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ORIGINAL ARTICLE

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Sentiment or habits: Why not both?

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Abstract

Habits and sentiment are important psychological behaviors in asset pricing. In this article I nest consumer sentiment as a risk factor into the Campbell–Cochrane (CC) habit model and examine its impact on asset prices. The model provides an economic mechanism for the pricing of sentiment risk through its impact on habit sensitivity and equilibrium habit levels but finds its market price of risk much lower than fundamentals. The additional sentiment factor does not improve the CC model, with both models returning a matched moments error of 12% from 1980Q1 to 2021Q4. The sentiment factor, however, subsumes risk aversion with a lower resulting risk coefficient than the CC model without sentiment. Furthermore, the model shows that during the COVID period, the risk premium was driven more by consumption growth than sentiment.

JEL CLASSIFICATION

G12, G17, G40, G41

1 | INTRODUCTION

Habits and sentiment are important psychological traits that relate to agents' consumption. Habits as defined by psychology are repeated acts of an activity developed through reinforcement and repetition. Sentiment, in contrast, refers to an attitude, thought, or judgment prompted by feelings, according to the *Merriam-Webster Dictionary*. Which affects asset prices more: habits or sentiment? Although the individual impacts of sentiment and habits on consumption growth and asset pricing have been studied with many stylized facts established, there is little examination of the interactive effects of market sentiment and habits on asset prices, which I study in this article.

I use the widely cited Campbell and Cochrane (1999) model (hereafter CC model) as a framework model to study the interactive habits of sentiment and habits. In the CC model, the surplus ratio S_t is modeled as the consumption relative to the habit level X_t:

$$S_t = \frac{C_t - X_t}{C_t}. \tag{1}$$

For a fixed consumption level C_t, if there is a larger surplus in the economy it is because the agents are comfortable with a lower habit level X_t. Conversely, if there is a small surplus ratio, agents demand a higher habit level X_t. Therefore, agents that have a lower habit level X_t of consumption take fewer risks. In contrast, agents that have a higher habit expectation are prone to take greater risks to attain it, much like the force of habit in Campbell and Cochrane's (1999) aptly titled paper.

Sentiment affects habit formation. In behavioral psychology, it is known that positive sentiment affects decision making, making agents more daring in Isen and Patrick (1983). Fogg (2020) in his *New York Times* bestseller *Tiny Habits* argues that it is emotions that create habits and not the conventional wisdom of repetition.

Habits have three defining psychological characteristics that we are familiar with as emotional beings: (1) equilibrium habit level (the level of habits we are comfortable with), (2) persistence of habits (how unwilling we are to change our habits), and (3) sensitivity (or urge) to regain a comfort habit level when external shocks take place. In the CC model, these are modeled as $\bar{S}$,[1] ϕ_s, and $\lambda(\cdot)$ respectively. I develop a new model (hereafter the sentiment model) with the sensitivity function $\lambda(\cdot)$ and $\bar{S}$ depending on consumer sentiment. I study its impact on the risk premium in particular. My article therefore contributes to the integration of deeper psychological traits (not just psychological biases) into existing asset pricing theories in this burgeoning literature at the intersection of psychology and behavioral finance (Akerlof & Shiller, 2009; Kahneman, 2003).

I use data from 1980Q1 to 2021Q4 including the COVID period with low interest rates, increased wealth, and consumption volatility. Both the CC model and the sentiment model remain robust and are able to model both the first and second moments of the risk premium, risk-free rate, and excess returns with a comparable 12% absolute error.[2] The results show that the sentiment model subsumes a lower risk aversion coefficient (1 to 1.5) than the CC model. This is consistent with research showing that sentiment states affect risk aversion (Aren & Koten, 2019; Conte et al., 2016; Drichoutis & Nayga, 2013). Drichoutis and Nayga (2013) in their psychological research show that induced negative and positive mood states increase risk aversion in a laboratory experiment. Furthermore, sentiment has an asymmetric impact on the market, with negative sentiment greater than positive sentiment. This is termed "negativity bias" in psychology. I model this through the agent's differential habit sensitivity to sentiment states. I also find that fundamentals rather than consumer sentiment play a more important role during the COVID period in driving asset prices.

A key benefit of nesting habits and sentiments in the same model is the ability to examine which is more important in asset pricing. I find that habits have a higher impact on the Sharpe ratio than sentiment. In the literature, there has been debate whether sentiment has a market price of risk because it does not reflect economic fundamentals. Empirical work (e.g., Doukas & Han, 2021) shows that it is a priced factor in a modified capital asset pricing model (CAPM) but does not elaborate on its mechanism. I provide an economic mechanism for market sentiment priced through its impact on habits.

