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ABSTRACT

According to the permanent income hypothesis, a low personal saving rate should predict rising future income (Campbell, 1987). However, the U.S. personal saving rate is initially poorly measured and has been repeatedly revised upward in benchmark revisions. We discuss the sources of these revisions and show they affect levels of the savings rate more than first differences. We use both conventional and real-time estimates of the personal saving rate in vector autoregressions to forecast real disposable income; using the level of the personal saving rate in real-time would have almost invariably made forecasts worse, but first differences of the personal saving rate are predictive. We also test the lay hypothesis that a low personal saving rate implies a low rate of real personal consumption growth in the future, and find no evidence of forecasting ability, either in conventional or real-time forecasts.

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I. Introduction

If consumption obeys the permanent income hypothesis, then as Campbell (1987) has shown, a low personal saving rate implies that real labor income is expected to accelerate. On the other hand, over the past four decades, when the personal savings rate has first been published it was almost always too low, and it has been revised upwards over the course of benchmark revisions. We show that in real-time, the level of the personal savings rate is uninformative for forecasting real disposable income growth—it is simply too noisy initially.[1] The first difference of the savings rate, however, has value in forecasting real income growth.

There is also a persistent lay hypothesis that a low personal saving rate signals an overextended consumer and future consumption decline, a hypothesis that has been put forward in U.S. monetary policy discussions.[2] We show that the level of the personal saving rate has no forecasting power for personal consumption expenditure, either in latest vintage data or in real time.

Economists have questioned how well personal saving is measured at least since Taubman (1968). Initially published estimates of the personal saving rate from 1965 Q3 to 1999 Q2 have been revised upward more than fifty percent, from 5.3 percent to 8.1 percent, as we document. Most of these revisions are due to the benchmark revisions that follow economic censuses, with large revisions decades after the initial estimate, in turn due to large upward

[1] We forecast real disposable income growth rather than real labor income growth because of data availability.

[2] For example, the minutes to the September 2004 U.S. Federal Open Market Committee meeting state, "Members perceived several possible sources of downside risk to household spending. In particular, households might hold back on spending in an attempt to increase their saving, which had fallen to a very low level relative to income."

revisions to both disposable personal income and personal outlays. Nominal disposable personal income from 1965 Q3 to 1999 Q2 has been revised up 8.3 percent from initial publication.[3] Benchmark revisions substantially change the relative ranking of saving rates for individual quarters and five-year averages. For example, the early 1980s is now viewed as the period with the highest saving rates in the postwar period; yet when first published it was reported to have had the lowest saving rates since the Korean War.

Revision does appear to bring us closer to the true state of affairs that economic agents confront. For tests of the permanent income hypothesis carried out by Campbell (1987) and Ireland (1995), revised data are preferable. But to test the practical value of an economic relationship for *forecasting* the n-step-ahead test based on real-time data should be preferred.

In related work, Mankiw and Shapiro (1986) argued that GNP revisions are rational forecasts of final data, but they used only a very short time series. Aruoba (2005), using more data, argues that revisions are not well-behaved, even when benchmark revisions are omitted. However, these tests are not related to forecasting: rationality of estimates is not crucial to forecast value.

In what follows, we briefly review our dataset and the process the U.S. Bureau of Economic Analysis (BEA) uses to revise national accounts data, and show that the major changes to the personal saving have occurred in benchmark revisions. We describe revisions to the 1979 personal saving rate and disposable income, as an example of the impact of the revisions. Finally, we use both conventional and real-time estimates of the personal saving rate to forecast real disposable income. We show that adding the level of the personal saving rate to univariate AR models in real-time almost invariably makes the real-time forecasts worse, but adding the first difference of the saving rate improves real-time forecasts. When we add cross-equation restrictions implied by the permanent income hypothesis, real-time forecasts are improved both in

[3] Boskin (2000) has pointed out the large upward revisions of nominal national income that have occurred over time.

levels and first difference VARs, but the constrained VARs in levels generally do not improve on the univariate forecasts.

The use of real-time data in this case provides us with information about the revision process that allows us both to avoid an empirical relationship that data limitations render invalid for forecasting purposes and to craft an alternative that rescues some of the valuable forecast information the personal saving rate contains.

II. Real-Time Data And Revisions To The Personal Saving Rate

The Federal Reserve Bank of Philadelphia maintains a real-time data set for macroeconomists that consists of vintage snapshots of data as they were reported in the middle of each quarter from 1965 Q3 to the present; it is documented in Croushore and Stark (2001) and on-line at http://www.phil.frb.org/econ/forecast/reaindex.html.

Definitions and measurement difficulties. The personal saving rate is personal saving as a percentage of disposable (after-tax) personal income. Personal saving, in turn, is disposable personal income less personal outlays. Disposable personal income includes wages and salary income and benefits, proprietors' and rental income, dividend and interest income, and transfer payments such as social security benefits, less contributions to social insurance and taxes. As such, it represents the income of households, nonprofits, and noncorporate businesses. Some of these items are easily measured, such as social insurance benefits and contributions, but other benefits and transfers are subject to measurement and conceptual problems. Wages and proprietors' income are subject to underreporting in government records as a result of tax evasion. And rental income and proprietors' income are net income measures that require quantification of depreciation and other expenses that are hard to define and measure well. Personal outlays are personal consumption expenditures (95 percent of personal outlays) plus transfers and nonmortgage interest payments.[4]

[4] Mortgage interest payments are netted out of rental income.

Capital gains on equity (other than from qualified equity stock options) and real estate are not included in personal income. A general rule of national income accounting is to ignore income from capital gains, whether realized or not. BEA has chosen to include realized capital gains from employee stock options in its measures of personal income. (These capital gains are subtracted from corporate profit, so there is no net impact upon gross domestic income), Maki and Palumbo (2001) argue that the decline in the saving rate in the 1990s can be largely attributed to a fall in the saving rate for the highest income quintile, whose wealth-to-income ratio rose at the same time, presumably as a result of capital gains.[5] Thus personal income may be understated to the extent that the value of equity holdings appears as (uncounted) capital gains rather than (counted) dividends and employee stock options, and to the extent that the rental return to property ownership omits the capital gains from rising house prices.[6]

The data revision process. The BEA revises the national income accounts as follows. Data on a given quarter's economic activity are first published in an *advance* estimate, late in the first month of the next quarter.[7] The data available at this time is recorded in the Philadelphia Fed's real-time data set as the vintage of that quarter. The *revised* estimate is published in the second month of a quarter followed a month later by a *final* estimate. These data are then generally left unchanged until the following summer, when the latest three years of national account data are revised.[8] A set of initial estimates thus undergoes three *summer* revisions. Thereafter, the estimates are only changed in what are called *benchmark* revisions, which now

[5] Real capital gains, measured by the increase in stock market value of domestic corporations, averaged 10.4 percent of real disposable income from 1984 to 2004, and only 1.9 percent from 1954 to 1984.
[6] Rental income, including implied income from owner-occupied housing, in 2004 was $166 billion. This is a 1.2 percent nominal return on net equity of housing (for households, nonprofits, and nonfarm, noncorporate businesses) of $13.7 trillion from the Federal Reserve's flow of funds data. Over the entire period from 1965 to 2004, according to latest vintage information, the average nominal return was 1.5 percent. By comparison, for the same period. the return to the 12-month constant-maturity U.S. Treasury bill averaged 6.6 percent.
[7] Until 1985, the BEA also published a "flash" GDP estimate 15 days before the end of a quarter, but this estimate only included aggregate nominal and real GDP, without any underlying detail (although some detail was circulated internally within the government), and did not include the personal saving rate.
[8] One change in the routine has been that wages and salaries, since 2002 Q3, are revised again 3 months after the final estimate.

occur every four years. Benchmark revisions provide the opportunity for BEA to make discretionary choices in defining the items it considers to be part of personal income; in addition more complete data from economic censuses is included at this time.

The personal saving rate from 1965 Q3 to 1999 Q2 was 5.3 percent if averaged over the rate first observed in the advance estimates (Figure 1); by the 2005Q3 vintage it averaged 8.1 percent. Thus the personal saving rate over time has been revised systematically upward.

The upward revisions occur in benchmark revisions. As Figure 2 shows, revisions that occur between the advance estimate and the last vintage before any benchmark revision have been relatively unbiased and small, with the mean rise 0.08 percentage point and a mean squared revision of 1.11 percentage points.[9] By contrast, the revisions from advance estimates to the latest vintage (the data published in 2005 Q3) have a mean of 2.44 percentage points and a mean squared revision of 9.52 percentage points (Figure 3). The benchmark revisions thus account for very nearly all of the bias and the bulk of the mean squared revision.

The revisions in the first three years after the data are first published are primarily from regular sources whose availability is delayed. Systematic biases related to these data can be estimated and eliminated, and BEA apparently has done so. Benchmark revisions, on the other hand, incorporate two basic types of changes: statistical changes, based on newly available data, and definitional changes. Statistical changes include data from censuses, such as the economic census or the population census, and other sources of data that become available with a long lag or irregularly, such as IRS random audit data. Definitional changes include changes in data recognition (such as reclassification of government pension contributions as personal income) and changes in concept (such as including software as investment or introducing chain-weighted prices).

[9] This figure and accompanying data omit the advance estimates that occur just before a benchmark revision, and thus had no opportunity to change. We also excluded the last advance estimate, for 2005 Q2, for the same reason from both this and the next figure.

These steady upward shifts have applied to all periods. The data begin in 1965 Q3, and they are averaged into five-year periods (Table 1). [10] Of the 26 changes that these groups underwent in benchmark revisions, 16 were positive and greater than 0.5 percentage point. Another view of the vintage data is presented in figures 4a – 4c, which show nine vintages in which the most recent saving rates are well below the average.

Why are saving rate revisions biased upward? Two factors drive revisions: income is harder to measure than expenditures and economic evolution creates new sources of income. Income is harder to measure than final expenditure, because it must be collected from more units. The vast bulk of gross domestic product measured from the expenditure side is final sales of domestic purchasers. Final sales data – purchases by consumers, businesses, and governments – do not require information about the entire production chain, only the final point of sale. By contrast, to obtain gross domestic income we need data from each industry on labor and capital income. Retailers, for example, account for nearly one-third of final product, but only about one-fifteenth of labor income. As income is costlier to collect, more of it escapes counting, particularly initially. Income-side data are aggregated to gross domestic income (GDI), conceptually the same as GDP, but in practice differing by between 2.3 percent and -1.8 percent; GDP minus GDI is called the statistical discrepancy. Generally speaking, the statistical discrepancy is positive – since 1965 Q3 it has averaged of 0.7 percent, with 131 of 160 observations positive – suggesting that typically income is undercounted. The fact that GDP and not GDI is used as the primary yardstick expresses BEA's judgment sense that it is the more precisely measured of the two aggregates.

Upward revisions to disposable personal income income have been very large. Disposable personal income has been revised as much as 14.8 percent; on average, from 1965 Q3 to 1999 Q2, the revision has been 8.4 percent (Figure 5). Over the same period, nominal GDP

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[10] Complete data back to 1947 is occasionally not available until two or three quarters after a benchmark revision.

and personal outlays were revised up by less, nominal GDP by 6.5 percent, and personal outlays by 5.1 percent.

As the economy evolves, new types of income and expenditures – such as stock equity options and Internet sales – arise. Comprehensive measures of economic activity, such as economic censuses and tax audits, and reassessments of income definitions, incorporated in the benchmark revisions, will tend to expand the universe to new industries and practices. To the extent that more income has been missed because it is harder to measure, saving will rise over the course of successive revisions.

Benchmark revisions may have an element of endogeneity – statisticians may respond to signals from the data itself. The statistical discrepancy itself is a signal of mismeasurement, and an increasing statistical discrepancy may trigger investigation of its source. The same may be true for subaggregates. If a part of income has been excluded, and it becomes more important, then the measured saving rate will appear out of kilter, and efforts will likely be made to find the source of the excluded income.

