Do Personal Consumption Expenditures Reflect Investor Stock Sentiment?

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Abstract

If investors choose consumption and investment levels jointly to maximize expected utility, then investor sentiment about stock returns should have an affect on consumption choices. I find a positive contemporaneous relationship between aggregate consumption of nondurables and investor stock sentiment. Investors' false perceptions of changes in stock market wealth appear to move consumption in the same direction initially. But as expected stock returns do not materialize, sentiment-based consumption is reversed. On average, this reversal occurs two to four years later, which coincides with the time it takes for sentiment to correct from prior levels. Sentiment does not positively predict returns as a positive proxy of rational expectations of risk would. Nor does sentiment negatively predict the covariance between consumption growth and returns as an inverse proxy for rational expectations of risk would. The results suggest that bias in investor expectations is an important factor in consumption-based asset pricing models.

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1 Introduction

In traditional general equilibrium asset pricing theory, investors maximize expected utility with a specific combination of current consumption and investment. As a result, the optimal level of current consumption is influenced by investors' expectations of the investment payoff. Housing wealth and the stock market comprise the bulk of the aggregate investment portfolio; therefore bias in investor expectations about stock market returns should be accompanied by bias in consumption choices. I investigate the relationship between the Baker and Wurgler (2007) measure of investor stock sentiment and consumption, and find a positive contemporaneous relationship between aggregate consumption of nondurables and aggregate investor stock sentiment. I also find a subsequent reversal in sentiment-based consumption—sentiment negatively predicts consumption of nondurables two to four years into the future.

Compared to the quantity of research regarding the role of sentiment in investment outcomes, relatively little research has been conducted on the role of investor sentiment in consumption outcomes. This is surprising, since a central idea in modern asset pricing theory is that investment and consumption levels are determined jointly in equilibrium. The canonical mechanism to determine equilibrium in consumption-based models of aggregate asset prices is for a representative agent to allocate resources between consumption and investment so that expected utility is maximized. Under this paradigm, if the expected risk-adjusted payoff of investment is affected by the representative agent's bias, then the level of consumption is also affected by investor bias.

In addition to asset pricing theory, consumption data is also central to the calibrations of many theoretical asset pricing models. Hence it is important to investigate whether consumption data reflects the outcome of a completely rational optimization process, or if data also reflects investor bias. In this study, investor stock sentiment is defined as the bias in investors' expectations of risk-adjusted stock market returns. Investor sentiment can be over–optimistic (pessimistic) because investors' expectations

of future payoffs are positively (negatively) biased, or because investors' perceptions of payoff risks are negatively (positively) biased.

To isolate the potential effects of stock sentiment on consumption, I control for consumption's relationship to labor income, equity wealth, and housing wealth. Traditional wealth effects studies seek to measure the marginal propensity to consume in response to changes in wealth and income. Most changes in consumption are related to changes in labor income. Therefore wealth effect studies in macroeconomics have focused on measuring consumption's relation to asset wealth, while holding labor income constant. The marginal propensity to consume changes in wealth is called a wealth effect. My study focuses on the marginal propensity to consume in response to a measure of *perceived* changes in wealth. I define the *sentiment wealth effect* as the change in consumption that corresponds to a change in investor sentiment regarding stock market returns.

Without direct tests, it is unclear if a sentiment wealth effect would be positive or negative. If positive (negative) stock sentiment causes investors to believe that they have more (less) current or future stock wealth, then positive (negative) sentiment can cause investors to consume more (less). Then again, because of positive (negative) stock sentiment, investors may expect a high (low) return on their stock investment, which encourages investors to substitute their consumption towards (away from) stock investment.

Any wealth effect will reflect a combination of income and substitution effects from a change in perceived wealth. When the income effect dominates then the sentiment wealth effect will be positive. When the substitution effect dominates then the sentiment wealth effect will be negative. It is also possible that the income and substitution effects cancel out in aggregate, so that unconditionally there is no sentiment wealth effect. However, to my knowledge, existing tests of the determinants of consumption have not investigated the potential effects of investor stock sentiment.

Using several econometric approaches, I find a robust positive contemporaneous relationship between stock sentiment and consumption of nondurable goods. However,

the apparent attempt to smooth consumption in response to perceived changes in future stock returns is counterproductive. On average, when investors' biased expectations do not materialize, and their sentiment corrects, I find a corresponding correction in their previous sentiment-influenced consumption choices.

I also consider the possibility that the measure of sentiment I use might capture changes in rationally assessed risk rather than investor bias. Focusing on the relationship between investor sentiment and consumption allows for new more direct ways to test if sentiment proxies for risk or not by measuring consumption growth's relationship to sentiment. I show that consumption growth, the consumption level, investor sentiment, and stock returns are not related in a way consistent with sentiment being a proxy for rationally assessed stock market risk. Investor sentiment does not positively predict returns as it should if it is positively correlated with rational expectations of risk. At the same time, sentiment does not negatively predict the future realized covariance between consumption growth and stock returns, as it should if it is negatively correlated with rational expectations of risk.

My results are consistent with interpreting investor sentiment, and the consumption choices associated with it, as reflecting investor bias. Sentiment is mean zero and mean reverting. For example, when it is over one standard deviation away from its mean, it returns to zero within two to three years. In this same period, the increased (decreased) consumption associated with high (low) sentiment reverses out, on average, so that sentiment is positively related with contemporaneous consumption, but negatively predicts consumption two to four years in the future.

2 Related Literature

The idea that consumption is influenced by consumer's economic outlooks seems intuitive, and is frequently purported in economic and financial news media. Consumer sentiment, consumer confidence, consumer attitude, and consumer mood are some of the various terms often used in reference to consumers' economic outlooks. The re-

lationship between consumers' outlooks and consumption has been studied amongst academics since at least as early as Tobin (1959), who finds that consumers' stated buying intentions predict durable consumption, but responses to surveys on consumers' economic outlook do not.

Friend and Adams (1964) extended the previous work on consumer sentiment and consumption by including stock market variables to explain durable consumption. Fair (1971) emphasizes that stock market prices and consumer mood are simultaneous variables that jointly determine each other. While Fair calls his variable on consumer outlook a mood variable, he treats it as a measure of the consumer's rational expectations. Surprisingly, none of the above–mentioned studies on consumer outlook formally consider their variables of consumer outlook as reflecting bias in consumer expectations.

Consumer sentiment is unlikely to proxy for uncertainty, according to theories of precautionary savings, such as Carroll, Hall, and Zeldes (1992), which suggest that increased uncertainty is positively correlated with future consumption growth. Carroll, Fuhrer, and Wilcox (1994) find that consumer sentiment is also positively correlated with future consumption growth. Hence high (low) consumer sentiment cannot be a proxy for low (high) rationally generated expectations of uncertainty. They conclude that existing theories of consumption do not explain their results. Their results point to the need to study how biased outlooks relate to consumption.

One possible reason for the lack of significant scholarly attention to the relationship between investor sentiment and consumption is that investor sentiment and equilibrium consumption theory involve significantly different branches of finance research. The equilibrium relationship between consumption and investment was developed in an area of research that also made significant contributions to the role of rational expectations theory in asset pricing (e.g. Merton (1973), Lucas (1978), and Breeden (1979)). In contrast, the study of investor sentiment has largely occurred outside the domain of consumption–based general equilibrium asset pricing theory, in areas of research that are less dependent on consumption–based models.

Models such as those of Daniel, Hirshleifer, and Subrahmanyam (2001) and Dumas,

Kurshev, and Uppal (2009) have integrated investor bias into a general equilibrium asset pricing framework, but these models did not directly address important stylized facts such as the equity premium. Benartzi and Thaler (1995), Barberis, Huang, and Santos (2001), and Andries (2011) have considered investors with loss aversion preferences in a consumption-based asset pricing framework. While loss aversion and short portfolio evaluation periods are not necessarily biases, they are a nonstandard behavioral traits in preference specifications. Ang, Bekaert, and Liu (2005) and Routledge and Zin (2010) use disappointment aversion risk preferences to explain aggregate asset prices. But like the loss aversion models, investors' beliefs are still unbiased, and it is the investors' preferences that depart from traditional expected utility.

Macroeconomic models based on rational inattention (see Sims (2003) as an overview) are driven by *disuse*, but not necessarily *misuse* of information. While the implications can be similar in certain cases, agents are still not biased in rational inattention models— they are only constrained. The first theoretical consumption-based model to use investor bias to empirically capture the equity premium is Hirshleifer and Yu (2011). Their model uses an endogenous production economy and investor overextrapolation of technological growth. Overextrapolation is not a preference, it is a bias in investor expectations. My study provides empirical support for a link between investor bias and consumption, and can help calibrate future theoretical models that merge consumption–based asset pricing with investor bias.

Lettau and Ludvigson (2001) find that the aggregate consumption-to-wealth ratio predicts returns. They argue that a cointegrated relationship between wealth, consumption, and expected stock returns produces this predictability. My findings confirm that wealth, consumption, and expected returns are cointegrated. But focusing on an observable proxy for investor bias, I am able to look at this cointegration relationship from a different angle. I provide evidence that it is the *bias* in expectations, rather than the rational component of expectations, that may generate the predictive power of the consumption-to-wealth ratio. Bias in expected stock returns incrementally effects consumption, hence investor bias is reflected in the consumption data. Meanwhile changes

in stock market wealth do not seem to have an incremental effect on consumption.

3 Data

My first series of tests are extensions of previous standard wealth effects studies which regress consumption on labor income and other sources of wealth. After controlling for income and asset wealth, I test the incremental effect of stock sentiment on consumption.

Data on investor stock sentiment

I define investor stock sentiment as a bias in expectations about future stock market returns. I use a sentiment index designed by Baker and Wurgler (Baker and Wurgler (2006), (2007)) as a measure of investor sentiment. Their sentiment index is designed to capture the portion of investor expectations about the U.S. aggregate stock market that is not justified by current fundamentals, i.e., investor bias. Baker and Wurgler provide a monthly sentiment index that is orthogonalized to NBER-defined business cycles, past growth in industrial production, and consumption. I use this orthogonalized version of their sentiment measure in my tests. This index allows for a measure of sentiment that is not confounded with the business cycle. Data is available from January 1966 to December 2005. Their index is specifically designed to capture bias in expectations of stock returns and is thus quite distinct from consumer sentiment. The Pearson pairwise correlation between investor sentiment and the Confidence Board consumer sentiment survey is only .13.

