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## By force of confidence\*

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**Abstract**

Recent macro-finance contributions explain a great deal of unconditional asset pricing by introducing persistent consumption risks and rare disasters. Only the volatility puzzles remain unresolved among the longer-established issues in this literature. Motivated by empirical finance contributions and conventional wisdom, we abstract from a consumption-centric analysis and let the asset-pricing kernel depend on habit formation and consumer confidence as a demand shifter correlated with consumption growth. The resulting model compares favorably with the literature explaining the risk-free rate volatility. Our findings justify using supplementary information to price assets while warning against neglecting a thorough analysis of consumption growth dynamics. We rationalize including confidence indicators in the definition of the demand shifter by drawing parallels to existing approaches such as wealth in the utility function and salience theory.

**JEL Classification:** G12, E21**Keywords:** Asset Pricing, Consumer Confidence, Habit Persistence, Recursive Utility, Salience Theory, Utility from Anticipation, Utility from Wealth, Year-on-Year Growth**1 Introduction**

In the last four decades, macro-finance models have gone a long way to explain the concurrent behavior of consumption growth, risk-free rate, equity return, and dividend yield. A number of breakthroughs have recently been achieved by considering preferences for early resolution of

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uncertainty, persistent consumption risks, and macroeconomic events resulting in rare disasters.<sup>1</sup> A key advantage of these approaches is that predictions obtain from analyzing consumption growth in isolation. However, this feature might also prevent other observables from explaining the origin of risk persistence or the human reaction to distressing events, as suggested elsewhere in the literature.<sup>2</sup> Indeed, casual observation suggests that the conventional focus is not limited to analyzing consumption dynamics; it also encompasses other notions, often of an emotional nature.

This paper incorporates observables reflecting consumers' psychological traits into a macro-finance model to produce a persistent state variable correlated with consumption growth. The resulting stochastic discount factor (SDF) appropriately prices assets without resorting to persistent risks or rare events. The predictions match those found in the literature concerning the first moments of the market return and risk premium. Importantly, they compare favorably with regard to the volatility of the risk-free rate, providing sensible justification for using additional notions to explain asset pricing. In line with most existing literature, they also show a limited ability to capture asset prices' variability, suggesting that an exhaustive analysis of consumption dynamics must not be overlooked.

The model considers two prominent aspects emerging from empirical finance contributions and macroeconomic business and political news. The first aspect concerns information sources. The financial literature considers confidence indicators as conditioning information in factor asset pricing models.<sup>3</sup> The financial markets, the media, and the business community hold consumer confidence indicators in high regard when assessing or forecasting economic and financial conditions. Confidence is generally interpreted as an indicator of prospective consumer income or wealth variations. Higher confidence, the typical story goes, signals better economic conditions; this induces consumers to feel richer and, accordingly, more prone to consume. We let this concept guide our modeling strategy without imposing the related conventional wisdom. Consumer confidence is a state variable signaling a favorable or critical attitude towards consumption.<sup>4</sup> Since confidence is beyond the consumer's control, we assume that the state variable

<sup>1</sup>Seminal works of these branches of the macro-finance literature include Epstein and Zin (1989), Weil (1989), Rietz (1988), Barro (2006), and Bansal and Yaron (2004), which culminated in the contribution owed to Barro and Jin (2021).

<sup>2</sup>For a disquisition on this matter, see, e.g., Constantinides (2017). Other comprehensive surveys of the macro-finance literature can be found in Mehra (2012), Ludvigson (2013), Campbell (2015), and Cochrane (2017). See Epstein, Farhi and Strzalecki (2014) for a discussion of the economic plausibility of the more popular macro finance approaches.

<sup>3</sup>Ho and Hung (2009) and Bathia and Bredin (2018) include investor sentiment to study the relevance of the size, value, liquidity and momentum effects on individual stock returns. Lemmon and Portniaguina (2006) investigate the time-series relationship between consumer confidence and the returns of small stocks. Chung, Hung, and Yeh (2012) study the potential asymmetry of the predictive power of investor sentiment on stock returns during economic expansions and recessions.

<sup>4</sup>Influential papers corroborate this view (e.g., Barsky and Sims, 2012). This approach also echoes prospect theory (Kahneman and Tversky, 1979) since the different state-specific realizations of the state variable imply that consumers assess their loss and gain perspectives asymmetrically.

is determined exogenously.<sup>5</sup>

The second aspect is practical: growth rates are computed using the year-on-year convention, regardless of the (often higher) actual data frequency. This method is hardly ever used in the asset pricing literature. A rare exception is Jagannathan and Wang (2007), who argue that the “use of calendar year returns avoids the need to explain various well-documented seasonal patterns in stock returns, [...] [and] also attenuates the errors that may arise due to ignoring the effect of habit formation on preferences” (p. 1626). Importantly, this statement points out that our approach includes habit persistence since the year-on-year convention causes the Euler equation to comprise several higher-frequency growth factor lags, albeit in the compounded form of yearly growth factors. Habit can be external (Abel, 1990; Campbell and Cochrane, 1999), merely acting as a reference point, or internal, letting consumers’ current marginal utility depend on their own past consumption choice (Constantinides, 1990). In line with the exogenous nature of the forward-looking state variable, we let habit be external following Abel (1990). It is then immediate to consider the whole demand shifter susceptible to economic interpretation in a “catching up with the Joneses” fashion. The rest of the model draws on the framework proposed by Epstein and Zin (1989) and Weil (1989), hereafter the “standard” model. As such, our model also features consumers’ preference over the timing of uncertainty resolution.

The model’s core mechanism is analogous to the one exploited by the seminal Lucas (1978) “tree” model. If the asset payoffs covary positively with the consumption growth process, the negative relationship between asset returns and the SDF drives the expected market premium upwards. The demand shifter’s effect on the marginal utility of consumption adds another layer of variation to the core mechanism. In the presence of a positive correlation between consumer confidence innovation and consumption growth, the impact of confidence on marginal utility reinforces the income effect generated by the change of future consumption’s relative price, in turn implied by the variation of returns’ potential realizations across states of nature. This process causes larger SDF deviations from its mean, generating higher equity premia for speculative assets. Furthermore, if the demand shifter is positively autocorrelated, habit persistence’s time linkages strengthen this effect. Therefore, the SDF volatility is higher when the model considers consumer confidence and year-on-year growth rates. This outcome suggests that the novel source of variability acts as a magnifier of asset prices’ response to consumption growth fluctuations. As a result, our approach is suited to replicate the observed financial statistics with a lower consumption growth volatility than the standard asset pricing model requires, in a similar fashion as the recent consumption-centric approaches to macro-finance but through a

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<sup>5</sup>Many contributions in the asset pricing literature implicitly or explicitly incorporate state variables. Indeed, Cochrane (2017) argues that virtually every idea behind macro-finance models can be seen as a generalization of the stochastic discount factor obtained by adding a state variable. Early examples of papers worked out in a similar fashion include Eichenbaum, Hansen, and Singleton (1988), Aschauer (1985), Startz (1989), and, Piazzesi, Schneider, and Tuzel (2007).

distinct (though not necessarily incompatible) mechanism.

The modeling strategy is parsimonious. We let the joint stochastic dynamics of consumption growth and consumer confidence innovation follow an autoregressive scheme, allowing the two variables to correlate. We estimate the time series parameters and, to facilitate the numerical solution of the model, we use them to implement Tauchen's (1986) method to approximate the continuous-valued autoregression with a discrete Markov chain. Preferences retain the same three-parameter specification as in the standard model. Consequently, the parameter governing risk aversion dictates whether the consumers' propensity to save increases or declines with the demand shifter. The model's dynamics are sufficiently rich to allow for calibrating the preference parameters by matching the values of three simulated statistics (namely, the first two moments of the risk-free rate and the mean excess return) with the relevant figures observed in the data. The calibrated parameters of the baseline model are within the literature standards. Importantly, our quantitative results suggest that confident consumers are prone to *save* more, reversing the conventional wisdom's logic. This outcome finds empirical support as it aligns with the observed positive relationship between consumer confidence and consumption growth (Ludvigson, 2004).

Considering consumer confidence as a state variable is unconventional. However, this assumption can be reconciled with adaptations of other approaches found in the literature. Perhaps the most natural is wealth in the utility function (Faria and McAdam, 2013). Defined by the present value of the stream of future average consumption levels in a "catching up with the Joneses" fashion, utility from wealth would reflect anticipatory fulfillment from future consumption, just like external habits introduce past consumption as a reference point in utility.<sup>6</sup> Campbell and Cochrane (1999, p. 208) eloquently state that habit formation "captures a fundamental feature of psychology: repetition of a stimulus diminishes the perception of the stimulus and responses to it." Utility of anticipation represents the symmetric stance in an intertemporal perspective: the anticipation of a future stimulus alters the perception of current stimuli and responses to them. From this perspective, one may interpret habit formation as a measure of the impact on the current marginal utility of consumption of past events' reminiscence; consumer confidence as the anticipation of *future* conditions. Salience theory (Bordalo, Gennaioli and Schleifer, 2013) could also be adapted to accommodate the presence of consumer confidence as a state variable. According to this theory, consumers regard some payoffs as more noticeable (salient) than others and overweight such payoffs relative to their objective probabilities.<sup>7</sup> In a

<sup>6</sup>For a discussion on the origin and the relevance of anticipatory utility, see Frederick, Loewenstein, and O'Donoghue (2002). In a seminal paper, Loewenstein (1987) explicitly links anticipation to *internal* factors such as the "pleasurable deferral of a vacation, the speeding up of a dental appointment, the prolonged storage of a bottle of expensive champagne" (p. 666), and defines utility from anticipation as proportional to the future stream of utility from personal consumption, a formalization later borrowed by the few contributions providing asset pricing applications: Caplin and Leahy (2001) investigate the role of anxiety in determining the risk-free rate of return and the equity premium; Kuznitz, Kandel, and Fos (2008) study the effect of anticipatory utility on the mean allocation to stocks. Our approach differs from theirs as it considers *external* factors.