If benchmark revisions arise partly from new sources of income that are growing relative to consumption over time, we might expect these revisions to contain a unit root. To see the significance of this, define fully revised (true) data as s_t (saving), y_t (disposable income), and c_t (personal outlays). where $s_t = y_t - c_t$.. Assume for simplicity that all the revisions are revisions to y_t. Measured disposable income, $y_{mt} = y_t - u_t$, where the u_t are the future revisions to disposable income. Then measured saving, $s_{mt} = s_t - u_t$. If u_t contains a unit root, for example, if $u_t = \sum_{s=0}^{t} \varepsilon_s$ where ε_s is i.i.d. noise, then first differences of y_t and of s_t will be contaminated by ε_s but levels of either will be contaminated by u_t, or unit root disturbances.

An example: Benchmark revisions to the 1979 personal saving rate. To flesh out the benchmark revision process, we have examined in detail the 6 benchmark revisions to the 1979 personal saving rate. The 1979 date was chosen because it was early in our sample and yet we had adequate information for a full analysis; the only benchmark revision we miss is that for 1976. Over the course of these benchmark revisions, the 1979 personal saving rate was revised from 4.5 percent to 8.9 percent, an $86 billion increase. Here we discuss the two largest revisions that raised the 1979 personal saving rate (a more detailed narrative of the benchmark revisions is provided in Appendix A).

In the 1985 revision, the BEA incorporated the findings of a series of random audits by the IRS (the Taxpayer Compliance Measurement Program) to attempt a full-scale assessment of undermeasurement resulting from the underground economy. This is an example of a statistical revision. Wages and salaries and proprietors' income were increased by $16 billion and $60 billion respectively. Because some of the proprietors whose income was previously uncounted were retailers and service providers, this newly counted income implied additional previously uncounted consumption expenditures, so personal consumption expenditures rose by $30 billion from this source. The net effect of these changes was a $46 billion increase in personal saving. Other changes in this benchmark revision reduced the total change in personal saving to $32 billion, as shown in appendix table 1.

In 1999, the BEA made a definitional change, reclassifying government employee retirement contributions as personal income. Retirement funds can be treated as income when they are received by the beneficiaries or when they are accrued. Private retirement funds are treated as income when they are accrued, while social security is treated as income when it is received. When the accounts were first set up, government retirement funds were dominated by the federal government, which did not need to set aside funds for retirement programs. As time passed, state and local employment came to dominate government employment, and it then became appropriate to treat government retirement programs in parallel with private pension programs. As previously uncounted contributions were larger than the previously counted benefits, the net result was to raise saving by $30 billion. In this case, the rise of state and local employment led to a reclassification of government expenditure.

The appendix also documents two definitional revisions that raised disposable personal income and personal outlays without affecting saving. One was the 1985 classification of payments to medical vendors as government transfers to households and personal consumption expenditures rather than, as previously, government expenditures. The other was the 1990 reclassification of payments to government educational and medical institutions as personal consumption expenditures rather than as nontax payments to government (which are treated like a tax and deducted from disposable income). The effect of these two changes was to raise both disposable personal income and personal outlays for 1979 by $49 billion.

III. **Do Early Intertemporal Differences In The Saving Rate Diminish Over Time?**

Thus far, we have focused on rising levels of the saving rate. Another question is whether the benchmark revisions have tended to wash away differences between advance estimates of the saving rate. Consider a regression whose left-hand side variable is a given vintage (V) personal saving rate (PSR_V) and whose right-hand side variables are the original advance estimates of the personal saving rate ($PSR_{advance}$) and a constant:

$$PSR_V = \alpha + \beta \, PSR_{advance}. \qquad (1)$$

If the revision process raised all the PSRs by the same percentage points, then the coefficient on the advance PSR, β, would be 1, and the revisions would show up as an increase in the constant term, α. On the other hand, if the revision process implies that initial differences tend to diminish, as they did for 1975 and 1980, we would expect β to be less than 1, and for α to be larger than the average increase in the PSR. Unadjsuted R squared tells us how much of the initial variance is due to true underlying difference as known at a given later vintage.

Mankiw, Runkle, and Shapiro (1984) have argued that equation 1 should have $\alpha = 0$ and $\beta = 1$ if the preliminary estimate of an economic measure is an optimal forecast of the final estimate of that measure. Note, however, that the usefulness of the preliminary estimate as a forecasting instrument depends on its correlation with the series to be forecasted, and does not depend on its optimality as a forecast of the final estimate. In particular, a nonzero α would have little importance in the saving rate as a forecasting variable.

The results of estimating equation 1 for overlapping 20-year periods are shown in Table 2A (we choose 20 years because we can get two complete non-overlapping groups into our 40-year sample), taking five-year intervals for our analysis. The most telling results are the first row. For the period from 1965 Q3 to 1985 Q2, estimated β is for all periods significantly different from 1, using Newey-West HAC robust standard errors. Unadjusted R squared declines with successive vintages. In the R-squared results for the 2005Q3 vintage, the advance estimates account for at most 43 percent of the variance and as little as 12 percent. Throughout, the personal saving rate fails the Mankiw et al test.

How are the first differences of the personal savings rate influenced by the revisions process? Table 2B shows the result of substituting first differences of the personal savings rate in place of the level in the regressions. The most striking point is that the coefficient on the first difference of the advance estimate does not fall over successive benchmarks to an appreciable extent.[11] The early vintage variations in the first differences of the personal saving rate capture a large part of the variations in later vintages.

The β coefficients in our regression equation fall over time as more revisions occur. Is this time effect of revisions statistically significant? Consider a regression that has the latest vintage saving rates on the left-hand side but allows the constant and the coefficient on the advance estimate to change as the amount of time available to revise the data increases. We call this revision time "Rtime" = number of quarters between the advance estimate of that observation and the latest vintage.

We run the regression $PSR_{2005Q3V} = a_0 + a_1 \text{ Rtime} + (b_0 + b_1 \text{ Rtime}) PSR_{advance}$.

[11] The first difference of the advanced estimate is taken within each vintage. That is, for the first differenced 1984q1 advance estimate, the 1983q4 saving rate is subtracted from the 1984q1 saving rate, both taken from the 1984q2 vintage.

$$
\begin{array}{lccccc}
PSR_{2005Q3V} = & .330 & +.0723 Rtime & + (.8875 & - .00687 Rtime) & PSR_{AE} \\
 & (.478) & (.0134) & (.1952) & (.00182) & \\
 & \textit{.4906} & \textit{.0000} & \textit{.0000} & \textit{.0002} &
\end{array}
$$

The standard errors, in parentheses under the coefficients, are Newey-West robust standard errors, and beneath these are p-statistics. The equation shows that the coefficient on the advance estimate falls by .027 annually (four times the coefficient .00687), suggesting that over the roughly 20 years that the median observation has been revised, more than half of its initial cross-sectional variation has proved to be measurement error.

When we run the same regression for the first differenced personal saving rate, the revision time variables have almost no impact; neither is statistically significant at the ten percent level.

$$
\begin{array}{lccccc}
DPSR_{2005Q3V} = & -.079 & +.0010 Rtime & + (.764 & - .00008 Rtime) & DPSR_{AE} \\
 & (.071) & (.0007) & (.1310) & (.00123) & \\
 & \textit{.2662} & \textit{.1833} & \textit{.0000} & \textit{.9511} &
\end{array}
$$

Our conclusion from this regression analysis is that in the past, large differences between levels of the personal saving rates have proved to be mostly the consequence of measurement error. It is possible that a large part of the current difference between the high saving rates in the early 1980s and the current low saving rate will also prove to be the result of measurement error. What is clear is that these data are measured with considerable noise, and there is little reason to believe that our measures have become more stable than in the past. However, the same is not true of first differences of the personal saving rate which tend be affected much less by benchmark revisions.

IV. Using The Personal Saving Rate to Forecast In Real Time

We now address the question of whether the personal saving rate is too noisy in practice to be useful in forecasting in real time. If saving rates are low, should we expect that future income will rise relative to consumption as saving rates mean-revert? Or, as the lay hypothesis suggests, will consumption fall?

The lay hypothesis of the overextended consumer. First let us address the lay hypothesis that a low personal saving rate implies a future decline in the growth rate of real personal consumption expenditure. A persistent lay belief is that a low personal saving rate is indicative of households being overextended, and portends lower real personal consumption expenditures in the future. Although the pure permanent income hypothesis implies that real consumption growth is unforecastable, that does not preclude the personal saving rate having forecast ability for personal consumption expenditures, if, for example, a low personal saving rate implies less consumer durable purchases in future periods, due to credit constraints.

We compare the root-mean-square error (RMSE) of a univariate autoregressive forecast, in which lags of past changes in real personal consumption growth are used to forecast future real personal consumption growth, to the RMSE of a bivariate vector autogression (VAR), which adds lags of the level of the personal saving rate. Our estimations use an expanding window of observations, adding an additional observation as we roll through each quarter of our sample. To compute forecast errors, we use three methods. First, we use latest vintage data (the data available in 2005 Q3) to estimate and forecast the models and to construct the forecast errors. We call these forecasts LV. This addresses the theoretical relationship as revealed in revised data. We then use real-time data to estimate and forecast, computing forecast errors in two ways. We first compute forecast errors based on real-time realizations, to see whether the data help predict income growth as reported at the time (RT). This test shows the ability of forecasts to track data as revealed in the short-run, as in the forecast contests that business economists are often judged by. We also compute forecast errors based on latest available vintage data (RTLV). Since the latest vintage data has a tighter relationship to economic fundamentals (such as sales, unemployment, inflation, or interest rates), a decisionmaker might prefer this latter test. To specify lag length, we use, alternatively, the Akaike Information Criterion (AIC), the Schwarz Information Criterion (SIC), and a fixed number of lags, set to six. In the case of the AIC and SIC, lag length is re-estimated each quarter. We consider four forecast horizons: One-step-ahead quarter-over-quarter growth, two-step-ahead two-quarter average growth, four-step-ahead four-quarter average growth, and eight-step-head eight-quarter average growth. We analyze forecast performance over the period 1971Q1 to 2005Q2. For reasons that we discuss below, we also examine the subperiods 1971Q1 to 1981Q4 and 1982Q1 to 2005Q2.

In table 3, we see that the level of the personal saving rate has no forecasting ability over the entire sample period (1971Q1 to 2005Q2), either with the latest vintage data or in real time. Nor does it have forecasting ability over either subperiod. A low saving rate does not predict future declines in consumption at any forecast horizon.

Permanent income hypothesis forecasts. John Campbell (1987) has argued that low saving should be a signal of expected future growth in labor income. In a bivariate vector autoregression of saving and real labor income growth, lags of saving should have a negative sum, according to this theory, so that increases in saving forecast declines in real labor income. Campbell's regressions, covering 1953 to 1985, confirmed that high saving did forecast slower real labor income growth.

Campbell also showed that the permanent income hypothesis implied a tight set of cross-equation restrictions between the coefficients of the bivariate VAR. The intuition behind these cross-equation restriction is that a future predictable permanent increase in real labor income should generate a current permanent increase in consumption and therefore a temporary decrease in saving. When the permanent increase in real labor income arrives, the saving rate rises at the same time. Formally, the system is

$$\begin{bmatrix} \Delta y_{lt} \\ s_t \end{bmatrix} = \begin{bmatrix} a(L) & b(L) \\ c(L) & d(L) \end{bmatrix} \begin{bmatrix} \Delta y_{lt-1} \\ s_{t-1} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix} \tag{2}$$

where y_{lt} is labor income at time t, s is saving, the polynominal lag operators are of order p, and the u are forecast error terms. The restrictions on the coefficients of the lag operators are $a_1=c_1$, ..., $a_p=c_p$, $d_1=b_1+1+r$, and $b_2=d_2$, ... , $b_p=d_p$, where r represents a constant real interest rate.

These tight restrictions of the model are strongly rejected when more than one lag is included in the bivariate VAR.

Campbell's empirical work was revisited by Peter Ireland (1995). The coefficients on saving had a negative sign as Campbell's hypothesis predicts. Once again, the cross-equation restrictions were strongly rejected. But Ireland pointed out that, as noted by King (1995), formal hypothesis seldom fail to reject the implications of detailed mathematical models. A better test, Ireland argued, might be out-of-sample forecast performance. Using latest vintage data, Ireland tested the constrained VAR and unconstrained VAR's rolling out-of-sample forecasts of one, two, four and eight quarters ahead against the univariate forecast for real labor income. At forecast horizons of one, two and four quarters ahead, the unconstrained VAR improved on the univariate model of real labor income. In addition, the constrained VAR improved on the univariate model at all forecast horizons, and improved on the unconstrained VAR at all horizons except the one quarter ahead, where they tie. Ireland took this to be evidence in favor of the PIH hypothesis.

