\boldsymbol{\pi} = \boldsymbol{\alpha\beta}'$ has an intuitive interpretation. The matrix $\boldsymbol{\beta}'$ contains the long-run *cointegrating* vector(s); the elements of $\boldsymbol{\beta}'$ are the estimates of the cointegrating coefficients. The matrix rows of $\boldsymbol{\beta}'\mathbf{X}_{t-1}$ are normalized on the variable(s) of interest in the cointegrating relation(s) and interpreted as the deviation(s) from the long-run.

By contrast, the columns of $\boldsymbol{\alpha}$ are *short run adjustment* coefficients: they show how quickly variables in the system adjust to disequilibria; as such disequilibria are eliminated. [19]

Table A.2 shows unrestricted estimates of both the $\boldsymbol{\beta}$ (cointegrating) and $\boldsymbol{\alpha}$ (adjustment speed) coefficients, along with their associated standard errors. Note that elements of $\boldsymbol{\beta}$ are normalized on S^* (coefficient on S^* always set to unity). A cointegrating vector may thus be written as $S^* + \beta_r \tilde{r}A + \beta_y Y^d = error$. Note that a positive value for the other elements of $\boldsymbol{\beta}$ indicate a *negative* cointegrating relationship with S^*. The estimate for the coefficient on $\tilde{r}A$ (β_r) is 0.462. *This result suggests that primary saving is negatively related to asset income in the long-run.* This confirms that the present value of household net wealth in the United States is bounded.

Estimates for elements of the $\boldsymbol{\alpha}$ vector are all negative. However, only one of the coefficients, namely S^*, appears to be significant, suggesting that households adjust primary

[19] The matrix $\boldsymbol{\alpha}$ is sometimes said to contain the "weighting elements" for the r^{th} cointegrating relation in each equation of the VAR. If the coefficient is zero in a particular equation, that variable is considered to be weakly exogenous and the VAR can be conditioned on that variable.

savings downward when asset accumulation exceeds its long-run equilibrium path. Note that the ratio of the coefficient to standard error (a t-ratio) is high: -0.02/0.003=6.7. More formally, in TableA.3 we show that the null hypothesis that the $\boldsymbol{\alpha}$ element for S^* equals zero is rejected ($Chi^2(1)$=21.1, p-value = 0.0). By contrast, the $\boldsymbol{\alpha}$ coefficients for both $\tilde{r}A$ and Y^d are not statistically different from zero, either individually or jointly. *This indicates that, in order to return to the equilibrium path, households deliberately modify their primary savings effort, rather than rely on innovations to either labor or asset income*

Table A.3 also presents tests of hypotheses regarding the cointegrating relation. These tests are distributed as Chi-squared under the null hypothesis. We first test whether the $\boldsymbol{\beta}$ coefficients on $\tilde{r}A$ and Y^d may be set to zero–that these variables may be eliminated from the cointegrating relationship. For $\tilde{r}A$, the test statistic is 20.3, p-value of 0.0. This indicates rejection of the hypothesis that the coefficient on $\tilde{r}A$ equals zero. By contrast, for Y^d, the test statistic is 0.55, p-value of 0.46. We cannot reject the hypothesis that the coefficient on Y^d equals zero. *Thus, while $\tilde{r}A$ belongs in the cointegrating vector, Y^d may be dropped from the cointegrating vector.* However, Y^d implicitly remains in the system, since primary savings is labor income minus consumption. Our results are consistent with the permanent income hypothesis: consumption and labor income move together one-to-one. (This hypothesis was confirmed separately).

We next test whether the cointegrating $\boldsymbol{\beta}$ coefficient on asset income $\tilde{r}A$ is equal to unity. This restriction cannot be rejected: the test statistic (see Table A.3) is 0.199 with a p-value of 0.6558. Finally, we test the *joint* hypothesis that the cointegrating $\boldsymbol{\beta}$ coefficients on asset income $\tilde{r}A$ is equal to unity and that for disposable labor income Y^d is equal to zero. This joint restriction cannot be rejected: the test statistic is 1.2016 with a p-value of 0.5484. *Hence we conclude that S^* and $\tilde{r}A$ cointegrate inversely on a one-to-one basis.* This is consistent with our finding (see Table A.1) that assets A are difference stationary (I(1)), since $\Delta A = S^* + \tilde{r}A_{t-1}$.

Appendix D. Pleasant Pigovian Accounting in an Open Economy

Now consider a variant of the paradox of thrift based on domestic demand, namely POT^{dom}. The expressions for domestic demand in economies N and F are:

$$Y^N_{dom,t} = \frac{1+\mu}{1-\beta+\mu}[-\sigma^{tot} A^N_{t-1} + Z^N_{dom}] - \frac{\beta}{1-\beta+\mu} Z^N_{ext} \tag{A6}$$

$$Y^F_{dom,t} = \frac{1+\mu}{1-\beta+\mu}[-\sigma^{tot} A^F_{t-1} + Z^N_{dom} - (1-\lambda)(1-\delta)\kappa] - \frac{\beta}{1-\beta+\mu}[Z^N_{ext} - (1-\lambda)\delta\kappa] \quad \text{(A7)}$$

The POT^dom holds if $Y^N_{dom,t} - Y^F_{dom,t} > 0$; that is, the condition holds if:

$$\frac{1+\mu}{1-\beta+\mu}[-\sigma^{tot}(A^N_{t-1} - A^F_{t-1}) + (1-\lambda)(1-\delta)\kappa] - \frac{\beta}{1-\beta+\mu}[(1-\lambda)\delta\kappa] < 0 \quad \text{(A8)}$$

This expression highlights several key issues. First, if $\lambda = 1$, and $\sigma^{tot} < 0$ the value of δ is irrelevant: POT^dom, like its parent POT, never holds. That is, so long as financial intermediation works well, the fact that households accumulate wealth implies that savings will stimulate domestic demand, *regardless of whether these assets are foreign or domestic*. Thus, a drop in imports, coupled with an increase in net foreign asset holdings, must imply higher levels of domestic demand–contrary to POT logic.

By contrast, if $0 \le \lambda < 1$, the value of δ matters. Here, consider a policy-induced increase in δ. We may think of this as a fiscal policy designed to boost domestic demand, by shifting savings away from the external sector and towards domestic (public) expenditure. It is easily seen that this government spending multiplier is exactly $(1-\lambda)$, since:

$$\frac{\Delta Y^N_{dom}}{\Delta(\delta\kappa)} = \{\frac{1+\mu}{1-\beta+\mu} - \frac{\beta}{1-\beta+\mu}\}(1-\lambda) = (1-\lambda) \quad \text{(A9)}$$

In this sense, fiscal policy may be seen as effective, insofar as it shifts resources from the external to the domestic sectors (thereby presumably increasing domestic employment).