Baker and Wurgler show that firms with different loadings on their sentiment measure have different average returns, even after controlling for standard asset pricing factors. This is a strong indication that their measure is not merely a proxy for standard asset pricing factors. Baker and Wurgler also find that the average return premium following periods of optimistic sentiment to firms with significant sentiment loadings is of the opposite sign as the average premium following periods of pessimistic sentiment.

The authors argue that the sign flipping of the return premium is evidence against the possibility that their sentiment index is a proxy for risk.

Since investor sentiment is the bias in expected risk-adjusted returns, the stock market level is not a sufficient statistic for sentiment, unless the correlation between bias and the stock market levels is perfect. Because investors' expectations are not directly observable, it can be difficult to interpret potential measures of sentiment. Measures designed to capture investor bias may instead capture changes in stocks' rationally assessed risks or changes in investors' risk-aversion. Analyzing the marginal propensity to consume in response to changes in measures of sentiment helps to clarify whether measures of sentiment are proxies for changes in rationally assessed consumption risk, or changes in investor bias, or are primarily noise.

Consumption, wealth, and income variables

I use monthly U.S. aggregate personal consumption expenditures and labor income data from the Bureau of Economic Analysis via the Global Insight database. I use S&P 500 market capitalization to measure aggregate stock wealth, but results are unchanged when the New York Stock Exchange composite market capitalization is used. Aggregate housing wealth is measured using the Office of Federal Housing Enterprise Oversight (OFHEO) quarterly total home price index. Monthly home price index data is constructed through linear interpolation from March 1973 to December 2005. The OFHEO index is based on prices from actual home sales and appraisal transactions in the single-family housing market. Including appraisal–based transactions is useful for capturing homeowners' estimates of their current housing wealth.

Each month, all wealth and income variables are adjusted for inflation using the Consumer Price Index, and are divided by the total current population to obtain real per capita variables. Definitions of variables are in Appendix A. Table 1 contains summary statistics, and table 2 shows the correlation between variables. Figure 1 shows sentiment over time. When sentiment drifts away from levels close to zero it takes about two to four years to come back to levels near zero again. Figure 2 show

home price and stock index levels over time.

4 Framework for interpreting sentiment wealth effects

The interpretation of any relationship between investor sentiment and consumption is not immediately obvious, so I first establish a theoretical framework to interpret the results.

4.1 Elasticity of intertemporal substitution and wealth effects

Again, if investor sentiment has a relationship with consumption, it could be positive or negative depending on whether the income effect or substitution effect from a change in perceived wealth from sentiment dominates. Whether the income or substitution effect dominates in aggregate depends on the aggregate elasticity of intertemporal substitution (EIS) of consumption. I focus my investigation on the sentiment-based consumption changes that are orthogonal to the effects of labor income, housing wealth, and the level of aggregate equity wealth.

If an investor's EIS is sufficiently high, then when their bias in expectations of future risk-adjusted stock returns goes up, other things being equal, they will be willing to reduce current consumption and substitute it towards the perceived investment opportunity in the stock market. Investors with a high EIS will then display a dominant substitution effect from changes in sentiment, which in the context of this study is a negative perceived wealth effect from sentiment.

If an investor's EIS is sufficiently low, then when their bias in expectations of future risk-adjusted stock returns goes up, they will want to increase their current consumption. While they may also want to increase their investment levels in stocks, they will not be willing to reduce current consumption in order to take greater advantage of

the perceived investment opportunity in the stock market. For investors with a low EIS the income effect from changes in sentiment will dominate the substitution effect, resulting in a positive perceived wealth effect from sentiment.

The effects of sentiment on current consumption for low and high EIS investors are depicted within Hicks decompositions in figures 3 and 4. For simplicity the figures assume a two period, representative agent economy. The EIS is captured by the slope and curvature of the indifference curves. When an investor's EIS is low enough (figure 3), as their sentiment increases, their current consumption also increases. For low EIS investors, an increase sentiment may also lead to an increase in investment, but the important takeaway is that the investor will not be willing to reduce their current consumption when their sentiment goes up. When an investor's EIS is high enough (figure 4), the investor will prefer to reduce current consumption when their sentiment goes up in order to take advantage of perceived increases in investment opportunity.

In power utility or log utility, the EIS is the inverse of the coefficient of relative risk aversion (CRRA). If a realistic CRRA is between 1 and 10, then a realistic EIS is between .1 and 1 in a power utility framework. For models with Epstein and Zin (1989) preferences, calibrations of the EIS may be higher. While most calibrations estimate an aggregate EIS of between close to zero and .5, Vissing-Jørgensen (2002) suggests that investors who invest in bonds but do not hold stocks may have an EIS between .8 and 1. More recently, debate over what the correct EIS is has grown with some studies suggesting an EIS greater than one. Despite the recent debate, much earlier work by Mankiw, Rotemberg, and Summers (1985) suggested that the canonical framework of a representative agent rationally optimizing consumption and investment fails to calibrate any plausible EIS parameter.

4.2 Investors that do not update their equity portfolios

While traditional asset pricing theory assumes that investors continuously adjust their consumption and investment in response to new information and expectations, in reality many investors do not seem to change their stock investments. I will call such

investors non-trading investors, or investors that do not update their equity portfolio. In this sense they are passive equity investors. For example, Americs and Zeldes (2004) find that in a large sample of TIAA-CREF individual investors, nearly half the investors do not update their portfolio in their nine-year sample period.

For the purpose of this study, I take the lack of portfolio updating as a stylized fact. If some investors have unique constraints to adjusting equity investment levels, then they will only adjust consumption when they attempt to re-optimize their balance between consumption and equity investment to reflect changes in their sentiment. They will increase (decrease) consumption when their stock sentiment is high (low), resulting in a positive sentiment wealth effect which is the same as a dominant income effect from sentiment.

Investors that do not regularly change their equity investment level, for whatever reason, may still change their consumption level in response to changes in sentiment. The case of non–trading investors shows that it is possible for stock sentiment to cause changes in consumption without a corresponding change in stock investments. Because their equity investment level does not change in response to changes in information or expectations, non–traders will not substitute consumption towards (away from) equity investment when their sentiment increases (decreases). Hence the income effect from a perceived change in stock market wealth will dominate their sentiment-based consumption adjustments. Appendix B discusses prior research on non-trading investors and possible explanations for the phenomenon.

For the investors who do trade on the basis of their sentiment, it is possible that their trading is partially, or even completely countered by traders who recognize the sentiment based trades as reflecting biased expectations. These counter-sentiment traders must have an EIS, that at a minimum, is high enough that they are willing to increase their investment when sentiment is low. Otherwise they would not be willing to trade against sentiment. If their EIS is sufficiently above this minimal level, then the counter–sentiment traders will substitute their consumption towards investment that is counter to sentiment. If their EIS is sufficiently high, unbiased traders will be

willing to decrease consumption when negative investor sentiment causes underpricing pressure in the aggregate market.

For biased investors, a sentiment wealth effect comes from a falsely perceived change in stock market wealth. For unbiased investors, a sentiment wealth effect comes from the sentiment-based mispricing they observe and can take advantage of.

5 Basic Tests and Results

The traditional way to measure wealth effects is to regress consumption on labor income and various sources of wealth. While there may be omitted variables in this standard specification, I use it to confirm that my monthly data gives results that are in line with earlier studies. The coefficients from such a regression capture the marginal propensity to consume in response to changes in income or wealth. Most consumption changes are explained by changes in labor income. An example of a standard wealth effect study is Case, Quigley, and Shiller (2011) who find a small and non-robust stock market wealth effect but a large and robust housing wealth effect, after controlling for income. My initial tests follow their standard methodology.

5.1 Standard wealth effects tests

In addition to using income, housing wealth, and stock market wealth to explain consumption, I add stock market sentiment as a novel explanatory variable. To make regression coefficients easily interpretable, all variables are logged unless otherwise stated. I begin with the most straightforward test, an OLS regression. The specifications for the OLS tests are:

$$ln(PCE_t) = b_0 + b_1 ln(disposable\ inc_t) + b_2 ln(OFHEO_t) + b_3 ln(SP500_t) + b_4 ln(sent\_o_t), \tag{5.1}$$

where PCE_t is consumption of either nondurable, durable, or service goods in month t.

In the first Personal Consumption Expenditures (PCE) nondurable column of table 3, consumption of nondurables is regressed on income, stock market capitalization, and the OFEHO home price index. The data is of monthly frequency from April 1976 to December 2005. Most studies on wealth effects focus on explaining consumption of nondurable goods, and first column of my results for nondurable consumption corroborate the results of previous studies. The labor income coefficient shows that the elasticity to consume additional labor income on nondurable goods is quite high at .5. There is no significant stock market wealth effect, while a one percent increase in the home price index is concurrent with a .38 percent increase in consumption of nondurables. These results are consistent with the key findings in Case, Quigley, and Shiller (2005) and (2011). Although their tests use annual data, my tests on monthly data closely replicate their regression coefficients, R-squares, and autocorrelation coefficients.

To test the relationship of stock sentiment to consumption, I include sentiment as an additional explanatory variable in the classic wealth effects regression. The second PCE nondurable column in table 3 shows that sentiment has a positive wealth effect incremental to the effects of income and wealth. A one percent increase in sentiment is concurrent with a .21 percent increase in consumption of nondurables. The previously mentioned studies by Case, Quigley, and Shiller and Bostic, Gabriel, and Painter (2009) find strong wealth effects from housing assets, but little to no wealth effect from stocks after controlling for housing. While confirming a negligible stock wealth effect, my results indicate that the stock sentiment wealth effect is economically and statistically significant. Indeed, the standard wealth effects specification has omitted investor sentiment as an important explanatory variable. Stock market sentiment, like housing wealth, is a major determinant of consumption of nondurable goods, even though sentiment is a false perception of a change in future risk-adjusted stock market wealth.