In light of the behavior of the revisions of the personal saving rate, we wish to revisit these findings to see whether in real-time forecasts would have been improved. To do this, we estimate our model and make our out-of-sample forecasts using real-time data. We compute forecast errors based on real-time data (RT) and on latest available vintage data (LV).

Our data is not the same as Ireland's: we have real-time data on real disposable income but not on real labor income, and we use the personal saving *rate*.[12] Labor income, a constructed variable that excludes dividend income, interest income, and the capital share of proprietor's income, is not a variable published as such by BEA. To check to see whether these substitutions create a large difference, we replicate Ireland's unconstrained analysis using the same sample period, vintage, and lag length, substituting disposable personal income for labor income and the personal saving rate for personal saving, in Table 4. This is to show that the essential features of

[12] All data used in this study are available on the Philadelphia Fed's web page. We deflate real-time observations on nominal disposable income with real-time observations on the personal consumption expenditure deflator.

the estimation are not disturbed by the inclusion of some of the capital income measures that Campbell and Ireland have excluded and by our use of the saving rate. As Ireland did, we use 6 lags and test the forecasts for one-step-ahead quarter-over-quarter growth, two-step-ahead two-quarter average growth, four-step-ahead four-quarter average growth, and eight-step-ahead eight-quarter average growth. If we focus on the latest vintage of data (LV) that Ireland used at the time (1994 Q4), we find that at forecast horizons of one, two and four quarters that forecast accuracy increases when we forecast real disposable income in the VAR but not as much as Ireland's forecasts of real labor income.[13] At an 8 quarter forecast horizon, we do not show forecast improvement, similar to Ireland. We take this as evidence that disposable personal income is a reasonable albeit noisier stand-in for labor income. In a preview of our results to follow, we find that when we use real-time data (RT and RTLV), personal saving does not help to forecast income growth.

Forecasts with levels and first-differences. We now proceed to our main forecast comparisons for disposable income in tables 5 and 6. The data used for the estimations go back to 1959 Q1 and our first forecast begins with 1971 Q1. The test used is the ratio of the root-mean-square error (RMSE) of the out-of-sample bivariate VAR forecast to the RMSE of the out-of-sample univariate AR forecast. This is performed forecasting one, two, four, and 8 quarters ahead, with tests taken separately at each horizon. We use 6 lags and lag lengths chosen using the Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC). In table 5, we show the regression results using the level of the saving rate while in table 6, we use first differences.

VARs in levels. The first three rows of table 5 show that in our full sample, 44 quarters longer than Ireland, the VAR including the level of the personal saving rate outperforms the univariate equation using latest vintage data in four cases out of 12. Using the AIC, the level of the saving rate adds information to the forecast one step ahead, two steps ahead and four steps

[13] Ireland gave ratios of MSE, so we have taken square roots. These data refer to unconstrained forecasts.

ahead. In real time, by contrast, there is essentially no advantage to using the level of the personal saving rate. The only forecast improvement is using the AIC in one-step ahead forecasts, and the forecast improvement is only 0.4 percent.

Two factors undermining forecast accuracy are the downward trend in the saving rate after 1981 and that the advance estimates of the saving rate are only weakly correlated with the final saving rates. We can eliminate both factors by focusing on latest vintage data before 1982, when the saving rate begins its long-term decline.

We find that there is value to using the level of the saving rate in the first part of the sample, 1971 to 1981, using latest vintage data, with ten out of 12 forecasts showing improvement. Forecast improvements using the AIC are quite large for the one-, two-, and four-step-ahead forecasts. Notably, at longer horizons, the forecast improvement disappears when we use real-time data. However, in the case of one-step ahead forecasts, using the AIC or the SIC, there is forecast improvement even with real time data.

The model using the level of the saving rate outperforms the model using the first-difference (Table 6) in 10 out of 12 cases, and in all 8 cases when AIC or SIC is used to choose lag lengths. When the data are sufficiently revised and stationary, the level of the saving rate is more informative than the first difference. In sharp contrast, in real time, the first difference regression is almost always superior.

And from 1982 forward, while the latest vintage of data suggests value to including the saving rate for one-step ahead forecasts (for 6 lags and AIC chosen lags), this completely disappears using real-time data.

First difference results. The first three rows of table 6 shows that in our full sample, using the AIC or the SIC, the first difference of the personal saving rate is useful in forecasting real disposable income, at all lag lengths, whether we use latest vintage data or real time data. Only in 1 case out of the 24 permutations is there a forecast worsening. Using 6 lags, there is improvement only in latest vintage data. Results for AIC and SIC are somewhat spottier when we divide the sample, with results actually improving most in the more recent sample.

Note further that parsimony is valuable: in table 6, the AIC and SIC chosen lag lengths almost invariably show improvement, while the 6 lag VARs show improvement only 8 times out of 36. Given that parsimony matters, the first difference regressions perform far better than level regressions. In the full sample, there is only one case out of 36 in which the levels regression outperforms the first difference regression.

Let us turn now to whether the data match the theory qualitatively in sample. Real-time data has negative sum-of-coefficients for the saving rate for most of the history, providing some evidence that the permanent income hypothesis is correct (Figure 6). However, the sum has become progressively less negative, and has actually been near zero since the late 1990s. This suggests either that the empirical validity of this aspect of the permanent income hypothesis has weakened over this period, or that the data on saving have become sufficiently noisy that the hypothesis cannot be verified.

Forecasts with PIH restrictions. Do the PIH restrictions improve forecasts of real disposable personal income? Following Ireland, we investigate whether the PIH restrictions improve forecasts compared to either the AR or the unrestricted VAR. In table 7, we see that for latest vintage data, in the pre-1982 period, the restricted VAR reduces forecast error at all forecast horizons, for all lag lengths. Reductions are also substantial, ranging from 6 to 16 percent, compared with the previous results shown for the unrestricted VAR in table 5.[14]

In addition, the PIH restricted VAR improves in the pre-1982 sample using real time data at all lag lengths for 1 step ahead forecasts, as well as in a few other cases. It is noteworthy, however, that in the post-1981 sample period, that with PIH restrictions, the VAR nowhere

[14] Following Ireland, we set r, the constant real rate of interest, to 0.01 when we impose the PIH restrictions. This implies an annualized rate of 4 percent.

improves forecasts compared to the univariate autoregressive model for real disposable personal income.

In table 8, we compare the PIH restricted VAR forecast performance with the unrestricted VAR. In general, we see that for all time periods, the PIH restrictions improve forecasts, as Ireland found, particularly for the AIC and SIC selected lag lengths. Interestingly, the worst performance is with latest vintage data. Even there, under the SIC selected lag lengths there is modest forecast improvement.

PIH restrictions in first-differences. Finally, to complete our analysis, we impose an approximation to the Campbell PIH restrictions on the first difference VARs. Since $E\Delta y_t = E\Delta c_t + E\Delta s_t$, if $E\Delta c_t = 0$, then $E\Delta y_t = E\Delta s_t$,. This turn roughly implies that in the system

Model 1: $\begin{pmatrix} \Delta y_t \\ \Delta s_t \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} + \begin{pmatrix} \tilde{a}(L) & \tilde{b}(L) \\ \tilde{c}(L) & \tilde{d}(L) \end{pmatrix} \begin{pmatrix} \Delta y_{t-1} \\ \Delta s_{t-1} \end{pmatrix} + \begin{pmatrix} u_{yt} \\ u_{st} \end{pmatrix}$

the coefficients across the two equations should be the same, that is,

$$\begin{aligned} \tilde{a}_i &= \tilde{c}_i, \quad i \geq 1 \\ \tilde{d}_i &= \tilde{b}_i, \quad i \geq 1 \end{aligned}.$$ [15]

Imposing this restriction, as we do in Table 9, we see that forecasts improve over the univariate specification in all but six out of 108 cases. In no cases does the restricted VAR root-mean-square error exceed that of the AR by more than one-half of a percent. This appears to be a very useful methodology for forecasting real disposable personal income, despite the probability that the savings rate in real time is very noisy.

Conclusion

[15] This is an approximation; in the Campbell system of equations, the restriction on the system in levels (2) is $d_1 = b_1 + 1 + r$. If this were $d_1 = b_1 + 1$, then this restriction would be exact. As it is, in the first difference specification we actually have $\Delta s_t = \Delta y_t + r s_{t-1}$, which we approximate as $\Delta s_t = \Delta y_t$.

We have argued that measures of personal saving are subject to substantial measurement error. In the past, large variations in personal saving across time have typically been revised away. The contention that the low personal saving rate implies that in the future consumption must rise more slowly than income may be wrong: benchmark revisions might well result in the current low rate being revised upward substantially. Taken together, our results show that one should be careful about drawing inferences based upon the latest observations of the level of the U.S. personal saving rate, but changes in the personal saving rate may provide useful information on future disposable personal income.

Appendix:

Revision narrative for 1979 disposable personal income and personal saving:

1979 disposable personal income was reported as $1624.3 billion (1980 Q4 vintage) before the first benchmark revision; most recently it was $1793.5 billion (2005 Q1). Benchmark revisions to disposable personal income increased it by $169.2 billion.

1979 personal saving was reported as $73.8 billion in the 1980 Q4 vintage; most recently as $159.2 billion in the 2005 Q3 vintage. Benchmark revisions to saving were $85.3 billion. The 1979 personal saving rate rose from 4.5 in the 1980 Q4 vintage to 8.9 percent in the 2005 Q3 vintage.

In the 1980 revision, 1979 disposable income was increased by $17 billion, outlays by $5, and saving by $12. The increase in disposable income was primarily due to increases in interest income ($16 billion), based on new statistical information from the IRS and the economic censuses, partially offset by an increase in interest payments ($4 billion) that raised outlays.

In the 1985 revision, 1979 disposable income was increased by $88 billion, outlays by $56 billion and saving by $32 billion. Three main factors affected the revision. First, the BEA incorporated the findings of a series of random audits by the IRS (the Taxpayer Compliance Measurement Program) to attempt a full-scale assessment of undermeasurement resulting from the underground economy. Wages and salaries and proprietors' income were increased by $16 billion and $60 billion respectively, and consumption expenditures by $30 billion. Second, expanded measures of costs incurred in providing rental housing and new measures of the rents themselves reduced rental income by $25 billion. Third, $24 billion in medicare payments which had been considered government expenditures were reclassified as transfer payments and as consumption expenditures. This reclassification was due to recognition that these expenditures were increasingly controlled by the medicare patients, in that the medicare patients were determining from whom they received the services. This reclassification raised disposable income and outlays without affecting saving.

In the 1991 revision, 1979 disposable income was increased by $24 billion, outlays by $18 billion, and saving by $5 billion. The largest change was due to a change in the treatment of payments to government educational and medical institutions, such as tuition payments at state universities. These had been treated as nontax payments (part of tax and nontax payments) to government, with the outlays of the institutions treated as government expenditures. They were redefined as consumption expenditures sold by government enterprises. This raised disposable income (since taxes fell) and personal consumption expenditures.

In the 1995-7 revision, 1979 disposable income was increased by $23 billion, outlays by $10 billion, and saving by $13 billion. Rental income was increased by $18 billion, essentially undoing the 1984 revision, as a result of a lowered rate of depreciation of rental property. Consumption expenditures were affected by many factors, but one important one was an increase in the proportion of restaurant meals that were considered personal rather than business. (Note: this benchmark revision was initially published in incomplete historical data in December 1995, but additional changes were made in final publication in 1997).

In the 1999 revision, 1979 disposable income was increased by $33 billion, outlays by $3 billion, and saving by $30 billion. The major change was a revision in the treatment of government retirement programs, which had been treated like social security and were now to be treated like private pension programs. Social security payments by employees and employers are considered to be like an indirect business tax, and excluded from personal income. Social security benefits are considered to be transfer payments, like welfare and medicare payments, and are included in personal income. Private pension benefits, on the other hand, are considered part of personal income, as if they were deposited in the employees' bank or brokerage accounts. No income is recorded when the benefits are paid out; benefit payments are treated like withdrawals from bank or brokerage accounts. When the federal government accounted for the bulk of government retirement programs, it was appropriate to treat these like social security, in the sense that the federal government did not have to set aside monies to fund the programs. But when state and local government employment came to surpass federal employment it was deemed reasonable to consider them like private pensions. The net effect of the change was to raise personal income by $30 billion, as contributions were substantially larger than benefits. Another factor raising personal income is that the interest payments and dividends to government retirement trust funds were added to interest and dividend income.

