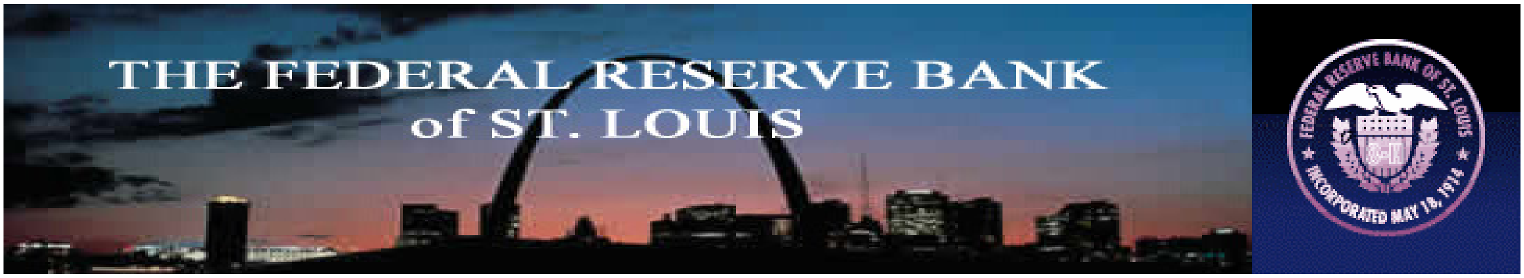

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On the Real-Time Forecasting Ability of the Consumption-Wealth Ratio

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On the Real-Time Forecasting Ability of the Consumption-Wealth Ratio

Abstract

Lettau and Ludvigson (2001a) show that the consumption-wealth ratio—the error term from the cointegration relation among consumption, net worth, and labor income—forecasts stock market returns out of sample. In this paper, we reexamine their evidence using real-time data. Consistent with the early authors, we find that consumption and labor income data are subject to substantial revisions, which reflect (1) incorporating new information or methodologies and (2) reducing noise. Consequently, in contrast with the results obtained from the current vintage, the out-of-sample forecasting power of the consumption-wealth ratio is found to be negligible in real time.

Keywords: Real-time data, Stock Return Predictability, Out-of-sample forecast, Stock Market Timing strategies, Consumption-Wealth ratio, Stock market volatility, and Short-term interest rate.
JEL number: G10, G14.

Lettau and Ludvigson (LL, 2001a) show that the consumption-wealth ratio (*cay*)—the error term from the cointegration relation among consumption, net worth, and labor income—is a strong predictor of stock market returns. Interestingly, Guo (2002a) finds that the forecasting power of *cay* improves dramatically if past stock market variance is also included in the forecasting equation because of a classic omitted variable problem: These two variables are negatively related to one another, although they are both positively related to future stock returns. More importantly, in sharp contrast with Bossaerts and Hillion (1999), Ang and Bekaert (2001), and Goyal and Welch (2003), among others, *cay* exhibits out-of-sample predictive power for stock market returns, especially when combined with past stock variance.[1] These results are consistent with an equilibrium model by Guo (2003), who argues that, in addition to a risk premium as in the standard model, shareholders also require a liquidity premium to hold stocks relative to risk-free bonds because of limited stock market participation.[2] That is, *cay* and past stock variance forecast stock returns because they are proxies for the liquidity and risk premiums, respectively.

There is a conceptual issue of using *cay* as a forecasting variable: Consumption, labor income, and net worth data are subject to revisions.[3] Lettau and Ludvigson (2003a) argue that

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[1] Bossaerts and Hillion (1999), Ang and Bekaert (2001), and Goyal and Welch (2003) focus on the forecasting variables advocated by the early authors (e.g., Campbell [1987] and Fama and French [1989]) such as the dividend yield, the default premium, and the term premium. These variables, however, lose their predictive abilities if we also include the consumption-wealth ratio and past stock market variance in the forecasting equation for stock market returns. There is, however, an exception: The stochastically detrended risk-free rate advocated by Campbell, Lo, and MacKinlay (1997) and many others provides additional information about future returns as well. Patelis (1997) suggests that variables such as the stochastically detrended risk-free rate forecast stock returns because these variables reflect the stance of monetary policies, which have state-dependent effects on real economic activities through a credit channel (e.g., Bernanke and Gertler [1989]). However, our results are not sensitive to whether we include it or not.

[2] The forecasting ability of *cay* is also consistent with many other rational equilibrium models, e.g., the habit formation model by Campbell and Cochrane (1999).

[3] Brennan and Xia (2002) argue that the forecasting power of *cay* is spurious because of a look-ahead bias introduced by estimating the cointegration parameters using the full sample. In particular, if calendar time is used in place of consumption, the resulting cointegration error, *tay*, performs as well as or better than *cay* in predicting stock

whether this issue is relevant depends on the research question at hand. In particular, if the question of concern is "Are expected excess returns time-varying?", we should estimate *cay* using the full sample of the latest release or the current vintage. This is because such a measure of *cay* is the best proxy for its true value, of which, agents supposedly have perfect knowledge in rational asset pricing models. Based on these rationales, recent authors, e.g., Guo (2002a, 2002b, 2002c), Lettau and Ludvigson (2001a, 2001b, 2002a, 2002b, 2003a, 2003b), and Ang and Liu (2003), have shown that the forecasting power of the current vintage *cay* is important for understanding stock market movements and their implications for aggregate economy.

Nevertheless, as stressed by Lettau and Ludvigson (2003a), data revisions are potentially an important concern for practitioners, e.g., mutual funds managers and policymakers, who have no prior knowledge about the cointegration parameters and must rely on the data that are available at the time of forecast to make inference.[4] Furthermore, Christoffersen, Ghysels, and Swanson (2002), among others, obtain very different results using real-time data from those of current vintage data in the test of asset pricing models. Therefore, it is important to understand the forecasting power of *cay* for stock market returns in real-time data, which is the main purpose of this paper.

Consistent with the early authors, e.g., Croushore and Stark (1999), we find that there are substantial revisions to consumption and labor income data; consequently, *cay* varies considerably across vintages.[5] For example, during the period 1996-97, *cay* is substantially below its sample average in real-time data, although it is above or around the sample average in

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returns. However, Guo (2002a) shows that *cay* always drives out *tay* if we add past stock market variance and the stochastically detrended risk-free rate to the forecasting equation.

[4] Cecchetti, Genberg, Lipsky, and Wadhwani (2000), among many others, argue that monetary authorities should incorporate information variables such as *cay* in the policymaking process because these variables provide a gauge about the deviation of stock prices from their fundamental values and thus forecast aggregate economic activity.

the 2002:Q3 vintage, the latest release when this paper was written. That is, in hindsight, there was no *irrational exuberance* in stock markets until 1998, which is over one year after the remarks by Fed Chairman Alan Greenspan. If investors had switched from stocks to bonds, as signaled by the level of real-time *cay*, they would have missed the stock market run-ups over this period. This example helps illustrate our main result that *cay* has negligible out-of-sample predictive power for stock market returns in real time. Similarly, given that stock prices continued to rise despite the irrational exuberance speech, Alan Greenspan switched to the *new economy* explanation in 1998, which led stock prices to rise further until the crash in 2000. This episode highlights the theoretical results in Bernanke and Gertler (1999, 2001): Although policymakers cannot ignore the dramatic movements in the equity market, it is tricky in practice for central banks to predict stock prices at the business-cycle frequency.[6] Therefore, our results suggest that investors and monetary authorities should be extremely cautious in using *cay* as an information variable.