Table A.1. Unit Root Tests for Variables in Levels and Differences

Variable	Lags	t-ADF		1% level	5% level
		Constant Included			
S^*	5	1.91		-3.46	-2.87
ΔS^*	1	-10.64	**	-3.46	-2.87
A	6	-0.55		-3.46	-2.87
ΔA	5	-3.51	**	-3.46	-2.87
$\tilde{r}$	2	-5.83	**	-3.46	-2.87
$\Delta\tilde{r}$	4	-10.41	**	-3.46	-2.87
$\tilde{r}A$	5	-2.38		-3.46	-2.87
$\Delta\tilde{r}A$	4	-9.07	**	-3.46	-2.87
Y^d	5	-0.13		-3.46	-2.87
ΔY^d	4	-6.76	***	-3.46	-2.87
		Constant and Trend Included			
S^*	2	-1.57		-4.00	-3.43
ΔS^*	4	-8.27	**	-4.00	-3.43
A	6	-2.43		-4.00	-3.43
ΔA	4	-4.51	**	-4.00	-3.43
$\tilde{r}$	2	-5.76	**	-4.00	-3.43
$\Delta\tilde{r}$	4	-10.46	**	-4.00	-3.43
$\tilde{r}A$	5	-1.94		-4.00	-3.43
$\Delta\tilde{r}A$	4	-9.17	**	-4.00	-3.43
Y^d	5	-2.32		-4.00	-3.43
ΔY^d	4	-6.74	**	-4.00	-3.43

Notes:
1. Δ denotes the difference operator.
2. For a given variable x, the Augmented Dickey-Fuller equation with a constant and trend included has the following form:

$$\Delta x_t = \pi\, x_{t-1} + \sum_{i=1}^{p} \theta_i\, \Delta x_{t-i} + a + \delta t + \varepsilon_t$$

and the specification with only a constant included simply excludes the trend term. ε_t is assumed to be white noise. For a given variable , the table reports the number of lags on the dependent variable, p, chosen using the Akaike information Criterion (AIC) , and the augmented Dickey-Fuller statistic, t-ADF, which is the t-ratio on π .
The statistic tests the null hypothesis of a unit root in x, i.e. $\pi = 0$, against the alternative of stationarity.
3. The symbols * and ** denote rejection of the null hypothesis at the 5% and 1% critical values respectively. The sample is 1954 (2) - 2008 (4)

Table A.2. Cointegration Analysis (Johansen (1990) Test

H0: rank	Eigenvalue	Loglik for rank	Trace test	[Prob]	Max test	[Prob]
0		-1897.402	46.32	[0.000]**	33.52	[0.000]**
1	0.140	-1880.640	12.79	[0.123]	12.27	[0.101]
2	0.054	-1874.503	0.52	[0.472]	0.52	[0.472]
3	0.002	-1874.244				

Unrestricted Coefficients

Variable	Beta Vector	Std Err	Alpha Vector	Std Err
S*	1	0	-0.020	0.003
rA	0.462	0.088	-0.292	0.246
Y^d	147.550	68.907	-0.000003	0.000004

Notes :
The VAR includes four lags on each of the variables (S*, rA, Yd), and a constant (unrestricted). The sample is: 1953 (2) to 2008 (4).

Table A.3. Hypothesis Tests, Restrictions on Cointegrating Coefficients

Hypotheses Tests for the Beta Vector

Zero Beta Coefficient

Variable	Statistic	Value	p-Value
rA	$Chi^2(1)$	20.282	[0.0001]**
Y^d	$Chi^2(1)$	0.54971	[0.4584]

Linear Beta Restrictions

	Statistic	Value	p-Value
rA=1	$Chi^2(1)$	0.199	[0.6558]
rA=1and Yd=0	$Chi^2(2)$	1.2016	[0.5484]

Hypotheses Tests for the Alpha Vector: Weak Exogeneity

Zero Alpha Coefficient

Variable	Statistic	Value	p-Value
S*	$Chi^2(1)$	21.072	[0.0000]**
rA	$Chi^2(1)$	1.0265	[0.3110]
Y^d	$Chi^2(1)$	0.45902	[0.4981]

Joint Zero Alpha Coefficients

	Statistic	Value	p-Value
rA=0and Yd=0	$Chi^2(2)$	2.051	[0.3587]

Joint Hypothesis Tests for the Alpha and Beta Vectors

	Statistic	Value	p-Value
Beta Restrictions: rA=1and Yd=0 Alpha Restrictions: rA=Yd=0	$Chi^2(4)$	4.054	[0.3987]

Final Restricted Coefficients

Variable	Beta Vector	Std Err	Alpha Vector	Std Err
S*	1.000	0.000	-0.010	0.002
rA	1.000	0.000	0.000	0.000
Y^d	0.000	0.000	0.000	0.000

Notes :

1. The VAR includes four lags on each of the variables (S*, rA, Yd), and a constant (unrestricted). The sample is: 1953 (2) to 2008 (4).
2. The final restricted coefficients are from a model imposing 4 restrictions: Weak exogeneity of asset income, weak exogeneity of disposable labor income, zero beta coefficient on disposable labor income, and a unity beta coefficient on asset income

Table A.4. Summary of Estimates, VECM System (3')

Dependent Variable		ΔY^d	ΔS^*	$\Delta \tilde{r}A$
F-Statistics with p-values				
ΔY^d	lags 1 to 5	2.77	1.29	0.41
		0.02	0.27	0.84
ΔS^*	lags 1 to 5	0.98	10.90	1.83
		0.43	0.00	0.11
$\Delta \tilde{r}A$	lags 1 to 5	1.29	7.35	27.70
		0.27	0.00	0.00
Error correction Term				
ΔA	lag 1			
Coefficient Estimate		0.00	-0.01	-0.22
T-statistic		-0.63	-5.35	-1.35
Std. Error of Estimate		0.01	9.44	673.35
Durbin-Watson Statistic		1.97	1.96	1.91

Note: a one-standard deviation shock to disposable income Y^d is 0.01 (about 1%)— about $30.6 billion. From IRFs, the first period response of ΔS^* to such a shock is $1.35 billion—about 4% (as reported in text).

Table 1. United States: Household Assets and Liabilities
Averages by Decade, except where noted
(In Trillions of Constant (2000) $U.S.)