In the 2004 revision, disposable income fell by $15 billion, personal outlays fell by $8 billion, and saving fell by $7 billion. Employer contributions to social insurance were included in compensation, but also included in the subtracted portion, contributions to social insurance, thus having no net impact on personal income. The major revision was a reduction in interest income of $16 billion; this was due to a definitional change in the calculation of banking services which was offset by a reduction in PCE of banking services.

Implications of extrapolation of revision estimates. Consider, for example, nonfarm proprietors' income. BEA relies on IRS tax data to measure this income, which it supplements with input-output tables. Unfortunately, there is a very large discrepancy between what is reported to the IRS and the BEA's best guess of such income. Adding together 2002 IRS adjusted gross income (AGI) for proprietors, estate and trusts, and partnerships, BEA arrives at $310 billion (Survey of Current Business, Nov. 2004, pp. 9-14). When BEA adjusts its concept of proprietors' income to the IRS definition, it finds $705 billion. What BEA finds is an "AGI gap" of $395 billion. Of this, $309 billion is due to BEA's estimate of tax misreporting, primarily based on evidence from the 1970s, with the rest being unexplained. Thus, 5 percent of disposable personal income is an extrapolation based primarily on information two decades old.

Appendix Table 1 summarizes benchmark revisions by detailed category of income and outlay for each bench. Appendix Table 2 Provides summary information on the major sources of revision within each detailed category.

Appendix Table 1. Benchmark revisions to 1979 U.S. personal income, by category, various years In billions of dollars							
Sources of and disposition of personal income	Benchmark revision date						total
	1980	1985	1991	1995,7	1999	2003	
personal income	19.6	90.2	-0.9	22.7	25.7	-19.3	138
wages and salary	8.5	16	3.3	0.5	-0.1	0.2	28.4
other labor income	-4.1	4.1	1.6	0	38.3	-0.2	39.7
employer contributions to SI*	0	0	0	0	0	82.6	82.6
proprietors' income	0.8	60.3	-10.1	3.2	-1.3	-3.6	49.3
rental income	3.6	-24.9	2.8	18.5	-2.6	-0.5	-3.1
interest income	17.5	11.9	1.7	0.4	9.9	-16.2	25.2
dividend income	-4.1	-0.5	2.3	0.1	6.9	0	4.7
transfers received by households	-2.6	23.7	-2.4	0	-36.5	1.1	-16.7
less contributions to SI	-0.1	0.4	0	0	-10.8	82.5	72
less taxes	2.1	2.7	-24.5	0	-6.9	-4.6	-31.2
disposable personal income	17.4	87.6	23.7	22.7	32.5	-14.7	169.2
personal outlays	5	55.8	18.3	9.9	2.9	-8	83.9
personal consumption expend	1.1	55.9	16.9	9.8	2.8	-4.1	82.4
interest paid	4.1	-0.2	1	0	0	-8.3	-3.4
transfers to government	0	0	0	0	0	4.3	4.3
transfers to ROW**	-0.1	0	0.4	0	0.2	0	0.5
personal saving	12.4	31.9	5.2	12.9	29.6	-6.7	85.3

*SI= Social Insurance **ROW= rest of world

Appendix table 2. 1979 Annual Personal Saving: Major sources of revision from 1980 to 2005				
	1980	2005	Revisions	Major Sources of Revision
1.Wage & Salary Disbursements	1227.6	1256.0	28.4	statistical (IRS audits, input-output tables)
2. Employer contributions to social insurance		82.6	82.6	offset by (9)
3. Other Labor Income	122.7	162.4	39.7	definitional: govt retirement payments
4. Proprietors Income	130.8	180.1	49.3	statistical
5. Rental Income	26.9	23.8	-3.1	
6. Interest Income	192.1	217.3	25.2	statistical
7. Dividends	52.7	57.4	4.7	
8. Transfer payments to persons	252	235.3	-16.7	
9. less Contributions for social insurance	80.7	152.7	72	definitional: offsets (2)
10. Personal Income	1924.4	2062.2	138.1	
11. less Tax & nontax payments	299.9	268.7	-31.2	definitional: redefine payments for public education and medicine (offset by 14)
12. Disposable Personal Income	1624.3	1793.5	169.2	
13. Personal Outlays	1550.5	1634.4	83.9	
14. Personal Consumption Expenditures	1509.3	1592.2	82.4	definitional: redefine payments for public education and medicine (offset by 11) stat: household expenditure at restaurants, etc.
15. Interest paid	39.6	36.2	-3.4	
16. Transfer payments to government		4.3	4.3	
17. Transfer payments to rest of the world	1.1	1.6	0.5	
18. Personal Saving	73.8	159.1	85.3	

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Table 1. Personal Saving Rate, 5 Year Averages, After Benchmark Revisions
(percent)

Five-year periods	Advance Estimate	Vintage						
		76Q1	81Q1	86Q1	93Q1	97Q2	00Q2	04Q1
65 Q3 to 70 Q2	6.30	6.57	7.21*	7.15	7.20	7.83*	8.55*	8.58
70 Q3 to 75 Q2	7.32	7.53	8.08*	8.71*	8.40	8.94*	10.09*	10.10
75 Q3 to 80 Q2	5.59		5.98	7.20*	7.10	7.68*	9.27*	9.14
80 Q3 to 85 Q2	5.49			6.52	7.98*	8.48*	10.25*	10.37
85 Q3 to 90 Q2	4.33				4.76	5.67*	7.80*	7.45
90 Q3 to 95 Q2	4.34					5.14	7.41*	6.32
95 Q3 to 00 Q2	2.69							3.53
00 Q3 to 05 Q2	1.78							

*More than 0.5 percentage points larger than in the previous benchmark revision.

Source: BEA, Federal Reserve Bank of Philadelphia Real-Time Data Set for Macroeconomists

Table 2A. Regression coefficients for:
Vintage Saving Rate = Constant + β * Advance Estimate Saving Rate
(Standard errors in parentheses are Newey-West HAC standard errors, lag truncation=3)

Time Period		Vintage 1985q3	1990q3	1995q3	2000q3	2005q3
1965Q3 to 1985Q3	constant	2.28* (0.54)	3.26* (0.71)	5.10* (0.64)	7.79* (0.78)	7.56* (0.70)
	AE coeff	0.747** (0.08)	0.665** (0.11)	0.416** (0.09)	0.284** (0.12)	0.321** (0.10)
	R-squared	0.57	0.45	0.25	0.10	0.12
1970Q3 to 1990Q2	constant		0.76 (0.88)	2.94* (0.82)	6.43* (0.62)	5.97* (0.65)
	AE coeff		1.026 (0.13)	0.724** (0.12)	0.514** (0.09)	0.579** (0.10)
	R-squared		0.62	0.40	0.36	0.36
1975Q3 to 1995Q2	constant			1.70** (0.87)	5.07* (0.85)	3.72* (1.12)
	AE coeff			0.893 (0.16)	0.732 (0.16)	0.932 (0.21)
	R-squared			0.35	0.33	0.33
1980Q3 to 2000Q2	constant				2.33* (0.86)	2.45* (0.72)
	AE coeff				1.173 (0.19)	1.059 (0.19)
	R-squared				0.53	0.43
1985Q3 to 2005Q2	constant					2.07* (0.55)
	AE coeff					0.830 (0.15)
	R-squared					0.41

*greater than 0, p value < .01
**less than 1, p value < .01
***less than 1, p value < .05

Table 2B. Regression coefficients for:
First Difference Vintage Saving Rate = Constant + β * First Difference Advance Estimate Saving Rate
(Standard errors in parentheses are Newey-West HAC standard errors, lag truncation=3)

		Vintage				
Time Period		1985q3	1990q3	1995q3	2000q3	2005q3
1965Q3 to 1985Q3	constant	0.025 (0.044)	0.030 (0.047)	0.056 (0.048)	0.066 (0.048)	0.066 (0.051)
	AE coeff	0.809* (0.072)	0.757* (0.060)	0.787* (0.063)	0.732* (0.067)	0.762* (0.061)
	R-squared	0.73	0.67	0.67	0.66	0.65
1970Q3 to 1990Q2	constant		0.018 (0.049)	0.011 (0.056)	0.030 (0.052)	0.023 (0.055)
	AE coeff		0.794* (0.062)	0.796* (0.064)	0.700* (0.067)	0.735* (0.065)
	R-squared		0.69	0.67	0.64	0.65
1975Q3 to 1995Q2	constant			0.000 (0.054)	-.019 (0.053)	-.021 (0.055)
	AE coeff			0.703* (0.087)	0.626* (0.085)	0.682 (0.085)
	R-squared			0.49	0.45	0.46
1980Q3 to 2000Q2	constant				-0.068 (0.052)	-0.037* (0.057)
	AE coeff				0.679 (0.082)	0.667 (0.100)
	R-squared				0.46	0.39
1985Q3 to 2005Q2	constant					-.066* (0.052)
	AE coeff					0.754 (0.090)
	R-squared					0.54

Table 3

Forecasts of Real Personal Consumption Expenditure Growth using the Level of the Personal Saving Rate

Model 1: $\begin{pmatrix} \Delta c_t \\ s_t \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} + \begin{pmatrix} \phi_{11}(L) & \phi_{12}(L) \\ \phi_{21}(L) & \phi_{22}(L) \end{pmatrix} \begin{pmatrix} \Delta c_{t-1} \\ s_{t-1} \end{pmatrix} + \begin{pmatrix} u_{ct} \\ u_{st} \end{pmatrix}$

Model 2: $\Delta c_t = \mu + \phi(L)\Delta c_{t-1} + u_t$

Data from 1959Q1 to 2005Q2

Forecast variable: Percent changes of real personal consumption at annual rates

RMSE (model 1)/RMSE (model 2)

Numbers below unity (bold italics) mean the saving rate improves the forecast for c.

	1 Step Ahead			**2 Step Ahead**			**4 Step Ahead**			**8 Step Ahead**		
	6	**AIC**	**SIC**	**6**	**AIC**	**SIC**	**6**	**AIC**	**SIC**	**6**	**AIC**	**SIC**
	1971:Q1 – 2005:Q2 (Full Sample)											
RT	1.050	1.008	1.022	1.051	1.034	1.044	1.112	1.059	1.054	1.092	1.085	1.038
LV	1.125	1.088	1.050	1.127	1.099	1.085	1.159	1.091	1.098	1.165	1.091	1.076
RTLV	1.063	1.016	1.029	1.061	1.033	1.042	1.122	1.049	1.046	1.160	1.094	1.051
	1971:Q1 – 1981:Q4 (Pre-1982)											
RT	1.062	***0.993***	1.004	1.048	1.025	1.030	1.109	1.029	1.031	1.054	1.052	1.006
LV	1.164	1.134	1.073	1.150	1.134	1.117	1.195	1.112	1.127	1.203	1.104	1.088
RTLV	1.064	1.012	1.003	1.025	1.028	1.012	1.087	1.032	1.001	1.050	1.058	***0.997***
	1982:Q1 – 2005:Q2 (Post-1981)											
RT	1.023	1.037	1.054	1.061	1.057	1.077	1.119	1.121	1.098	1.153	1.139	1.088
LV	1.047	***0.999***	1.010	1.069	1.022	1.021	1.095	1.054	1.048	1.106	1.070	1.059
RTLV	1.061	1.024	1.074	1.140	1.042	1.096	1.181	1.079	1.114	1.313	1.147	1.124

Each entry is the ratio of out-of-sample RMSE of the VAR model (with lags of the personal saving rate) to the RMSE of univariate AR model. *Numbers below unity (bold italics) mean the saving rate improves the forecast for c.* LV indicates that the latest vintage of data (2005Q3) was used to estimate and forecast the model and to compute the forecast errors. RTLV indicates that real-time data were used to estimate and forecast the model, but the latest vintage of data was used to compute forecast errors. RT indicates that real-time data were used to estimate and forecast the model and to evaluate forecast errors.