The central result is that, in aggregate, investor sentiment has a positive contemporaneous relationship with the consumption of nondurables. This is evidence that

investor sentiment about stocks generates a positive perceived wealth effect. In aggregate, the income effect from investor sentiment dominates the substitution effect from sentiment. Notably, investor sentiment shows a significant relationship with consumption of nondurables, while stock market wealth does not. Since I use both stock market capitalization and stock sentiment as explanatory variables it is helpful to re-emphasize that sentiment is not completely captured by the stock market level. In fact, sentiment does not have to be captured by the level of the stock market at all.

Figure 5 shows how stock market capitalization and investor sentiment are generally distinct. The large dashed-line rectangle is investor sentiment and the large solid-line rectangle is the aggregate stock market price. Investor sentiment may lead to a rebalancing between stocks, while leaving the overall level of stock investment unchanged. Furthermore, the sentiment of investors who do not update their equity portfolios does not affect their stock investment level, it affects only their consumption. Finally, the portion of sentiment that does affect the aggregate stock price level may be partially or completely offset by unbiased counter-sentiment traders. Only if investor sentiment creates aggregate price pressure, *and* it is not offset by unbiased traders will it result in market capitalization changes.

The results for durable and service goods differ from the results on nondurable goods. Durable and service consumption goods can have investment-like properties. Durable consumption goods can include assets such as art, jewelry, and boats. Service consumption can include investments in education and personal health, which are key determinants of the value of a person's labor capital. For these reasons, consumption of durable and service goods are considered poor measures of pure consumption. However, in order to make sentiment-driven adjustments to consumption of nondurables, an investor may make corresponding adjustments to consumption of durables and services. In the PCE durable and PCE service columns of table 3, I find that stock market sentiment demonstrates an asset substitution effect in relation to consumption of durables and services.

Investments in durable and service consumption goods are reduced when investor

sentiment goes up. Theses results suggest that as sentiment rises, the increase in consumption of nondurables is partly financed by reducing the investment in durable and service goods. The remainder of my tests focus on consumption of nondurables, which is the classic measure of consumption in asset pricing theory. The OLS tests control for positive autocorrelation by using Newey-West standard errors, but I use three other methods as robustness checks.

5.2 Robustness checks

Replicating the robustness checks of Case, Quigley, and Shiller (2005), I use first differences, generalized least squares, and vector error-correction methods to confirm the central findings of the OLS regression. The first robustness check is to rerun the regression in table 3 with first differences in the variables. While the Newey-West standard errors adjust for autocorrelation, the first difference data transformation is a more direct way to address autocorrelation. The specifications for the first difference tests are:

$$\Delta_t ln(PCE\ nondurable_t) = \tag{5.2}$$
$$b_0 + b_1 \Delta_t ln(disposable\ inc_t) + b_2 \Delta_t ln(OFHEO_t) + b_3 \Delta_t ln(SP500_t) + b_4 \Delta_t ln(sent\_o_t),$$

where Δ_t is the difference operator, indicating change from period $t-1$ to period t. The first difference results of model 2 in table 4 are similar to those of the OLS tests—stock sentiment has a positive wealth effect about half as large as the housing wealth effect while the stock market shows no wealth effect. The post-test Durbin–Watson statistic shows that serial correlation is reasonably well corrected.

The Prais–Winsten estimated generalized least squares (EGLS) method is a more sophisticated data transformation designed to correct for autocorrelation. The specifi-

cations for the Prais–Winsten tests are:

$$ln(PCE\ nondurable_t) - \rho\ ln(PCE\ nondurable_{t-1}) = b_0(1-\rho\ ) \tag{5.3}$$
$$+ b_1(ln(disposable\ inc_t) - \rho\ ln(disposable\ inc_{t-1})) + b_2(ln(OFHEO_t) - \rho\ ln(OFHEO_{t-1}))$$
$$+ b_3(ln(SP500_t) - \rho\ ln(SP500_{t-1})) + b_4(ln(sent\_o_t) - \rho\ ln(sent\_o_{t-1})),$$

where ρ is the estimated autocorrelation coefficient of the OLS residuals. See Prais and Winsten (1954) for details on the estimation of ρ. Compared to the first difference results, the Prais–Winsten results (Model 2 in table 5) are even closer to the OLS results, and better correct for autocorrelation. The high R^2 values are consistent with the results of Case, Quigley, and Shiller (2005); in essence my results replicate theirs on a monthly frequency.

As a final robustness check, to address the possibility of a unit root, I use a vector error-correction model (VECM). Davidson, Hendry, Srba, and Yeo (1978) give details on the model's specification. The basic idea is that autocorrelation in consumption data can be corrected for by: (1) taking first differences in consumption, income, and wealth variables, (2) including lagged changes in consumption, and (3) including an error-correction term. The error-correction term should have a stable long-run fundamental level so that the lag of the error-correction represents previous deviations from the sustainable fundamental level. Davidson, Hendry, Srba, and Yeo (1978) use the lagged consumption-to-income ratio as the error-correction term[1]. The specifications for the VECM tests are:

$$\Delta_t ln(PCE\ nondurable_t) = \tag{5.4}$$
$$b_0 + b_1 L1.\Delta_t ln(PCE\ nondurable_t) + b_2\Delta_t ln(disposable\ inc_t) + b_3\Delta_t ln(OFHEO_t)$$
$$+ b_4\Delta_t ln(SP500_t) + b_5\Delta_t ln(sent\_o_t) + b_6 L1.ln(PCE\ nondurable_t/disposable\ inc_t),$$

[1]Because Davidson, Hendry, Srba, and Yeo (1978) work with annual data they use a one year lagged consumption-to-income ratio. Lag order tests indicate that a one month lagged error correction term is best for my monthly data.

where L is the lag opperator so L1 is a lag of one month. The lagged logged consumption-to-income ratio, $L1.ln(PCE\ nondurable_t/disposable\ inc_t)$, is the error-correction term, and Δ_t is the difference operator, indicating change from period $t-1$ to period t.

The results in model 2 of table 6 are consistent with the OLS, first difference, and Prais–Winsten results. There is a significant positive perceived wealth effect from stock sentiment, while the stock market itself demonstrates no wealth effect. The VECM completely corrects for autocorrelation as indicated by the post-test Durbin–Watson statistic. Adding investor sentiment to the VECM significantly improves the model's ability to explain variation in consumption of nondurables, as shown by the difference in R^2 between model 1 and model 2.

Results, which are not shown, on consumption of durables and services are not robust in all the empirical models. This reflects the complications that arise from the dual consumption and investment properties of durable and service goods.

6 Investor sentiment as a predictor of consumption changes

The main result from the standard wealth effects tests is that sentiment has a positive contemporaneous relationship with consumption of nondurable goods. But because sentiment is a mean reverting stationary process, it should also predict future consumption. The predictive power of sentiment on consumption provides evidence that sentiment's effect on consumption is due to biased expectations about future stock wealth.

6.1 Investor sentiment as an error-correction variable

Because sentiment is mean zero and mean reverting over a two to four year cycle, non-zero levels of sentiment represent deviations from a stable long-term fundamental level. This stationary property, combined with sentiment's contemporaneous affect on

consumption, makes the sentiment level an error-correction term for future changes in consumption. Non-zero levels in sentiment are errors in expectations, and they should predict corrections in sentiment-based consumption. Employing this idea, I build a VECM where the lagged level in sentiment is the error-correction term. The specifications for the VECM tests with sentiment as an error-correction term are:

$$\begin{aligned}\Delta_t ln(PCE\ nondurable_t) &= b_0 + b_1 L1.\Delta_t ln(PCE\ nondurable_t) \\ &+ b_2 \Delta_t ln(disposable\ inc_t) + b_3 \Delta_t ln(OFHEO_t) + b_4 \Delta_t ln(SP500_t) \\ &+ b_5 \Delta_t ln(sent\_o_t) + b_6 L1.ln(PCE\ nondurable_t / disposable\ inc_t) + b_7 L1.ln(sent\_o_t),\end{aligned} \tag{6.1}$$

where L is the lag operator, so L1 is a lag of one month. The lagged log of the consumption-to-income ratio, $L1.ln(PCE\ nondurable_t/disposable\ inc_t)$, and the lagged *level* of logged investor sentiment, $L1.sent\_o_t$, are the error-correction terms. Δ_t is the difference operator, indicating change from period $t-1$ to period t.

The results in model 3 of table 7 show that the lagged level of sentiment does indeed function as an error-correction term. After controlling for sentiment changes and the other vector error-correction model variables, the lagged level of sentiment negatively predicts changes in consumption. Investor sentiment functions as a consumption error-correction term in the same way the consumption-to-income ratio does in model 1 of table 6. Consistent with my previous results, sentiment still shows a positive contemporaneous wealth effect on consumption of nondurables when previous sentiment is used as an error-correction term (table 7, model 4). The negative coefficient on the sentiment error-correction term suggests that sentiment-driven changes in consumption are not sustainable and are reversed in the future. These results indicate that sentiment-based consumption corrects over time.

Notably, the sentiment error-correction term has an economic magnitude as large as the consumption-to-income ratio error-correction term (table 6, model 1), but unlike the consumption-to-income ratio, it also has a high degree of statistical significance (table 7, model 3). Since the consumption-to-income ratio is itself influenced by the

wealth effect of sentiment, sentiment may be an improved error-correction term for vector error-correction models of consumption. Shifts in preferences and other factors may cause the steady state consumption-to-income ratio to change regimes over time. But sentiment will stay mean zero in the long-run as long as realized stock market earnings eventually correct investor's bias. For this reason, sentiment may be a more stable error-correction term. However, once contemporaneous investor sentiment is used to explain consumption, then both the lagged consumption-to-income ratio error-correction term and the lagged investor sentiment level error-correction term show little incremental explanatory power (table 7, model 5).