Despite its poor real-time performance, our results are consistent with the early assessment that *cay* is a valid forecasting variable for at least three reasons. First, the revisions reflect the fact that the Bureau of Economic Analysis (BEA) has improved the quality of consumption and labor income data through (1) incorporating new information or methodologies and (2) reducing noise. If *cay* is theoretically motivated, it is expected to perform best in the current vintage, as we have documented in this paper. In other words, real-time *cay* doesn't

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[5] Revisions of net worth data constructed by the Federal Reserve Board are very small and thus have little effect on the predictive power of *cay*. This result should not be a surprise because most variations in net worth come from stock price movements, which are not subject to revisions.

[6] It is unlikely that Alan Greenspan used *cay* as a measure of the deviation of stock prices from their fundamental values because the first version of LL circulated in 1999. But many financial economists have made similar remarks using conventional information variables. For example, in their testimony before the Board of Governors of the Federal Reserve System on December 3, 1996, Campbell and Shiller argued that the stock market was overvalued because the price-to-dividend ratio, for example, was much higher than its historical average. But, as shown by

forecast stock returns out of sample because it is a poor measure of true *cay*.[7] Second, Inoue and Kilian (2002) argue that, while out-of-sample tests are not necessarily more reliable than in-sample tests, in-sample tests are more powerful than out-of-sample tests, even asymptotically. Indeed, we find that *cay* is a strong predictor of stock returns in the in-sample regression for various vintages, especially if we also add past stock variance to the forecasting equation, as suggested by the theory. Third and more importantly, real-time investors might obtain the same information about future stock returns from alternative sources. In particular, Guo and Savickas (2003) show that the value-weighted idiosyncratic volatility, which is directly observable and not subject to revisions, exhibits very similar forecasting patterns for stock market returns to those of *cay*.

The remainder of the paper is organized as follows. We discuss data in section I and present the forecasting results in section II. Section III offers some concluding remarks.

I. Data

A. Real-time cay

We use the exactly same formula as LL to construct *cay* in real-time data. We denote a variable, for example, consumption expenditure, as $C_{t,v}$, where t is the date of the observation and v is the date of the vintage. For example, $C_{1962:Q2,1962:Q3}$ is consumption expenditure of 1962:Q2 reported in the 1962:Q3 vintage. We define $C_{t,v}$ as

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Goyal and Welch (2003), among others, the price-dividend ratio doesn't forecast stock returns if we extend the sample beyond 1995.

[7] For example, in the 1999 comprehensive benchmark revision, the BEA reclassified the employer contributions of government employee retirement plans as "other labor income" instead of "transfer payments to persons." This change, which was intended to treat government plans consistently with those of the private sector and is thus appropriate, helps explain the difference between real-time *cay* and current vintage *cay* during the period 1996-97, as mentioned above.

(1) $$C_{t,v} = CN_{t,v} + CS_{t,v} - CNL_{t,v},$$

where $CN_{t,v}$ is non-durable consumption, $CS_{t,v}$ is services, and $CNL_{t,v}$ is shoes and clothing. Labor income, $Y_{t,v}$, is defined as

(2) $$Y_{t,v} = YPW_{t,v} + YPTP_{t,v} + YPL_{t,v} - YPSS_{t,v} - \frac{YPW_{t,v} \cdot YPX_{t,v}}{YPW_{t,v} + YOP_{t,v} + YRI_{t,v} + YPDV_{t,v} + YPIN_{t,v}},$$

where $YPW_{t,v}$ is wages and salaries, $YPTP_{t,v}$ is transfer payments, $YPL_{t,v}$ is other labor income, $YPSS_{t,v}$ is social security contributions, $YOP_{t,v}$ is proprietors' income with inventory valuation adjustment (IVA) and capital consumption adjustment (CCAdj), $YRI_{t,v}$ is rental income with CCAdj, $YPDV_{t,v}$ is personal dividend income, $YIN_{t,v}$ is personal interest income, and $YPX_{t,v}$ is personal tax and non-tax payment. Net worth, $A_{t,v}$, is directly available and doesn't require any transformation. We then divide $C_{t,v}$, $A_{t,v}$, and $Y_{t,v}$ by total population, $POP_{t,v}$, and by the corresponding price deflators. As in LL, we use the deflator of personal consumption expenditure, $JC_{t,v}$, for net worth and labor income, while each component of consumption in equation (1) has its own deflator: $JCN_{t,v}$ for non-durable consumption, $JCS_{t,v}$ for services, and $JCNL_{t,v}$ for shoes and clothing. We can sum up the real components of consumption directly before 1996, when the BEA used the fixed weighting scheme; however, we would have to construct real consumption using the Fisher ideal index subsequently when the BEA uses the chained weighting scheme.

We obtain real-time net worth data from the Federal Reserve Board.[8] The vintages span from 1995:Q3 to 2002:Q3 and the observations of each vintage start from 1952:Q1. Net worth data is available to the public with about a two-month delay, for example, the 2002:Q3 vintage contains observations from 1952:Q1 to 2002:Q2.

We follow Croushore and Stark (1999) in the collection of all the other real-time data from various issues and supplements of the *Survey of Current Business*. However, our timing convention is different from theirs. For example, for the 2002:Q3 vintage, Croushore and Stark use information up to August 15, 2002, the middle point of that quarter. In contrast, we incorporate all the information available at the end of the quarter and collect the data on September 30, 2002. Our approach is appropriate given that the purpose of this paper is to forecast stock returns using all the available information. Like net worth data, consumption and labor income are also available to the public with about a one-month delay. The vintages of consumption and labor income data spans from 1968:Q2 to 2002:Q3 and with a few exceptions, the observations of each vintage start from 1952:Q1 in order to match net worth data.[9] We compare the two common variables of our dataset, (1) real non-durable consumption and (2) real services, with those collected by Croushore and Stark; we find that they match very well except for the difference due to the timing convention mentioned above.[10]

For each vintage v, we estimate the ordinary least-squares (OLS) regression for the equation

$$(3) \qquad c_{t,v} = \alpha_v + \beta_{a,v} a_{t,v} + \beta_{y,v} y_{t,v} + \sum_{i=-k}^{k} b_{a,i,v} \Delta a_{t-i,v} + \sum_{i=-k}^{k} b_{y,i,v} \Delta y_{t-i,v} + \varepsilon_{t,v},\ t \le v-1,$$

where lower cases denote log, real, and per capita variables; Δ denotes the first difference; α_v, $\beta_{a,v}$, $\beta_{y,v}$, $b_{a,i,v}$, and $b_{y,i,v}$ are coefficients; and $\varepsilon_{t,v}$ is the error term. It should be noted that, as in LL, $a_{t,v}$ is the net worth at the beginning of the period and we set k equal to 8. Thus $cay_{t,v}$ is the

[8] We thank Michael Palumbo at the Federal Reverse Board for providing real-time net worth data.
[9] The observations of some vintages start from a later date. For example, after the 1996 comprehensive revision, the BEA didn't release the observations prior to 1959 until 1997:Q2.
[10] We provide a detailed discussion of data in an appendix, which is available upon request.

deviation from the trend or $cay_{t,v} = c_{t,v} - \hat{\beta}_{a,v} a_{t,v} - \hat{\beta}_{y,v} y_{t,v}$, where hats denote the estimated parameters.