I also explain the value premium in habits models through sentiment mean reversion. By model construction and calibration, price–consumption (PC) ratios have a lower value for negative sentiment. When the negative sentiment eventually mean reverts to positive in the economic cycle, the PC ratio increases and reduces the stochastic discount, resulting in a positive value premium in the longer duration.

[1]The equilibrium surplus ratio $\bar{S}$ has a 1-1 inverse mapping with the equilibrium habit level $\bar{X}$ for a given consumption C_t from Equation (1).
[2]For purpose of comparison, the risk-free rate volatility is excluded from the error calculation because the CC model fixes the risk-free rate.

2 | BACKGROUND DISCUSSION

In this section I describe the consumer sentiment and the habit utility model used in economics, which is the basis of this article.

The monthly University of Michigan index is the most popular measure of consumer sentiment. A macroeconomic paper by Carroll et al. (1994) shows that consumer sentiment predicts household consumption spending. The authors use the University of Michigan consumer index and show that it Granger causes the real personal consumption expenditures. Household spending constitutes a large portion: 60% of the US economy even today. Carroll et al. (1994) suggest two possible reasons for the prediction. The first is that sentiment predicts consumption as an independent driver of consumer spending. The second is that sentiment creates optimism and expectation in the consumers. Mehra and Martin (2004) later show that the second reason is more plausible, in particular if habits are factored in Carroll et al. (1994). My study validates this in that the primary impact of sentiment on consumption is through the habit sensitivity and equilibrium habit level. Figure 1 shows a time series of the normalized Michigan sentiment index.

The sentiment is normalized to range from −0.2 to 0.2[3] and is used as a state variable $\epsilon_{x,t}$ for the model described in Section 3. The Michigan sentiment is highly persistent and follows an autoregressive AR(1) model with a coefficient of 0.90:

$$\epsilon_{x,t+1} = 0.9\epsilon_{x,t} + 0.003. \tag{2}$$

3 | THE ECONOMY

3.1 | The model

The economy has a representative agent with habit utility preferences and consumption growth following an independent and identically distributed (i.i.d.) process defined by, respectively:

$$u(X_t, C_t) = \delta\frac{(C_t - X_t)^{1-\gamma}}{1\text{-}\gamma}, \tag{3}$$

$$\Delta c_{t+1} = c^a_{t+1} - c^a_t = g_c + \epsilon_{c,t+1}. \tag{4}$$

Its marginal utility of consumption and second-order derivatives are, respectively:

$$u_c(X_t, C_t) = \delta(C_t - X_t)^{-\gamma}, \tag{5}$$

$$u_{cc}(X_t, C_t) = \frac{-\delta\gamma}{(C_t - X_t)^{\gamma+1}} < 0. \tag{6}$$

The evolving habits X_t are modeled as the surplus ratio S_t, which logarithm s_t evolves as a heteroskedastic AR(1) process:

$$s^a_{t+1} = (1 - \phi_s)\bar{s} + \phi_s s^a_t + \lambda(s_t) \underbrace{(\Delta c_{t+1} - g_c)}_{\epsilon_{c,t+1},consumptionshock} \tag{7}$$

[3]The normalization interval is chosen to match the S_t values. They are adjusted for in the model by its normalized volatility of ≈0.09 in Table 1.

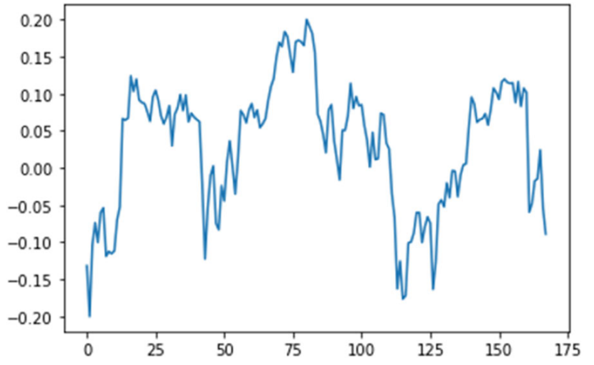

FIGURE 1 University of Michigan index. Time series of Michigan consumer sentiment index from 1980Q1 to 2021Q4. Notably, consumer sentiment is pro-cyclical and mean reverting. When the economy is booming, consumer sentiment is high, and vice versa, when there is a recession consumer sentiment is low [Color figure can be viewed at wileyonlinelibrary.com]

As per convention, small caps are for logarithm values and large caps indicate the original values. The superscript *a* indicates an aggregate consumption of all agents for external habit models. For notational simplicity, this is omitted in the subsequent discussion. At this juncture, this economy behaves the same as the CC model.