6.2 Investor sentiment as a predictor of consumption of nondurables

Thus far, I have focused on the contemporaneous relationship between stock sentiment and consumption. The nature of the classic consumption–investment optimization suggests that if sentiment affects the amount of investment, then it will simultaneously affect the amount of consumption. However, the VECM results suggest that sentiment may also predict future consumption.

I run a series of regressions predicting consumption of nondurables three to 48 months in the future. Table 8 shows that stock sentiment can positively predict consumption of nondurables in the short run (within a year). Over the course of a year, the positive wealth effect from an initial change in sentiment decreases monotonically. Beyond a year into the future, the sentiment wealth effect disappears.

But between two-and-a-half to four years in the future, sentiment begins to *negatively* predict consumption. This time frame closely corresponds with the time it takes sentiment to return to its mean of zero following periods of significant deviation (see Figure 1). From 27 to 45 months in the future, the negative wealth effect of sentiment is monotonically increasing in magnitude and is about, 8% larger in magnitude than the positive wealth effects from the first 12 months.

Investor sentiment is different from consumer sentiment because it focuses on the bias in the investors' stock market expectations. But to address the concern that investor sentiment may be a proxy for consumer sentiment, I include consumer sentiment as an explanatory variable in the predictive regressions of table 8. The wealth effects of investor sentiment that I find are incremental to any effects from consumer sentiment.

Because durable goods include large purchases that are costly to reverse, one may think that the effect of investor sentiment on durables could be similar to its effect on nondurables, but even more dramatic. However the results of table 3 suggest that because durable goods can have investment asset properties, investment in durable goods moves in the opposite direction as sentiment. Investment flows out of (into) durable goods when stock sentiment is high (low). Future research that can disentangle the investment and consumption properties of durable goods is necessary before the relationship between sentiment and durable goods can be cleanly interpreted.

7 Interpretations of Results

7.1 Sentiment as investor bias

If measures of stock sentiment capture the bias in investors' expectations of risk-adjusted stock returns, then the responses of both biased and unbiased investors must be considered. There are two types of investors who will exhibit a positive wealth effect. When sentiment causes mispricing in the aggregate stock market, then unbiased high EIS counter-sentiment traders will adjust consumption in the direction of sentiment. This is so that they can adjust equity investment in the opposite direction of sentiment and take advantage of the mispricing caused by sentiment. Biased low EIS investors with a dominant income effect from sentiment will shift consumption in the direction their bias in perceived risk-adjusted stock wealth moves.

The amount of counter-sentiment investing cannot be greater than the amount of sentiment-based trading. As long as the income effect from sentiment dominates for

some of the biased investors, the positive aggregate wealth effect from sentiment that I observe cannot solely come from unbiased contra-sentiment traders.

The results from the predictive tests (table 8) indicate that when sentiment is over-optimistic, the initial increase in current spending later reverses as sentiment corrects. If investors borrow money to fuel sentiment-driven increases in spending, then interest expense dictates that an even larger decrease in spending will be required when their biased expectations about the future do not come to fruition. By similar reasoning, if investors increase their savings rates by reducing consumption when sentiment is low, then they will have more to spend in the future when their sentiment corrects. In the predictive results of table 8 I find that the reversal in consumption growth that occurs 24 to 42 months after a change in sentiment is about 8% larger than the consumption changes contemporaneous to the sentiment change.

One reason for the insignificant stock wealth effect but significant stock sentiment wealth effect may be that not all investors resize their equity holdings when information or expectations change. For some investors, the costs and effort to adjust equity investments may be too high, while these costs are significantly lower for consumption adjustments. As a result, these investors will adjust their consumption to changes in sentiment, but they will not adjust their equity investment level. See appendix B for further discussion about investors who do not regularly adjust their equity investment levels.

Infrequent equity portfolio updating has been incorporated into relatively few theoretical models, with Chien, Cole, and Lustig (2011) being a recent example. My results suggest that incorporating investor bias into theoretical economies with non-trading equity investors may help such models better capture the consumption-stock return relationship. New models which simultaneously consider investor bias along with the phenomenon of infrequent portfolio updating will be useful for developing calibrations of aggregate EIS. Such models will be necessary for learning how low aggregate EIS must be for the income effect of sentiment to dominate the substitution effect and cause a positive aggregate sentiment wealth effect.

Investors who face prohibitive constraints or costs to changing their equity investment levels will still try to smooth consumption over time when they believe their future equity investment wealth has changed. An important takeaway from this case is that sentiment about stock returns does not need to affect the current aggregate stock market level in order to affect current consumption. After controlling for income, equity wealth, and housing wealth, non-trading investors can adjust their consumption to changes in sentiment in the following ways: changing income savings rates (which can be negative with borrowing), changing dividend reinvestment rates, or changing their investment levels in durable and service consumption goods.

The consumption adjustments of investors with sentiment who do not update their equity portfolios would explain why sentiment is a robust positive predictor of consumption over the next 12 months, but a weak negative predictor of returns. These investors adjust their consumption, but not their equity investment, in response to sentiment. Although the relationship between the consumption of nondurables and equity investment is important to asset pricing theory, the stock market level has not shown a strong incremental relationship to the consumption of nondurables. Case, Quigley, and Shiller (2005, 2011), and Carroll, Otsuka, and Slacalek (2011) find that the stock market does not display a significant wealth effect on aggregate consumption of nondurables after housing wealth and labor income are controlled for.

On their own, these results might suggest that housing wealth is important to consumption-based asset pricing models, but stock market wealth is not. This is alarming since the calibrations for many asset pricing models consider the stock market as the central investment asset. The positive relationship that I discover between investor sentiment and consumption of nondurables shows that investors' expectations of stock returns are important to consumption, but not in the ways previously assumed. In particular, it is the *bias* in stock market expectations that provides a significant link between consumption of nondurables and expectations of stock returns.

7.2 Sentiment as a proxy for rational expectations of risk

Changes in sentiment might be a proxy for changes in risk in three ways: (1) a proxy of changes in the relative risk between individual stocks, but not of aggregate risk; (2) a positive proxy of aggregate risk (high sentiment indicates high risk and low sentiment indicates low risk); (3) an inverse proxy of aggregate risk (high sentiment indicates low risk and low sentiment indicates high risk). Regardless of how sentiment might be a proxy for rational expectations of risk, sentiment would have to be a proxy of *temporary* changes in risk because sentiment is mean zero and mean-reverting (Figure 1).

There is no clear presumption about how rational expectations of risk might cause a positive relationship between aggregate sentiment and the aggregate consumption of nondurables. If sentiment is a proxy only for cross-sectional changes in risk, then sentiment may cause equity portfolio rebalancing. However, if sentiment changes reflect only risk changes in cross-section, then aggregate investment and consumption levels will not be affected. If sentiment is a same-sign proxy for stock market risk, then sentiment should positively predict returns. Baker and Wurgler (2007) find the opposite. Their investor sentiment index negatively predicts aggregate stock market returns, although they cannot predict the precise timing of future crashes or rallies with sentiment.

If sentiment is an inverse proxy for rational expectations of risk, then I should find that sentiment negatively predicts the realized risk that occurs ex post to the sentiment changes. The traditional definition of risk in consumption-based asset pricing models is the covariance between the stochastic discount factor (SDF) and returns. The realized covariance between consumption growth and returns is how risk is most often measured, where the use of consumption growth as a representation of the SDF is derived from traditional utility specifications. I find that sentiment does not show any power to predict realized stock market risk. Table 9 shows investor sentiment as an explanitory variable for subsequent realized covariance between consumption growth and stock market returns over the next 6, 12, 36, and 60 months. The results indicate that

investor sentiment does not capture rational expectations of risk, under the traditional definition of risk.

If sentiment proxies for the risk aversion of investors with rational expectations, then high sentiment would have to represent risk-seeking behavior, since the return premium for young and small firms that do not pay dividends is negative following periods of high sentiment (Baker and Wurgler (2006)). In periods following high sentiment, the negative returns of these firms would need to have a strong negative correlation with aggregate portfolios to justify their negative returns in a risk-averse rational expectations context. However, such firms do not appear to be an efficient form of portfolio insurance. They do not give abnormally high returns when housing investments or the aggregate stock market perform poorly.

The realized covariance between consumption growth and returns may not even represent ex ante rational expectations of risk if investor bias is a factor in aggregate consumption. So while the traditional measure of aggregate risk does not explain my results, it is possible that a different measure of ex ante rational expectations of risk will help explain my main findings. As a second measure of risk expectations, I use the implied volatility of stock index options.

The implied volatility for options on the S&P 500 and 100 indices is often thought of as a measure of the market's expectation of index price volatility. While implied volatility is not a direct measure of expected risk, as defined in models with a stochastic discount factor, I will assume it to be positively correlated with risk (see appendix C for details on this assumption). I find that high sentiment is associated with *high* implied volatility (table 10). Again, it does not seem likely that high sentiment represents low rational expectations of stock market risk. Han (2008) also finds that the relationship between index option implied volatility and investor sentiment does not fit a rational pricing model. Because of investor sentiment, implied volatility may also fail to capture ex ante rational expectations of risk.

If sentiment is a proxy for investor expectations of risk, then my results indicate that, in aggregate, these expectations are biased. In contrast, my results are consis-

tent with investor sentiment being a measure of bias in expectations of risk, returns, or both. The aggregate relationship between investor sentiment and consumption of nondurables that I document implies that, in aggregate, investors are following a sub-optimal strategy. Investors that simply do not adjust consumption or investment in response to investor sentiment can reduce the covariance between their consumption and stock returns, while the mean of both consumption and stock market wealth will be at least as high.

8 Conclusion

Perhaps because investor sentiment has not shown strong predictive power over aggregate returns, investor sentiment has not played an important role in macro asset pricing. However, by analyzing consumption's relation to investor sentiment, I find that sentiment does reflect investor bias about aggregate returns.