<sup>7</sup>In this light, our approach also relates to measures of valuation uncertainty. See, e.g., Joos, Piotroski and

reduced-form version of such a framework, confidence would signal the effect of such overweighting.<sup>8</sup> We draw these parallels after presenting the quantitative analysis to aid the economic interpretation of our findings.

Carroll, Fuhrer and Wilcox (1994) argue that the observed correlation between consumer confidence and consumption growth suggests a potential role for habit formation. Our analysis shows that one should jointly consider consumer confidence and habit. The outcomes of the model significantly worsen once we either drop from its specification the consumer confidence as a state variable, or we refrain from using the year-on-year convention to compute growth rates, or both (which corresponds to a version of the standard model, here a special case of our approach). These findings indicate that consumer confidence influences the SDF *persistently*, with lagged signals concurring with the current one in shaping the asset prices' behavior.

The paper relates to several studies that investigate the relationship between consumer confidence and consumption growth. Ludvigson (2004) reports that these studies are motivated by empirical evidence suggesting that consumer confidence predicts consumption growth, over and above other commonly used economic indicators. Acemoglu and Scott (1994) rationalize the observed correlation by positing that consumer confidence variations reflect alterations in the degree of economic uncertainty. As such, these variations might alter precautionary savings motives, owing to changes in the forecast variance of consumption. The authors provide evidence that consumer confidence not only covaries with forecast variance, which suggests a positive link between saving and uncertainty.<sup>9</sup> It also correlates with consumption growth. Building on the latter observation, we show that consumer confidence variations may affect the SDF in the absence of time-varying consumption growth volatility.<sup>10</sup>

Our work relates to models with preferences for early resolution (or recursive utility). At least two fundamental branches of the modern micro-finance literature draw on these models: long-run risks (Bansal and Yaron, 2004; Hansen, Heaton, and Li (2008); Bansal, Kiku, and Yaron, 2012); rare disasters (Rietz, 1988; Barro, 2006, 2009) and persistent-rare disasters (Wachter, 2013; Barro and Jin, 2021). To allow for a more transparent comparison with this literature,

Srinivasan (2016) and Golubov and Konstantinidi (2021).

<sup>8</sup>Note that this approach differs from the more conservative consideration of consumer confidence merely as conditioning information for the events' probability distribution. In the latter approach, confidence's role is limited to measuring consumers' subjective beliefs concerning variations in available resources while abstracting from altering their propensity to consume. As we show in Section 4, we also look into this alternate setup and conclude that the relevant predictions do not substantially improve those delivered by the standard asset pricing model.

<sup>9</sup>In contrast, Ludvigson (2004) finds a negative correlation between confidence and uncertainty in U.S. data and argues that precautionary saving motives would lead to a positive relationship between consumption growth and lagged uncertainty, which would contradict the observed positive correlation between confidence and consumption growth.

<sup>10</sup>Examples in which time preference shocks can be regarded as a way to capture the relationship between fluctuations in market sentiment and volatility of asset prices, see Barberis, Shleifer, and Vishny (1998) and Dumas, Kurshev, and Uppal (2009).

we stick to the traditional approach and do not calibrate the consumption growth dynamics to accommodate either feature.

The contributions closer in spirit to our approach are Melino and Yang (2003) and Albuquerque, Eichenbaum, Luo and Rebelo (2016). In a framework featuring recursive utility, Melino and Yang (2003) introduce a state variable, letting the preference parameters vary across states. In our paper, instead, all preference parameters hold constant and, as such, are not state-contingent. Albuquerque et al. (2016) is an important example of including an asset demand shifter into an asset pricing model with recursive preferences. These authors reverse-engineer the properties that a time preference shock should have to replicate some observed stylized facts in the macro-finance literature. We complement their work by investigating whether the intertemporal linkages created by incorporating consumer confidence and habit persistence may act as measurable fundamentals for the asset demand shifter. Importantly, our framework lets the demand shifter correlate with consumption. From this viewpoint, one might also interpret our model as allowing for the emergence of animal spirits of Keynesian tradition.

The paper is organized as follows. Section 2 illustrates the consumption-based asset pricing model with preferences augmented with an exogenous demand shifter. It also shows under which specifications of the demand shifter the stochastic discount factor depends on year-on-year growth rates in an environment characterized by higher-frequency time intervals and offers intuitions regarding the viability of considering consumer confidence as a state variable and the efficacy of our approach. Section 3 describes the data we use for our quantitative exercises. Section 4 details the procedure to estimate the stochastic process, calibrates the preference parameters, and presents our findings. Section 5 concludes. An online appendix offers some anecdotal support for the relevance of consumer confidence based on Google search engine queries and contains the most relevant mathematical derivations.<sup>11</sup>

## 2 The model

This section develops a parsimonious macro-finance model with recursive utility incorporating an exogenous demand shifter. We begin by describing a simple asset pricing framework with a generic demand shifter, which is possible because the model's derivations are unaffected by the shifter's particular definition (as long as it represents quantities beyond the consumer's control). Then, we show that the framework is sufficiently flexible to nest four model specifications. We conclude the section by discussing the plausibility of considering consumer confidence as a state variable and, through a graphical representation, an intuition about the model's suitability to replicate the observed financial asset statistics with reasonable preference parameter values.

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<sup>11</sup>The online appendix is available on the webpage <https://sites.google.com/site/vincenzomerella/research>.

### Recursive utility and demand shifter

Consider a consumption-based asset pricing model in which the consumers' preferences are represented by a recursive utility function (Kreps and Porteus, 1978), with the one-period utility non-separable in consumption and an exogenous demand shifter. Formally, we let the representative consumer's lifetime utility  $U_t$  from date  $t$  onward be represented by the function

$$U_t = [(1 - \beta)(\kappa_t c_t)^\rho + \beta \mu_t \{U_{t+1}\}^\rho]^\frac{1}{\rho}, \quad (1)$$

where  $c$  is consumption and  $\kappa$  is the demand shifter.<sup>12</sup> The term  $\mu_t \{\cdot\}$  is a 'certainty equivalent' operator, conditional on information at date  $t$ , specified as the nonlinear function of the expected value of future lifetime utility

$$\mu_t \{U_{t+1}\} = \left[ E_t \left\{ (U_{t+1})^{1-\alpha} \right\} \right]^\frac{1}{1-\alpha}. \quad (2)$$

The preference parameters  $\beta > 0$  and  $0 < \alpha \neq 1$  represent the subjective discount factor and the relative risk aversion coefficient, respectively;  $0 \neq \rho < 1$  governs the intertemporal elasticity of substitution  $\eta \equiv 1/(1 - \rho)$ .<sup>13</sup>

Under this preference specification, the stochastic discount factor (SDF) is given by

$$m \{s_t, s_{t+1}\} = \beta (x_{t+1})^{\rho-1} (\gamma_{t+1})^\rho \left( \frac{V \{s_{t+1}\}}{\mu_{s_t} \{V \{s_{t+1}\}\}} \right)^{1-\rho-\alpha}, \quad (3)$$

where  $x_{t+1} \equiv c_{t+1}/c_t$  and  $\gamma_{t+1} \equiv \kappa_{t+1}/\kappa_t$  are respectively the consumption and demand shifter growth factors,  $V \{\cdot\}$  is the value function in equilibrium, and  $s = (\kappa, \gamma, c, x)$  denotes the aggregate state.<sup>14</sup>

The SDF incorporates three terms. The first term,  $\beta (x_{t+1})^{\rho-1}$ , is the product between the subjective discount factor and a non-increasing power function of consumption growth. It represents the SDF in the seminal contribution by Mehra and Prescott (1985). The third term,  $(V \{s_{t+1}\} / \mu_{s_t} \{V \{s_{t+1}\}\})^{1-\rho-\alpha}$ , involves the representative consumer's value function and reflects the consumer's preferences for the timing of resolution of uncertainty. Together with the first term, it comprises the SDF in the standard model (Epstein and Zin, 1989; Weil, 1989). If early resolution is preferred, i.e.,  $1 - \rho - \alpha < 0$ , asset payoffs in states where realized lifetime utility is lower than the conditional certainty equivalent will have a greater impact on the

<sup>12</sup>Alternatively, one could introduce the demand shifter using a CES aggregator. We instead opt for the Cobb-Douglas type to stress the exogenous nature of the demand shifter, as in, e.g., Matsuyama (2019).

<sup>13</sup>More precisely, the expression

$$\log U_t = (1 - \beta) \log \{\kappa_t c_t\} + \beta \log \{\mu_t \{U_{t+1}\}\}$$

replaces (1) whenever  $\rho = 0$ .

<sup>14</sup>See Section B.1 in the online appendix for a formal derivation of equation (3).



asset price than payoffs in states where the opposite occurs. Here, however, the value function also depends on the demand shifter: that is, the latter affects the magnitude of the potential rise in the volatility of the SDF relative to that generated by the first term. The second term,  $(\gamma_{t+1})^\rho$ , is a concave function of the innovation in the demand shifter. Taken in isolation, it reflects the impact of the demand shifter on the representative consumer's choice abstracting from uncertainty.<sup>15</sup>

We now turn to specialize the model by giving the demand shifter an explicit definition. To illustrate the link between habit persistence and year-on-year convention in a transparent fashion, it proves convenient to state the length of a model's period explicitly: in line with our quantitative analysis, we let a quarter represent the time elapsing between the dates  $t$  and  $t + 1$ .