	1950s	1960s	1970s	1980s	1990s	2000-07	end-2008
Total Assets	8.3	12.8	16.8	24.6	38.2	55.9	53.7
Tangible Assets	3	4.2	6.4	9.8	12.7	20.6	20.3
Total Real Estate	2.2	3.2	4.9	7.8	10	17.3	16.8
Equip./Software (Non-Profit Sector)	0	0	0	0.1	0.1	0.2	0.2
Consumer Durables	0.7	1	1.5	1.9	2.6	3.2	3.4
Financial Assets	5.4	8.6	10.3	14.8	25.5	35.2	33.3
Public Sector Financial Assets	0.5	0.5	0.5	1	1.8	1.5	1.8
Private Sector Financial Assets	4.9	8.1	9.8	13.8	23.7	33.7	31.6
Equity shares and Mutual Funds	1.3	2.7	1.9	2.3	7.4	10	7.2
Pension, Insurance, and Other	3.6	5.4	7.9	11.5	16.3	23.7	24.4
Total Liabilities	0.8	1.5	2.2	3.5	5.7	9.7	11.6
Home Mortgages	0.5	1	1.3	2.2	3.8	6.8	8.5
Consumer Credit	0.2	0.4	0.6	0.9	1.3	2	2.1
Other	0.1	0.2	0.3	0.4	0.6	0.9	1
Net Worth: Alternative Measures							
Total	7.6	11.2	14.6	21.1	32.4	46.2	42
Less Consumer Durables	6.8	10.2	13.1	19.2	29.8	43	38.7
Less Consumer Durables & Public Assets	6.4	9.7	12.6	18.2	28.1	41.5	36.9
Financial Net Worth: Mortgages Netted Out	5.1	8	9.5	13.6	23.5	32.4	30.2
Financial Excluding Public Sector	4.6	7.5	9	12.5	21.8	30.9	28.5
Memo: Deposits and Money Market Funds	0.9	1.7	2.5	3.7	3.8	5.2	6.3
Memo: Equity (Direct + Indirect)	1.3	2.9	2.3	3	9.9	14.6	9.9
Persibak Saving	0.1	0.2	0.3	0.4	0.3	0.1	0.2
Corporate Saving	0.1	0.1	0.1	0.2	0.2	0.3	0.2
Market Value of Non-Financial Corp. Eq	1.2	2.6	2.2	2.9	8.2	11.1	8
Net Worth, Non Financial Firms	3.4	4.3	6.7	8.7	9.4	15.2	16.3

Source: Federal Reserve Board, Flow of Funds, Bureau of Econ. Analysis.
Note: Household equity holdings do not equal "Market Value of Non-Financial Corp. Equities," since some equities are held by foreigners.

Table 2. United States: Household Assets and Liabilities
Averages by Decade, except where noted
(In percent of Total Personal Disposable Income)

	1950s	1960s	1970s	1980s	1990s	2000-07	end-2008
Total Assets	535.8	557.6	501.2	526.8	602.2	701.7	634.9
Tangible Assets	190.2	185.4	187.8	209.9	206.8	258.9	240.6
Total Real Estate	142	140.9	143.4	166.3	162.5	216.3	198.1
Equip/Softwar (Non-Profit Sector)	0.8	1	1.4	1.6	1.9	2.2	2.5
Consumer Durables	47.4	43.4	43.1	41.9	42.5	40.4	39.9
Financial Assets	345.6	372.3	313.3	316.9	395.3	442.8	394.3
Public Sector Financial Assets	30	23.4	15.2	20.5	28.8	19	20.8
Private Sector Financial Assets	315.6	348.8	298.2	296.4	366.6	423.7	373.5
Equity shares and Mutual Funds	82	115.6	64.8	49.1	106.5	125.9	84.6
Pension, Insurance, and Other	233.6	233.2	233.4	247.3	260	297.8	288.9
Total Liabilities	49.1	65.9	64.6	73.4	90.8	121	137.6
Home Mortgages	30.4	41.1	39	46.6	60.6	85.1	101
Consumer Credit	14.3	17.9	18	18.1	20.1	24.8	25.1
Other	4.4	6.9	7.5	8.7	10.2	11.1	11.5
Net Worth: Alternative Measures							
Total	486.7	491.7	436.6	453.5	511.3	580.6	497.3
Less Consumer Durables	439.4	448.3	393.5	411.5	468.8	540.2	457.4
Less Consumer Durables and Public Assets	409.4	424.9	378.3	391	440.1	521.2	436.6
Financial Net Worth (Mortgages Netted Out)	326.9	347.5	287.8	290.2	365.1	406.9	357.7
Financial Excluding Public Sector	296.9	324	272.6	269.6	336.3	387.8	336.9
Memo: Deposits and Money Market Funds	59.9	70.3	74.5	78.5	64.1	65.6	74.2
Memo: Equity (Direct + Indirect)	83.8	122.6	76	63.8	142.3	183	117.3
Personal Saving	7.9	8.1	9.2	8.8	5.1	1.5	1.9
Corporate Saving	4.7	5.8	4.2	3.4	3.5	3.8	2.7
Market Value of Non-Financial Corp. Equities	78.8	110.9	72.5	61.9	118.8	139.3	94.4
Net Worth, Non Financial Firms	220.5	189.6	194.2	194.8	153.8	191.1	192.9

Source/Notes: See Table 1.

Table 3. United States: Household Assets and Liabilities
Changes between Decades
(In percent of Personal Disposable Income)

	Differences					
	60s-50s	70s-60s	80s-70s	90s-80s	00s-90s	08q4-00s
Total Assets	21.8	-56.5	25.7	75.3	99.5	-66.8
Tangible Assets	-4.9	2.5	22.1	-3.1	52.1	-18.3
Total Real Estate	-1.1	2.5	23	-3.9	53.8	-18.1
Equip / Softwar (Non-Profit Sector)	0.2	0.4	0.3	0.2	0.3	0.3
Consumer Durables	-3.9	-0.4	-1.2	0.6	-2.1	-0.5
Financial Assets	26.6	-58.9	3.6	78.4	47.4	-48.5
Public Sector Financial Assets	-6.6	-8.3	5.4	8.2	-9.7	1.8
Private Sector Financial Assets	33.2	-50.6	-1.8	70.2	57.1	-50.3
Equity shares and Mutual Funds	33.6	-50.9	-15.7	57.5	19.4	-41.3
Pension, Insurance, and Other	-0.4	0.2	13.9	12.7	37.8	-8.9
Total Liabilities	16.8	-1.3	8.8	17.5	30.2	16.6
Home Mortgages	10.7	-2	7.6	14	24.5	15.9
Consumer Credit	3.6	0.1	0.1	2	4.7	0.3
Other	2.5	0.6	1.2	1.5	0.9	0.4
Net Worth: Alternative Measures	0	0	0	0	0	0
Total	5	-55.2	16.9	57.9	69.3	-83.4
Less Consumer Durables	8.9	-54.8	18.1	57.3	71.4	-82.8
Less Consumer Durables and Public Assets	15.5	-46.5	12.7	49.1	81.1	-84.6
Financial Net Worth (Mortgages Netted Out)	20.6	-59.7	2.4	74.9	41.8	-49.2
Financial Excluding Public Sector	27.2	-51.4	-3	66.7	51.5	-50.9
Memo: Deposits and Money Market Funds	10.4	4.2	4	-14.4	65.6	8.7
Memo: Equity (Direct + Indirect)	38.8	-46.6	-12.2	78.4	183	-65.7
Personal Saving	0.2	1.1	-0.5	-3.7	1.5	0.3
Corporate Saving	1.1	-1.6	-0.8	0.1	3.8	-1.2
Mkt. Value, Non-Fin. Corp. Equities	32.1	-38.4	-10.7	56.9	139.3	-44.9
Net Worth, Non Financial Firms	-30.9	4.6	0.6	-41	191.1	1.8

Source/Notes: See Table 1.