In the sentiment model, the representative agent responds differently to consumption shock depending on their sentiment state by the sensitivity $\lambda(\cdot)$ function. $\lambda(\cdot)$ is:

$$\lambda(S_t, \epsilon_{x,t}) = \begin{cases} \frac{1}{\bar{S}}\sqrt{1 - 2(s_t - \bar{s}) - B_{2'}\epsilon_{x,t}} - 1 & \text{for} s_t < s_{\max} \\ 0 & \text{for} s_t \geq s_{\max}. \end{cases} \tag{8}$$

$\lambda(\cdot)$ is the habit sensitivity to consumption shocks. In a recessionary environment with low surplus ratios S_t, $\lambda(\cdot)$ is higher in value than in an expansionary environment with high surplus ratios S_t. Similarly, in recession states, negative sentiment results in increased sensitivity, high risk premium, and a larger marginal utility. In contrast, in economic boom times, positive sentiment contributes to a lower risk premium and a higher discount factor. $\lambda(\cdot)$ reaches a zero value at $S_{\max}$. $\bar{S}$ is the long-run surplus ratio:

$$\bar{S} = \sigma_c\sqrt{\frac{\gamma}{1 - \phi_s - B_1/\gamma}}. \tag{9}$$

$\bar{S}$ is the inverse of the equilibrium habit level $\bar{X}$, which is a consumption level the agent is comfortable with. Equation (9) means that $\bar{S}$ increases/$\bar{X}$ decreases with an increase in B_1. This increases the surplus ratio S_t for a fixed consumption level C_t in Equation (1). ϕ_s is the habit persistence—how "sticky" or hard it is to break past habits. Poldrack (2021) explores how neuroscience explains why habits are so hard to break. This parameter has been relatively constant regardless of sentiment and economy and fixed at 0.93. The agent's sensitivity to sentiment is determined by $B_{2'}$ depending on the sentiment states:

$$B_{2'} = \begin{cases} 2B_2 & \text{for} \epsilon_t < 0 \\ 0.5B_2 & \text{for} \epsilon_t > 0. \end{cases} \tag{10}$$

In the psychological literature, there is evidence of a so-called negativity bias (Vaish et al., 2008). In this form of bias, agents react emotionally more to negative news than to positive news. This asymmetry has also been observed in the financial markets (Li, 2015; Lutz, 2015). For $B_2 > 0$, a negative sentiment $\epsilon_{x,t} < 0$ increases $\lambda(\cdot)$. The sentiment model nests to the original CC model for $B_1 = B_2 = 0$.

3.1.1 | Relation to the risk-free rate and the risk premium

I next consider how the risk-free rates and risk premium are linked to the stochastic discount factor M_t from the agent's consumption. Following standard derivation, this stochastic discount factor or the marginal rate of substitution at time t to time $t + 1$ is:

$$M_{t+1} = \delta \frac{u_c(C_{t+1}, X_{t+1})}{u_c(C_t, X_t)} = \delta (\frac{S_{t+1}}{S_t} \frac{C_{t+1}}{C_t})^{-\gamma} \tag{11}$$

The substitution of Equations (4) and (7) for the consumption growth and the surplus ratio (with the derivation in Section A1 of the Online Appendix) results in:

$$M_{t+1}|_t = \delta e^{-\gamma [g_c + (1-\phi_s)(\bar{s} - s_t) + (1+\lambda(\cdot))\epsilon_{c,t}]}. \tag{12}$$

The unconditional risk-free rate is obtained by taking expectations of Equation (12) through $r_f = \frac{1}{\mathbb{E}[M_t]}$. The risk-free rate equation with the derivation in Section A1 of the Online Appendix is:

$$r_{f,t} = \underbrace{-\log(\delta) + \gamma g_c}_{intermporalsubstitution} \underbrace{- \gamma(1 - \phi_s)(s_t - \bar{s}) - \left[\frac{\gamma^2 \sigma_c^2}{2}(1 + \lambda(\cdot))^2\right]}_{precautionarysavings}. \tag{13}$$

The first two terms on the right-hand side (RHS) correspond to the intertemporal rate of substitution whereas the last two terms on the RHS pertain to the precautionary savings motive. In the CC model, $\lambda(\cdot)$ and $\bar{S}$ are specified to result in a fixed risk-free rate (hence zero volatility). In the sentiment model, Equation (13) reduces to Equation (14) with the derivation in the Online Appendix:

$$r_{f,t} = -\log(\delta) + \gamma g_c - \frac{\gamma}{2}(1 - \phi_s) + \frac{B_1}{2} - B_1(s_t - \bar{s}) + \frac{B_2}{2}[\gamma(1 - \phi_s) - B_1]\epsilon_{x,t}. \tag{14}$$