B. Data Revisions

After the release of the end of quarter data, as we collect from various issues of *Survey of Current Business*, the BEA revises data on a regular basis, including the 1-year revision, the 3-year revision, and the comprehensive benchmark revision about every 5 years. We denote a revision

(4) $R_{v1,v2}(x_t) = x_{t,v2} - x_{t,v1}$, $t < v1, t < v2,$ and $v1 < v2$.

As suggested by Mankiw, Runkle, and Shapiro (1984) and Croushore and Stark (1999), among others, the revision can be characterized as (1) containing news or (2) reducing noise. In the first case, the revision $R_{v1,v2}(x_t)$ is correlated with the subsequent release, $x_{t,v2}$, but not related with the earlier release, $x_{t,v1}$, because $x_{t,v2}$ contains new information beyond $x_{t,v1}$. Also, given that $x_{t,v1}$ is an efficient estimate of $x_{t,v2}$, the variance of $x_{t,v2}$ is larger than the variance of $x_{t,v1}$. In the second case, however, the revision, $R_{v1,v2}(x_t)$, is correlated with the earlier release, $x_{t,v1}$, but not the subsequent release, $x_{t,v2}$, because the latter just eliminates the noise of the former. Similarly, the variance of $x_{t,v2}$ is smaller than the variance of $x_{t,v1}$.

Following Croushore and Stark (1999), we define the initial released growth rate of consumption as $\Delta c_t^p = c_{t-1,t} - c_{t-2,t}$, where $c_{t-1,t}$ is the last observation of vintage *t*. It should be noted that our notation reflects the fact that macrovariables are available with a one-quarter delay. To analyze the effect of the revisions, we also calculate the growth rate in the vintage one year later as $\Delta c_t^1 = c_{t-1,t+4} - c_{t-2,t+4}$, in the vintage three years later as $\Delta c_t^3 = c_{t-1,t+12} - c_{t-2,t+12}$, and in the current vintage as $\Delta c_t^c = c_{t-1,c} - c_{t-2,c}$, where c refers to the 2002:Q3 vintage (the latest release when this paper was written). We calculate the growth rates for labor income and net worth in the same fashion.

Table 1 reports the standard deviation of the growth rates for both the full sample (upper panel) and the post-1996 subsample (lower panel). All numbers are reported in percentage. As mentioned above, real-time net worth is available only in the post-1996 subsample. We report the results of real per capita consumption and labor income; however, we use nominal net worth because we want to show that nominal net worth is not much revised.

In the full sample, the standard deviation increases from the initial release to the 1-year-later release and falls from the 1-year-later release to the 3-year-later release for both consumption and labor income. From the 3-year-later release to the latest release, the standard deviation rises for consumption and is about the same for labor income. Therefore, while the revision from the initial to the 1-year-later releases reflects mainly news, the subsequent revisions normally reduce noise. These patterns are consistent with those documented by Croushore and Stark (1999), who analyze a large set of macrovariables.[11]

Because of the relatively small number of vintages, we do not consider the 3-year-later release in the lower panel of the post-1996 subsample. Consumption exhibits the same pattern as in the full sample. However, for labor income, the variance increases dramatically from 0.35 for the 1-year-later release to 0.50 for the current vintage, indicating that the revision from 1-year-later release to the latest release incorporates substantial news. For net worth, the revision from the initial to the 1-year-later releases reduces noise, while the subsequent revision incorporates news. Nevertheless, the relative change in the variance of net worth is much smaller than that of consumption and labor income, indicating that the net worth data are reliably measured in real time. This difference reflects the fact that most variations in net worth are accounted for by stock price movements, which are not subject to revisions. To further illustrate this point, we report the correlation among the growth rates of the various releases in Table 2. As expected, the correlation coefficients of net worth are almost equal to one and are much larger than those of consumption and labor income. It should be noted that, in the post-1996 subsample, the correlation coefficient between the initial and latest releases of labor income is only 0.34. This result explains the substantial difference between real-time and current vintage *cay* in forecasting stock market returns, as we show below.

Table 3 reports the correlation coefficient between the revision and the growth rate, with the heteroskedastic-consistent t-statistics in parentheses. Bold denotes significant at the 5 percent level. In the full sample, the revision of consumption from the initial to the 1-year-later releases reflects adding news rather than reducing noise. However, the subsequent revisions both incorporate news and reduce noise. We document a similar pattern for labor income. In the post-1996 subsample, however, while the revision of consumption mainly reflects reducing noise, the revision of labor income incorporates substantial new information. In contrast, the correlation is never statistically significant for net worth because the revision of net worth is rather small, as shown in Tables 1 and 2.

C. Other Forecasting Variables and Stock Market Returns

We download the data of stock market returns and the risk-free rate from the website of Kenneth French at Dartmouth College and excess stock market return is the difference between

[11] Our results are not sensitive to the switch from the fixed weighting to the chained weighting in 1996 since we find very similar results using the vintages from 1968:Q2 to 1995:Q4. Croushore and Stark (1999) also use the pre-1996

these two variables.[12] Return data are available at monthly frequency and we aggregate them into quarterly data through compounding. As mentioned above, we also use realized stock market variance and the stochastically detrended risk risk-free rate as additional forecasting variables. Following Merton (1980) and many others, we construct quarterly realized stock market variance using daily stock market return data, which is assumed to be the return on the S&P 500 index.[13] As in Campbell, Lettau, Malkiel, and Xu (2001), we adjust downward realized stock market variance for 1987:Q4 because the 1987 stock market crash has confounding effects on it. The stochastically detrended risk-free rate, *rrel*, is the difference between the nominal risk-free rate and its last four-quarter average. It should be noted that these financial variables are never revised.

II. Empirical Results

As shown in the preceding section, the revisions of net worth are very small relative to those of consumption and labor income. In this section, we first assume that there are no revisions in net worth and use its latest release (2002:Q3) for all vintages. This assumption allows us to analyze the performance of *cay* using vintages from 1968:Q2 to 2002:Q3 in forecasting stock market returns over the period 1968:Q3 to 2002:Q4, an updated sample analyzed by LL. For robustness, we also analyze a shorter subsample of vintages from 1996:Q1

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vintages.

[12] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html. We obtain very similar results using the return on the S&P 500 index as well as the CRSP (the Center of Research on Security Prices) value-weighted stock market return. These results are available upon request. We don’t use the CRSP data here because it was available to us only up to 2001 when this paper was first written.