Evidence of the aggregate bias of investor sentiment is observed in the consumption patterns of nondurables. My findings indicate that overspending occurs when investor sentiment is high, and subsequent consumption must be cut back when the falsely-anticipated high stock returns do not happen. By consuming and investing contrarian to stock sentiment, one can decrease intertemporal consumption volatility while increasing average stock returns. There may be a minority of unbiased investors who, on average, consume more and have less consumption volatility than the aggregate average. Nevertheless, aggregate results suggest that overall, investors are behaving sub-optimally because they are treating changes in their bias about the stock market as permanent changes in their future risk-adjusted stock market wealth.

The reason that aggregate bias about stock returns is strongly reflected in consumption, but shows only weak traces in aggregate stock prices, may be because of the infrequent equity portfolio updating phenomenon. While it is debated why many investors do not regularly update their equity portfolios, these non-trading investors may be able and willing to adjust their consumption. The positive sentiment wealth effect

that I measure suggests that future research develop asset pricing theory that simultaneously incorporates investor bias and the irregular portfolio updating phenomenon of many equity investors. If consumption data for individuals can be matched to data on individual investment portfolios (e.g. individual portfolio data from Finland or Sweden), then distinct sentiment wealth effect calibrations for frequent and infrequent traders could be measured in future research.

Among consumption-based asset pricing models, most departures from the assumption of strict rational expectations have been in the form of structural uncertainty (e.g. Weitzman (2007))—imperfect knowledge about the distribution of parameters driving the economy and asset prices. Bakshi and Skoulakis (2010) find that implausible levels of structural uncertainty would be required to explain historical asset pricing moments. This does not mean structural uncertainty is not an important consideration in explaining asset pricing moments, but further divergences from rational expectations may improve model calibrations. My results suggest that researchers also consider a theoretical approach that incorporates investor sentiment, which is imperfect *use* of information.

Efforts to measure the EIS parameter can also benefit from my findings. As new consumption-based asset pricing theoretical models begin to include investor bias, they can calibrate to the elasticity of .21 that I find between investor sentiment and consumption of nondurable goods. This additional constraint may help resolve current debates about EIS levels. Whatever the EIS level is, my results indicate that it is low enough that, in aggregate, investors are unwilling to substitute consumption towards investment in order to trade on their sentiment.

Because sentiment-based changes in consumption eventually are reversed, investor sentiment successfully functions as an error-correction variable for explaining consumption. This suggests a way to identify new measures of investor sentiment. Variables that negatively predict returns (or do not predict returns), yet have a positive contemporaneous relationship to consumption may capture investor sentiment. Such variables may capture the perceived increase in future stock market wealth and excessive con-

sumption that occurs when investor sentiment is high. Extensions to my tests are possible with other measures of investor sentiment and consumption. Furthermore, if stock market sentiment is an important determinant of consumption of nondurables, then housing sentiment may be a very important consumption factor since the housing wealth effect is strong and robust.

Personal consumption expenditures represents about two thirds of all U.S. domestic final spending. Economic policy makers consider consumption patterns to be an important factor in economic growth. Therefore, understanding how investor sentiment relates to expenditures can help us begin to learn how investor sentiment might affect economic growth and production.

Appendices

A Definitions of Variables

Variables with an asterisk are per capita and adjusted to 2005 dollars by the monthly Consumer Price Index.

***Personal Consumption Expenditures (PCE).** From the Bureau of Economic Analysis. Data is seasonally adjusted and annualized.

Investor Stock Sentiment (sent and sent_o). From Baker and Wurgler (2006) and Baker and Wurgler (2007), sent is an index of stock market sentiment indicators, standardized to be approximately mean zero with unit standard deviation. Sent_o has been orthogonalized to macroeconomic business cycle variables. See Baker and Wurgler (2007) for details. Data is available from January 1966 to December 2005. In order to take the natural log of sentiment, sent and sent_o are transformed to a mean of 100 and an annual standard deviation of 20. Hence, sentiment is assumed to be approximately as volatile as the stock market.

***Disposable Income.** From the Bureau of Economic Analysis. Data is seasonally adjusted and annualized. Disposable income is the total after-tax personal income.

***Office of Federal Housing Enterprise Oversight Home Price Index (OFHEO).** A quarterly U.S. home price index based on actual sales transactions and appraisal transactions. Monthly data is constructed from quarterly linear interpolation. Data is available from March 1973.

***S&P 500 Stock Index (SP500).** The Standard and Poor's 500 U.S. equity index.

Consumer confidence (consumer conf.) The Conference Board's monthly index of consumer expectations.

CBOE Volatility Index. The Chicago Board of Options Exchange provides two indices to capture the implied volatility of index-options. The VIX since January

1990 is implied volatility on the S&P 500 index and the VXO since June 1986 is implied volatility on the S&P 100.

B Evidence and explanations for infrequent equity portfolio updating

While prior research has shown that discount brokerage accounts display lots of reshuffling activity between stocks (e.g. Dorn and Sengmueller (2009) and Barber and Odean (2011)), rebalancing of the equity portfolio should not affect consumption, since it does not change the overall investment level. Only *resizing* of the equity portfolio should affect consumption levels, and in contrast to discount brokerage accounts, 401k accounts display little rebalancing or resizing (Agnew, Balduzzi, and Sundén (2003)). Hirshleifer et al. (2008) find that the churning activity amongst overactive traders does not explain post–earnings announcement drift (PEAD). Indirectly, their findings may also provide evidence of a lack of portfolio updating amongst a large segment of individual investors. It may be the portion of individual investors who do not update their portfolio that contribute to aggregate market inefficiency and PEAD, while overactive traders mostly reshuffle between stocks.

There are many possible reasons for infrequent equity portfolio updating, including the following: reliance on 401k retirement account defaults (Madrian and Shea (2001), Choi, Laibson, and Madrain (2004a)); lack of wealth or education (Calvet, Campbell, and Sodini (2009)); and costly information acquisition (Chen (2006), Huang and Liu (2007)). Previous research also suggests that investors prefer simplicity (Choi, Laibson, and Madrain (2004b)), and do not pay attention to all relevant information because their attention is limited (e.g. Hirshleifer, Lim, and Teoh (2009)). Investors that prefer simplicity and have limited attention may update their equity portfolio infrequently if the equity updating decision is not simple enough or requires too much attention.

C Index option implied volatility as a measure of risk expectations

In models with a stochastic discount factor (SDF), stock market risk is defined as the negative of covariance between the SDF and stock returns:

$$Risk = -Cov(m, r) = -\rho_{m,r}\sigma_m\sigma_r, \tag{C.1}$$

where m is the SDF and r is the stock return. $\rho_{m,r}$ is the correlation between the SDF and returns; σ_m and σ_r is SDF volatility and return volatility respectively. $Cov(m, r)$ is not realized risk, it is the expectation of what realized risk will be. So σ_r is not realized stock market volatility, it is expected volatility, which reflected in stock index option prices as implied volatility.

If σ_r goes up, then all else equal, risk also goes up. SDF volatility or the correlation between returns and the SDF would have to change in order for implied stock volatility and risk to move in opposite directions.

$$\sigma_r \uparrow \textit{and}\, Risk \downarrow \Rightarrow \rho_{m,r}\sigma_m \downarrow . \tag{C.2}$$

A sufficient condition for implied volatility to be a same sign proxy for risk is:

$$\rho(\rho_{m,r}\sigma_m,\, \sigma_r) \geq 0, \tag{C.3}$$

where $\rho(X, Y)$ is the correlation between X and Y.

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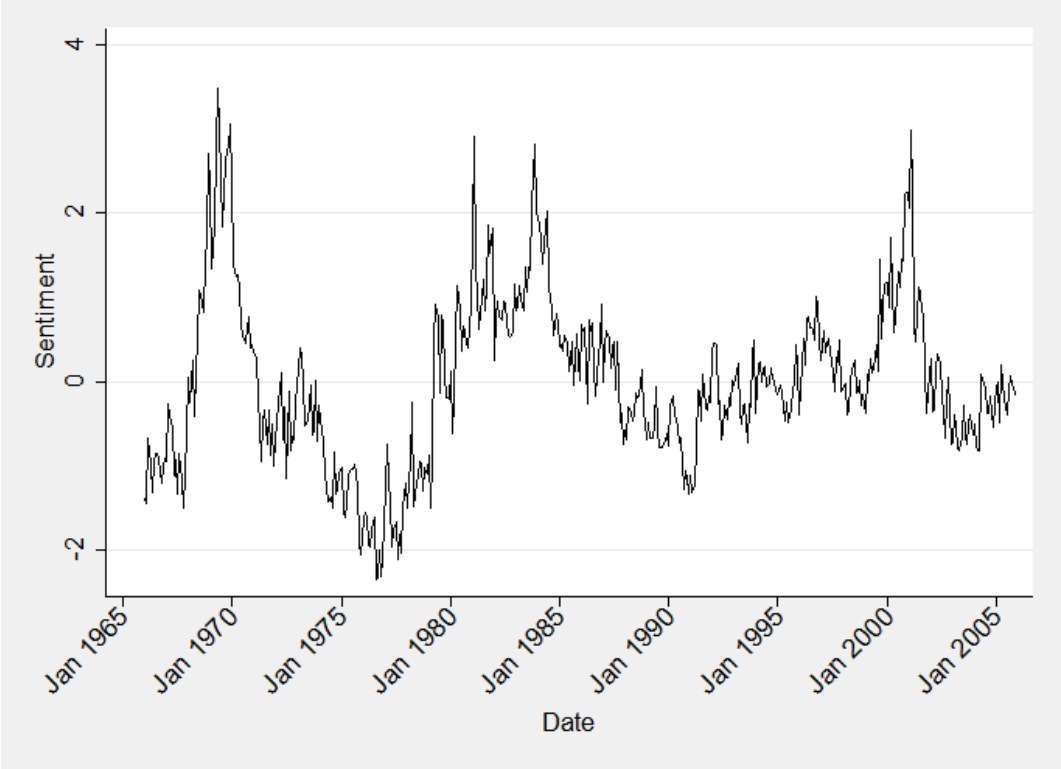

Figure 1: **Sentiment Over Time**. Sentiment has been orthogonalized to business cycle variables. See appendix A for variable definitions. The sample period is January 1966-December 2005, monthly.