### Baseline model and decomposition

Let  $\kappa_t \equiv \psi_t^{\iota_\psi} \cdot \varphi_t^{\iota_\varphi} \cdot \xi_t^{\iota_\xi}$ , where  $\psi_t$  denotes the value of consumer confidence at date  $t$ ,

$$\varphi_t \equiv \psi_{t-1} \cdot \psi_{t-2} \cdot \psi_{t-3} \quad (4)$$

is a composite function defined over three lagged values of consumer confidence,

$$\xi_t \equiv (c_{t-1} \cdot c_{t-2} \cdot c_{t-3})^{(\rho-1)/\rho} \quad (5)$$

is another composite function defined over three lagged values of consumption, with  $\iota_\psi, \iota_\varphi, \iota_\xi = \{0, 1\}$ .<sup>16</sup> The model nests four different specifications. Table 1 illustrates their respective parameterizations.

The baseline model (*CCHF*) incorporates consumer confidence and habit persistence, with the SDF given by

$$m^{CCHF} \{s_t, s_{t+1}\} = \beta \left( \frac{\psi_{t+1}}{\psi_{t-3}} \right)^{\rho-1} \left( \frac{c_{t+1}}{c_{t-3}} \right)^\rho \left( \frac{V^{CCHF} \{s_{t+1}\}}{\mu_{s_t} \{V^{CCHF} \{s_{t+1}\}\}} \right)^{1-\rho-\alpha}, \quad (6)$$

where  $V^{CCHF}$  indicates the value function that arises in equilibrium when  $\kappa_t = \psi_t \varphi_t \xi_t$ . The expression in (6) is the price kernel under the fully specified approach. Comparing (6) with (3), we may note that the demand shifter explicitly incorporates the state variable  $\psi$  growth rate into the SDF *and* entails year-on-year growth rate computations.

<sup>15</sup>If the consumer is indifferent to the timing of resolution of uncertainty, i.e.  $1 - \rho - \alpha = 0$ , then the SDF is ordinally equivalent to  $m \{s_{t+1}\} = \beta (x_{t+1})^{-\alpha} (\gamma_{t+1})^{1-\alpha}$ . In this case, the term  $(\gamma_{t+1})^{1-\alpha}$  captures the conditional response of consumer choice to the demand shifter innovation: payoffs in states where innovation is above average have a smaller impact than payoffs in states where the opposite occurs if the coefficient of relative risk aversion is larger than one, and vice versa.

<sup>16</sup>By letting (5) capture habit formation, we opt for Abel's (1990) multiplicative definition rather than an additive form as in, e.g., Campbell and Cochrane (1999).

**Table 1.**

Model parameterization.

		(1)	(2)	(3)	(4)
Model	Specification	$(\iota_\psi, \iota_\varphi, \iota_\xi)$	$\kappa_t$	$x_{t+1}$	$\gamma_{t+1}$
<i>CCHF</i>	Consumer confidence and habit persistence	(1, 1, 1)	$\psi_t \varphi_t \xi_t$	$\frac{c_{t+1}}{c_{t-3}}$	$\frac{\psi_{t+1}}{\psi_{t-3}}$
<i>CC</i>	Consumer confidence	(1, 0, 0)	$\psi_t$	$\frac{c_{t+1}}{c_t}$	$\frac{\psi_{t+1}}{\psi_t}$
<i>HF</i>	Habit persistence	(0, 0, 1)	$\xi_t$	$\frac{c_{t+1}}{c_{t-3}}$	1
<i>EZW</i>	–	(0, 0, 0)	1	$\frac{c_{t+1}}{c_t}$	1

**Note.** The table reports the parameterization of four different models, which nest into the general framework. The indicator triplet  $(\iota_\psi, \iota_\varphi, \iota_\xi)$  governs the parameterization. The specification of the demand shifter  $\kappa_t$  in turn determines the convention used to compute consumption ( $x_{t+1}$ ) and confidence ( $\gamma_{t+1}$ ) growth rates (either quarter-on-quarter or year-on-year).

The second specification (*CC*) abstracts from habit persistence. The SDF reads

$$m^{CC} \{s_t, s_{t+1}\} = \beta \left( \frac{\psi_{t+1}}{\psi_t} \right)^{\rho-1} \left( \frac{c_{t+1}}{c_t} \right)^\rho \left( \frac{V^{CC} \{s_{t+1}\}}{\mu_{s_t} \{V^{CC} \{s_{t+1}\}\}} \right)^{1-\rho-\alpha}, \quad (7)$$

where  $V^{CC}$  is the value function arising in equilibrium when  $\kappa_t = \psi_t$ . Under this specification, the SDF explicitly features the state variable growth factor as an exogenous demand shifter.

The third specification (*HF*) abstracts from consumer confidence, with the SDF expressed as

$$m^{HF} \{s_t, s_{t+1}\} = \beta \left( \frac{c_{t+1}}{c_{t-3}} \right)^{\rho-1} \left( \frac{V^C \{s_{t+1}\}}{\mu_{s_t} \{V^C \{s_{t+1}\}\}} \right)^{1-\rho-\alpha}, \quad (8)$$

where  $V^{HF}$  is the value function corresponding to the case  $\kappa_t = \xi_t$ . In this case, the presence of the demand shifter merely implies that the consumption growth rate is computed over four quarters (year-on-year convention).

The last specification (*EZW*) disregards consumer confidence and habit persistence, in line with the standard model. The SDF reduces to

$$m^{EZW} \{s_t, s_{t+1}\} = \beta \left( \frac{c_{t+1}}{c_t} \right)^{\rho-1} \left( \frac{V^{EZW} \{s_{t+1}\}}{\mu_{s_t} \{V^{EZW} \{s_{t+1}\}\}} \right)^{1-\rho-\alpha}, \quad (9)$$

where  $V^{HF}$  is the equilibrium value function when  $\kappa_t = 1$ .

### Rationale for consumer confidence as state variable

Introducing consumer confidence as a demand shifter into the one-period utility function proves quite convenient. It is technically tractable, provides a rationale for the practitioners' use of confidence indicators, and is in line with a bulk of empirical finance literature. Despite the benefits, this assumption is somewhat unconventional. Before proceeding, we present some justification for including a state variable in the utility function and using consumer confidence as a proxy. We do so by drawing parallels to a couple of well-established approaches in the literature. For simplicity, we abstract from all time linkages, consider the one-period utility function  $u\{c, \kappa\}$ , and denote the marginal utility of consumption  $c$  by  $u'\{c, \kappa\}$ . The effect of a shock to the demand shifter  $\kappa$  is then  $\partial u'\{c, \kappa\} / \partial \kappa$ .

It is important to note that the nature of the demand shifter's impact on consumer's choice is independent of how the demand shifter is defined, as long as the shifter is exogenous. Our model posits that the relative risk aversion coefficient  $\alpha$  governs the influence of the demand shifter on the marginal utility of consumption. To see this, consider the lifetime utility specification (1)-(2), abstract from the consumer's preference for the timing of uncertainty resolution ( $1 - \rho - \alpha = 0$ ), and use the ordinally equivalent transformation,  $\tilde{U} = U^{1-\alpha} / [(1-\beta)(1-\alpha)]$ . We obtain the usual time additive preference specification, with one-period utility given by  $u\{\kappa, c\} = (\kappa c)^{1-\alpha} / (1-\alpha)$ , from which it follows that  $\partial u'\{\kappa, c\} / \partial \kappa = (1-\alpha)(\kappa c)^{-\alpha}$ . As shown in Section 4 below, our quantitative results indicate that  $\alpha > 1$ , hence  $\partial u'\{\kappa, c\} / \partial \kappa < 0$ . With all other conditions holding constant, a larger value of the demand shifter then implies a lower marginal utility, inducing consumers to save more.<sup>17</sup>

Perhaps the most natural parallel to considering consumer confidence as a demand shifter is the inclusion of wealth in the utility function (e.g., Faria and McAdam, 2013). Wealth is defined as the expected discounted value of the future consumption stream. In our context, it is given a "catching up with the Joneses" meaning, in line with consumer confidence being beyond the single consumer's control. Formally, at any date  $t$ , we may let  $\kappa_t = \sum_{\tau=1}^{\infty} \nu^{\tau} E_t \{\tilde{c}_{t+\tau}\}$ , where  $\nu$  is a subjective discount factor, and  $\tilde{c}_{t+\tau}$  is the average level of per-capita consumption (as opposed to the consumer's own consumption, as in Abel, 1990). Within this framework, consumer confidence as a demand shifter is justified by arguing that its variations capture anticipated shocks to future consumption  $\tilde{c}$ . In light of the discussion about the effect of the demand shifter on marginal utility, the higher propensity to save of confident consumers could be justified by the attempt to "catch up with the Joneses." Consumers tend to postpone consumption when they perceive a positive future state of the economy to ensure that their own future consumption

<sup>17</sup>See also Footnote 15 for the corresponding argument regarding the stochastic discount factor. Note that the model allows for  $\alpha < 1$ . Should that be the case, the conventional wisdom asserting that confident consumers would be more prone to consume would apply instead. As discussed in the introduction, we remain ex-ante agnostic and let the data suggest the direction of the shifter's impact on consumers' decisions.

levels will match the neighbors'.<sup>18</sup>

Another approach consistent with including consumer confidence in the utility function is salience theory (Bordalo, Gennaioli and Schleifer, 2012, 2013). This theory builds on the idea that individuals focus on certain events more than others when evaluating a financial asset. In a nutshell, a salience function assigns a weight to each state-contingent payoff of the asset: the larger the weight, the more salient the payoff. Letting  $\omega_s$  denote the weight associated with the state- $s$  payoff of the market portfolio, the expected value of the portfolio would deviate by the amount  $E\{(\omega - 1)x\}$  from the standard  $E\{x\}$ . In our context, a reduced form of the impact of such a deviation would be captured by  $\kappa_t = \nu E_t\{(\omega_{t+1} - 1)x_{t+1}\}$ . Within this framework, consumer confidence as a demand shifter is justified by arguing that it reflects the impact of the salience ranking of the payoff distribution on the consumer's choice. Consumer confidence as a proxy of future payoffs' salience suggests a more direct financial interpretation of the model's outcomes. Anticipating that states associated with greater returns will be more salient, consumers would be induced to invest more in financial assets, showing a tendency to postpone consumption.<sup>19</sup>

### Consumer confidence, year-on-year growth rates, and the SDF

The different versions of the SDF depicted by (6)-(9) lead to different asset price moments. In order to illustrate why simultaneously incorporating consumer confidence and habit persistence may help in replicating the observed asset pricing behavior, we graphically compare the simulations of the first two moments of the SDF generated by the baseline model (9) and the standard model (6).