[13] We obtain almost identical results using the CRSP daily value-weighted stock market return. We don’t use the CRSP data here because it was available to us only up to 2001 when this paper was first written.

to 2002:Q3, over which real-time net worth is available.[14] However, for the post-1996 subsample, the results obtained from real-time net worth data are very similar to those from the latest net worth data. This last result should not be a surprise because net worth data are not much revised, as shown in Tables 1-3.

A. Full Sample: Vintages 1968:Q2 to 2002:Q3

Figure 1 plots the estimated cointegration parameters of equation (3) for the vintages 1968:Q2 through 2002:Q3. The straight line is $\beta_{y,v}$ and the dashed line is $\beta_{a,v}$. For comparison, we also superimpose the thick straight line ($\beta_{y,v}$) and the thick dashed line ($\beta_{a,v}$) estimated using the current (2002:Q3) vintage. It should be noted that, unless otherwise indicated, we use the exactly same procedure for the current vintage *cay* as that for real-time *cay* throughout the paper: The only difference between the two is that the latter also incorporates data revisions. For example, we estimate the cointegration parameters recursively and use two-quarter lagged macrovariables to forecast returns.

Figure 1 shows that real-time cointegration parameters change substantially after the comprehensive benchmark revisions as denoted by the vertical bars. For both real-time and current vintage data, the estimated cointegration parameters appear to be relatively stable after 1991, although they fluctuate widely during the earlier periods because of the relatively small number of observations used in the estimation. Moreover, the real-time estimates track closely their counterparts of the current vintage after 1996 when the BEA switched to the chained weighting from the fixed weighting. Therefore, estimating cointegration parameters recursively should have little effect on the out-of-sample performance of *cay* after 1996.

[14] The BEA uses the fixed weighting scheme before 1996, which, as we show below, has a confounding effect on the forecasting ability of *cay*. To avoid this complication, we focus on the post-1996 sample, even though the vintages of net worth start from 1995:Q3.

Figure 2 plots the adjusted R^2 of in-sample regression using vintages 1968:Q2 to 2002:Q3 for real-time data (solid line), along with the adjusted R^2 obtained from the current vintage (dashed line) over the corresponding period. In addition to *cay*, we also include realized stock market variance and the stochastically detrended risk-free rate in the forecasting equation. Consistent with Guo (2002a), past stock variance improves the forecasting power of *cay* substantially for all vintages; however, our results are not sensitive to whether we include the stochastically detrended risk-free rate or not. Figure 2 shows that the adjusted R^2 of real-time *cay* is always above 15 percent and exhibits a similar pattern to that of the current vintage, especially after 1996. It should also be noted that *cay* is statistically significant at the conventional level except a few early vintages because the cointegration parameters are not precisely estimated in these vintages, as shown in Figure 1. Therefore, consistent with LL and Guo (2002a), among others, *cay* is a strong in-sample predictor of stock market returns in real-time data.

Table 4 compares the out-of-sample performance of the real-time consumption-wealth ratio (cay_{RT}) with that of the current vintage (cay_{CV}).[15] We consider two forecasting specifications: (1) *cay* only (columns 2 and 3) and (2) *cay* augmented by past stock market variance, σ^2, and the stochastically detrended risk-free rate, *rrel* (columns 4 and 5). For comparison, we also include a benchmark of constant stock market return (column 1). In panel A, we use the vintages 1968:Q2 to 2002:Q3 to make one-quarter-ahead forecasts of stock returns over the period 1968:Q3 to 2002:Q4. Real-time data performs substantially worse than the current vintage does: cay_{RT} (column 2) has a root-mean-squared forecasting error (RMSFE) of 0.0957, much larger than the RMSFE of 0.0916 for cay_{CV} (column 3). However, they are both

[15] It should be noted that, as mentioned above, we use the latest release rather than real-time data for net worth in Table 4. We investigate real-time net worth in Table 5 below.

bigger than the RMSFE of 0.0907 for the benchmark model of constant return (column 1).[16] Consistent with Guo (2002a), we find that the augmented model performs substantially better than the corresponding model of *cay* by itself for both real-time data (column 4) and the current vintage (column 5). However, again, real-time *cay* performs considerably worse than its current vintage counterpart: While the former has a RMSFE of 0.0938, the RMSFE is 0.0895 for the latter. Overall, the augmented cay_{CV} is the only model that performs better than the benchmark model of constant return.

Panel B of Table 4 reports qualitatively the same results for the forecast period 1996:Q2 to 2002:Q4, over which the cointegration parameters are relatively stable for both real-time and current vintage data, as shown in Figure 1. Therefore, the poor forecasting performance of real-time *cay* cannot be solely explained by the large variations in the estimated cointegration parameters.

Following Leitch and Tanner (1991) among many others, we also investigate whether we can exploit the forecasting ability of *cay* using a simple but popular trading strategy, i.e., hold stocks (bonds) if the one-quarter-ahead forecast of excess return is positive (negative). To save space, we report only the results of the augmented model, which are similar to the model that uses only *cay*.[17] For comparison, in Figure 3, we first plot the return on the managed portfolio (thick solid line) based on the current vintage, along with the return on the buy-and-hold portfolio (dashed line). We find that the switching strategy avoids several large downward movements in the stock market. Overall, based on this strategy, a $100 investment in 1968:Q3 grew to $7,621 by 2002:Q4, which is over three times as much as the $2,483 gained with the

[16] Lettau and Ludvigson (2001a) find that *cay* performs better than the benchmark model of constant return using the 1998:Q3 vintage data.

[17] We also find similar results using the strategy of choosing optimal portfolio weight, as analyzed in Guo (2002a) and many others.

buy-and-hold strategy. In stark contrast, however, Figure 4 shows that the switching strategy (thick solid line) performs poorly in real time; for example, it misses most stock market run-ups in the 1990s. Overall, real-time switching strategy turned the $100 investment into $2,567, slightly above that of the buy-and-hold strategy.

As mentioned above, the BEA used a fixed weighting price index before 1996, which suffers from a so-called substitution bias. Moreover, the substitution bias is amplified in the calculation of *cay* because, as in LL, we use different price deflators for consumption, labor income, and net worth. As a result, during the early 1990s, *cay* is overly downward biased in real-time data relative to the current (2002:Q3) vintage, which is free of the substitution bias. Unfortunately, our data source doesn't provide enough details to allow us to construct the chained weighting price index prior to 1996. However, we might partially solve this problem by deflating labor income and net worth using the price deflator of consumption as defined by equation (1), rather than that of the personal consumption expenditure. Figure 5 shows that, although the switching strategy based on modified real-time *cay* captured some stock market run-ups in the early 1990s, it still missed quite a few large gains during the period 1996-97. Overall, the $100 investment grew to $3,542, which is far less than that from the current vintage. Moreover, the modified real-time *cay* has a bigger RMSFE than the benchmark of constant return as well.