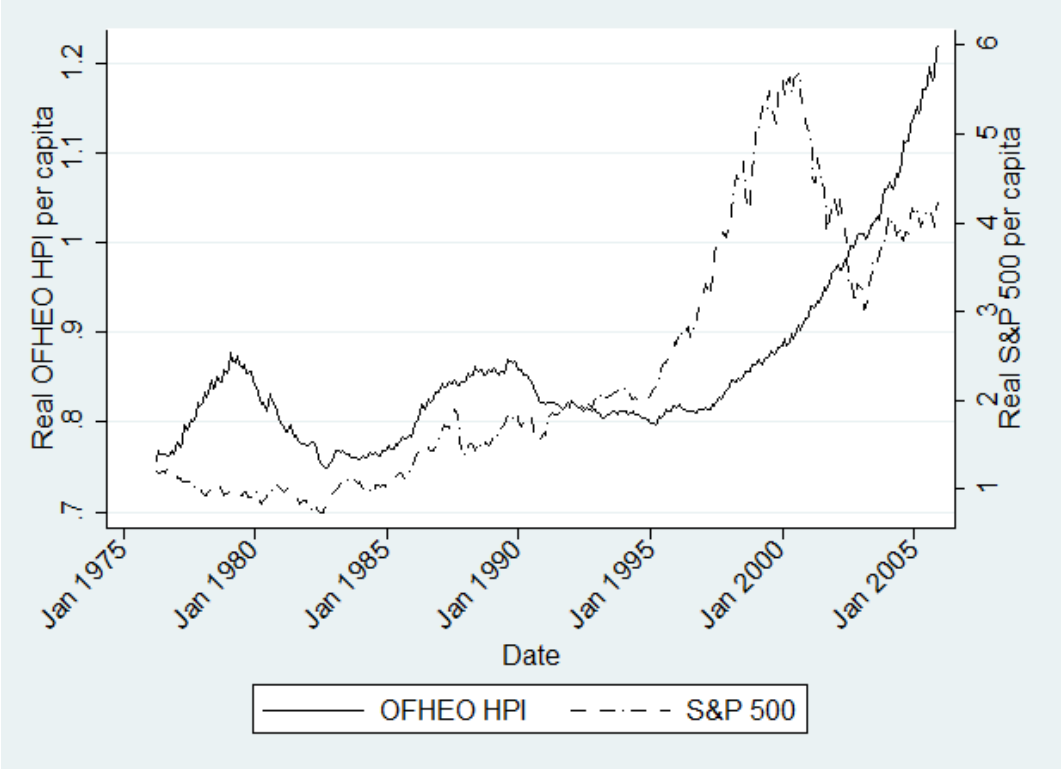

Figure 2: **Housing and Stock Prices Over Time**. The OFHEO home price index and S&P 500 index are inflation-adjusted to 2005 units, and are in per capita term. Population is measured in millions. See appendix A for variable definitions. The sample period is April 1976-December 2005, monthly.

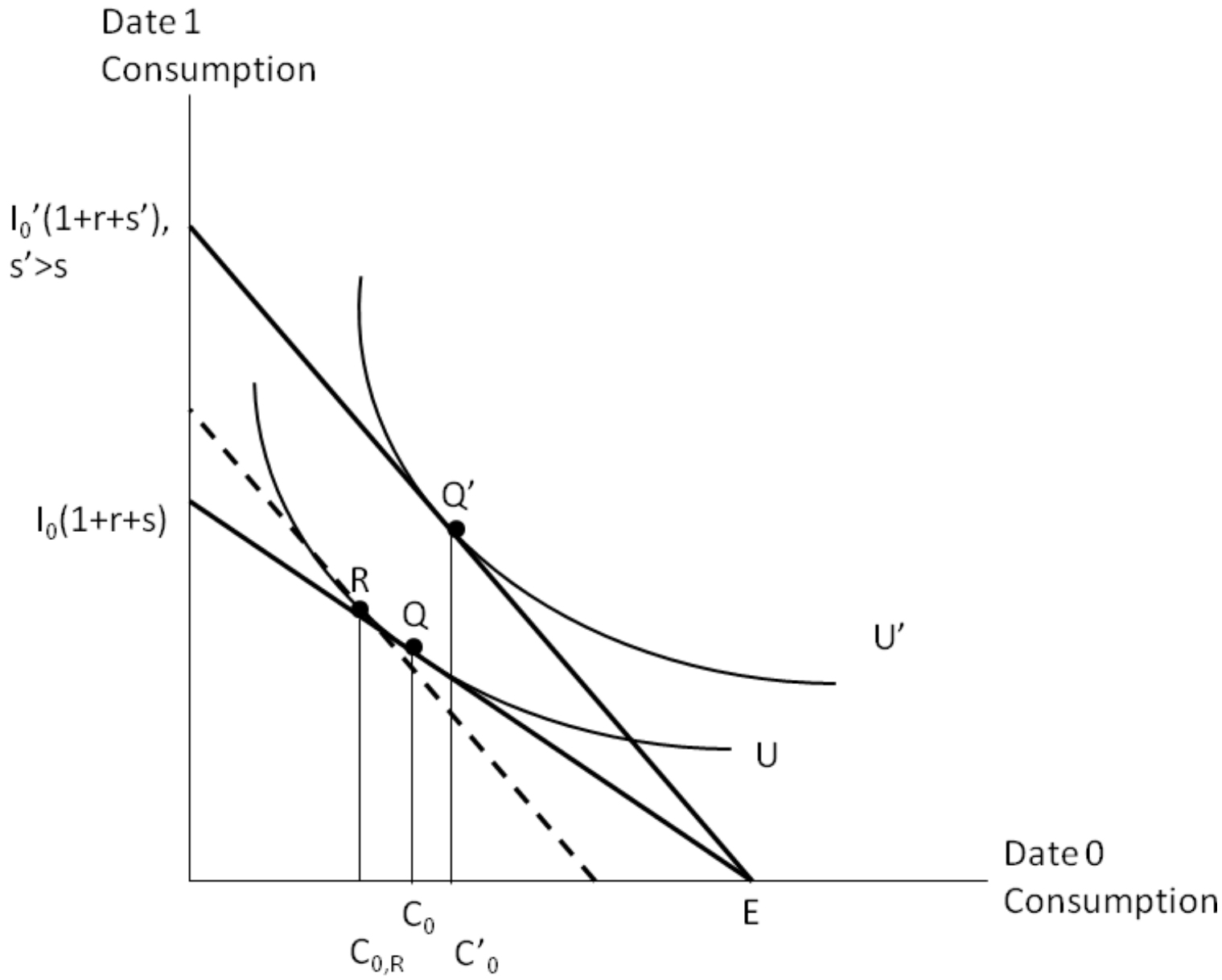

Figure 3: **Low EIS and investor sentiment's wealth effect**. This Hicks decomposition shows the tradeoff between consumption on date 0 and date 1 in an economy with a representative investor, one stock and a risk-free bond. U is an indifference curve, Q is a consumption bundle, E is the endowment at date zero, s is sentiment about the risk-adjusted stock return, and r is the rational expectation of the risk-adjusted return. When investor sentiment increases from s to s', current consumption *increases* from C_0 to C_0'. $C_{0,R} - C_0$ is the pure substitution effect, and $C_0' - C_{0,R}$ is the pure income effect. The EIS (determined by the slope and curvature of the indifference curves) is *low* enough that the negative substitution effect from sentiment on current consumption is dominated by the positive perceived income effect from sentiment. Investment goes from I_0 to I_0'. $I_0 = E - C_0 + B$, where B is the investors holding in the bond.