Figure 1 illustrates the evolution of the mean and standard deviation of the SDF as the relative risk aversion coefficient varies.<sup>20</sup> We set the subjective discount factor to be  $\beta = 0.99$  and the intertemporal elasticity of substitution to one ( $\rho = 0$ ). The top panel deals with the expected value of the SDF. We note that the values delivered by the baseline model are, at low levels of RRA, larger than those obtained by the standard framework. The bottom panel concerns the volatility of the SDF. There, the values delivered by the baseline model are substantially higher than the standard framework's at low levels of RRA; the gap narrows as the

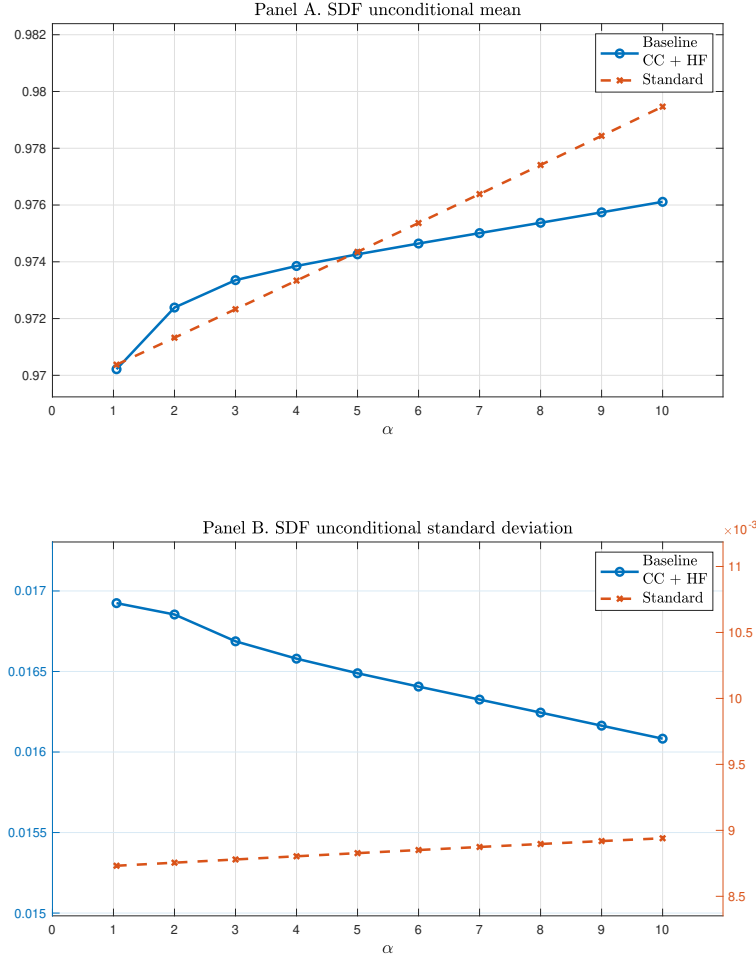
<sup>18</sup>From this viewpoint, consumer confidence in the utility function may be regarded as a device to correct the impact of the typical mechanism governing consumption/saving decisions, aligning them to the empirical evidence of a positive correlation between consumer confidence and consumption growth. According to the standard model and the conventional wisdom, consumers would counterfactually react to confidence shocks regarding future economic conditions by anticipating resources to smooth intertemporal consumption.

<sup>19</sup>Similarly, consumer confidence might be seen as capturing anticipated shocks to measures of valuation uncertainty echoing, e.g., Joos, Piotroski, and Srinivasan (2016) and Golubov and Konstantinidi (2021). Valuation uncertainty allows choice of valuation model and model parameters as a common-place way of expressing degrees of confidence. It is, therefore, plausible to interpret consumer confidence in the utility function as a reduced-form approach to those choices.

<sup>20</sup>Figure C.1 in Section C of the online appendix portrays the same exercise for all specifications of the model.

**Figure 1.**

SDF average and volatility as the relative risk aversion coefficient varies.



**Note.** The figure illustrates the patterns of the stochastic discount factor (SDF) mean (Panel A) and standard deviation (Panel B) as the relative risk aversion coefficient varies for two models: the Baseline CC + HF model incorporates both consumer confidence and habit persistence; the Standard model neither. The subjective discount factor is set to  $\beta = 0.99$ , and the intertemporal elasticity of substitution to one ( $\rho = 0$ ). The SDF standard deviations reported in Panel B are expressed in different scales: the left-hand side refers to the Baseline CC + HF model, the right-hand side to the Standard model. Sections 3 and 4 describe the data and the calibration procedure used to produce the simulations.

RRA coefficient rises, yet the magnitude of the SDF volatility generated by the former remains significantly more prominent.<sup>21</sup>

We use some basic financial relations to guide our reasoning and develop our intuition. Consider the following illustrative exercise. Recall that  $cov\{m, R\} = E\{mR\} - E\{m\}E\{R\}$  and  $\rho_{m,R} = cov\{m, R\} / (\sigma\{m\}\sigma\{R\})$ ; furthermore, consider that for any return  $R$  on the efficient mean-variance frontier it holds that  $R \approx a - b m$ , with  $a, b$  some positive numbers, and therefore  $\rho_{m,R} = -1$ .<sup>22</sup> Then, from the central asset pricing formula,  $E\{mR\} = 1$ , we may obtain the following three equations that our illustrative simulation must obey:

$$E\{R^f\} = 1/E\{m\}, \quad (10)$$

$$E\{R^m - R^f\} \approx \frac{b\sigma^2\{m\}}{E\{m\}}, \quad (11)$$

$$\sigma\{R^m\} \approx b\sigma\{m\}, \quad (12)$$

where  $E\{R^f\}$  and  $E\{R_m - R^f\}$  are the annualized risk-free rate and the market premium unconditional means,  $\sigma\{R_m\}$  is the annualized market return unconditional volatility and  $b$  is a value governed by the preference parameters.

From (10), we learn that the expected risk-free return is merely the reciprocal of the SDF expected value. Considered in conjunction with the results displayed in the top panel of Figure 1, our exercise suggests that incorporating consumer confidence and using the year-on-year convention can predict lower riskless rates for modest levels of risk aversion. Furthermore, from (11), we establish that the market premium is proportional to the ratio between the SDF's variance and mean. In light of the simulation results illustrated in Figure 1, we expect the baseline model to predict larger market premia at virtually any level of relative risk aversion. Finally, (12) indicates that the market return volatility is proportional to the SDF's standard deviation. Our simulations are then suggestive of the predictions on  $\sigma\{R^m\}$  following a similar pattern as those on  $E\{R^m - R^f\}$ . Each of these three predictions has the potential to represent an improvement over those delivered by the standard model.

<sup>21</sup>The decline in SDF volatility as the magnitude of  $\alpha$  increases is due to the conditional value function  $V^{CCHF}\{s_{t+1}\}$  decreasing much faster with  $\alpha$  than  $V^{EZW}\{s_{t+1}\}$ . The resulting scale effect drives the magnitude of the variance down with rising  $\alpha$ , as illustrated in Figure 1. As far as the mechanics of our model are concerned, however, this particular feature of the model is inconsequential. What matters is that the SDF volatility in the baseline model is larger than the standard model's, particularly so at low levels of risk aversion, regardless of whether the SDF volatility increases or declines with the level of relative risk aversion.

<sup>22</sup>More precisely, for  $R^m \approx a - b m$  to hold, the risky asset should be a good approximation of the market portfolio, and the financial market should not be too far from being complete. For a more exhaustive discussion, see, e.g., Cochrane (2005, Chapter 1).

### 3 Descriptive analysis

We need to feed the model data on consumption growth and consumer confidence innovation to obtain predictions regarding the risk-free rate, the market return, and the dividend yield. Naturally, we also need data on the latter variables to create targets for calibrating the model and assessing its performance. We detail our sources in turn.<sup>23</sup> Our database spans from the third quarter of 1967 to the last quarter of 2018, thereby containing 206 observations. Growth factors and gross returns are computed using the year-on-year convention and the more customary (to the macro-finance literature) quarter-on-quarter convention.

The consumption growth time series is calculated using the U.S. Bureau of Economic Analysis data. The United States personal consumption expenditures on non-durable goods and services, expressed in nominal seasonally adjusted annual rates, are deflated using the seasonally adjusted United States personal consumption expenditures 2012 year-base chain-type price index. The resulting monthly figures are converted in per-capita terms using the United States population. We then average the data at a quarterly frequency.