Table 4. Summary of Estimates, Equations (4a), (4b), (4c)

		(4a)	(4b)	(4c)
Dependent Variable		ΔY^d	ΔS^*	$\tilde{r}$
F-Statistics with p-values				
ΔY^d				
	lags 1 to 5	2.60	1.43	0.38
		0.02	0.21	0.89
ΔS^*				
	lags 1 to 5	1.21	7.93	1.46
		0.30	0.00	0.20
$\Delta \tilde{r} A$				
	lags 1 to 5	1.12	6.49	…
		0.35	0.00	…
$\tilde{r}$				
	lags 1 to 5	…	…	1.76
ΔA				
Error correction Term	lag 1			
Coefficient Estimate		…	-0.01	…
T-statistic		…	-4.22	…
Adj R2		0.06	0.26	0.02
Durbin-Watson		1.98	1.94	1.92

Table 5. Summary of Alternative Savings Scenarios
Shift Variable: Constant in Savings Function

Savings Adjustment Scenarios (values of $\hat{\kappa}$)				
	Real, Quarterly	Real, Annualized	Percent of GDP_{08}	Percent of $Y^d{}_{08}$
No shift	0	0	0	0
1990s	100	400	3.43	6.2
1980s	185	740	6.35	11.5
1950-70s	280	1120	9.61	17.5
Savings Change from Peak (2011:1) to trough (2007:Q4)				
	Real, Quarterly	Real, Annualized	Percent of GDP_{08}	Percent of $Y^d{}_{08}$
No Shift	66	263.4	2.26	4.1
1990s	161	642.6	5.51	10.0
1980s	241	964.8	8.28	15.0
1950-70s	331	1325.1	11.37	20.7

Table 6. Summary of Estimates, Equation (12)

Dependent Variable		ΔC
F-Statistics with p-values		
ΔC	lags 1 to 5	1.92
		0.08
ΔS^{*}	lags 1 to 5	2.99
		0.01
$\Delta \tilde{r} A$	lags 1 to 5	7.10
		0.00
Error correction Term ΔA	lag 1	
Coefficient Estimate		0.01
T-statistic		3.94
Adj R2		0.27
Durbin-Watson		1.96

Table 7. Summary of Estimates, Equation (13)

Dependent Variable		ΔFC
F-Statistics with p-values		
ΔFC	lags 1 to 5	8.64
		0.00
ΔY^{d}	lags 1 to 5	1.02
		0.41
ΔA	lags 1 to 5	1.82
		0.10
$\tilde{r}$	lags 1 to 5	5.51
		0.00
Adj R2		0.47
Durbin-Watson		2.01

Figure 1. Household Net Wealth and Personal Savings (in Percent of GDP)

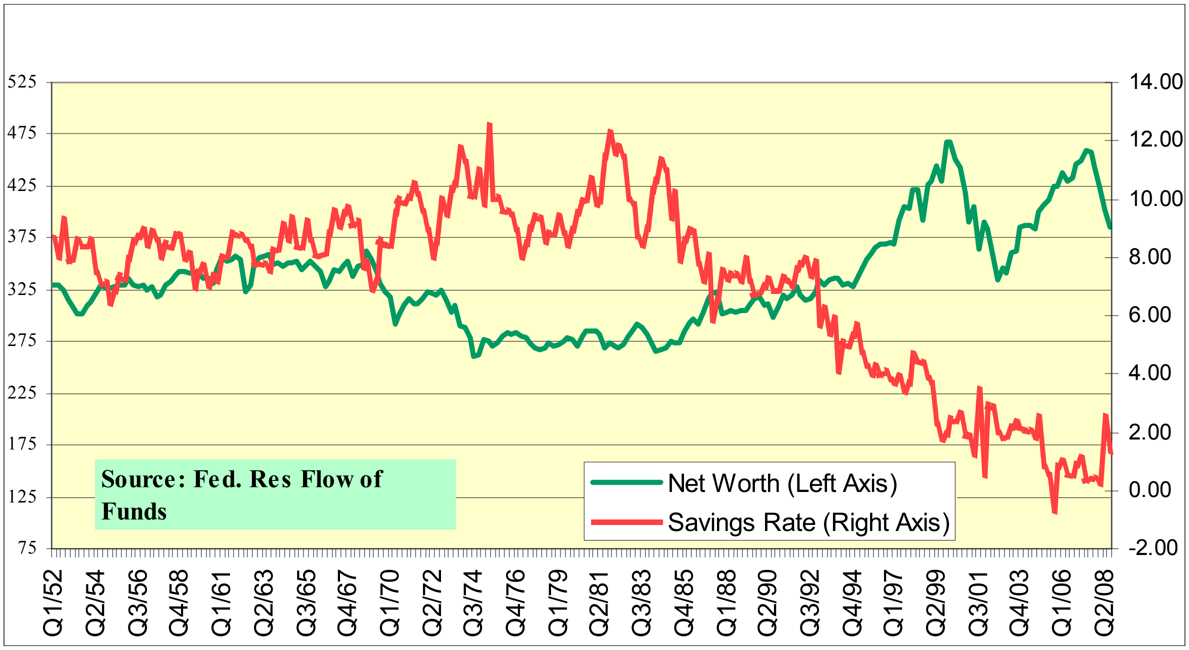


Figure 2. United States: Real Rates of Return on Assets
Percent per Annum, Yearly Moving Average