In Section A3 of the Online Appendix, I show that this sentiment model meets equilibrium stability conditions that are similar to the original CC model. These equilibrium conditions set the range of possible values for B_1 and B_2 parameters, which are in Table 1. Following standard derivation, the Euler's equation for consumption is:

$$\frac{P_t}{C_t} = \mathbb{E}_t\left[M_{t+1}\left(\left(\frac{P_{t+1}}{C_{t+1}} + 1\right)\frac{C_{t+1}}{C_t}\right)\right]. \tag{15}$$

Let $G(\epsilon_{x,t}, s_t)$ denote the solution for the PC ratios as functions of the sentiment shock $\epsilon_{x,t}$ and the surplus ratio s_t. Equations (4) and (12) for the consumption growth and the stochastic discount factor, respectively, are substituted into Equation (15) to result in:

$$\begin{aligned} G(\epsilon_{x,t}, s_t) &= \mathbb{E}_t[\delta e^{-\gamma [g_c + (1-\phi_s)(\bar{s} - s_t) + (1+\lambda(\cdot))\epsilon_{c,t+1}]} e^{(g_c + \epsilon_{c,t+1})}(G(\epsilon_{x,t+1}, s_{t+1}) + 1)] \\ &= \mathbb{E}_t[\delta e^{(1-\gamma)g_c - \gamma(1-\phi_s)(\bar{s} - s_t) + [1 - \gamma(1+\lambda(\cdot))]\epsilon_{c,t+1}}(G(\epsilon_{x,t+1}, s_{t+1}) + 1)] \end{aligned} \tag{16}$$

Unlike the original CC model, this equation has two state variables s_t and $\epsilon_{x,t}$, with the latter a new addition. Equation (16) is solved as a fixed-point problem with double grid values for s_t and the sentiment shock $\epsilon_{x,t}$ using values from −0.2 to +0.2, which act like “slices” on the three-dimensional PC surface. The construction of the PC surface depends on the model parameters ($B_1, B_2, \gamma, \phi_s, \delta$) and is determined by the market conditions ($\sigma_c, \sigma_x, \rho, g_c$) in Table 1. This PC surface is linked to the risk premium through standard derivation:

$$R_{t+1} = \frac{[PC_{t+1}(s_{t+1}, \epsilon_{x,t+1}) + 1]}{PC_t(s_t, \epsilon_{x,t})} \frac{C_{t+1}}{C_t} \tag{17}$$

TABLE 1 Model calibration and results

	Symbol	Market data 1980Q1 to 2021Q4	CC model 1980Q1 to 2021Q4	Sentiment model 1980Q1 to 2021Q4
Risk premium	r	1.03%	0.88%	0.81%
Risk volume	σ	2.79%	3.10%	2.50%
Risk-free rate	r_f	3.26%	3.10%	3.10%
Risk-free volume	σ_{rf}	2.88%	0%	3.10%
Excess return		−2.20%	−2.22%	−2.25%
Excess return volume		3.98%	2.80%	3.20%
Mean absolute error		-	12.0%*	12.1%*
Model parameters				
Habit level	B_1	-	-	−0.04
Habit sensitivity	B_2	-	-	0.8
Habit stickiness	φ_s		0.93	0.93
Discount factor	δ		0.925	0.92
Risk coefficient	γ		1.5	1.0
Fixed from market data				
Consumption growth	g_c	0.016	-	-
Consumption volume	σ_c	0.01525	-	-
Sentiment volume	σ_x	0.007	-	-
Model output				
Eqm surplus ratio	S	-	0.086	0.055
Max surplus ratio	$^{S}\max$	-	0.25	0.31

Note: The parameters are all annualized and estimated using quarterly data from 1980Q1 to 2021Q4. The error rate excludes the risk-free volatility because, by default, the Campbell & Cochrane, (1999) model (hereafter CC model) fixes this rate. The subjective discount factor δ used in Campbell and Cochrane (1999) is 0.89, which is expressly lower. The higher δ used here reflects the lower interest rate environment since the 2000s. Both models are comparable in performance, with an average error of 12%. However, for the CC model to match the sentiment model, a higher risk coefficient 1.5 is used (compared to 1.0 for the sentiment model). This leads to the conclusion that the sentiment model subsumes risk aversion to a certain extent. The sentiment model also has a higher $S_{\max}$ as positive sentiment causes agents to expect more.

4 | MODEL CALIBRATION

I first construct the PC surfaces for market conditions 1980Q1 to 2021Q4 by solving the fixed-point problem of Equation (16). The 2010s period is characterized by low interest rates, increased wealth from high equity levels, and changed consumption patterns. For example, during the COVID period and for the last 10 years, consumption has encompassed digital and online spending. This increased online spending has created a shift and added convenience to consumption patterns (Tao et al., 2022; Charm et al., 2020). The construction of the consumption ratios is explained in Section A4 of the Online Appendix and follows the methodology of Bansal and Yaron (2004).