The consumer confidence innovation's time series is calculated using the Conference Board's Consumer Confidence Index (CC) monthly data, retrieved from the Macrobond Financial database.<sup>24</sup> The index is based on a five-question survey, including queries about current and future general market conditions and job availability. Specifically, the questions seek the respondents' appraisal regarding current (i) business conditions and (ii) employment conditions; and the respondents' expectations six months hence regarding (iii) business conditions, (iv) employment conditions, and (v) their total family income. Note that the first four questions relate to general (rather than the respondent's) economic conditions. This feature supports the assumption that the index is beyond the consumer's control. We later exploit this notion to interpret the model's results in a "catching up with the Joneses" fashion and as the outcome of a salience theory reduced-form approach.

Each question of the CC questionnaire can be given a positive, negative, or neutral answer. The answers' resulting proportions are seasonally adjusted. For each question, the proportion of positive answers is divided by the sum of the proportions of positive and negative answers to obtain an indicator, then standardized using the average indicator of the calendar year 1985 to calculate the index level. The overall index value is calculated as the simple monthly average of the five questions' index levels.<sup>25</sup> The index values are then averaged at a quarterly frequency.

The market return time series is derived from the price and dividend time series of the

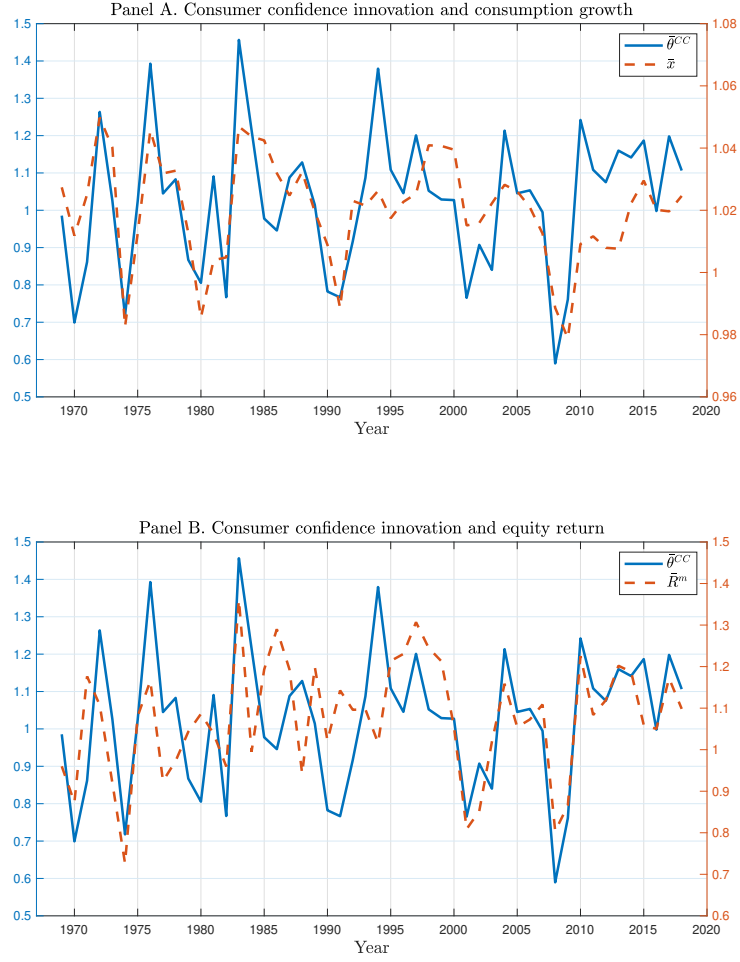
<sup>23</sup>Unless otherwise specified, the time series are sourced at a monthly frequency from the Federal Reserve Economic Data, available at the webpage: <https://fred.stlouisfed.org>.

<sup>24</sup>For further information, visit the webpage: [macrobond.com](https://macrobond.com).

<sup>25</sup>Additional details can be found in the Consumer Confidence Survey Technical note, available at the webpage: [conference-board.org/pdf\\_free/press/TechnicalPDF\\_4134\\_1298367128.pdf](https://conference-board.org/pdf_free/press/TechnicalPDF_4134_1298367128.pdf).

**Figure 2.**

Consumer confidence, consumption growth and equity return.



**Note.** The figure illustrates the evolution over time of the Consumer Confidence Index innovation ( $\bar{\theta}^{CC}$ ) against consumption growth ( $\bar{x}$ , Panel A) and the market return ( $\bar{R}^m$ , Panel B). The bars over symbols indicate that the data consist of yearly averages of annualized quarterly growth factors (for  $\bar{\theta}^{CC}$  and  $\bar{x}$ ) and gross return (for  $\bar{R}^m$ ). The values are pairwise expressed in different scales: the left-hand side refers to  $\bar{\theta}^{CC}$ , the right-hand side either to  $\bar{x}$  (Panel A) or  $\bar{R}^m$  (Panel B).



**Table 2.**

Cross correlations.

	(1)	(2)	(3)	(4)
Panel A. Quarter-on-quarter				
Variable	$\omega_{t+1}^m$	$R_{t+1}^m$	$\psi_{t+1}^{CS}/\psi_t^{CS}$	$\psi_{t+1}^{CC}/\psi_t^{CC}$
$C_{t+1}/C_t$	-0.1027	0.1561	0.3294	0.3947
$\psi_{t+1}^{CC}/\psi_t^{CC}$	-0.0844	0.2142	0.6605	
$\psi_{t+1}^{CS}/\psi_t^{CS}$	-0.0436	0.2702		
$R_{t+1}^m$	-0.0984			
Panel B. Year-on-year				
Variable	$\omega_{t+4}^m$	$R_{t+4}^m$	$\psi_{t+4}^{CS}/\psi_t^{CS}$	$\psi_{t+4}^{CC}/\psi_t^{CC}$
$C_{t+4}/C_t$	-0.1419	0.0211	0.4092	0.5899
$\psi_{t+4}^{CC}/\psi_t^{CC}$	-0.1504	0.0494	0.7859	
$\psi_{t+4}^{CS}/\psi_t^{CS}$	-0.0981	0.1574		
$R_{t+4}^m$	-0.0978			

**Note.** The table reports the pairwise cross correlation between consumption growth ( $C_{t+i}/C_t$ ), the Consumer Confidence Index innovation ( $\psi_{t+i}^{CC}/\psi_t^{CC}$ ), the Consumer Sentiment Index innovation ( $\psi_{t+i}^{CS}/\psi_t^{CS}$ ), the market return ( $R_{t+i}^m$ ), and the market dividend yield ( $\omega_{t+i}^m$ ), using both the quarter-on-quarter ( $i = 1$ , Panel A) and year-on-year ( $i = 4$ , Panel B) convention. In Panel A (resp., B), the data consist of annualized quarterly (yearly) growth factors (quarterly gross return for  $R_{t+i}^m$ ).

Standard & Poor's 500 composite index, sourced monthly from Shiller's database.<sup>26</sup> The risk-free rate is calculated using the three-month Treasury bill secondary market rate. Treasury bills rates, market prices, and dividends are expressed in real terms through the same price index used to deflate consumption growth data. In order to aggregate the data at a quarterly frequency, dividends are cumulated over the relevant three months; Treasury bills rates are capitalized over the same period. The market price corresponds to the last month's observation of the quarter. The market return is computed as the sum of the current price and dividends divided by the lagged price.

For robustness, we also use the University of Michigan's Consumer Sentiment Index, sourced from the Macrobond Financial database, as an alternative measure of consumer confidence. The index is constructed similarly to the Conference Board's Consumer Confidence Index, although

<sup>26</sup>Shiller's database is available at the webpage: [econ.yale.edu/~shiller/data/ie.data.xls](http://econ.yale.edu/~shiller/data/ie.data.xls).

the sample design and the index estimation are substantially different.<sup>27</sup> This indicator is averaged quarterly over the period covered by our database, too.

Figure 2 illustrates the time path of the Consumer Confidence Index innovation against consumption growth and the market return, respectively.<sup>28</sup> The mean and standard deviation are 1.0064 and 0.114 for consumption growth, 1.021 and 0.026 for Consumer Confidence Index innovation, 1.002 and 0.061 for the Consumer Sentiment Index innovation, 1.076 and 0.064 for market return. We note a marked tendency to pairwise comovement of the variables involved.

This remark is also confirmed by the figures reported in Table 2, which reports the pairwise correlation coefficients of the mean factors of consumption growth, the Consumer Confidence Index, the Consumer Sentiment Index, and market return, along with the mean market dividend yield. Specifically, the table offers a comparison between the correlation arising from quarter-to-quarter (Panel A) and year-on-year (Panel B) computations. It might be noticed that all correlations between consumption growth and confidence and sentiment innovations grow in magnitude when moving from the first to the second set of figures. This fact is consistent with the scenario outlined in the introductory section: habit persistence tends to strengthen the positive correlation between consumption growth and the demand shifter when the latter is positively autocorrelated. (Table 4 below shows that this is indeed the case.)

## 4 Quantitative analysis

We now turn to illustrate the model outcomes. We explain the calibration procedure and illustrate and discuss the model predictions. We also critically compare our results with those reported by Barro and Jin (2021) regarding the long-run risks and rare events model as well as those obtained by the standard model proposed by Epstein and Zin (1989) and Weil (1989), here a special case of our approach. We initially focus on the results obtained when considering the Consumer Confidence Index, then we show that our findings are robust to using the Consumer Sentiment Index as a proxy for the demand shifter. Furthermore, we confine our state variable to the role of probability shifter and produce some robustness checks on the transition probability matrix, the state variable impact, and dividends equalling levered consumption.

### Calibration

We calibrate two sets of objects to allow the model to deliver the simulated unconditional means and standard deviations of the risk-free rate, the market return, and the dividend yield: the transitional probabilities and the preference parameters governing the consumer's subjective

<sup>27</sup>For more information about the Consumer Sentiment Index, visit the webpage: [sca.isr.umich.edu](http://sca.isr.umich.edu).