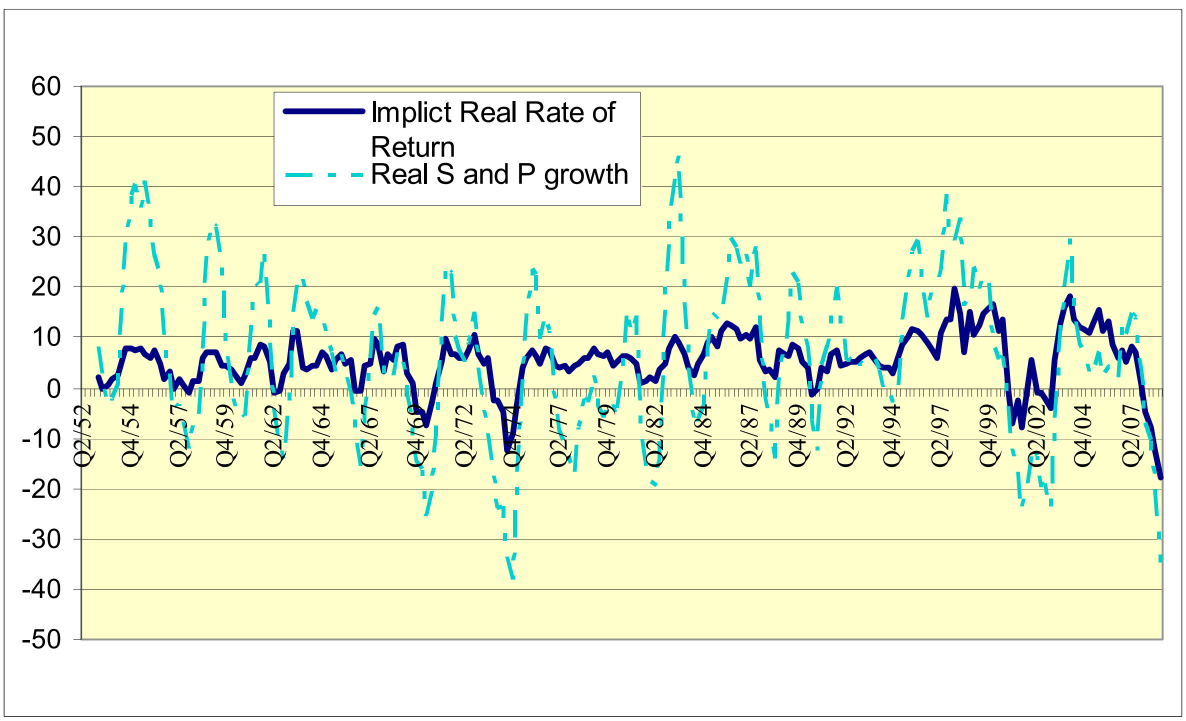


Figure 3. United States: Saving, Alternative Measures (In Percent of Disposable Household Income)

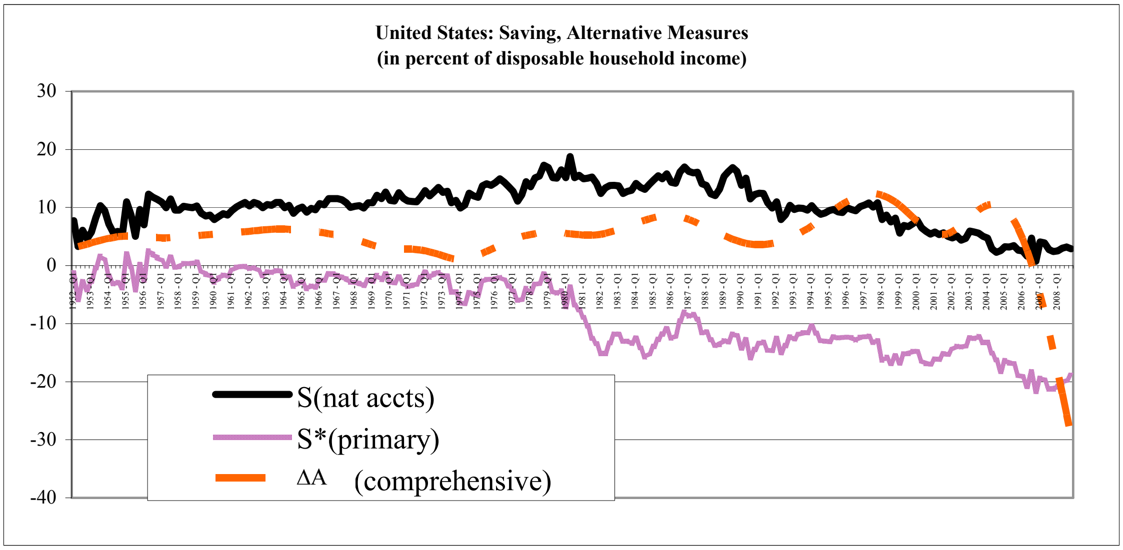
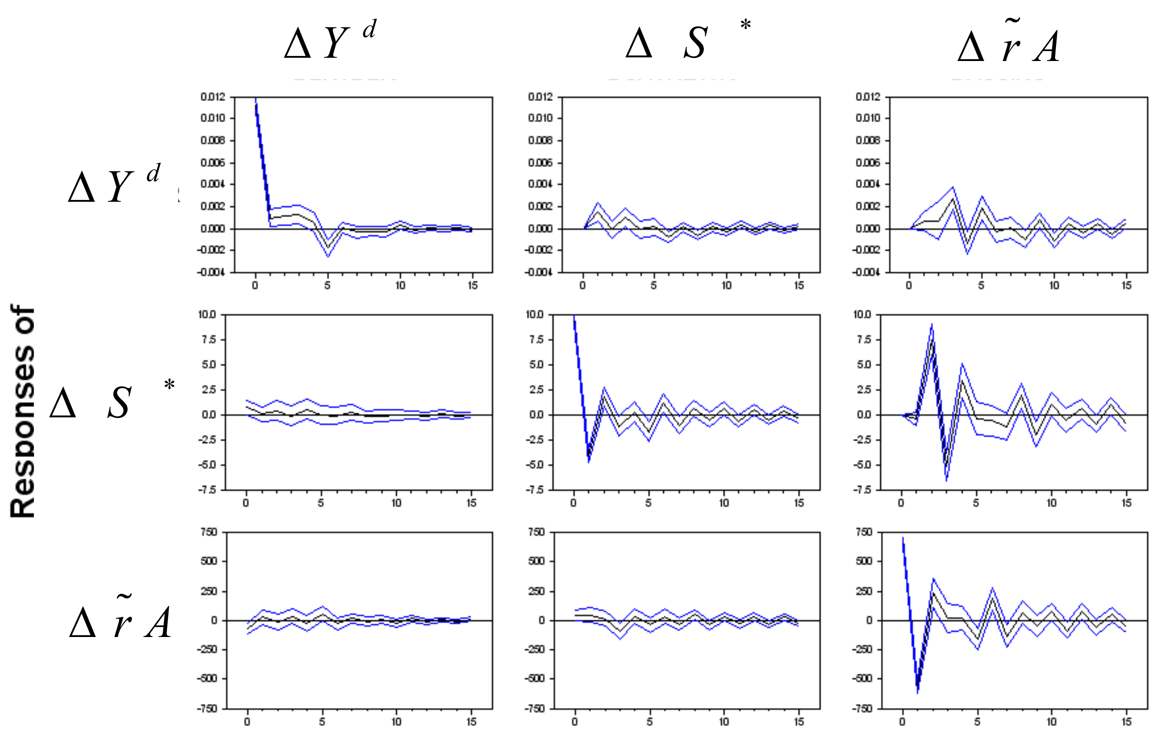