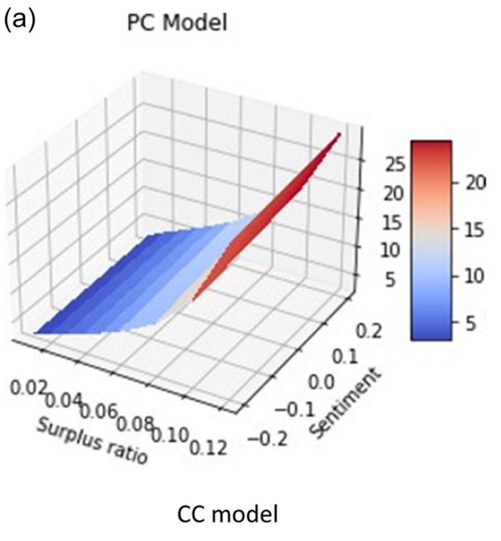

FIGURE 2 Price consumption (PC) surface. The plots show the PC surfaces generated by solving a fixed-point solution for the two models: (a) Campbell and Cochrane (1999) model (hereafter CC model) and (b) sentiment model. There are a couple of points to note on these surfaces. These are the tilts of the surface relative to the surplus ratio or the negative sentiment. A steeper slope increases the volatility of the risk premium through Equation (17). The tilt in the sentiment model is steeper for the surplus ratio relative to the sentiment axis, indicating a much higher price of risk for the surplus ratio. For the CC model, there is no tilt when the PC ratio moves in the direction of sentiment axis. On the contrary, the PC ratio increases, moving from negative sentiment to positive sentiment in the sentiment model. This latter increase can be an explanation for the value premium when negative sentiment mean reverts in the long run [Color figure can be viewed at wileyonlinelibrary.com]

The risk-free rate is the 1-month Treasury bills from Ken French's webpage[4] and the risky rates are the monthly average of Center for Research in Security Prices (CRSP) value-weighted equity returns. Figure 2 shows the PC surfaces for the CC model and sentiment model.

A key question is: What set of parameters ($\gamma, \phi_s, \delta, B_1, B_2$) should be used to construct the PC surfaces?[5] The PC surfaces from these parameter values are generated to match the first and second moments of the market data: the risk premium, risk-free rates, and excess returns in Table 1.

A time series of surplus ratios s_t is first simulated historically from Equation (7) and realized $\epsilon_{x,t}$ assuming a set of parameter values for (γ, B_1, B_2).[6] Each set of these parameter values solves for a specific PC surface illustrated in Figure 2. A time series of PC ratios is read off the simulated surplus ratio s_t and $\epsilon_{x,t}$ from the PC surface in quarterly intervals. These quarterly PC ratios and the consumption–growth ratios are then used to calculate the risk premium and excess returns from Equations (17) and (14). These are matched to calculated moments for market data from 1980Q4 to 2021Q4 by adjusting the set of parameter values (with a new PC surface each time) in trial and error to within 12% absolute error in Table 1. Risk-free rate volatility is deliberately omitted for comparison with the CC model, which fixes it.

The values $B_1 = -0.04$ and $B_2 = 0.8$ are calibrated for the sentiment model. $B_1 = B_2 = 0$ are set to 0 for the CC model. Comparatively, Wachter (2005) has $B_1 \approx 0.1$ and $B_2 \approx -0.12$. However, there is no sentiment risk

[4]https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

[5]There is need for caution for the grid granularity used in the fixed-point solution for the PC surface (see Wachter, 2005), which can affect the model results. To this extent, the PC ratios are shown to have an average percentage error of 0.2% for PC values that range from 0 to 20. Convergence is generally obtained with 20 iterations.

[6]To reduce the degree of freedom, ϕ_s and δ are fixed at 0.93 and 0.925, respectively.

factor in Wachter (2005), whose key concern is to model the risk-free rate that is fixed in the original CC model. The boundary conditions for equilibrium for the sentiment model are also proved in Section A.3 of the Online Appendix.

An interesting observation for the PC surface is the relative "tilts" from high to low values for the surplus ratio and consumer sentiment, respectively. The tilt is steeper for the surplus ratio than consumer sentiment. This directly affects the result from time t to time $t + 1$ for $\frac{PC_{t+1}(s_{t+1}, \epsilon_{x,t+1}) + 1}{PC_t(s_t, \epsilon_{x,t})}$ in Equation (17). Comparatively, an increase in the surplus ratio S_t from 0.05 to 0.07 (for zero sentiment shock) increases the PC ratio from 8.5 to 15.0 (estimated returns of 180%). In contrast, even an extreme increase in the sentiment from −0.2 to 0.2 (which are the observed normalized limits of sentiment and when the surplus ratio is near equilibrium at 0.06) only increases the PC ratio from 8 to 10.5 (estimated returns of 25%), respectively. This shows that the surplus ratio (and hence habits) is still the main driver of the risk premium compared to market sentiment, although the importance of sentiment cannot be ignored.