<sup>28</sup>Figure C.2 in Section C of the online appendix portrays the analogous comparison regarding the Consumer Sentiment Index.

time discounting, relative risk aversion and intertemporal elasticity of substitution. The transitional probability distribution is a prerequisite to running simulations, so we deal with it first. Once the probabilities are calculated, we run an iterative procedure to identify the preference parameters.

**Transitional probabilities** We model the joint process for consumption growth  $x$  and consumer confidence innovation  $\theta$  as the first-order autoregressive scheme

$$\tilde{x}' = A_{xx}\tilde{x} + A_{x\theta}\tilde{\theta} + \varepsilon_x \quad (13)$$

$$\tilde{\theta}' = A_{\theta x}\tilde{x} + A_{\theta\theta}\tilde{\theta} + \varepsilon_\theta \quad (14)$$

where  $\tilde{x}$  and  $\tilde{\theta}$  are respectively the current detrended growth factors of consumption and confidence indicator,  $A_{ij}$ ,  $i, j = x, \theta$ , are autoregression coefficients, and  $\varepsilon_i$  are white noise processes. The future values  $\tilde{x}'$  and  $\tilde{\theta}'$  may refer to the end of the quarter or the year, depending on the convention used for each model specification.<sup>29</sup> It is assumed that  $\varepsilon_x$  and  $\varepsilon_\theta$  are mutually independent with cumulative probability  $\Pr\{\varepsilon_{it} \leq u\} = Z_i\{u/\sigma(\varepsilon_i)\}$ , where  $Z_i$  is a standardized Gaussian distribution.

Table 3 reports the estimated coefficients (and their standard deviations) obtained from regressing (13)-(14) using a number of different models and data specifications. Concerning the coefficients of (13),  $A_{xx}$  and  $A_{x\theta}$ , the results are in line with the typical existing evidence across the board: confidence innovation has explanatory power over consumption growth, which is also self-correlated. A distinctive outcome arises instead about (14): the estimated coefficients  $A_{\theta\theta}$  are statistically different from zero only when growth factors are computed with the year-on-year convention, regardless of which index (either the Consumer Confidence Index or the Consumer Sentiment Index) proxies the demand shifter in the analysis. This finding suggests that habit formation has interesting novel implications when considered in conjunction with consumer confidence: by letting confidence be more predictable via (14), it improves consumption growth forecasting via (13).

We approximate (13)-(14) with a finite-state Markov chain using Tauchen's (1986) method.<sup>30</sup> The method consists of using the autoregression coefficients,  $A_{ij}$ ,  $i, j = x, \theta$ , and the vector of the error terms,  $\varepsilon_i$ , obtained by estimating the autoregressive scheme (13)-(14) to compute the variance-covariance matrix of consumption growth and consumer confidence,  $\Sigma_y$ . The elements of  $\Sigma_y$  are then used to produce the values,  $\bar{y}_s^v$ , that the variables  $v$  take in each state  $s$ , as well as the relevant Markov chain transitional probabilities,  $\pi(s, s')$ , from state  $s$  to state

<sup>29</sup>In particular, letting  $\tilde{x} = \tilde{x}_t$  and  $\tilde{\theta} = \tilde{\theta}_t$ ,  $\tilde{x}' = \tilde{x}_{t+4}$  for the model specifications involving consumption habits, and  $\tilde{x}' = \tilde{x}_{t+4}$  for those abstracting from it;  $\tilde{\theta}' = \tilde{\theta}_{t+4}$  for the specifications considering confidence habits, and  $\tilde{\theta}' = \tilde{\theta}_{t+1}$  for those abstracting from it.

<sup>30</sup>The method is formally discussed in Section B.2 of the online appendix.

**Table 3.**

Estimated VAR coefficients.

	(1)	(2)	(3)	(4)	(5)	(6)
Coefficient	Baseline CC + HF	CS + HF	CC only	CS only	HF only	Standard
$A_{xx}$	0.8391 (0.0396)	0.8196 (0.0335)	0.2665 (0.0713)	0.2909 (0.0697)	0.8855 (0.0322)	0.3225 (0.0661)
$A_{x\theta}$	0.0064 (0.0032)	0.0238 (0.0049)	0.0322 (0.0162)	0.0408 (0.0297)		
$A_{\theta x}$	0.5199 (0.7181)	-0.7443 (0.3493)	0.6625 (0.3308)	-0.0287 (0.1739)		
$A_{\theta\theta}$	0.7161 (0.0585)	0.7819 (0.0515)	-0.0349 (0.0753)	0.0255 (0.0740)		

**Note.** The table reports the coefficients produced by the VAR(1) estimation of six different model specifications considering: the year-on-year convention and either consumer confidence [Column (1)] or consumer sentiment [Column (2)] as a demand shifter, or neither [Column (5)]; the quarter-on-quarter convention and either consumer confidence [Column (3)] or consumer sentiment [Column (4)] as a demand shifter, or neither [Column (6)]. Two consecutive rows relate to each coefficient: the top one reports the point estimate; the bottom the estimate's standard deviation (in parentheses). A set of Schwarz Information Criterion tests support the one-lag VAR specification.

$s'$ . For each variable, the state-specific values  $\bar{y}_s^v$  are equidistant deviations from the variable mean in both directions, with the broader deviation representing the largest shock the variable is allowed to take in the Markov chain. The probabilities associated with the states are the cumulative density of regularly spaced intervals of the joint distributional domain around the values that the two variables take in each given state. The number of states and the magnitudes of the largest shocks must be determined ex-ante. In our exercises, we assign five states ( $n = 5$ ) to each variable (for a total of 25 states jointly) and set the largest shock to be equal to three times ( $q = 3$ ) the magnitude of the relevant standard deviation.

Table 4 reports the summary statistics of the observed and simulated consumption growth and confidence and sentiment innovations. We generate the predictions via Monte Carlo simulation of the Markov process for the observed time-span length and 100,000 replications. The simulated process performs well in matching the observed figures, with an average discrepancy of 3.2%, indicating that the finite-state Markov chain reliably reflects its continuous counterpart.

**Table 4.**

Summary statistics: data and simulations.

	(1)	(2)	(3)	(4)
Statistic	Standard		HF only	
	Data	Sim.	Data	Sim.
$E\{C'/C\}$	1.0211	1.0211	1.0209	1.0208
$\sigma\{C'/C\}$	0.0260	0.0284	0.0183	0.0213
$\varrho\{C'/C\}$	0.3222	0.3102	0.8855	0.8853
Statistic	CS + HF		Baseline CC + HF	
	Data	Sim.	Data	Sim.
$E\{C'/C\}$	1.0209	1.0208	1.0209	1.0208
$\sigma\{C'/C\}$	0.0183	0.0196	0.0183	0.0195
$\varrho\{C'/C\}$	0.8855	0.8406	0.8855	0.8496
$E\{\psi'/\psi\}$	1.0081	1.0080	1.0244	1.0242
$\sigma\{\psi'/\psi\}$	0.1238	0.1533	0.2246	0.2514
$\varrho\{\psi'/\psi\}$	0.7369	0.7573	0.7407	0.7069

**Note.** The table reports the observed figures [Columns (1) and (3)] and the simulated values [Columns (2) and (4)] obtained from four different model specifications. The variables under scrutiny include the first two moments of consumption growth ( $E\{C'/C\}$  and  $\sigma\{C'/C\}$ ) and index innovation ( $E\{\psi'/\psi\}$  and  $\sigma\{\psi'/\psi\}$ ) and the respective first-lag autocorrelation coefficients ( $\varrho\{C'/C\}$  and  $\varrho\{\psi'/\psi\}$ ). Letting  $C = C_t$  and  $\psi = \psi_t$ , we consider: the year-on-year convention and either the index of consumer confidence [bottom-right] or sentiment [bottom-left] as a demand shifter ( $C' = C_{t+4}$  and  $\psi' = \psi_{t+4}$ ); no variable as a demand shifter and either the year-on-year [top-right,  $C' = C_{t+4}$ ] or the quarter-on-quarter convention [top-left,  $C' = C_{t+1}$ ].

**Preference parameters** The model's dynamics are sufficiently rich to match a set of observed figure with values of the three parameters well within the boundaries typically considered in the asset pricing literature. The procedure to determine the exact parameter values is as follows. We search for parameter values that minimize a constrained quadratic loss function. The constraints are chosen to contain the values admitted by the existing contributions. Specifically, the subjective discount factor can take values no larger than one: i.e.,  $\beta \in (0.9, 1)$ . The relative risk aversion coefficient is assumed to be positive but no larger than 10, representing the upper bound considered reasonable by Mehra and Prescott (1985): i.e.,  $\alpha \in (0, 10)$ . The intertemporal elasticity of substitution (IES) is, as always, lower-bounded in zero. Whether the

magnitude of IES may or may not be greater than one is a source of considerable debate.<sup>31</sup> On the one hand, Hall (1988) famously estimates IES to be well below one (around 0.1). On the other hand, a value above one is consistent with the findings of several contributions in the literature since Hansen and Singleton (1982). Furthermore, Bansal and Yaron (2004) show that an above-unity intertemporal elasticity of substitution is essential for rationalizing the observed correlation between consumption volatility and price-dividend ratios. In light of this evidence, we choose  $\eta \in (0, 2)$  to constrain the minimization problem concerning the intertemporal elasticity of substitution.

The quadratic loss function is given by the sum of squares of the deviations of the simulated values of three targets (one per parameter) from the observed ones. In our benchmark exercise, the data targets are: (i) the mean of the risk-free rate,  $E\{R^f\}$ , to pinpoint the subjective discount factor,  $\beta$ ; (ii) the mean of the market return,  $E\{R^m\}$ , to pinpoint the relative risk aversion coefficient,  $\alpha$ ; (iii) the standard deviation of the risk-free rate,  $\sigma\{R^f\}$ , to pinpoint the intertemporal elasticity of substitution,  $\eta$ .