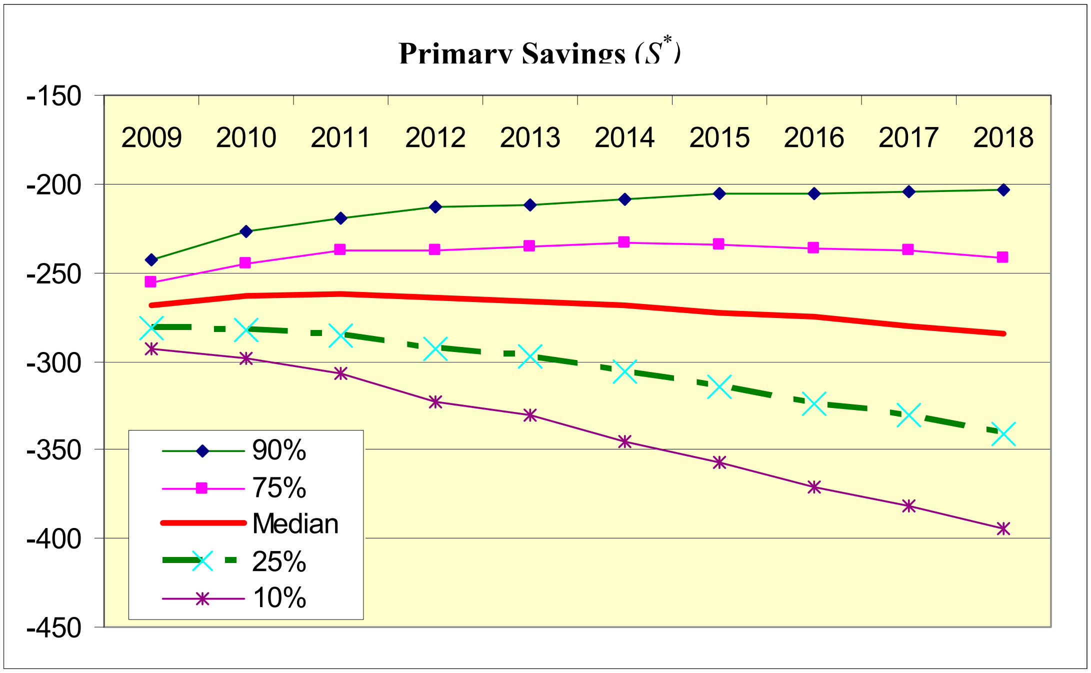
Figure 4. Impulse Response Functions, VECM System (3′)

Reponses to a 1-standard deviation impulse (shock).



Note: simulated standard errors calculated by RATS program (Monte Carlo simulation).

Figure 5. Stochastic Simulations
US $Billion (constant, base year = 2000)



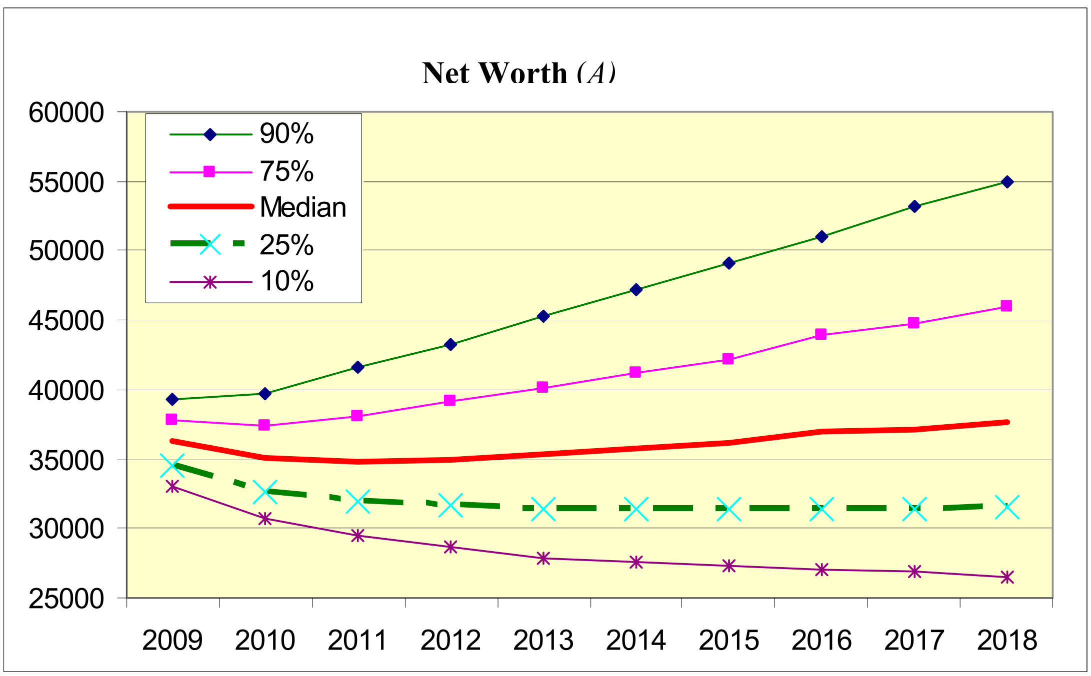
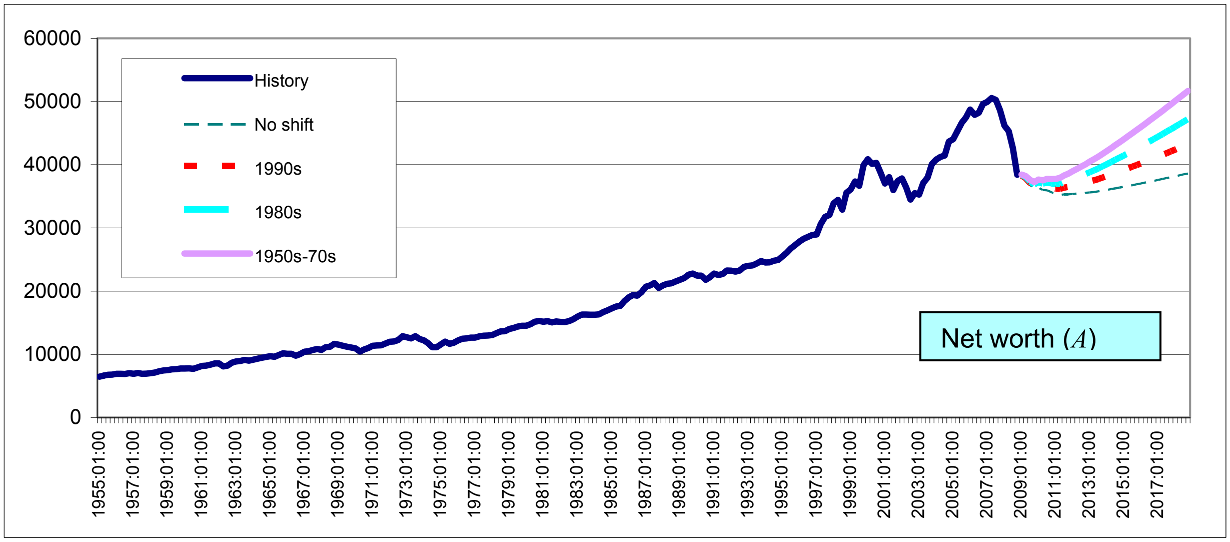