Table 4. Comparing Ireland's forecasts of real labor income with our forecasts of real disposable income *Numbers below unity (bold italics) mean the saving rate improves the forecast for y.* Forecasting real disposable income using the saving rate with latest vintage and real-time data, using 6 lags Data from 1959 Q1 to 1994 Q3 Forecast period: 1971 Q1 to 1994 Q3				
Forecast period	Forecast horizon			
Forecast period: 1971 Q1 to 1994 Q3	1 Quarter Ahead	2 Quarters Ahead	4 Quarters Ahead	8 Quarters Ahead
Forecast variable: Total change in real labor income per capita (Ireland, 1995)				
LV	***.97***	***.95***	***.90***	1.07
Forecast variable: Percent change in real disposable income				
RT	1.050	1.068	1.078	1.113
LV	***.974***	***.982***	***.956***	1.065
RTLV	1.047	1.072	1.094	1.158

Each entry is the ratio of out-of-sample RMSE of the VAR model (with lags of the personal saving rate) to the RMSE of the univariate AR model, 6 lags.

LV indicates that the latest vintage of data (2004Q4) available at the time of Ireland's study was used to estimate and forecast the model and to compute the forecast errors. RTLV indicates that real-time data were used to estimate and forecast the model, but the latest vintage of data was used to compute forecast errors. RT indicates that real-time data were used to estimate and forecast the model and to evaluate forecast errors.

Ireland forecasted the total change in real labor income per capita. We forecast the percent change in real disposable income. "One quarter ahead" refers to forecasts for the one-step-ahead quarter-over-quarter change (percent change). "Two quarters ahead" refers to forecasts for the two-step-ahead two-quarter average change (percent change). "Four quarters ahead" and "eight quarters ahead" are defined in a similar manner.

Table 5
Forecasts of Real Disposable Personal Income Growth using Level of Personal Saving Rate

Model 1: $\begin{pmatrix} \Delta y_t \\ s_t \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} + \begin{pmatrix} \phi_{11}(L) & \phi_{12}(L) \\ \phi_{21}(L) & \phi_{22}(L) \end{pmatrix} \begin{pmatrix} \Delta y_{t-1} \\ s_{t-1} \end{pmatrix} + \begin{pmatrix} u_{yt} \\ u_{st} \end{pmatrix}$

Model 2: $\Delta y_t = \mu + \phi(L)\Delta y_{t-1} + u_t$

Data from 1959Q1 to 2005Q2
Forecast variable: Percent changes of real disposable income at annual rates

RMSE (model 1)/RMSE (model 2)
Numbers below unity (bold italics) mean the saving rate improves the forecast for y.

	1 Step Ahead			**2 Step Ahead**			**4 Step Ahead**			**8 Step Ahead**		
	6	**AIC**	**SIC**	**6**	**AIC**	**SIC**	**6**	**AIC**	**SIC**	**6**	**AIC**	**SIC**
	1971:Q1 – 2005:Q2 (Full Sample)											
RT	1.029	***0.996***	1.018	1.069	1.092	1.133	1.086	1.124	1.190	1.119	1.202	1.297
LV	***0.978****	***0.928***	1.013	1.010	***0.968***	1.061	1.015	***0.975***	1.095	1.102	1.118	1.206
RTLV	1.010	***0.996***	1.007	1.052	1.069	1.110	1.100	1.117	1.183	1.205	1.244	1.350
	1971:Q1 – 1981:Q4 (Pre-1982)											
RT	1.024*	***0.963***	***0.947***	1.049	1.050	1.056	1.066	1.049	1.075	1.147	1.115	1.131
LV	***0.968****	***0.882****	***0.959****	***0.989****	***0.919****	***0.971****	1.005	***0.889****	***0.941****	1.108	***0.977****	***0.967****
RTLV	1.002*	***0.967****	***0.951***	1.037	1.043	1.044	1.110	1.071	1.079	1.267	1.167	1.175
	1982:Q1 – 2005:Q2 (Post-1981)											
RT	1.036	1.040	1.111	1.104	1.150	1.240	1.126	1.245	1.364	1.073	1.317	1.501
LV	***0.989***	***0.978***	1.064	1.039	1.025	1.156	1.029	1.060	1.234	1.095	1.237	1.402
RTLV	1.023	1.029	1.075	1.076	1.103	1.195	1.083	1.171	1.299	1.123	1.323	1.519

Each entry is the ratio of out-of-sample RMSE of the VAR model (with lags of the personal saving rate) to the RMSE of the univariate AR model
* indicates a lower ratio than corresponding forecasts with first differences. *Numbers below unity (bold italics) mean the saving rate improves the forecast for y.*
LV indicates that the latest vintage of data (2005Q3) was used to estimate and forecast the model and to compute the forecast errors. RTLV indicates that real-time data were used to estimate and forecast the model, but the latest vintage of data was used to compute forecast errors. RT indicates that real-time data were used to estimate and forecast the model and to evaluate forecast errors.

Table 6

Forecasts of Real Disposable Personal Income Growth using First Difference of Personal Saving Rate

Model 1: $\begin{pmatrix} \Delta y_t \\ \Delta s_t \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} + \begin{pmatrix} \phi_{11}(L) & \phi_{12}(L) \\ \phi_{21}(L) & \phi_{22}(L) \end{pmatrix} \begin{pmatrix} \Delta y_{t-1} \\ \Delta s_{t-1} \end{pmatrix} + \begin{pmatrix} u_{yt} \\ u_{st} \end{pmatrix}$

Model 2: $\Delta y_t = \mu + \phi(L)\Delta y_{t-1} + u_t$

Data from 1959Q1 to 2005Q2

Forecast variable: Percent changes of real disposable income at annual rates

RMSE (model 1)/RMSE (model 2)

Numbers below unity (bold italics) mean the saving rate improves the forecast for y.

	1 Step Ahead			2 Step Ahead			4 Step Ahead			8 Step Ahead		
	6	**AIC**	**SIC**	**6**	**AIC**	**SIC**	**6**	**AIC**	**SIC**	**6**	**AIC**	**SIC**
	1971:Q1 – 2005:Q2 (Full Sample)											
RT	1.019	***0.947***	***0.922***	1.035	***0.986***	***0.985***	1.012	***0.954***	***0.967***	1.042	***0.987***	***0.991***
LV	***0.980***	***0.907***	***0.954***	***0.985***	***0.953***	***0.986***	***0.955***	***0.925***	***0.976***	1.002	***0.972***	***0.982***
RTLV	1.009	***0.981***	***0.947***	1.023	1.007	***0.997***	1.015	***0.956***	***0.965***	1.064	***0.981***	***0.989***
	1971:Q1 – 1981:Q4 (Pre-1982)											
RT	1.030	***0.950***	***0.894***	1.028	***0.994***	***0.989***	1.003	***0.936***	***0.966***	1.062	***0.991***	***0.998***
LV	1.011	***0.902***	***0.974***	1.011	***0.961***	1.010	***0.993***	***0.913***	***0.991***	1.030	***0.988***	***0.992***
RTLV	1.010	***0.986***	***0.922***	1.000	1.012	1.000	1.008	***0.931***	***0.951***	1.095	***0.976***	***0.995***
	1982:Q1 – 2005:Q2 (Post-1981)											
RT	1.000	***0.943***	***0.961***	1.048	***0.974***	***0.979***	1.031	***0.985***	***0.971***	1.009	***0.982***	***0.981***
LV	***0.941***	***0.912***	***0.933***	***0.948***	***0.944***	***0.958***	***0.903***	***0.939***	***0.960***	***0.971***	***0.956***	***0.971***
RTLV	1.008	***0.974***	***0.979***	1.058	1.000	***0.994***	1.026	***0.987***	***0.982***	1.024	***0.986***	***0.983***

Each entry is the ratio of out-of-sample RMSE of the VAR model (with lags of the personal saving rate) to the RMSE of univariate AR model. *Numbers below unity (bold italics) mean the saving rate improves the forecast for y.* LV indicates that the latest vintage of data (2005Q3) was used to estimate and forecast the model and to compute the forecast errors. RTLV indicates that real-time data were used to estimate and forecast the model, but the latest vintage of data was used to compute forecast errors. RT indicates that real-time data were used to estimate and forecast the model and to evaluate forecast errors.

Table 7
Forecasts of Real Disposable Personal Income Growth Adding PIH Restrictions using Levels of Personal Saving Rate

Model 1: $\begin{pmatrix} \Delta y_t \\ s_t \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} + \begin{pmatrix} \tilde{a}(L) & \tilde{b}(L) \\ \tilde{c}(L) & \tilde{d}(L) \end{pmatrix} \begin{pmatrix} \Delta y_{t-1} \\ s_{t-1} \end{pmatrix} + \begin{pmatrix} u_{yt} \\ u_{st} \end{pmatrix}$ $\tilde{a}_i = \tilde{c}_i, i \geq 1; \quad \tilde{d}_1 = \tilde{b}_1 + (1+0.01); \quad \tilde{d}_i = \tilde{b}_i, i \geq 2$

Model 2: $\Delta y_t = \mu + \phi(L)\Delta y_{t-1} + u_t$

Data from 1959Q1 to 2005Q2
Forecast variable: Percent changes of real disposable income at annual rates

RMSE (model 1)/RMSE (model 2)
Numbers below unity (bold italics) mean the saving rate improves the forecast for y.

	1 Step Ahead			**2 Step Ahead**			**4 Step Ahead**			**8 Step Ahead**		
	6	**AIC**	**SIC**	**6**	**AIC**	**SIC**	**6**	**AIC**	**SIC**	**6**	**AIC**	**SIC**
	1971:Q1 – 2005:Q2 (Full Sample)											
RT	***0.992***	***0.981***	***0.992***	1.050	1.063	1.083	1.052	1.090	1.129	1.096	1.138	1.193
LV	***0.980***	***0.928***	***0.990***	1.027	***0.981***	1.030	1.008	***0.998***	1.061	1.072	1.109	1.133
RTLV	***0.978***	***0.974***	***0.973***	1.033	1.032	1.052	1.037	1.065	1.103	1.101	1.142	1.205
	1971:Q1 – 1981:Q4 (Pre-1982)											
RT	***0.965***	***0.954***	***0.924***	1.015	1.020	1.017	***0.994***	1.025	1.043	1.021	1.043	1.062
LV	***0.928***	***0.840***	***0.912***	***0.935***	***0.851***	***0.897***	***0.878***	***0.839***	***0.887***	***0.912***	***0.909***	***0.900***
RTLV	***0.946***	***0.943***	***0.914***	***0.997***	***0.988***	***0.981***	***0.997***	1.020	1.022	1.049	1.064	1.079
	1982:Q1 – 2005:Q2 (Post-1981)											
RT	1.033	1.017	1.081	1.111	1.123	1.175	1.169	1.195	1.262	1.202	1.262	1.356
LV	1.038	1.018	1.063	1.145	1.116	1.164	1.153	1.147	1.214	1.222	1.270	1.323
RTLV	1.022	1.010	1.043	1.090	1.088	1.142	1.098	1.116	1.195	1.163	1.221	1.330

Each entry is the ratio of out-of-sample RMSE of the constrained VAR model (with lags of the personal saving rate) to the RMSE of univariate AR model. *Numbers below unity (bold italics) mean the saving rate improves the forecast for y.* LV indicates that the latest vintage of data (2005Q3) was used to estimate and forecast the model and to compute the forecast errors. RTLV indicates that real-time data were used to estimate and forecast the model, but the latest vintage of data was used to compute forecast errors. RT indicates that real-time data were used to estimate and forecast the model and to evaluate forecast errors.

Table 8

Forecasts of Real Disposable Personal Income Growth Adding PIH restrictions using Levels of Personal Saving Rate

Model 1: $\begin{pmatrix} \Delta y_t \\ s_t \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} + \begin{pmatrix} \tilde{a}(L) & \tilde{b}(L) \\ \tilde{c}(L) & \tilde{d}(L) \end{pmatrix} \begin{pmatrix} \Delta y_{t-1} \\ s_{t-1} \end{pmatrix} + \begin{pmatrix} u_{yt} \\ u_{st} \end{pmatrix}$ $\tilde{a}_i = \tilde{c}_i, i \geq 1; \quad \tilde{d}_1 = \tilde{b}_1 + (1+0.01); \quad \tilde{d}_i = \tilde{b}_i, i \geq 2$

Model 2: Model 1 without PIH restrictions.