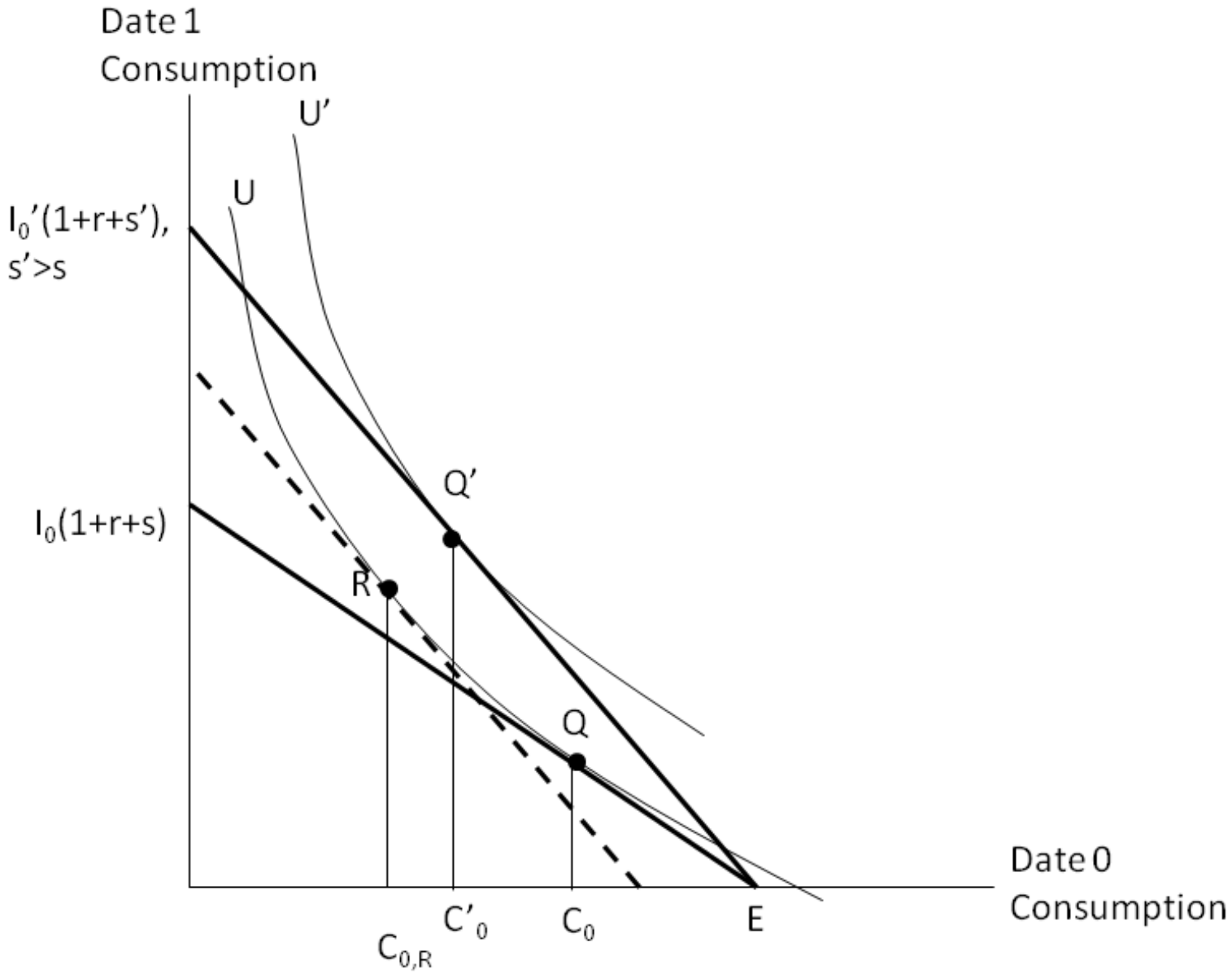

Figure 4: **High EIS and investor sentiment's wealth effect**. This Hicks decomposition shows the tradeoff between consumption on date 0 and date 1 in an economy with a representative investor, one stock, and a risk-free bond. U is an indifference curve, Q is a consumption bundle, E is the endowment at date zero, s is sentiment about the risk-adjusted stock return, and r is the rational expectation of the risk-adjusted return. When investor sentiment increases from s to s', current consumption *decreases* from C_0 to C_0'. $C_{0,R} - C_0$ is the pure substitution effect and $C_0' - C_{0,R}$ is the pure income effect. The EIS (determined by the slope and curvature of the indifference curves) is *high* enough that the negative substitution effect from sentiment on current consumption dominates the positive perceived income effect from sentiment. Investment goes from I_0 to I_0'. $I_0 = E - C_0 + B$, where B is the investors holding in the bond.

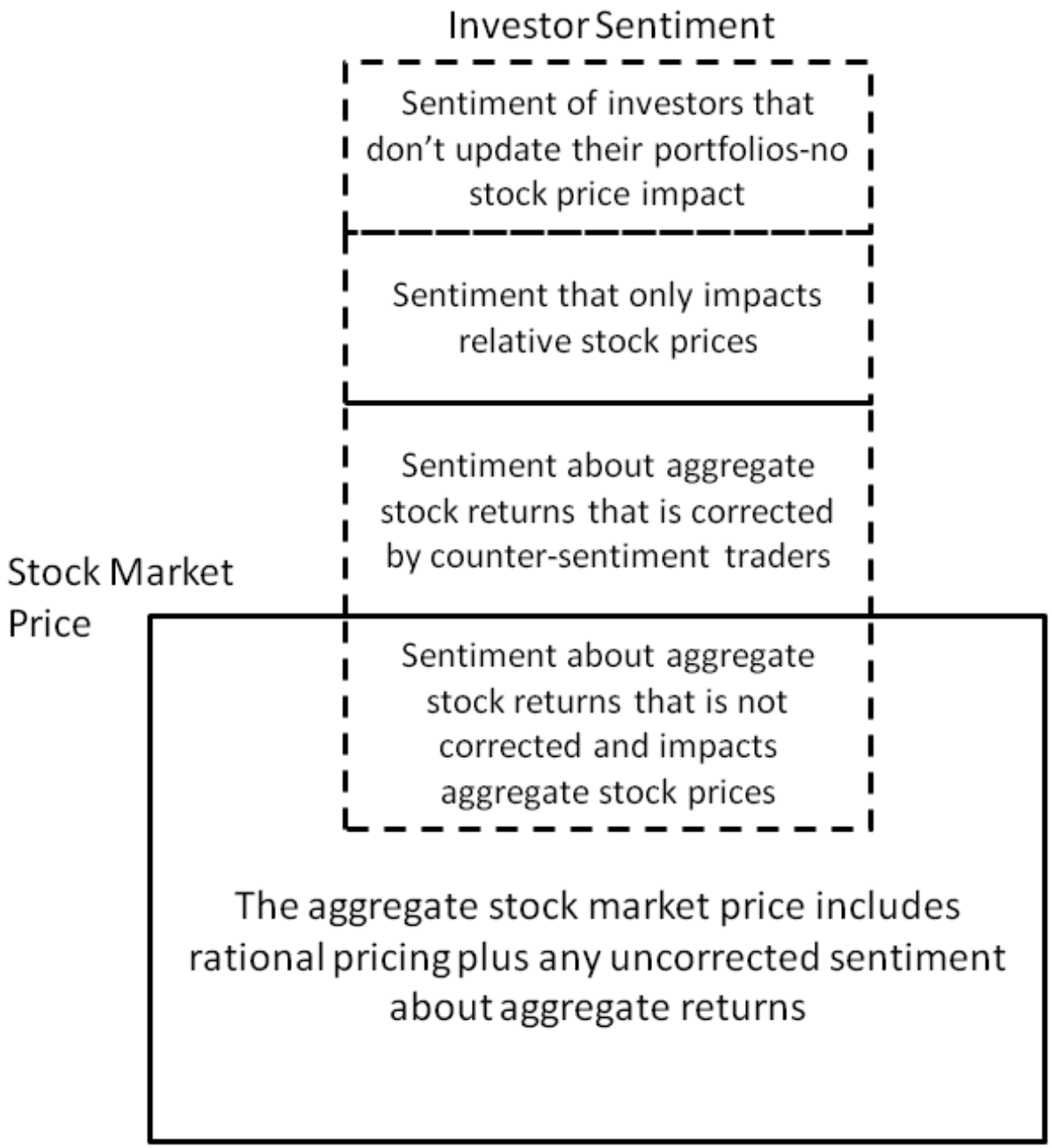

Figure 5: **The Distinction Between Sentiment and Stock Market Prices**. The large dashed-line rectangle is investor sentiment and the large solid-line rectangle is the aggregate stock market price. Only sentiment that generates aggregate stock market price pressure *and* is not corrected will affect the aggregate stock market.

Table 1: **Summary Statistics**. Consumption and income variables are inflation-adjusted to 2005 dollars and are in per-capita terms. See appendix A for variable definitions. The sample period is April 1976-December 2005, monthly.

Variable	**Mean**	**Standard Deviation**	**Median**	**Min**	**Max**
sent_o	0.0040	0.9217	-0.0300	-2.3600	2.9900
sent	0.0601	0.8889	0.1050	-2.3300	2.6100
PCE	$19930.31	5088.93	19354.55	12474.46	30388.43
PCE durable	$2639.81	634.56	2572.38	1645.04	3976.22
PCE service	$12195.78	3864.6	11875.1	6584.38	19881.41
PCE nondurable	$5094.72	629.2	4969.98	4205.38	6875.35
Disposable income	$21972.46	5072.2	21496.64	14195.05	32525.59

Table 2: **Correlations**. Consumption, income, and financial asset variables are inflation adjusted to 2005 dollars and are in per-capita terms. See appendix A for variable definitions. The sample period is April 1976-December 2005, monthly. Pearson product moment pair–wise correlations are shown with p–values in parenthesis.

Variables	sent_o	sent	PCE total	PCE durable	PCE service	PCE nondurable	disposable income	SP500	OFHEO
sent_o	1.0000								
sent	0.9321	1.0000							
	(0.0000)								
PCE	0.1027	0.1920	1.0000						
	(0.0245)	(0.0000)							
PCE durable	0.0998	0.1933	0.9904	1.0000					
	(0.0288)	(0.0000)	(0.0000)						
PCE service	0.0982	0.1868	0.9993	0.9864	1.0000				
	(0.0315)	(0.0000)	(0.0000)	(0.0000)					
PCE nondurable	0.1185	0.2066	0.9959	0.9859	0.9927	1.0000			
	(0.0094)	(0.0000)	(0.0000)	(0.0000)	(0.0000)				
disposable income	0.1063	0.1980	0.9996	0.9901	0.9983	0.9971	1.0000		
	(0.0199)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)			
SP500	0.1516	0.2027	0.9216	0.9328	0.9232	0.8991	0.9156	1.0000	
	(0.0009)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		
OFHEO	0.1674	0.2091	0.9842	0.9588	0.9829	0.9891	0.9827	0.8625	1.0000
	(0.0012)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	

Table 3: **OLS Model**. The natural logarithm is used for all variables. See appendix A for variable definitions. The sample period is April 1976-December 2005, monthly. R^2 is not show as it is biased in the presence of positive autocorrelation, but the Newey-West t-statistics in parentheses are robust to autocorrelation effects for up to a year.

Natural log of:	PCE nondurable	PCE nondurable	PCE durable	PCE service
ln(disposable income)	0.5053	0.4847	0.6449	1.1976
	(14.6006)	(12.9802)	(4.3830)	(31.6871)
ln(sp500)	-0.0015	0.0144	0.1257	0.0232
	(-0.1477)	(1.5818)	(3.1973)	(2.4735)
ln(OFHEO)	0.3842	0.3584	0.2065	-0.0618
	(9.3779)	(9.2190)	(1.4675)	(-1.6383)
ln(sent_o)		0.2143	-0.2624	-0.1710
		(4.9399)	(-1.6589)	(-5.9888)
N	418	370	370	370
F	6337	14607	1117	78196

Table 4: **First Difference Model**. The monthly change (i.e. the first difference) in the natural logarithm is used for all variables. Δ_t is the difference operator, indicating change from period $t-1$ to period t. See appendix A for variable definitions. The sample period is April 1976-December 2005, monthly.