Consumer sentiment works indirectly through sensitivity to consumption shocks. Suppose sentiment increases from negative to positive in an expanding economy. The $\lambda(\cdot)$ habit sensitivity decreases (because $B_2 > 0$ in Equation [8]). The agent becomes less sensitive to the same consumption shock, which decreases s_{t+1}. This increases the expected M_{t+1} in Equation (11) and decreases the risk premium.

The risk coefficient γ for the CC model is found to be higher than for the sentiment model, 1.5 to 1.0. Sentiment encapsulates part of the risk-taking behavior of the agent compensated by the inclusion of sentiment in the model discussed in Section 5.2. Next, I discuss the market price of risk.

The market price of risk is defined as the ratio of the first and second moments of the risky asset return. The bound in Hansen and Jagannathan (1991) is an upper bound on the Sharpe ratio of an equity return R^e_{t+1} with $\rho_t(M_{t+1}, R^e_{t+1}) = -1$:

$$\frac{\mathbb{E}_t[R^e_{t+1}]}{\sigma(R^e_{t+1})} = -\rho_t\left(M_{t+1}, R^e_{t+1}\right)\frac{\sigma(M_{t+1})}{\mathbb{E}_t[M_{t+1}]} \leq \frac{\sigma(M_{t+1})}{\mathbb{E}_t[M_{t+1}]} \tag{18}$$

The base stochastic discount factor is expressed in Equation (12). The stochastic discount factor is $M_t = e^{\mu_m + \sigma_m \epsilon_c}$ where μ_M and σ_M are its lognormal mean and standard deviation, respectively. The maximum Sharpe ratio is derived in Section A2 of the Online Appendix and depends only on σ_M:

$$\text{max Sharpe ratio} = \sqrt{e^{\sigma_m^2} - 1} \tag{19}$$

This σ_M is derived in Equation (A6) in the Online Appendix for the sentiment model with an additional term $-B_2\epsilon_{x,t}$ in the Sharpe ratio:

$$\sigma_M = \left[\frac{1}{\bar{S}}\sqrt{1 - 2(s_t - \bar{s}) - B_2\epsilon_{x,t}}\right]\sigma_c \tag{20}$$

This additional term may either decrease or increase the Sharpe ratio further. Because $B_2 > 0$, it increases the Sharpe ratio in a recession for $\epsilon_{x,t} < 0$ and decreases the Sharpe ratio in a booming economy for $\epsilon_{x,t} > 0$. This is consistent with the result in Lustig and Verdelhan (2012) and Tao et al. (2008), which shows that Sharpe ratios are higher in recessions than in an expansionary environment. Note in this case the surplus ratio has a similar effect in Equation (20) because $s_t < <\bar{s}$ decreases in a recession. Both the surplus ratios and the sentiment hence act in the same direction and are pro-cyclical with economic expansions and recessions. One is based on actual fundamentals and the other is based on consumers' expectations of growth.

Using typical $S_t = 0.06$ values from Figure 3, the volatility movements of $2(s_t - \bar{s}) = 0.52$ is still greater than $B_2\epsilon_{x,t} = -1.6 \times 0.1 = 0.162$ (assuming $\Delta\epsilon_{x,t} = 0.1$), meaning the impact of the surplus ratio s_t is still more important in determining Sharpe ratios. Furthermore, the volatility of s_t is 0.76, an order higher than $\sigma(\epsilon_{x,t}) = 0.09$. This is consistent with the earlier discussion on the tilt attributing the surplus ratio as a more