## Results

We now illustrate the outcomes of the baseline model and its specializations and compare them against the relevant observed statistics. One of the special cases is a version of the standard Epstein-Zin-Weil model, instrumental since it allows for a direct comparison of our results with those of previous contributions. We also contrast our findings with those in Barro and Jin (2021) concerning long-run risks (LRR), rare events (RE), and their combination (LRR + RE). We subsequently check the robustness of our results along three dimensions. First, we let the Consumer Sentiment Index proxy the demand shifter. Second, we restrain our state variable from acting as a demand shifter. Third, in computing the transition probability matrix, we set to nil the VAR coefficients that are not significantly different from zero. Finally, we discuss a more flexible state variable impact and dividends equalling levered consumption.

Table 5 reports the simulated values of a number of statistics, and the calibrated preference parameters used to run the simulations, along with the relevant observed figures. Column (1) details the latter. Columns (2)-(5) correspond to different model specifications. Column (2) gives an account of the outcomes of the baseline model, whose stochastic discount factor (SDF), expressed by (6), includes consumer confidence as a demand shifter in the representative consumer's preference specification, and all moments are computed using the year-on-year convention. In line with our discussion in the previous sections, we refer to the baseline model when simultaneously considering consumer confidence and habit formation. Columns (3)-(5) refer to baseline model's specializations: Column (3) abstracts from habit formation; Column (4) from

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<sup>31</sup>For a review of the empirical literature on the intertemporal elasticity of substitution, see Thimme (2017).

**Table 5.**

Asset pricing statistics: data and predictions.

	(1)	(2)	(3)	(4)	(5)
Statistic	Data	Baseline CC + HF	CC only	HF only	Standard
$E \{R^f\}$	0.0118	0.0118	0.0340	0.0264	0.0376
$E \{R^m\}$	0.0758	0.0758	0.0644	0.0569	0.0498
$E \{R^m - R^f\}$	0.0640	0.0641	0.0304	0.0305	0.0122
$\sigma \{R^f\}$	0.0229	0.0227	0.0084	0.0066	0.0078
$\sigma \{R^m\}$	0.1640	0.0156	0.0301	0.0101	0.0122
$\sigma \{R^m - R^f\}$	0.1618	0.0126	0.0222	0.0036	0.0200
$E \{\omega^m\}$	0.0291	0.0533	0.0399	0.0344	0.0269
$\sigma \{\omega^m\}$	0.0121	0.0027	0.0019	0.0032	0.0008
$\beta$		0.995	0.999	0.966	0.971
$\eta$		1.07	1.99	2.00	1.22
$\alpha$		5.72	9.49	10.0	9.99

**Note.** The table reports the observed figures [Column (1)] and the simulated values obtained from four different model specifications considering: the year-on-year convention and either consumer confidence [Column (2)] or no variable [Column (4)] as a demand shifter; the quarter-on-quarter convention and either consumer confidence [Column (3)] or no variable [Column (5)] as a demand shifter. The variables under scrutiny include the first two moments of the risk-free rate ( $E \{R^f\}$  and  $\sigma \{R^f\}$ ), market return ( $E \{R^m\}$  and  $\sigma \{R^m\}$ ), market premium ( $E \{R^m - R^f\}$  and  $\sigma \{R^m - R^f\}$ ), and dividend yield ( $E \{\omega^m\}$  and  $\sigma \{\omega^m\}$ ). The parameters  $\beta$ ,  $\eta$ , and  $\alpha$  respectively refer to the subjective discount factor, the intertemporal elasticity of substitution and the relative risk aversion coefficient.

consumer confidence; Column (5) from both, thereby representing a version of the standard model.

Comparing Column (2) to (1) reveals that the model performs well in replicating the observed average market return and the risk-free rate (hence, the average risk premium), and the risk-free rate volatility. Each of these figures represents virtually a 100% match. Furthermore, contrasting Columns (2) and (5) show that our framework roundly outperforms the standard one, which can only account for 19% of the excess return and 34% of the risk-free rate standard deviation. Our results also compare favorably with the ones produced by the LRR and RE approaches

(and their combination). While these approaches can also rationalize the risk premium fully, they can only explain up to 30% of the risk-free rate volatility. It is important to note that the baseline model's outcomes obtain with very reasonable calibrated parameter values.<sup>32</sup>

Our findings suggest that both consumer confidence and habit formation play a vital role in delivering the model's outcomes. The figures in Columns (3) and (4), which respectively refer to specializations of the model that abstract from habit formation and consumer confidence, mark a general improvement relative to those in Column (5) concerning the standard model. They also signify a marginal improvement over the baseline model regarding the second group of statistics. Nevertheless, a comparison with Column (2) shows that the outcomes of these decompositions regarding the first group of statistics remain significantly worse than the baseline model's (and, hence, far away from the targets).

The improved performance of the baseline model aligns with the determinations illustrated in Figure 1 and the ensuing discussion. The large SDF mean results in a low return for the risk-free asset. The large SDF volatility and the positive covariance with the market return ensure significant equity risk premia through a low asset price. The high persistence in expected growth rates generated by the demand shifter implies that conditional risk-free returns vary moderately. For the same reason, our approach does not excel in reproducing market return volatility. Conditional asset prices also vary modestly, causing the model to underestimate market return and dividend yield volatility. Furthermore, the large SDF standard deviation and the positive covariance with the market return imply a low asset price, which inflates the dividend yield.

Before concluding, we check the sensitivity of our results to some changes in the procedure that we use to obtain the simulated predictions. We begin with considering an alternative measure for consumer confidence. The Conference Board's Consumer Confidence Index is often considered jointly with the University of Michigan's Consumer Sentiment Index.<sup>33</sup> Therefore, it seems natural to explore whether the results of our approach extend to using the Sentiment Index as a proxy for consumer confidence.

Table 6 summarizes the ensuing comparison. In order to aid the contrast with our previous findings visually, the first three columns are the same as in Table 5. Columns (4) and (5) instead report the predictions obtained using consumer sentiment as a demand shifter, respectively without and with habit formation. The table reveals that the two models deliver similar figures. A modest deterioration in replicating the first group of statistics accompanies a slight improvement in matching the second one. We can then conclude that the same assessment of

<sup>32</sup>Table C.1 in Section C of the online appendix compares the performance of the model with those proposed by Barro and Jin (2021).

<sup>33</sup>For a discussion on the historical reasons for this pairing, together with a detailed description of differences and similarities between the two indices, see Bram and Ludvigson (1998).



**Table 6.**

Asset pricing statistics: comparison with consumer sentiment predictions.

	(1)	(2)	(3)	(4)	(5)
Statistic	Data	Baseline CC + HF	CC only	CS + HF	CS only
$E \{R^f\}$	0.0118	0.0118	0.0340	0.0125	0.0366
$E \{R^m\}$	0.0758	0.0758	0.0644	0.0750	0.0508
$E \{R^m - R^f\}$	0.0640	0.0641	0.0304	0.0625	0.0142
$\sigma \{R^f\}$	0.0229	0.0227	0.0084	0.0256	0.0048
$\sigma \{R^m\}$	0.1640	0.0156	0.0301	0.0158	0.0163
$\sigma \{R^m - R^f\}$	0.1618	0.0126	0.0222	0.0108	0.0209
$E \{\omega^m\}$	0.0291	0.0533	0.0399	0.0524	0.0277
$\sigma \{\omega^m\}$	0.0121	0.0027	0.0019	0.0031	0.0009
$\beta$		0.995	0.999	0.991	0.977
$\eta$		1.07	1.99	1.17	1.98
$\alpha$		5.72	9.49	6.26	9.99

**Note.** The table reports the observed figures [Column (1)] and the simulated values obtained from four different model specifications considering: the year-on-year convention and either consumer confidence [Column (2)] or consumer sentiment [Column (5)] as a demand shifter; the quarter-on-quarter convention and either consumer confidence [Column (3)] or consumer sentiment [Column (4)] as a demand shifter. The variables under scrutiny include the first two moments of the risk-free rate ( $E \{R^f\}$  and  $\sigma \{R^f\}$ ), market return ( $E \{R^m\}$  and  $\sigma \{R^m\}$ ), market premium ( $E \{R^m - R^f\}$  and  $\sigma \{R^m - R^f\}$ ), and dividend yield ( $E \{\omega^m\}$  and  $\sigma \{\omega^m\}$ ). The parameters  $\beta$ ,  $\eta$ , and  $\alpha$  respectively refer to the subjective discount factor, the intertemporal elasticity of substitution and the relative risk aversion coefficient.

the baseline model also applies to the framework considering the Consumer Sentiment Index.

Several scholars deem consumer confidence as yielding information with exclusive regard to the availability of resources rather than consumers' proneness to consume. From this viewpoint, a more conservative approach considering the state variable merely as conditioning information for the events' probability distribution would appear more sensible. To address this issue, we consider the confidence indicator in the consumers' information set upon which we calculate the transitional probabilities while abstracting from any impact it might have on the marginal utility of consumption. Table 7 reports the results of limiting consumer confidence to measure consumers' subjective beliefs concerning variations in available resources. Alongside the observed

**Table 7.**

Asset pricing statistics: confidence as probability shifter.