Δ_t ln(PCE nondurable)	Model 1	Model 2
Δ_t ln(disposable income)	0.1583	0.1882
	(3.0774)	(3.7439)
Δ_t ln(SP500)	0.0222	0.0098
	(1.8662)	(0.8077)
Δ_t ln(OFHEO)	0.1184	0.1357
	(1.7907)	(2.0468)
Δ_t ln(sent_o)		0.0772
		(4.3430)
N	417	369
Adjusted R^2	0.0439	0.1033
Durbin–Watson statistic	2.1557	2.3796

Table 5: **Prais–Winsten GLS Model**. The natural logarithm is used for all variables. PW is the Prais–Winsten transformation operator. See appendix A for variable definitions. The sample period is April 1976-December 2005, monthly. Post estimation Durbin–Watson statistics suggest that autocorrelation has been well–corrected for. The high R^2 values are consistent with the results of Case, Quigley, and Shiller (2005).

PW.ln(PCE nondurable)	Model 1	Model 2
PW.ln(disposable income)	0.4191	0.4408
	(10.3405)	(12.0745)
PW.ln(SP500)	0.0298	0.0230
	(2.6557)	(2.2853)
PW.ln(OFHEO)	0.4278	0.3997
	(8.5359)	(8.9554)
PW.ln(sent_o)		0.0848
		(4.4289)
N	418	370
Adjusted R^2	0.9920	0.9957
Durbin–Watson Statistic	2.0818	2.2236
Serial Correlation Coefficient	0.9248	0.8913

Table 6: **Vector Error-Correction Model**. The dependent variable is the change in the log of nondurable consumption. The monthly change in the natural logarithm is used for all independent variables except the error-correction term ln(PCE/disposable income), for which the lagged level is used. The sample period is April 1976-December 2005, monthly. Δ_t is the difference operator indicating change from period $t-1$ to period t. L is the lag operator so L1 is a lag of one month. See appendix A for variable definitions.

Δ_t ln(PCE nondurable)	Model 1	Model 2
L1.Δ_t ln(PCE nondurable)	-0.0824	-0.1971
	(-1.7234)	(-4.0638)
Δ_t ln(disposable income)	0.1602	0.1886
	(3.1261)	(3.8341)
Δ_t ln(SP500)	0.0210	0.0079
	(1.7666)	(0.6689)
Δ_t ln(OFHEO)	0.1135	0.1248
	(1.7213)	(1.9156)
Δ_t sent_o		0.0750
		(4.3114)
L1.ln(PCE/disposable inc)	-0.0265	-0.0243
	(-1.7106)	(-1.5908)
N	417	369
Adjusted R^2	0.0525	0.1432
Durbin–Watson	1.9884	2.0050

Table 7: **Vector Error-Correction Model with Sentiment as the Error-Correction**. The dependent variable is the change in the log of nondurable consumption. The monthly change in the natural logarithm is used for all independent variables except the error-correction terms ln(sent_o) and ln(PCE/disposable income), for which lagged levels are used. The sample period is April 1976-December 2005, monthly. Δ_t is the difference operator indicating change from period $t-1$ to period t. L is the lag operator so L1 is a lag of one month. See appendix A for variable definitions.

Δ_t ln(PCE nondurable)	Model 3	Model 4	Model 5
L1.Δ_t ln(PCE nondurable)	-0.2101	-0.2012	-0.2019
	(-4.2698)	(-4.1425)	(-4.1660)
Δ_t ln(disposable income)	0.2024	0.1927	0.1895
	(4.0549)	(3.9211)	(3.8606)
Δ_t ln(SP500)	0.0090	0.0083	0.0071
	(0.7473)	(0.7000)	(0.6048)
Δ_t ln(OFHEO)	0.0863	0.1036	0.1106
	(1.3022)	(1.5802)	(1.6866)
Δ_t ln(sent_o)		0.0681	0.0681
		(3.8058)	(3.8143)
L1.ln(sent_o)	-0.0199	-0.0128	-0.0129
	(-2.5432)	(-1.6161)	(-1.6408)
L1.ln(PCE/disposable inc)			-0.0247
			(-1.6159)
N	370	369	369
Adjusted R^2	0.1116	0.1434	0.1472
Durbin–Watson	2.0255	2.0155	2.0091

Table 8: **OLS Predictive Model**. The dependent variable is the natural logarithm of nondurable consumption. Column headers indicate the number of months forward for the dependent variable. The natural logarithm is used for all independent variables. See appendix A for variable definitions. The sample period is April 1976-December 2005, monthly. R^2 is not show as it is biased in the presence of positive autocorrelation, but the Newey-West t-statistics in parentheses are robust to autocorrelation effects for up to a year.

ln(PCE nondurable)	0	3	6	9	12	15	18	21	24
ln(disposable income)	0.4893	0.4193	0.3566	0.2987	0.2612	0.2282	0.1974	0.1692	0.1394
	(14.1562)	(12.0987)	(9.2835)	(6.9704)	(5.1611)	(3.9876)	(3.1627)	(2.5914)	(2.1657)
ln(sp500)	0.0200	0.0285	0.0362	0.0439	0.0466	0.0504	0.0551	0.0602	0.0647
	(2.3468)	(3.2087)	(3.5417)	(3.6607)	(3.3967)	(3.4213)	(3.5022)	(3.6832)	(3.8416)
ln(OFHEO)	0.3385	0.4110	0.4759	0.5341	0.5752	0.6064	0.6325	0.6542	0.6805
	(8.9114)	(10.8906)	(11.7689)	(12.2342)	(11.0823)	(10.1765)	(9.6740)	(9.3931)	(9.9312)
ln(sent_o)	0.2230	0.1959	0.1652	0.1305	0.0672	0.0192	-0.0253	-0.0675	-0.1188
	(5.6570)	(5.2782)	(4.4343)	(3.0909)	(1.3576)	(0.3510)	(-0.4095)	(-0.9924)	(-1.5953)
ln(consumer conf)	-0.0339	-0.0255	-0.0227	-0.0200	-0.0125	-0.0091	-0.0069	-0.0044	0.0028
	(-2.9446)	(-2.2273)	(-1.8647)	(-1.3542)	(-0.7267)	(-0.5277)	(-0.3564)	(-0.2206)	(0.1402)
N	370	370	370	370	370	370	370	370	370
F	9901.6	14163.7	13001.5	8831.9	4600.6	2928.4	2045.1	1583.2	1423.3

	27	30	33	36	39	42	45	48
ln(disposable income)	0.1085	0.0795	0.0541	0.0639	0.0902	0.1205	0.1390	0.1522
	(1.7310)	(1.2721)	(0.8659)	(0.9364)	(1.0824)	(1.2732)	(1.4874)	(1.7714)
ln(sp500)	0.0726	0.0820	0.0899	0.0960	0.1010	0.1065	0.1134	0.1202
	(4.0997)	(4.2928)	(4.3407)	(4.3479)	(4.2644)	(4.3098)	(4.4641)	(4.6454)
ln(OFHEO)	0.6998	0.7128	0.7250	0.6871	0.6268	0.5599	0.5081	0.4647
	(10.4158)	(10.7134)	(10.8335)	(8.6418)	(6.0195)	(4.5613)	(4.1274)	(4.0900)
ln(sent_o)	-0.1566	-0.1830	-0.2156	-0.2328	-0.2375	-0.2451	-0.2527	-0.2406
	(-1.9145)	(-2.0531)	(-2.2664)	(-2.3104)	(-2.1896)	(-2.1710)	(-2.1272)	(-1.9668)
ln(consumer conf)	0.0058	0.0051	0.0062	0.0045	0.0047	-0.0012	-0.0103	-0.0169
	(0.2789)	(0.2343)	(0.2624)	(0.1735)	(0.1673)	(-0.0419)	(-0.3470)	(-0.5376)
N	370	370	370	370	370	370	370	370
F	1315.0	1191.6	1045.5	798.1	648.7	558.2	513.6	487.2

Table 9: **Does investor sentiment predict risk?** The dependent variable is the realized covariance between monthly consumption growth and monthly S&P 500 stock returns. This covariance is used as a traditional measure of realized stock market risk. Column headers indicate the number of months included in a rolling window of time for the covariance calculation. Sentiment at the beginning of the time window is used to predict the time window's realized risk. See appendix A for details on the sentiment variable, sent_o. The average sentiment over the previous 6 months (sent_o 6m avg) is also used to predict realized risk. The sample period is April 1976-December 2005, monthly. R^2 is not show as it is biased in the presence of positive autocorrelation, but the Newey-West t-statistics in parentheses are robust to autocorrelation effects for up to a year.

Realized risk	6	12	36	60	12
sent_o	0.0000	-0.0000	-0.0000	-0.0000	
	(1.4017)	(-0.3176)	(-0.9307)	(-0.8832)	
sent_o 6m avg					0.0000
					(0.8022)
N	480	480	480	468	485
F	1.965	.1008	.8661	.7801	.6435
lag	12	12	12	12	12

Table 10: **Index-option implied volatility and sentiment**. This table reports the average index-option implied volatility, conditional on investor sentiment (sent_o). The first column gives the standard deviations (σ) from sentiment's mean of zero that define low and high investor sentiment. Investor sentiment is considered moderate when it is between $-\sigma$ and σ. The top panel shows impled volatility for S&P 500 options (VIX), the bottom panel shows implied volatility for S&P 100 options (VXO). See appendix A for variable definitions. The VIX and VXO sample periods are monthly, from January 1990 to December 2005, and June 1986 to December 2005, respectively. T-statistics are in parenthesis.

Low and high sentiment cutoffs, $-\sigma$ and σ	Low sentiment $sent\_o < -\sigma$	Moderate sentiment $sent\_o \in [-\sigma, \sigma]$	High sentiment $sent\_o > \sigma$
VIX			
0.5 σ	21.3833	18.2206	22.3488
	(17.5867)	(32.0181)	(30.3004)
N	30	129	33
1 σ	23.8157	18.8277	23.5124
	(13.0761)	(37.8368)	(25.7302)
N	7	168	17
VXO			
0.5 σ	22.2570	19.6931	24.2203
	(19.4036)	(31.1853)	(31.0312)
N	43	154	38
1 σ	23.7871	20.3764	26.1300
	(13.4481)	(38.5912)	(25.5161)
N	7	211	17