Data from 1959Q1 to 2005Q2

Forecast variable: Percent changes of real disposable income at annual rates

RMSE (model 1)/RMSE (model 2)

Numbers below unity (bold italics) mean the PIH restrictions improve the forecasts for y relative to the forecasts of the unconstrained VAR.

	1 Step Ahead			2 Step Ahead			4 Step Ahead			8 Step Ahead		
	6	**AIC**	**SIC**	**6**	**AIC**	**SIC**	**6**	**AIC**	**SIC**	**6**	**AIC**	**SIC**
	1971:Q1 – 2005:Q2 (Full Sample)											
RT	***0.964***	***0.985***	***0.974***	***0.983***	***0.974***	***0.955***	***0.969***	***0.970***	***0.949***	***0.980***	***0.947***	***0.919***
LV	1.002	1.000	***0.978***	1.017	1.013	***0.971***	***0.993***	1.024	***0.969***	***0.973***	***0.992***	***0.940***
RTLV	***0.968***	***0.978***	***0.966***	***0.982***	***0.965***	***0.947***	***0.943***	***0.953***	***0.932***	***0.914***	***0.918***	***0.892***
	1971:Q1 – 1981:Q4 (Pre-1982)											
RT	***0.942***	***0.991***	***0.975***	***0.968***	***0.971***	***0.962***	***0.932***	***0.978***	***0.971***	***0.890***	***0.935***	***0.939***
LV	***0.958***	***0.953***	***0.951***	***0.945***	***0.926***	***0.924***	***0.874***	***0.944***	***0.944***	***0.823***	***0.931***	***0.931***
RTLV	***0.944***	***0.975***	***0.961***	***0.962***	***0.947***	***0.939***	***0.898***	***0.953***	***0.947***	***0.829***	***0.912***	***0.918***
	1982:Q1 – 2005:Q2 (Post-1981)											
RT	***0.997***	***0.978***	***0.973***	1.006	***0.977***	***0.948***	1.038	***0.960***	***0.926***	1.120	***0.958***	***0.903***
LV	1.049	1.042	***0.999***	1.103	1.089	1.007	1.121	1.082	***0.984***	1.116	1.026	***0.944***
RTLV	1.000	***0.981***	***0.970***	1.013	***0.986***	***0.956***	1.013	***0.953***	***0.919***	1.036	***0.923***	***0.875***

Each entry is the ratio of out-of-sample RMSE of the constrained VAR model to the RMSE of the unconstrained VAR model *Numbers below unity (bold italics) mean the PIH restrictions improve the forecasts for y relative to the forecasts of the unconstrained VAR.* LV indicates that the latest vintage of data (2005Q3) was used to estimate and forecast the model and to compute the forecast errors. RTLV indicates that real-time data were used to estimate and forecast the model, but the latest vintage of data was used to compute forecast errors. RT indicates that real-time data were used to estimate and forecast the model and to evaluate forecast errors.

Table 9

Forecasts of Real Disposable Personal Income Growth Adding PIH Restrictions using First Difference of Personal Saving Rate

Model 1: $$\begin{pmatrix}\Delta y_t \\ \Delta s_t\end{pmatrix} = \begin{pmatrix}\mu_1 \\ \mu_2\end{pmatrix} + \begin{pmatrix}\tilde{a}(L) & \tilde{b}(L) \\ \tilde{c}(L) & \tilde{d}(L)\end{pmatrix}\begin{pmatrix}\Delta y_{t-1} \\ \Delta s_{t-1}\end{pmatrix} + \begin{pmatrix}u_{yt} \\ u_{st}\end{pmatrix}$$ $$\tilde{a}_i = \tilde{c}_i, \quad i \geq 1$$ $$\tilde{d}_i = \tilde{b}_i, \quad i \geq 1$$

Model 2: $\Delta y_t = \mu + \phi(L)\Delta y_{t-1} + u_t$

Data from 1959Q1 to 2005Q2

Forecast variable: Percent changes of real disposable income at annual rates

RMSE (model 1)/RMSE (model 2)

Numbers below unity (bold italics) mean the saving rate improves the forecast for y.

	1 Step Ahead			**2 Step Ahead**			**4 Step Ahead**			**8 Step Ahead**		
	6	**AIC**	**SIC**	**6**	**AIC**	**SIC**	**6**	**AIC**	**SIC**	**6**	**AIC**	**SIC**
	1971:Q1 – 2005:Q2 (Full Sample)											
RT	***0.973***	***0.940***	***0.903***	1.005	***0.989***	***0.964***	***0.986***	***0.975***	***0.972***	***0.989***	***0.990***	***0.989***
LV	***0.974***	***0.909***	***0.945***	***0.990***	***0.963***	***0.977***	***0.924***	***0.960***	***0.988***	***0.968***	***0.985***	***0.985***
RTLV	***0.973***	***0.957***	***0.915***	1.001	***0.990***	***0.959***	***0.952***	***0.965***	***0.954***	***0.982***	***0.984***	***0.978***
	1971:Q1 – 1981:Q4 (Pre-1982)											
RT	***0.974***	***0.944***	***0.862***	1.005	***0.999***	***0.953***	***0.950***	***0.964***	***0.962***	1.005	***0.990***	***0.987***
LV	***0.991***	***0.883***	***0.944***	***0.991***	***0.939***	***0.966***	***0.912***	***0.936***	***0.990***	***0.961***	***0.987***	***0.980***
RTLV	***0.964***	***0.960***	***0.872***	***0.989***	***0.986***	***0.930***	***0.929***	***0.945***	***0.922***	***0.987***	***0.972***	***0.964***
	1982:Q1 – 2005:Q2 (Post-1981)											
RT	***0.971***	***0.935***	***0.958***	1.004	***0.973***	***0.981***	***0.988***	***0.993***	***0.989***	***0.965***	***0.991***	***0.992***
LV	***0.954***	***0.938***	***0.945***	***0.990***	***0.991***	***0.989***	***0.939***	***0.986***	***0.986***	***0.975***	***0.984***	***0.990***
RTLV	***0.986***	***0.954***	***0.966***	1.021	***0.996***	***0.998***	***0.986***	***0.989***	***0.992***	***0.974***	***0.996***	***0.992***

Each entry is the ratio of out-of-sample RMSE of the VAR model (with lags of the personal saving rate) to the RMSE of univariate AR model. *Numbers below unity (bold italics) mean the saving rate improves the forecast for y.* LV indicates that the latest vintage of data (2005Q3) was used to estimate and forecast the model and to compute the forecast errors. RTLV indicates that real-time data were used to estimate and forecast the model, but the latest vintage of data was used to compute forecast errors. RT indicates that real-time data were used to estimate and forecast the model and to evaluate forecast errors.

Figure 1. Measured Personal Saving Rates

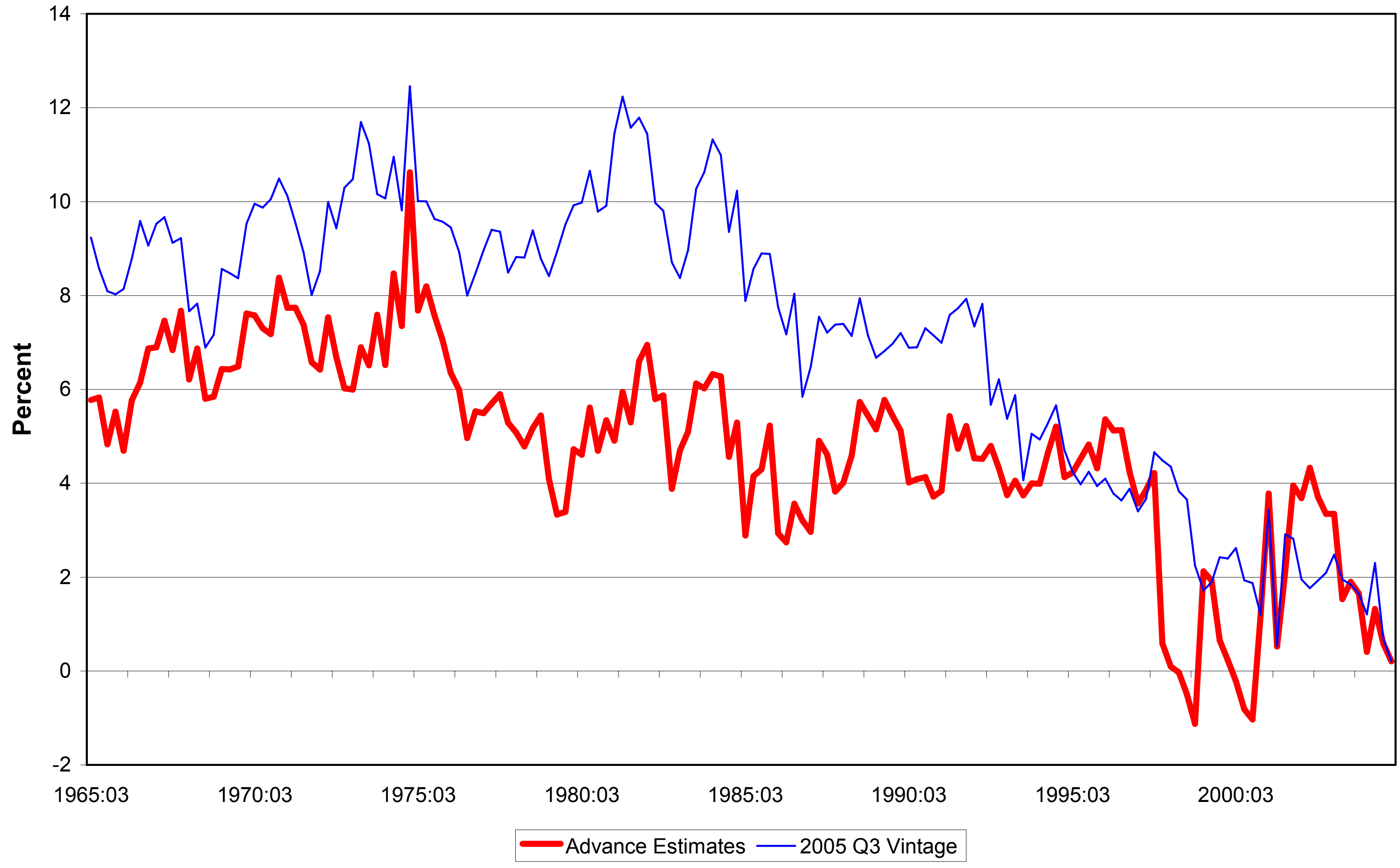


Figure 2
Histogram of Revisions to the Personal Savings Rate
Last-Before-Benchmark minus Advance Estimates