B. Post-1996 Subsample: Vintages 1996:Q1 to 2002:Q3

The post-1996 vintages are particularly interesting for the following reasons. First, over this period, we have all the required data, including net worth, to construct real-time *cay.* Second, the BEA switched to the chained weighting scheme in 1996. Focusing on the post-1996 subsample, we avoid the undesirable complication brought about by the substitution bias associated with the fixed weighting scheme used previously. Third, a relatively large number of observations are required to obtain sensible estimates of the cointegration parameters. As shown in Figure 1, the parameter estimates appear to be quite stable from the 1996 vintage on. Therefore, the vintages of 1996:Q1 to 2002:Q3 allow us to make a reliable assessment about the forecasting ability of *cay* in real time.

Table 5 reports the RMSFE. For comparison, we also include the results of the current vintage and the benchmark model of constant return, which are the same as those in panel B of Table 4. Again, real-time data performs substantially worse than the current vintage: RMSFE is 0.1145 for cay_{RT} and is 0.1123 for the augmented cay_{RT}, compared with 0.1063 and 0.1014 for cay_{CV} and the augmented cay_{CV}, respectively. Most importantly, they are both larger than the RMSFE of 0.1042 for the benchmark model of constant return, indicating that real-time *cay* has negligible out-of-sample forecasting power for stock returns. Interestingly, the augmented cay_{CV} is again the only model that beats the benchmark of constant return. We also note that these results are very similar to those in the lower panel of Table 4, in which current vintage of net worth is used to calculate real-time *cay*.

To illustrate why *cay* performs poorly in real time, we plot in Figure 6 the one-quarter-ahead forecast from both real-time data (solid line with square) and current vintage (dashed line with triangle), along with the realized stock market returns (thick solid line). Compared with the current vintage, the real-time forecast is downward biased during the period 1996-97 and is upward biased during the period 2000-01. This is because, as shown in Figure 7, real-time *cay* (solid line) is severely downward biased during the period 1996-97 and is upward biased during the period 2000-01 relative to the current vintage (dashed line).[18] In hindsight, the current vintage suggests that the stock market did not exhibit *irrational exuberance* until the middle of 1998, more than one year after the remarks by Fed Chairman Alan Greenspan. Similarly, LL claim that "over this period (last five years), consumption often remained far below its trend relationship with assets and labor earnings." That is, *cay* has been below the sample average since 1995:Q4 in the 1998:Q3 vintage reported by LL. However, in the 2002:Q4 vintage constructed by the same authors, *cay* remains above the sample average until 1997:Q3.[19] Therefore, the concern about the stock market overvaluation is clearly exaggerated in real-time data. This difference also accounts for the poor performance of real-time switching strategy. As shown in Figure 8, a real-time investor would have missed stock market run-ups in 1996-97 and suffered from a big loss in 2000 (thick solid line with square), compared with the outcome from the current vintage (dashed line with triangle).

The discrepancy between real-time data and the latest release reflects the ongoing revisions by the BEA as discussed in the preceding section. In particular, as shown in panel B of Table 3, the final labor income data incorporate substantial new information in the post-1996 sample. For example, the BEA reclassified the employer contributions of government employee retirement plans as "other labor income" instead of "transfer payments to persons" in the 1999 comprehensive revision. Accordingly, the dividend and interest paid to these plans were reclassified as personal interest income and personal dividend income, respectively. As a result, labor income defined by equation (2) was substantially revised downward and thus *cay* was revised upward for the period 1996-97.

[18] For each date in Figure 7, for example, 1996:Q1, we first estimate *cay* using the 1996:Q1 vintage (observations up to 1995:Q4 for the current vintage data), then subtract the sample mean from it, and use the value of the last observation for 1996:Q1.

III. Conclusion

In the past two decades, there has been an on-going debate about stock market return predictability. In particular, while many early authors find that some variables forecast stock market returns in sample, others attribute the in-sample evidence to data snooping because these variables have negligible out-of-sample predictive power. Recently, Lettau and Ludvigson (2001a) and Guo (2002a) find that the consumption-wealth ratio forecasts stock returns out of sample, especially when combined with past stock market variance. In this paper, however, we add another controversy to this literature: While the consumption-wealth ratio forecasts stock market returns out of sample in the current vintage data, it doesn't do so in real-time data. This difference reflects the fact that real-time consumption-wealth ratio is a biased estimate of its true value because of the ongoing revisions of consumption and labor income data. Investors and monetary authorities, therefore, should be extremely cautious in using the consumption-wealth ratio to predict stock market movements.

Our results, however, don't contradict the early assessment that the consumption-wealth ratio is a valid forecasting variable for stock market returns, given that it is significant in the in-sample regression for most vintages. Also, recent results by Guo and Savickas (2003) suggest that investors might obtain the same information about future stock returns from alternative sources, namely, the value-weighted idiosyncratic volatility. Moreover, we note that the current vintage consumption-wealth ratio has the smallest measurement errors among all vintages and thus is the best proxy for conditional stock market returns. Therefore, as argued by Lettau and Ludvigson (2003a), it should have important implications for understanding asset price movements and their implications for aggregate economy.

[19] We obtain both vintages from Martin Lettau at New York University, which can also be replicated using our real-time data.

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Table 1. Standard Deviations of Growth Rates

Data Set	Consumption	Net Worth	Labor Income
	Vintages 1968:Q2 to 1999:Q3		
Initial	0.47		0.84
1-Year-Later	0.49		0.90
3-Year-Later	0.44		0.88
Latest	0.46		0.88
	Vintages 1996:Q1 to 2001:Q3		
Initial	0.32	3.41	0.28
1-Year-Later	0.33	3.38	0.35
Latest	0.24	3.47	0.50

Note: We define the initial released growth rate of consumption as $\Delta c_t^p = c_{t-1,t} - c_{t-2,t}$, where $c_{t-1,t}$ is the last observation of each vintage. It should be noted that our notation reflects the fact that macrovariables are available with a one-quarter delay. To analyze the effect of the revisions, we also calculate the growth rate in the vintage one year later as $\Delta c_t^1 = c_{t-1,t+4} - c_{t-2,t+4}$, in the vintage three years later as $\Delta c_t^3 = c_{t-1,t+12} - c_{t-2,t+12}$, and in the latest (2002:Q3) vintage as $\Delta c_t^c = c_{t-1,c} - c_{t-2,c}$. We define the growth rates for labor income and net worth in the same fashion. We report the results of real, per capita consumption and labor income; however, we use nominal net worth because we want to show that nominal net worth is not much revised. All numbers are reported in percentage.