Figure 6. Net Worth (A, Upper Chart) and Primary Savings (S*, Lower Chart), Billions of 2000 US Dollars, Historical Data through 2008:4, Simulations thereafter.



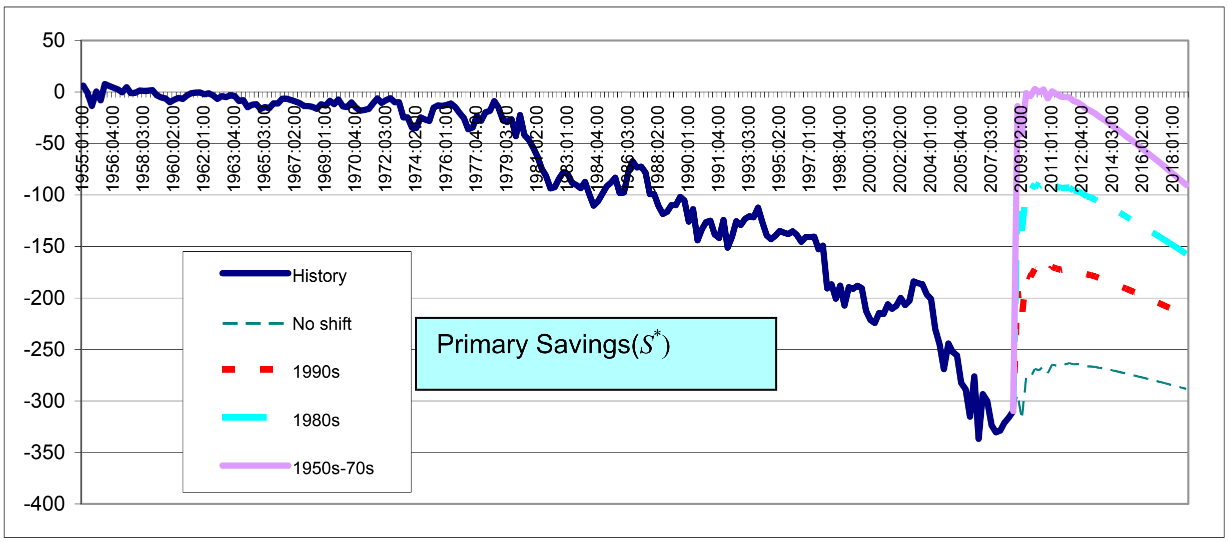


Figure 7. U.S. Savings: Corporate vs. Household Savings

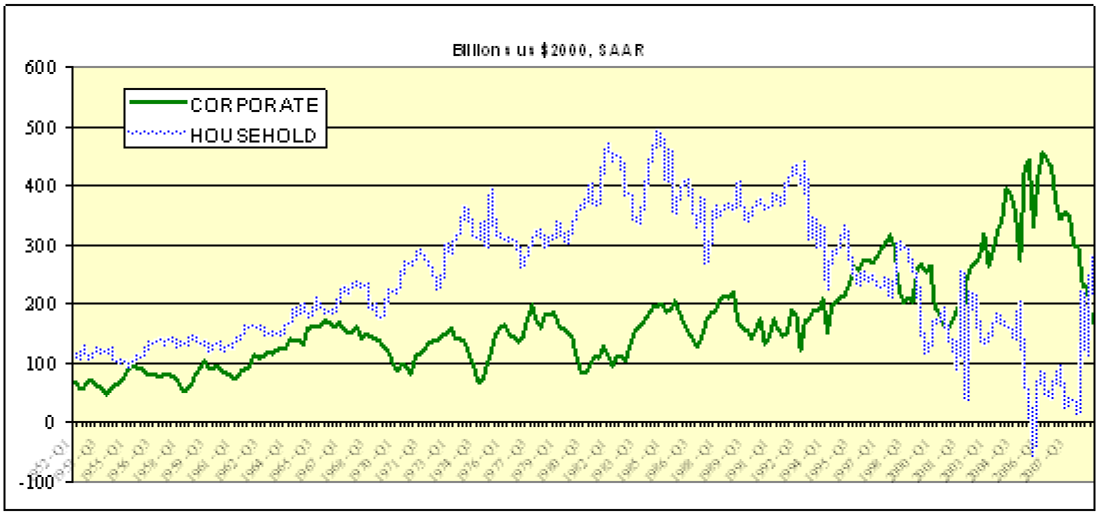


Figure 8. US: Capital Formation and Net Wealth