	(1)	(2)	(3)	(4)	(5)	(6)
		shifter: CC		shifter: CS		
Statistic	Data	with HF	w/o HF	with HF	w/o HF	Standard
$E \{R^f\}$	0.0118	0.0310	0.0385	0.0353	0.0384	0.0376
$E \{R^m\}$	0.0758	0.0528	0.0490	0.0500	0.0490	0.0498
$E \{R^m - R^f\}$	0.0640	0.0218	0.0105	0.0147	0.0106	0.0122
$\sigma \{R^f\}$	0.0229	0.0074	0.0091	0.0086	0.0091	0.0078
$\sigma \{R^m\}$	0.1640	0.0075	0.0155	0.0080	0.0132	0.0122
$\sigma \{R^m - R^f\}$	0.1618	0.0016	0.0215	0.0042	0.0208	0.0200
$E \{\omega^m\}$	0.0291	0.0305	0.0262	0.0279	0.0263	0.0269
$\sigma \{\omega^m\}$	0.0121	0.0022	0.0007	0.0016	0.0007	0.0008
$\beta$		0.968	0.975	0.968	0.974	0.971
$\eta$		2.00	0.97	2.00	0.98	1.22
$\alpha$		10.0	9.99	9.99	9.99	9.99

**Note.** The table reports the observed figures [Column (1)] and the simulated values obtained from five different models specifications considering: the year-on-year convention and consumer confidence [Column (2)] or consumer sentiment [Column (4)] as a probability shifter; or the quarter-on-quarter convention and consumer confidence [Column (3)], consumer sentiment [Column (5)], or no variable [Column (6)] as a probability shifter. The variables under scrutiny include the first two moments of the risk-free rate ( $E \{R^f\}$  and  $\sigma \{R^f\}$ ), market return ( $E \{R^m\}$  and  $\sigma \{R^m\}$ ), market premium ( $E \{R^m - R^f\}$  and  $\sigma \{R^m - R^f\}$ ), and dividend yield ( $E \{\omega^m\}$  and  $\sigma \{\omega^m\}$ ). The parameters  $\beta$ ,  $\eta$ , and  $\alpha$  respectively refer to the subjective discount factor, the intertemporal elasticity of substitution and the relative risk aversion coefficient.

figures and simulated values from the standard model already reported in the previous tables [in Columns (1) and (6)], Table 7 illustrates the outcomes of using consumer confidence [respectively, sentiment] as a probability shifter, with or without considering habit formation, in Columns (2) and (3) [resp., (4) and (5)].

Contrasting Columns (2)-(5) to (6), it is immediate to note that the framework featuring the state variable as probability shifter yields only modest improvements relative to the standard model in replicating the observed statistics when habit formation is taken into account, and even a slight worsening when abstracting from habit persistence. These findings invariably translate

**Table 8.**

Asset pricing statistics: tighter approach to VAR coefficients.

	(1)	(2)	(3)	(4)
Statistic	Data	Baseline CC + HF	CC only	CS only
$E\{R^f\}$	0.0118	0.0118	0.0326	0.0384
$E\{R^m\}$	0.0758	0.0758	0.0661	0.0490
$E\{R^m - R^f\}$	0.0640	0.0640	0.0335	0.0106
$\sigma\{R^f\}$	0.0229	0.0228	0.0074	0.0086
$\sigma\{R^m\}$	0.1640	0.0182	0.0296	0.0119
$\sigma\{R^m - R^f\}$	0.1618	0.0064	0.0222	0.0205
$E\{\omega^m\}$	0.0291	0.0530	0.0415	0.0263
$\sigma\{\omega^m\}$	0.0121	0.0030	0.0020	0.0007
$\beta$		0.991	0.999	0.974
$\eta$		1.08	2.00	0.98
$\alpha$		3.79	9.21	9.99
$A_{x\theta}$		Yes	Yes	No
$A_{\theta x}$		No	Yes	No
$A_{\theta\theta}$		Yes	No	No

**Note.** The table reports the observed figures [Column (1)] and the simulated values obtained from three different models specifications considering: consumer confidence as a demand shifter and either the year-on-year convention [Column (2)] or the quarter-on-quarter convention [Column (3)], or consumer sentiment as a demand shifter and the quarter-on-quarter convention [Column (4)], with the VAR coefficients set to nil whenever the relevant estimated value are not significantly different from zero. The variables under scrutiny include the first two moments of the risk-free rate ( $E\{R^f\}$  and  $\sigma\{R^f\}$ ), market return ( $E\{R^m\}$  and  $\sigma\{R^m\}$ ), market premium ( $E\{R^m - R^f\}$  and  $\sigma\{R^m - R^f\}$ ), and dividend yield ( $E\{\omega^m\}$  and  $\sigma\{\omega^m\}$ ). The parameters  $\beta$ ,  $\eta$ , and  $\alpha$  respectively refer to the subjective discount factor, the intertemporal elasticity of substitution and the relative risk aversion coefficient.

in a significant deterioration in matching the first set of statistics, accompanied by a marginal amelioration in accounting for the second set. The entire set of results is obtained with poorer values of the calibrated preference parameters.

In order to allow for a more transparent comparison across the different model specifications, we produced the findings presented so far by letting the VAR coefficients take the relevant

estimated values, regardless of whether these were significantly different from zero.<sup>34</sup> By affecting the transition probability matrix, this choice might alter the resulting simulated statistics. To rule out the possibility that the outcomes are seriously affected by our lenient approach to assigning values to VAR coefficients, Table 8 reports the results obtained by setting to nil those coefficients that are not statistically different from zero and shows that the simulated predictions remain virtually unchanged relative to those delivered by the baseline model and its specialization. In conjunction with the findings reported in Table 7, this result stresses the role of consumer confidence/sentiment as a demand shifter rather than a mere probability shifter in affecting asset prices' behavior.

Maintaining the original EZW three-parameter specification is convenient as it keeps the model parsimonious and allows for a direct comparison with the standard model. However, the impact of confidence on the consumer's choice could be milder or even reversed, in which case the conventional wisdom discussed in the introduction would apply. As a robustness check, we redefine the demand shifter by letting  $\kappa = \tilde{\kappa}^\xi$ , where  $\tilde{\kappa}$  represents the state variable and  $\xi$  a preference parameter.<sup>35</sup> Regarding the baseline model, the calibrated value of  $\xi$  is close to one, supporting our initial modeling strategy. The model's performance drops moderately, as the other calibrated parameters are also affected by the departure of  $\xi$  from one. When the Consumer Sentiment Index is involved in the analysis, the calibrated value of  $\xi$  is about 0.4, suggesting that, under some specifications, it may be worth using the extended version of the model. Opting for fixed values of  $\xi$  further away from one or negative yields a further deterioration of the model's performance.

It could be argued that the assumption that dividends are equal to consumption is somewhat unrealistic. While plausible from a theoretical perspective and often exploited in the literature, recent macro asset pricing papers assume that dividends are equal to levered consumption, which seems empirically more reasonable. We contrast the results obtained by letting  $y = c$  and  $y = c^\vartheta$ , with  $\vartheta$  the leverage coefficient.<sup>36</sup> The baseline model's performance drops moderately across the board when we set  $\vartheta = 2.6$  as in Wachter (2013), with more marked deterioration of the simulated moments of the dividend yield. The model featuring the Consumer Sentiment Index improves, matching the first two moments of the risk-free rate and the market return's unconditional mean. These results indicate that, while the validity of our findings remains essentially intact, it would be advisable to explore this feature further, a task that we leave to future research.

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<sup>34</sup>This robustness exercise is essential since the method proposed by Tauchen (1986) does not explicitly specify a clear-cut rule regarding the exclusion of estimated coefficients that are not statistically different from zero.

<sup>35</sup>Table C.2 in Section C of the online appendix reports our findings.

<sup>36</sup>Table C.3 in Section C of the online appendix illustrates the relevant results.

## 5 Concluding remarks

We have investigated the effects of including strong time preference linkages in a non-consumption-centric macro-finance model. We have done so by analyzing the effects of incorporating an exogenous demand shifter on the representative consumer's choice regarding consumption and investment decisions. The demand shifter has introduced two elements in the stochastic discount factors of the baseline model: a state variable (confidence indicator) and year-on-year growth rates (on a quarterly data frequency). The year-on-year convention adopted to compute the growth rates may be interpreted as capturing potential habit formation; and confidence indicator as the symmetric concept in an intertemporal perspective. In other words, as a way to capture potential utility from anticipation.

Our findings have indicated that the model compares favorably with the well-established approaches in the literature while suggesting an underlying economic mechanism that might be easier to identify than the origin and the nature of the state variable generating low-frequency innovations in the long-run growth rate and volatility in the typical frameworks featuring long-run risks. The model does well in terms of preference parameters (governing the subjective discount factor, relative risk aversion, and intertemporal elasticity of substitution) and concerning a set of three statistics, namely the mean of the risk-free rate, the market return and the market risk premium. It outperforms the existing contributions in rationalizing the standard deviation of the risk-free rate. In contrast, the model is less reliable in matching the second set of four statistics: the standard deviation of the market return and risk premium, and the mean and volatility of the dividend yield.

We have considered three other model specifications to evaluate the impact of the two elements in isolation and the model's performance that abstracts from both. We have found that disregarding either or both elements results in an acute deterioration of the model's performance. Our results suggest that dropping consumer confidence is slightly less detrimental than excluding habit persistence or discarding both elements. Furthermore, we have examined the effect of replacing the Consumer Confidence Index with the Consumer Sentiment Index as a measure of the confidence indicator. Our results suggest that the models' performance using the two alternative measures is comparable. Finally, two additional robustness checks point out that one should not regard confidence indicators merely as probability shifters; instead, evidence suggests that they play the role of demand shifters.

By matching the observed risk premium and the risk-free rate volatility, the baseline model is a serious candidate to offer an alternative rationale for asset prices' behavior. Nevertheless, its inability to produce sufficient variability across the different conditioning states suggests that the model cannot fully account for the pricing kernel's dynamics captured by the approaches considering long-run risks and rare events jointly.

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