Table 2. Correlation between Growth Rates of Different Vintages

Panel A. Consumption

	Initial	1-Year-Later	3-Year-Later	Latest
		Vintages 1968:Q2 to 1999:Q3		
Initial	1.00			
1-Year-Later	0.86	1.00		
3-Year-Later	0.75	0.86	1.00	
Latest	0.69	0.76	0.86	1.00
		Vintages 1996:Q1 to 2001:Q3		
Initial	1.00			
1-Year-Later	0.93	1.00		
Latest	0.78	0.87		1.00

Panel B. Labor Income

	Initial	1-Year	3-Year	Latest
		Vintages 1968:Q2 to 1999:Q3		
Initial	1.00			
1-Year-Later	0.88	1.00		
3-Year-Later	0.84	0.91	1.00	
Latest	0.81	0.89	0.96	1.00
		Vintages 1996:Q1 to 2001:Q3		
Initial	1.00			
1-Year-Later	0.55	1.00		
Latest	0.50	0.34		1.00

Panel C. Net Worth

	Initial	1-Year	3-Year	Latest
		Vintages 1996:Q1 to 2001:Q3		
Initial	1.00			
1-Year-Later	0.99	1.00		
Latest	0.99	1.00		1.00

Note: We define the initial released growth rate of consumption as $\Delta c_t^p = c_{t-1,t} - c_{t-2,t}$, where $c_{t-1,t}$ is the last observation of each vintage. It should be noted that our notation reflects the fact that macrovariables are available with a one-quarter delay. To analyze the effect of the revisions, we also calculate the growth rate in the vintage one year later as $\Delta c_t^1 = c_{t-1,t+4} - c_{t-2,t+4}$, in the vintage three years later as $\Delta c_t^3 = c_{t-1,t+12} - c_{t-2,t+12}$, and in the latest (2002:Q3) vintage as $\Delta c_t^c = c_{t-1,c} - c_{t-2,c}$. We define the growth rates for labor income and net worth in the same fashion. We report the results of real, per capita consumption and labor income; however, we use nominal net worth because we want to show that nominal net worth is not much revised.

Table 3. Correlation between Revisions and Growth Rates

A. Consumption

Revisions/Data Set	Initial	1-Year	3-Year	Final
		Vintages 1968:Q2 to 1999:Q3		
Initial to 1-Year	-0.17	**0.35**	**0.28**	**0.20**
	(-1.45)	(3.34)	(3.12)	(2.13)
Initial to 3-Year	**-0.42**	-0.07	**0.29**	0.18
	(-5.00)	(-0.79)	(2.88)	(1.78)
Initial to Final	**-0.41**	-0.14	0.13	**0.38**
	(-4.72)	(-1.76)	(1.44)	(4.80)
		Vintages 1996:Q1 to 2001:Q3		
Initial to 1-Year	-0.10	0.26		0.32
	(-0.53)	(1.35)		(1.75)
Initial to Final	**-0.66**	**-0.45**		-0.04
	(-4.88)	(-2.35)		(-0.28)

B. Labor Income

Revisions/Data Set	Initial	1-Year	3-Year	Final
		Vintages 1968:Q2 to 1999:Q3		
Initial to 1-Year	-0.11	**0.38**	0.28	0.28
	(-1.89)	(2.03)	(1.66)	(1.57)
Initial to 3-Year	**-0.21**	0.13	**0.36**	**0.33**
	(-3.63)	(0.66)	(2.40)	(2.14)
Initial to Final	**-0.25**	0.07	0.26	**0.37**
	(-3.60)	(0.36)	(1.56)	(2.42)
		Vintages 1996:Q1 to 2001:Q3		
Initial to 1-Year	**-0.30**	**0.64**		-0.08
	(-3.17)	(4.13)		(-0.44)
Initial to Final	-0.07	0.04		**0.83**
	(-0.47)	(-0.18)		(10.65)

C. Net Worth

Revisions/Data Set	Initial	1-Year	3-Year	Final
		Vintages 1996:Q1 to 2001:Q3		
Initial to 1-Year	-0.13	-0.02		-0.04
	(-0.33)	(-0.06)		(-0.15)
Initial to Final	0.08	0.17		0.20
	(0.42)	(0.95)		(1.15)

Note: We define the initial released growth rate of consumption as $\Delta c_t^p = c_{t-1,t} - c_{t-2,t}$, where $c_{t-1,t}$ is the last observation of each vintage. It should be noted that our notation reflects the fact that macrovariables are available with a one-quarter delay. To analyze the effect of the revisions, we also calculate the growth rate in the vintage one year later as $\Delta c_t^1 = c_{t-1,t+4} - c_{t-2,t+4}$, in the vintage three years later as $\Delta c_t^3 = c_{t-1,t+12} - c_{t-2,t+12}$, and in the latest (2002:Q3) vintage as $\Delta c_t^c = c_{t-1,c} - c_{t-2,c}$. The revision, for example, from initial to 1 year, is defined as $\Delta c_t^1 - \Delta c_t^p$. We define the growth rates and revisions for labor income and net worth in the same fashion. We report the results of real, per capita consumption and labor income; however, we use nominal net worth because we want to show that nominal net worth is not much revised. We report heteroskedastic-consistent t-statistics in parentheses and bold denotes significant at the 5 percent level.

Table 4. Root-Mean-Squared Forecasting Error: Current Vintage Net Worth

	(1) Constant	(2) cay_{RT}	(3) cay_{CV}	(4) cay_{RT}+$rrel$+σ^2	(5) cay_{CV}+$rrel$+σ^2
			Panel A. 1968:Q3 to 2002:Q4		
RMSFE	0.0907	0.0957	0.0916	0.0938	0.0895
			Panel B. 1996:Q2 to 2002:Q4		
RMSFE	0.1042	0.1149	0.1063	0.1122	0.1014

Note: This table reports root-mean-squared forecasting error (RMSFE) of five forecasting models: (1) the benchmark of constant return (Constant); (2) real-time *cay* (cay_{RT}); (3) current vintage *cay* (cay_{CV}); (4) real-time *cay* augmented by the stochastically detrended risk-free rate and past stock market variance (cay_{RT}+$rrel$+σ^2); and (5) current vintage *cay* augmented by the stochastically detrended risk-free rate and past stock market variance (cay_{CV}+$rrel$+σ^2). We use real-time consumption and labor income data, and the latest vintage of net worth in the construction of real-time *cay*. In panel A we use vintages 1968:Q2 to 2002:Q3 to forecast stock market returns over the period 1968:Q3 to 2002:Q4. In panel B we use vintages 1996:Q1 to 2002:Q3 to forecast stock market returns over the period 1996:Q2 to 2002:Q4.

Table 5. Root-Mean-Squared Forecasting Error: Real Time Net Worth

	(1) Constant	(2) cay_{RT}	(3) cay_{CV}	(4) $cay_{RT}+rrel+\sigma^2$	(5) $cay_{CV}+rrel+\sigma^2$
			1996:Q2 to 2002:Q4		
RMSFE	0.1042	0.1145	0.1063	0.1123	0.1014

Note: This table is the same as panel B of Table 4 except that we use real-time net worth data in the calculation of real-time *cay*. See note of Table 4 for details.