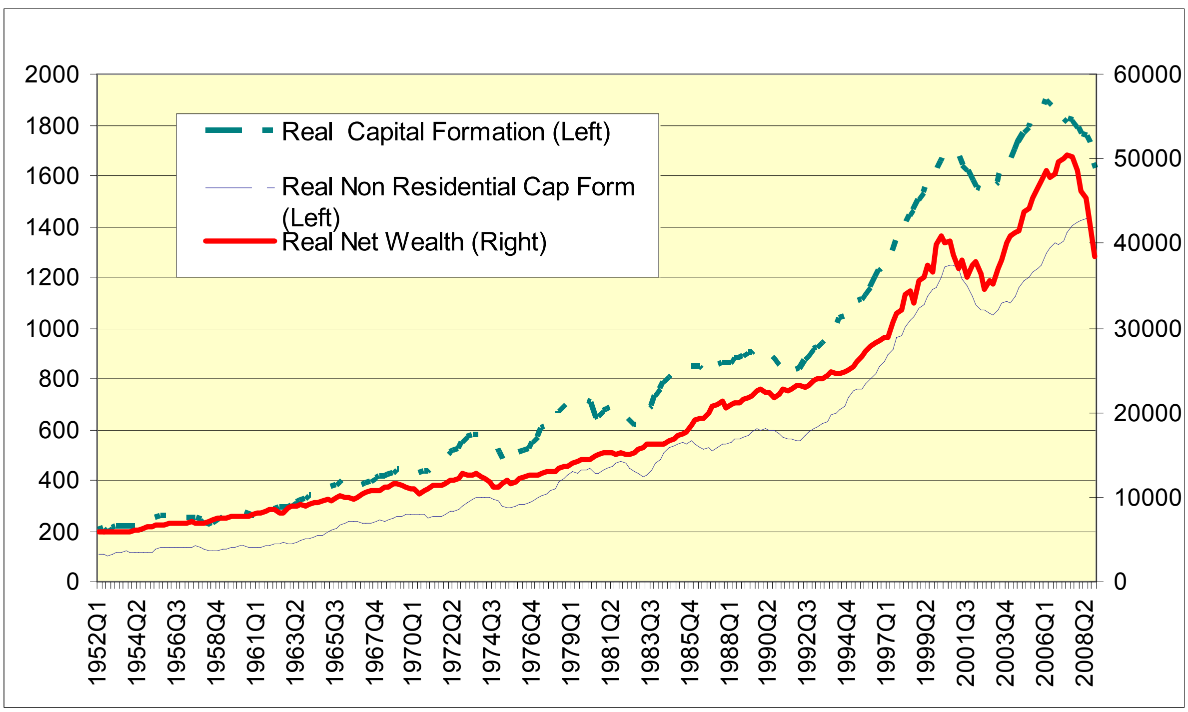


Figure 9. US Household Consumption
(Quarterly, Seasonally Adjusted, Billions of 2000 $US)

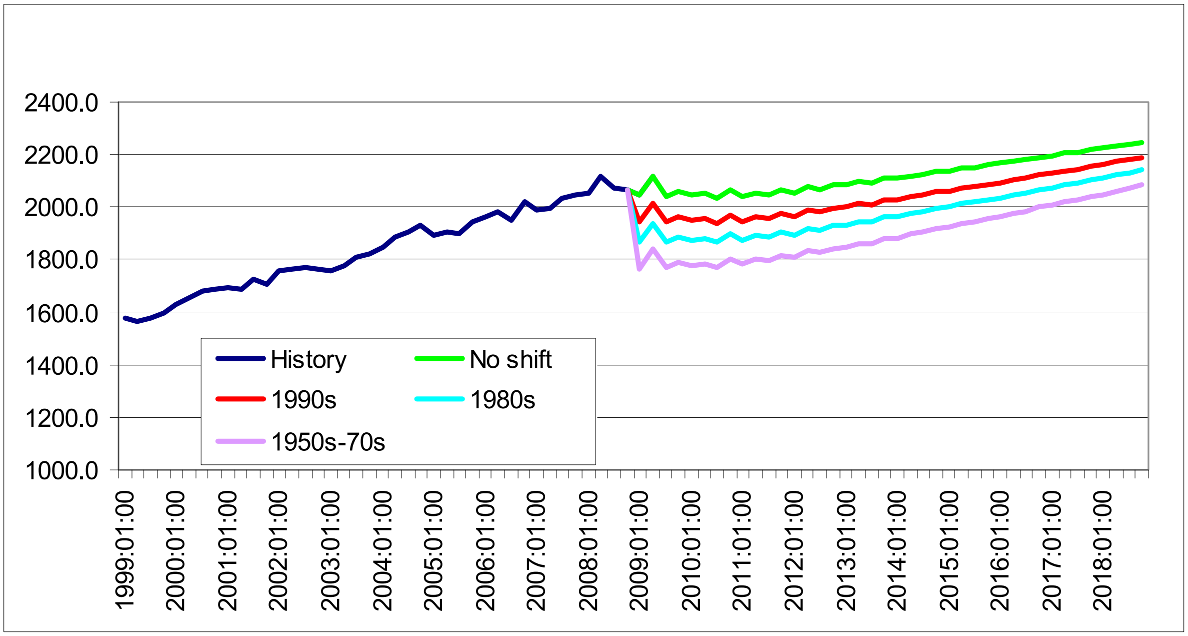


Figure 10. Fixed Capital Formation (*FC*)
Stochastic Simulations (US $Billions)

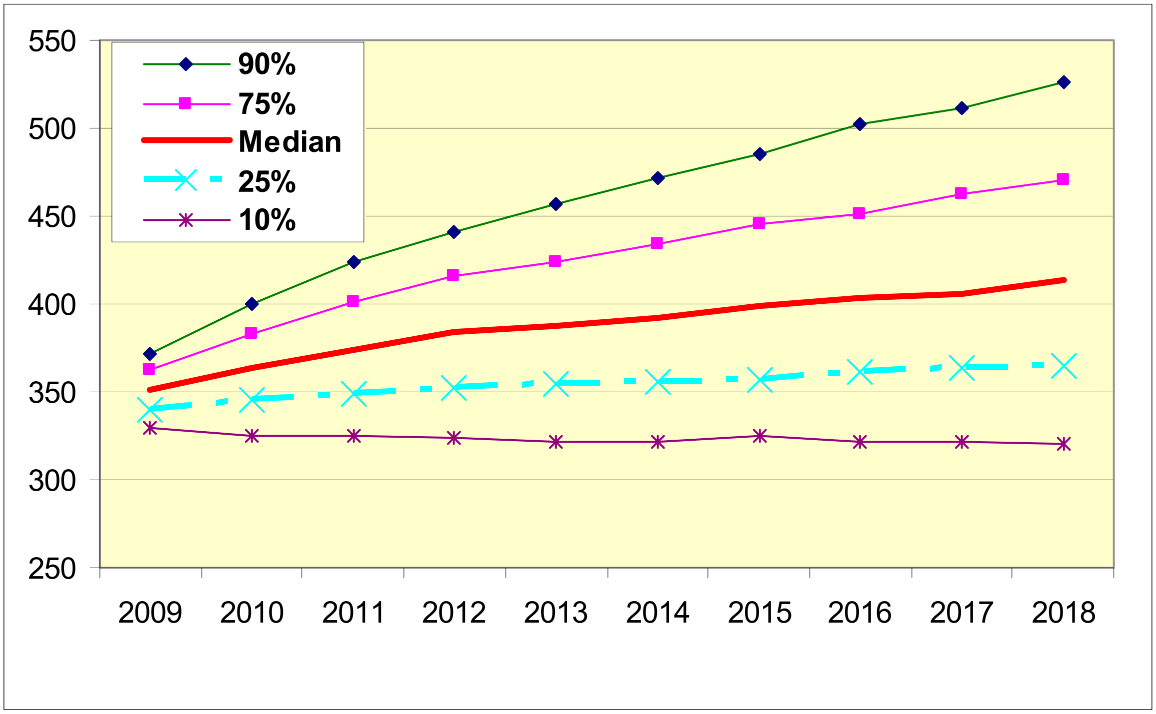


Figure 11. Total Fixed Investment (Billions of 2000 $US)