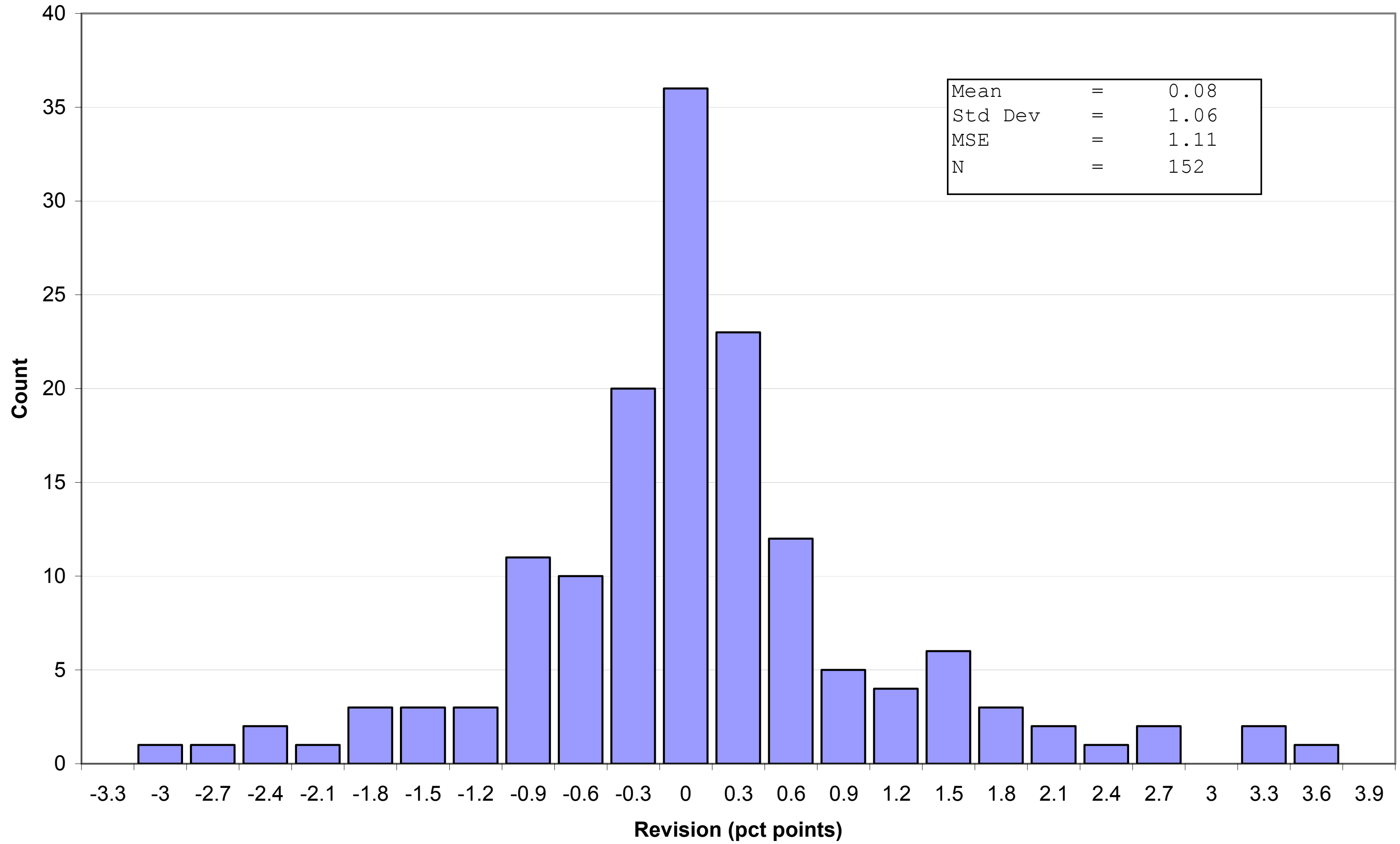


Figure 3
Histogram of Revisions to the Personal Savings Rate
Latest-Available Minus Advance Estimates