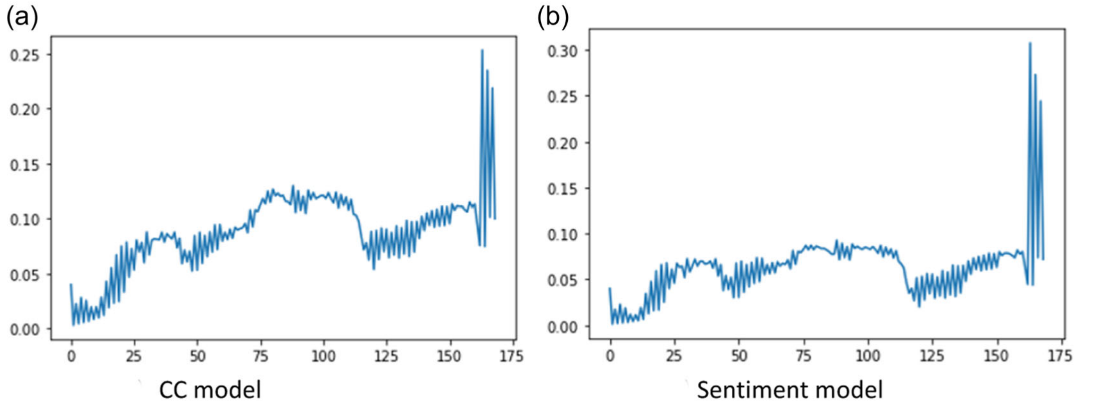

FIGURE 3 Historical surplus ratios. The plots show the surplus ratios S_t from 1980Q1 to 2021Q4. Both the Campbell and Cochrane (1999) model (hereafter CC model) and the sentiment model show similar volatile surplus ratios and consumption growth during the COVID pandemic. In 2020Q2, the consumption growth irrespective of the model experienced a decrease of −5.3%, but this recovered quickly to +10.8% in the next quarter. Correspondingly, the surplus ratio S_t overshot the max surplus ratio S_{max} and the habit sensitivity $\lambda \cdot = 0$. The sentiment model has generally lower S_t during the 2000s but saw higher S_{max} values and volatility during the COVID period [Color figure can be viewed at wileyonlinelibrary.com]

important driver of the risk premium than sentiment. In the long run, $\mathbb{E}[\epsilon_{x,t}] \approx 0$, which evens out the sentiment impact, unlike the surplus ratio, which averages about ≈0.07 in the normal economic times observed in the data, and is higher than $\bar{S}$.

Another general trend observed in Figure 3 is the generally increasing trend of S_t. This increased surplus ratio could be due to the growing affluence (and wealth) of consumers in general. Furthermore, the surplus ratio in the sentiment model has a wider range, with an equilibrium habit level of 0.055 to a maximum surplus ratio of 0.31 than the CC model in Table 1. This is because $B_1 < 0$ lowers $\bar{S}$. Positive sentiment further makes agents demand more (a higher maximum surplus ratio) whereas sadness causes impatience (lowering the equilibrium surplus ratio) and potentially increases the intertemporal discount rate as in Lerner et al. (2013).

5 | ECONOMIC DISCUSSION

I discuss the historical performance of the model, especially during the COVID period and a partial behavioral explanation of the value premium.

5.1 | Historical performance of consumption capital asset pricing model in the modern era

During the COVID pandemic in 2020–2021, consumption growth decreased by −5.3% in 2020Q2 but bounced back remarkably +10.4% in the following quarter 2020Q3. This is for ND + S + D (nondurables + service + durables). Excluding durables, the numbers were −8.5% and 7.2%, respectively. This swing in consumption growth caused surplus ratios S_t to fluctuate between 0.09 and 0.25 for the CC model. It was even more volatile between 0.05 and 0.3 for the sentiment model, as observed in Figure 3. In the same periods 2020Q2 and 2020Q3, the equally weighted CRSP (EWRET) returns decreased −7.4% and increased 7%, respectively. This initial COVID period was characterized by lockdowns that stifled consumption and disrupted supply chains. Although the consumer sentiment fell by 26.4% in 2020Q2, it did not rebound back sharply in the next quarter 2020Q3, unlike consumption growth. Instead, it grew slowly at +2 to 5% for the subsequent quarters. Consumer sentiment fell significantly again by a cumulative −20% in 2021Q3 and 2021Q4 with the discovery of the Delta variant. However, there was no corresponding large decrease in consumption growth or EWRET.

These observations lead to a couple of points. The equity market during the COVID period was driven largely by consumption and not consumer sentiment. Could the increased omnichannel for consumption help with smoothing and recovery effects when the COVID pandemic persists? During the initial COVID period with negative sentiment and falling equity prices, consumers became more habit sensitive. This caused larger swings in the surplus ratios S_t for the sentiment model than in the CC model. However, this change in habit sensitivity did not persist. Although consumer sentiment played a part in the initial period 2020Q2, its effects were muted in subsequent quarters.

5.2 | Subsuming risk aversion in the sentiment

In the finance literature, research has shown that risk aversion is not constant. For example, Guiso et al. (2018) link investor risk aversion to changes in wealth, expected income, and perceived probabilities, and emotional changes in the utility function. Muir (2017) shows that the risk premium increases substantially in financial crises, and the asset price decline in financial crises is substantially larger than the decline in fundamentals so that expected returns going forward are large. Diaz and Esparcia (2019) explore this nature of time-varying risk aversion and relate it to macroeconomic factors, investor sentiment, and behavioral factors. Earlier in Section 4, both the fundamentals (surplus ratios) and consumer sentiment are shown to increase the Sharpe ratios in recessionary markets.