Figure 1. Cointegration Parameters: Real Time vs. Current Vintage (Thick Lines)

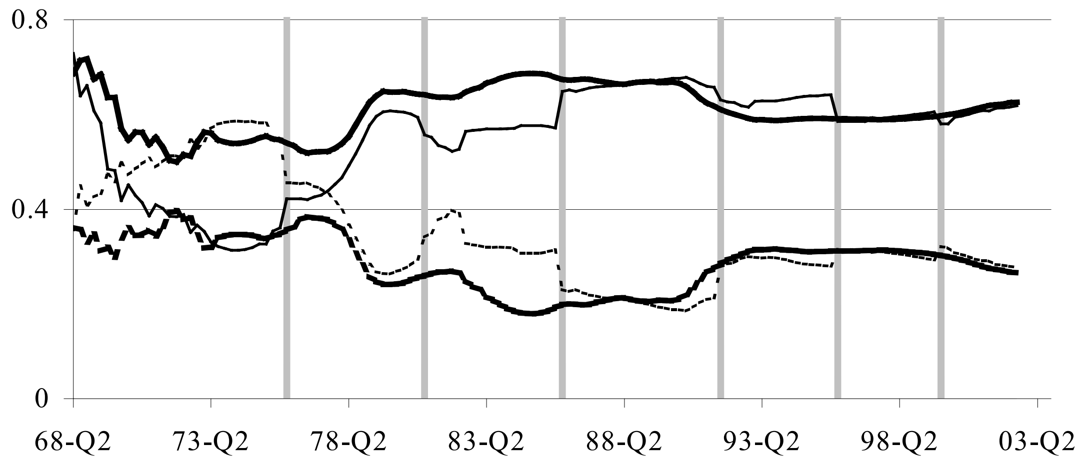

Figure 2. Adjusted R^2: Real Time (Thick Solid Line) vs. Current Vintage (Dashed Line)

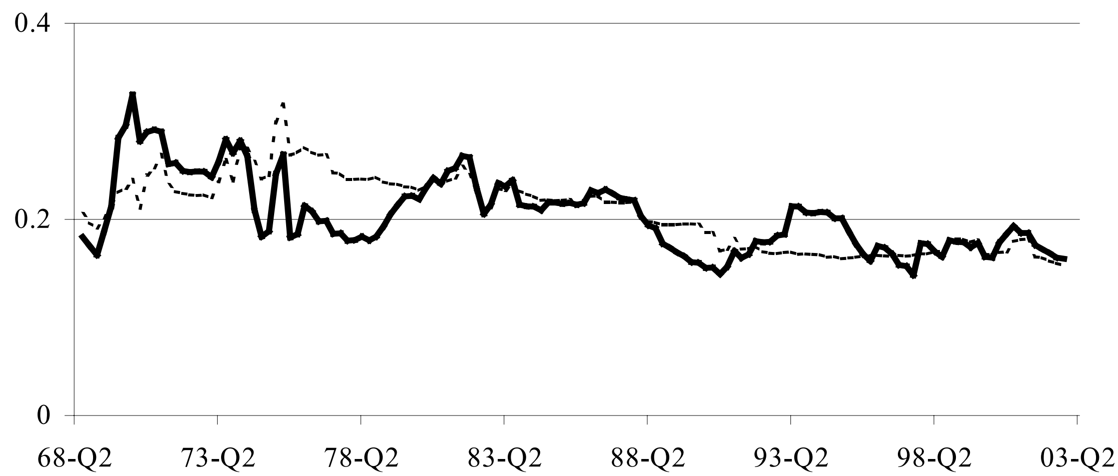

Figure 3. Switching Strategy in Current Vintage (Thick Solid Line) vs.
Buy and Hold (Dashed Line)

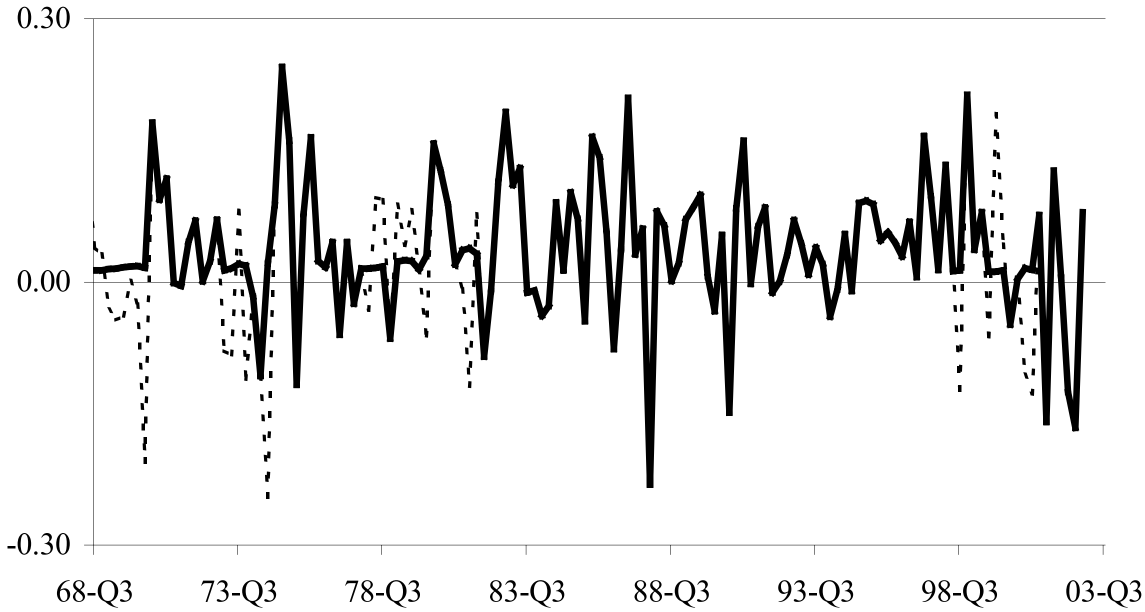

Figure 4. Switching Strategy in Real Time (Thick Solid Line) vs. Buy and Hold (Dashed Line)

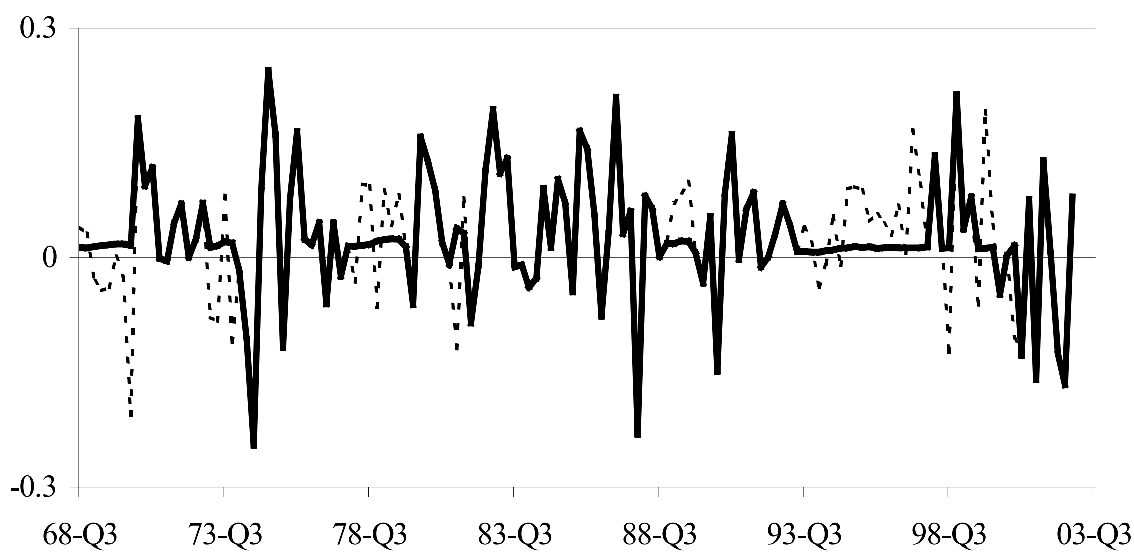

Figure 5. Switching Strategy in Real Time with Common Price Deflator (Thick Solid Line) vs. Buy and Hold (Dashed Line)