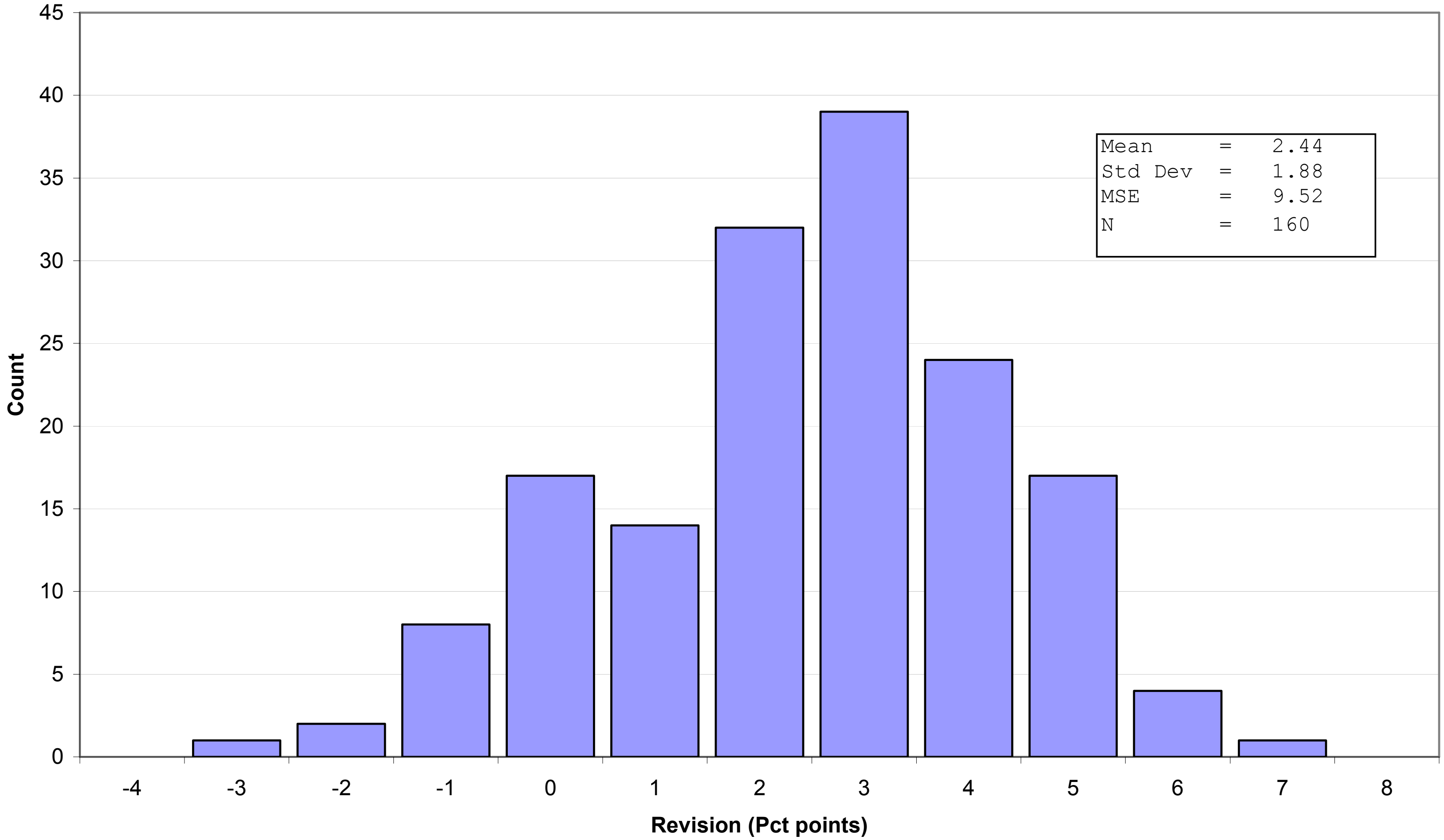


Figure 4a
Recent Saving Rates are Often Below Average

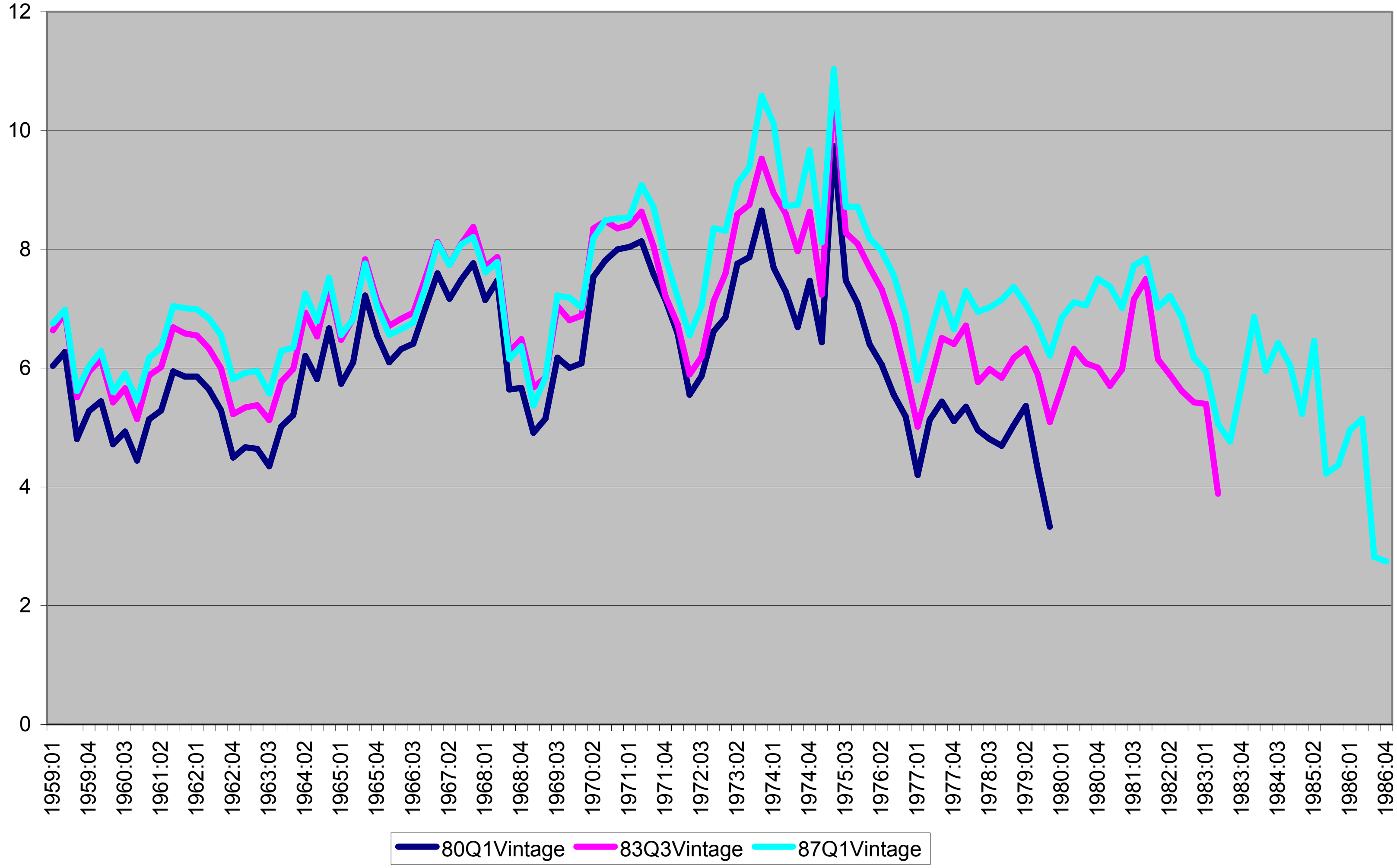


Figure 4b:
Recent Saving Rates are Often Below Average

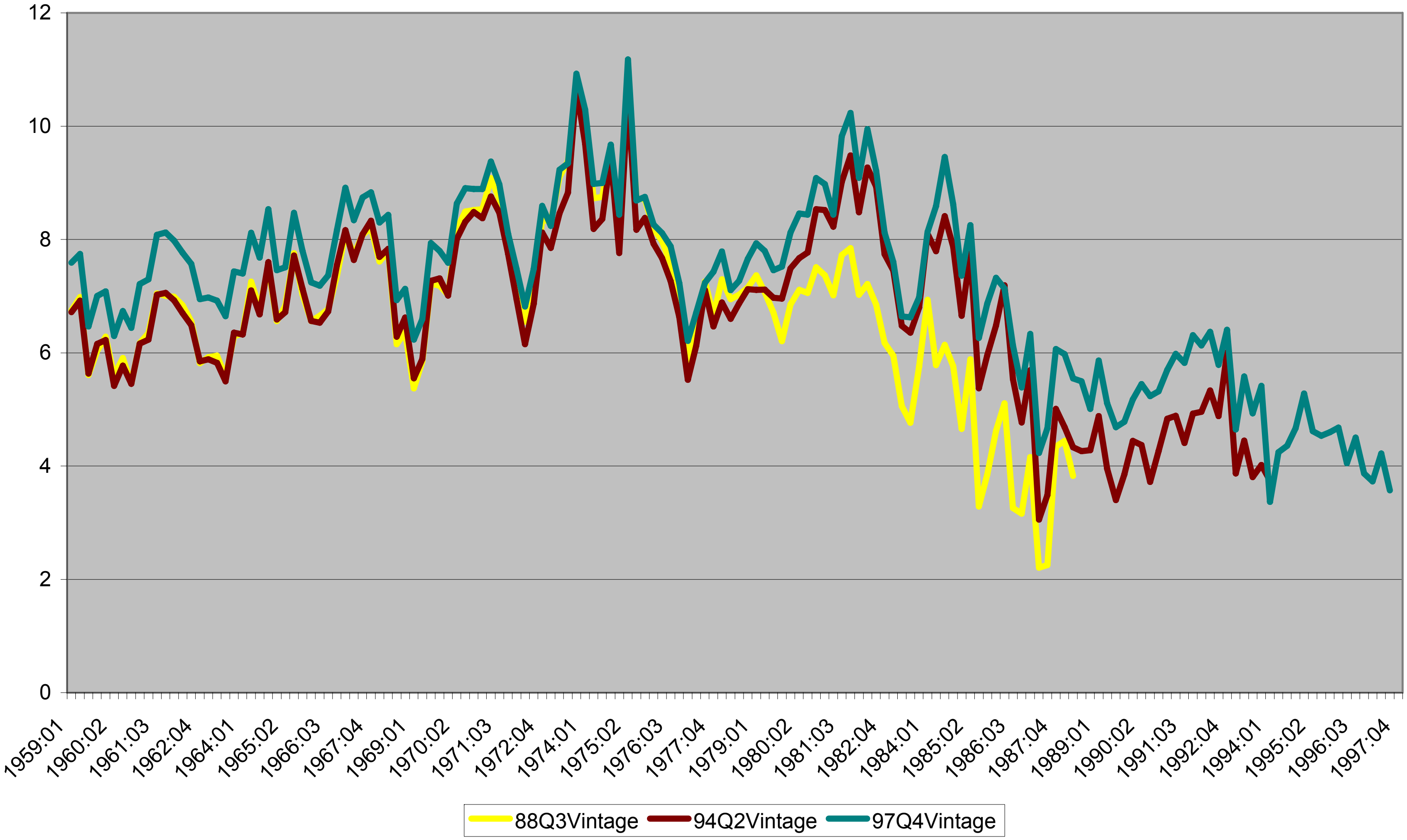


Figure 4c
Recent Saving Rates are Often Below Average

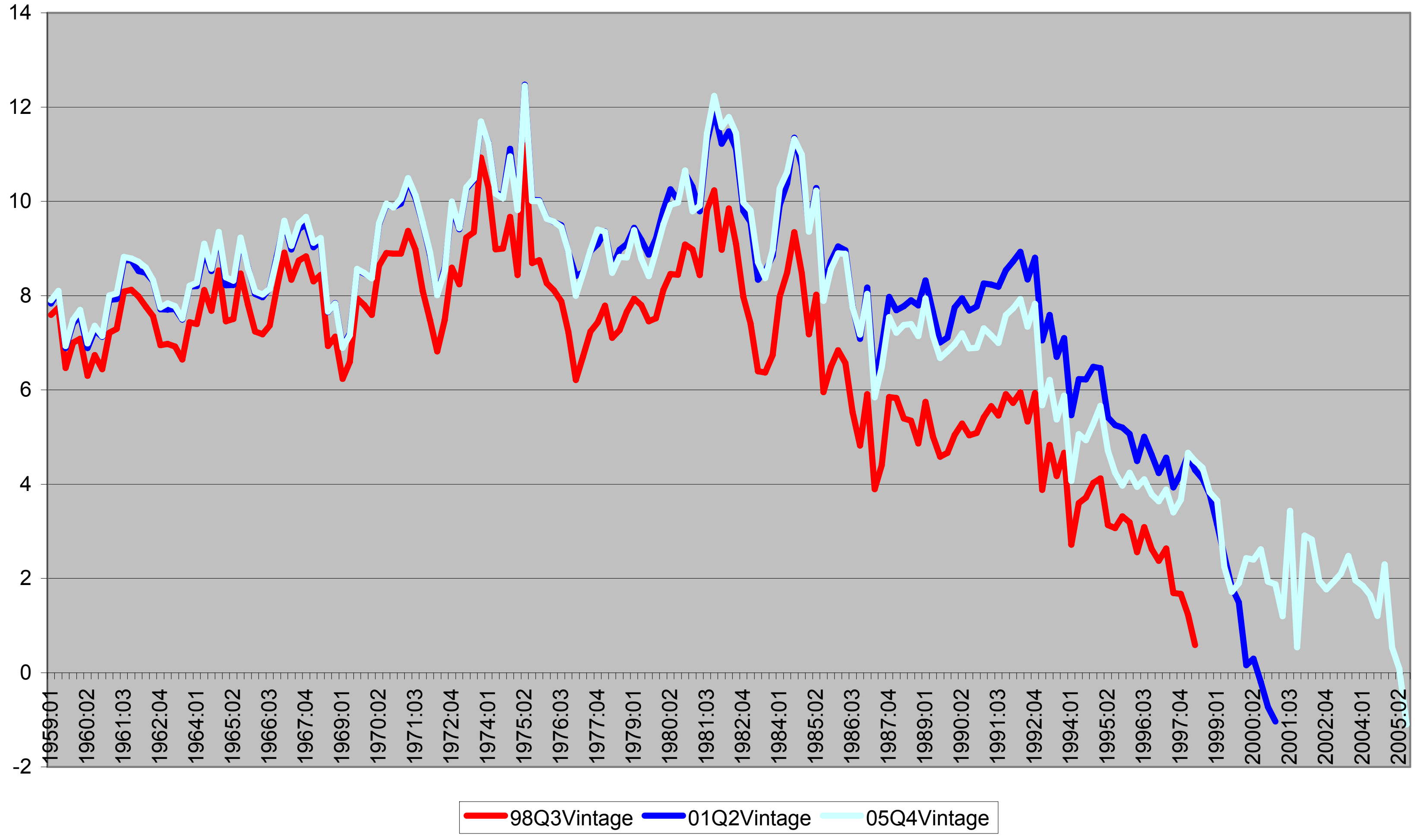


Figure 5
Revisions to Nominal Income and Output

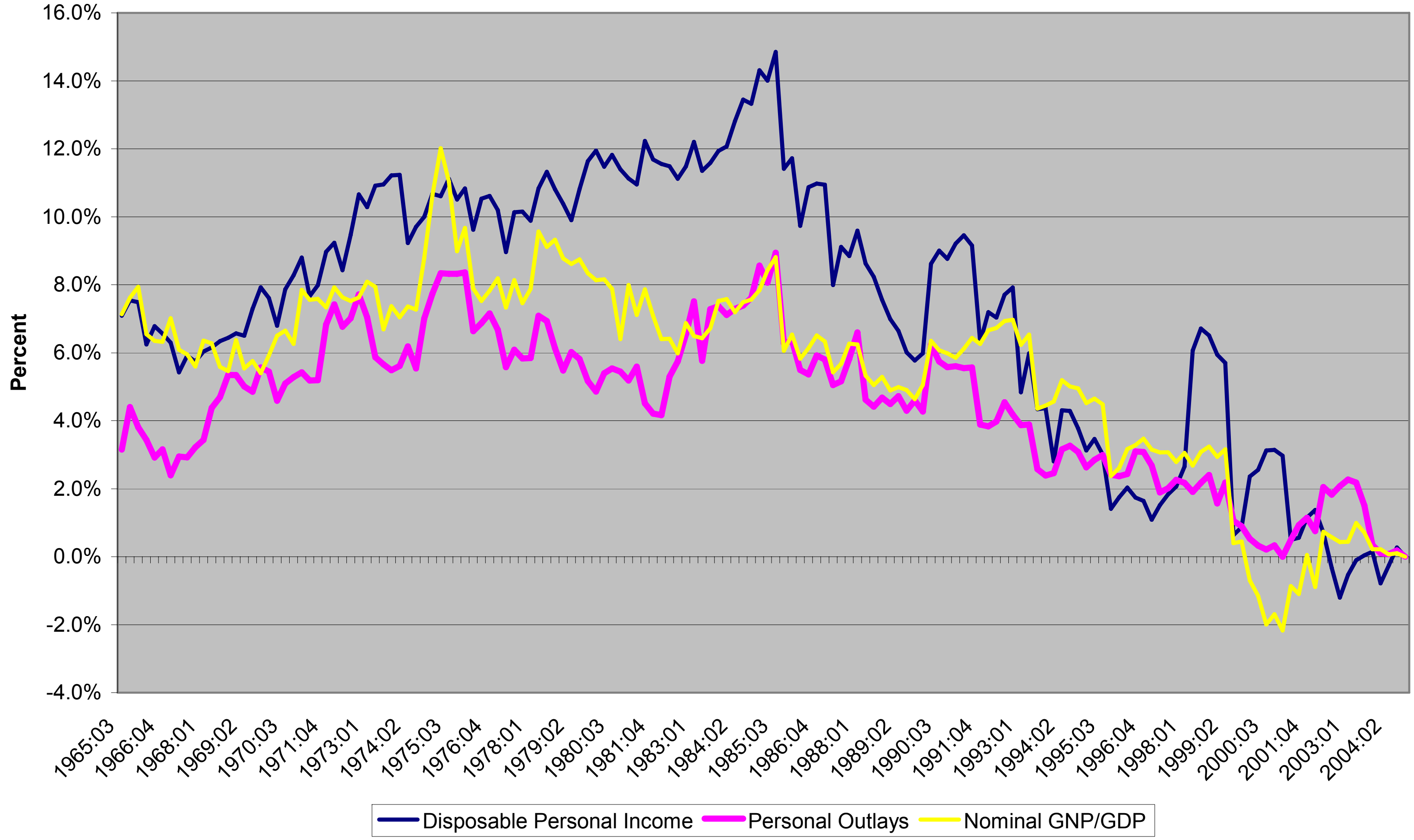
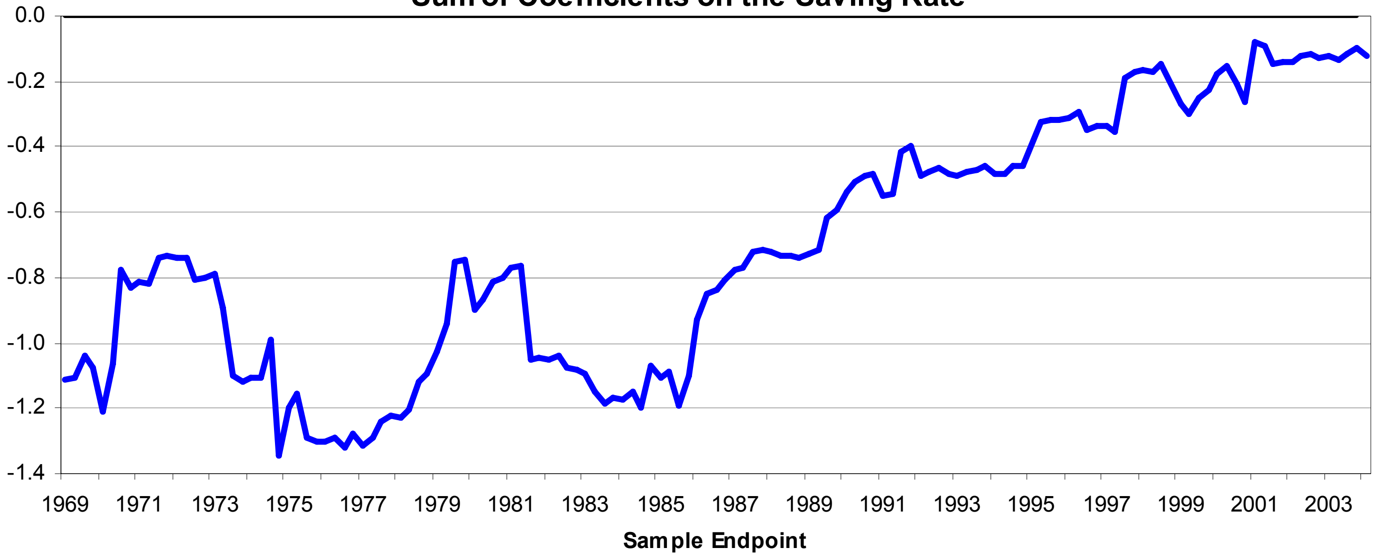


Figure 6.
Sum of Coefficients on the Saving Rate



Notes. The figure plots the sum of coefficients on the saving rate from the VAR equation for real disposable personal income growth. The saving rate is expressed in percentage points. Income growth is expressed in annualized percentage points. Lag length was chosen by the SIC. All estimation begins with the observation for 1959Q1 and adds one additional real-time observation per quarter. The horizontal axis gives the sample endpoint.