In fact, the CC model helped explain the equity premium puzzle in Mehra and Prescott (1985). How did smooth consumption growth result in a high equity premium without resorting to implausibly high risk aversion? This was solved by using surplus ratios in Constantinides (1990) with a more plausible risk aversion coefficient ≈2. The sentiment model further shows that sentiment could be subsumed into and lower the risk aversion coefficient.

This leads to the next question. What is the psychological make-up of risk aversion? Campos-Vazquez and Cuilty (2014) show that emotions (sentiment) play a pivotal role in risk aversion in a prospect theory experiment. Sadness increases risk aversion over gains. Nguyen and Noussair (2014) show that a more positive emotional state is positively correlated with risk taking.

A psychological intuition of how sentiment lowers risk aversion is through impatience. Humans feel impatient when something does not go according to habits. Dizikes (2017) examines how impatience guides financial behavior. Dohmen et al. (2010) find that lower cognitive ability is associated with greater risk aversion and more pronounced impatience. Spending (or consumption) is shown to be highly related to impatience in Parker (2017).

Hence, in the sentiment model, when agents are unhappy (negative sentiment $\epsilon_{x,t} < 0$), they become more reactive and impatient, and habit sensitivity increases. This psychological reaction has economic implications by lowering the surplus ratio S_t and, depending on $\bar{S}$, further increases the risk premium in Equation (7).

5.3 | Sentiment, habits, and the value premium

Santos and Veronesi (2010) and Lettau and Wachter (2007) note that habits models do not generate a value premium inasmuch as a growth premium in the cross-section of stocks. Santos and Veronesi (2010) show through a simulation exercise that to account for the value premium under the habits model, value stocks need to exhibit abnormally high cash-flow risk, thus creating a cash-flow risk puzzle. This model offers a partial explanation from the behavioral aspect.

Zhang (2005) attributes the value premium to two key reasons: costly reversibility and countercyclical price of risk. However, Barberis et al. (1998) explain the value premium through behavioral biases. In Barberis et al. (1998), value stocks are underweighted because of conservatism. This results in a low sentiment, which mean reverts and subsequently leads to higher returns as investors' initial conservative behavior toward the earnings stream fades.

By construct, my nested model has lower PC ratios for negative sentiment. When the negative sentiment mean reverts in Equation (2), higher PC ratios and a higher return result. My nested model can do this as the PC ratios depend on both the surplus ratio and sentiment, whereas the original CC model depends only on the surplus ratio. This postulation trivially does not invoke the cash-flow risk puzzle, as it considers the risk premium and not actual cash flows.

Consider an agent with a risky asset and a risk-free asset. At time $t = 0$, the agent observes a positive earnings stream for the risky asset and reacts conservatively to it in the prevailing negative market sentiment. This agent's conservatism lowers his price projection and through the stochastic discount factor, M_{t+1} in Equation (12) decreases. At time $t = 1$, investors correct their initial conservatism and the sentiment mean reverts, bringing prices back up to equilibrium and generating a positive premium. Because value stocks are associated with a greater earnings stream than growth stocks, they are more affected by this phenomenon effect.[7]

6 | CONCLUSION

Although sentiment (and irrationality) has been known to affect asset prices in the literature, its economic mechanism of it is not well established. This article provides an avenue for determining how sentiment drives habits in asset prices. Negative sentiment increases habit sensitivity and causes agents to be more risk taking, driving up the risk premium. Both sentiment and the surplus ratio are pro-cyclical with macroeconomic conditions. The impact is also asymmetric, with negative sentiment stronger than positive sentiment.

Although the sentiment model establishes sentiment as a priced risk factor, its overall effect is still much smaller than fundamentals expressed through consumption. This is because sentiment has smaller unconditional volatility and is mean reverting with an unconditional mean of 0. The addition of sentiment to the model does not improve the moments matched relative to the CC model. Both models have similar performance and continue to be robust during the COVID period despite the shift in consumption patterns. The COVID pandemic from 2020 to 2022 was driven more by shocks to consumption patterns than by sentiment (other than during the first quarter).

Another novel contribution of my article is an application of deeper psychology to asset pricing, in particular, the observed lower risk aversion in the sentiment model compared to the CC model. Although the sentiment factor does not improve the CC model historically, it results in a lower risk aversion coefficient in the model. I argue that emotions (sentiment) play a role in risk aversion and suggest that sentiment affects habit formation or sustenance through impatience.

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[7] Wang (2018) has a similar explanation for the value premium but from an accounting perspective.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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