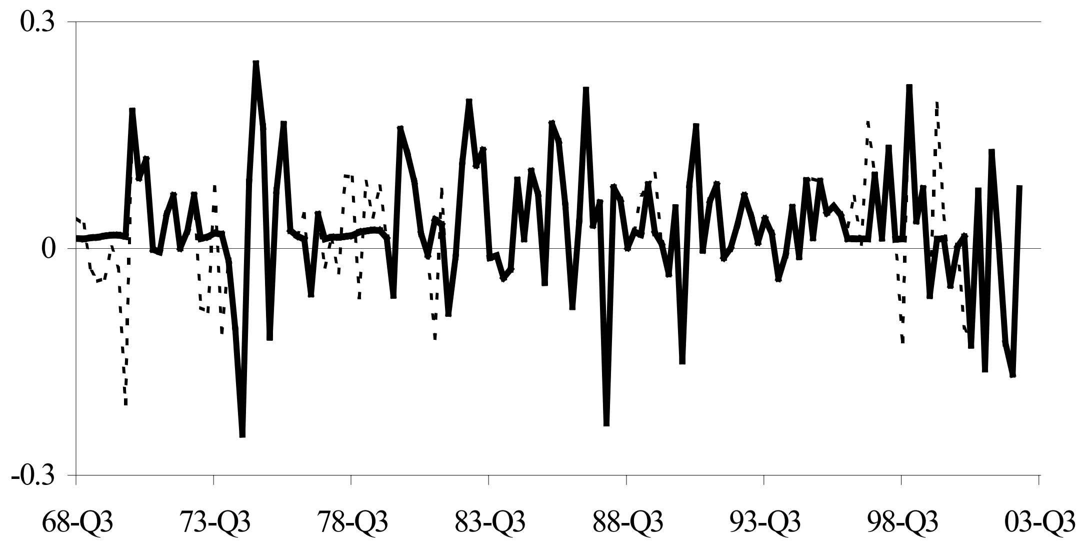

Figure 6. One-Quarter-Ahead Forecast: Real Time (Solid Line with Square), Current Vintage (Dashed Line with Triangle), and Realized Return (Thick Solid Line)

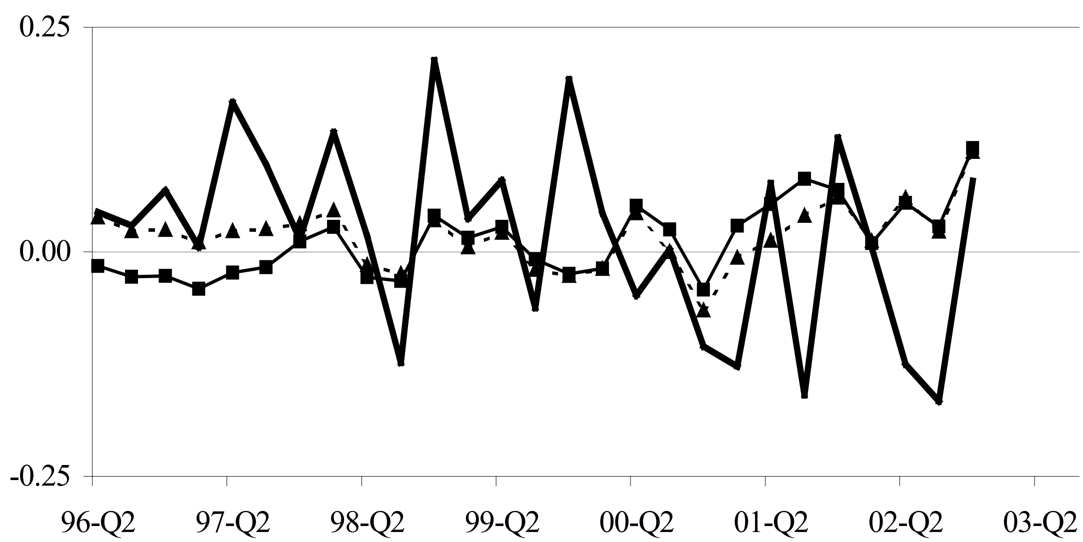

Figure 7. Demeaned *cay*: Real Time (Thick Solid Line) vs. Current Vintage (Dashed Line)

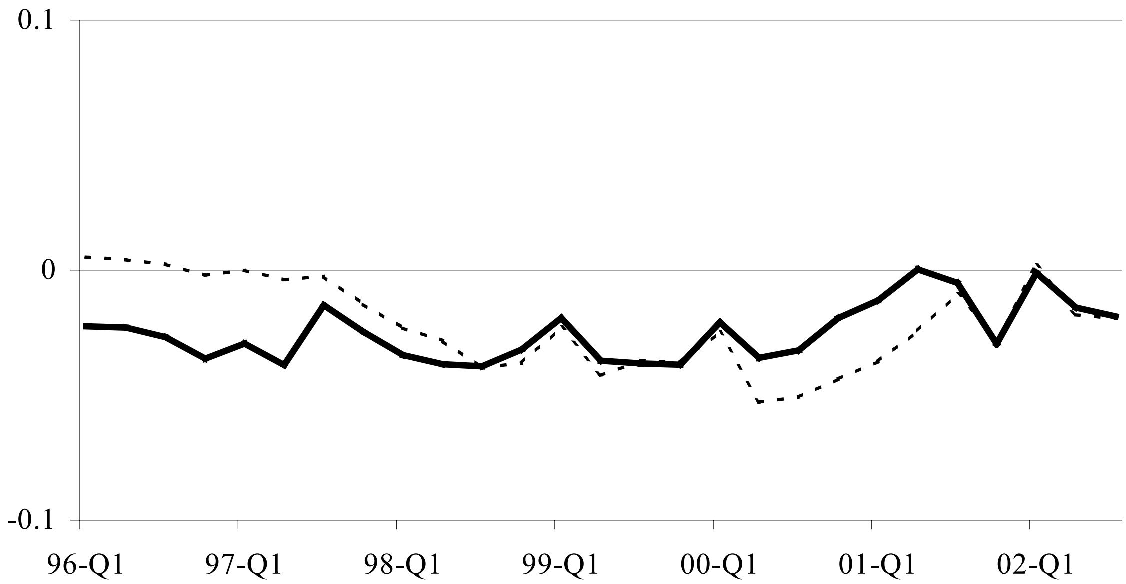

Figure 8. Switching Strategies: Real Time (Thick Solid Line) vs. Current Vintage (Dashed Line)