Asset Pricing with and without Garbage: Resurrecting Aggregate Consumption*

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Abstract

This paper challenges the view that alternative consumption measures (e.g., garbage, fourth quarter, unfiltered consumption) can address the shortcomings of consumption-based asset pricing. When the standard CRRA model is confronted with the joint cross-section of asset returns and the risk-free rate, the fit of the alternative consumption processes is poor. Further, when I introduce more complicated preference specifications that disentangle time preferences from risk aversion (e.g., Epstein-Zin) or emphasize the importance of downside risk (e.g., disappointment aversion), the standard measure of aggregate consumption shows a better fit than the alternative ones. I conclude that non-standard preferences are more important in improving the cross-sectional accuracy of consumption-based models than non-standard consumption measures.

Keywords: cross-section, consumption growth, garbage, unfiltered consumption, disappointment aversion

JEL classification: D51, D91, E21, G12

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1 Introduction

Identifying the sources of risk that drive the cross-section of asset returns is one of the most important issues in asset pricing. In the consumption-based paradigm of Breeden (1979), aggregate consumption is the only source of systematic risk. Despite its straightforward theoretical predictions, the empirical performance of the canonical consumption model with constant relative risk aversion (CRRA) and aggregate consumption data from the Bureau of Economic Analysis (BEA) is weak, both in terms of plausibility of preference parameters (e.g., Mehra and Prescott (1985)) as well as cross-sectional accuracy (e.g., Liu et al. (2009)).

The empirical shortcomings of the traditional consumption-based framework with CRRA preferences and BEA consumption have prompted a novel strand of literature that replaces BEA consumption with alternative consumption measures. One important argument in this literature is that BEA consumption is a poor empirical proxy of the true aggregate consumption because of measurement issues. For example, instead of the standard BEA consumption process, Savov (2011) proposes a consumption measure based on the quantity of municipal waste. More recently, Kroencke (2017) argues that BEA consumption is a smoothed version of the true aggregate consumption, which is a more volatile and less persistent process. Kroencke proposes a methodology to unfilter BEA consumption and obtain a more accurate measure of aggregate consumption.

Another argument in this literature is that the annual BEA consumption process does not reflect certain aspects of the investors' decision-making process that should be taken into account when developing structural models. For instance Parker and Julliard (2003) propose a consumption measure defined over multiple periods to capture the forward-looking impact of financial shocks. Similarly, Jagannathan and Wang (2007) replace annual consumption growth with fourth quarter to fourth quarter consumption growth to address the time aggregation bias in aggregate consumption and to show that investor attention matters when aligning the time series of consumption growth to asset returns.

Whether the motivation is measurement error or decision-making parametrization, the existing literature has shown that by using alternative measures for aggregate consumption growth, the canonical CRRA discount factor can explain the aggregate equity risk premium with much lower risk aversion coefficients than those implied by the BEA consumption. Hence, the alternative consumption measures can successfully address the equity premium puzzle of Mehra and Prescott (1985). However, this literature is characterized by two important shortcomings. First, the asset pricing tests of this literature rely exclusively on the assumption of CRRA preferences (e.g., Parker and Julliard (2003), Jagannathan and Wang (2007), Savov (2011), Kroencke (2017)), and ignore more realistic models of investor behavior towards risk. Second, and more importantly, this literature tends to focus on the aggregate risk premium and does not provide conclusive empirical evidence on whether these alternative measures can improve the fit of the consumption framework in the cross-section of asset returns.

Based on the above observations, in this paper, I examine the ability of alternative measures of aggregate consumption to explain the cross-section of risk premia while relaxing the CRRA assumption for investor preferences. Moving away from the CRRA specification is important for two reasons. To begin with, despite its simplicity, the CRRA utility function is not consistent with recent empirical evidence on how investors evaluate risky payoffs (e.g., Kahneman and Tversky (1979), Rabin (2000), Choi et al. (2007), Abeler et al. (2011)). Additionally, the CRRA framework limits the cross-sectional accuracy of consumption-based models because of its restrictive assumption that the risk aversion coefficient, which determines investor appetites towards risk, is the inverse of the elasticity of intertemporal substitution (EIS), which determines the sensitivity of consumption growth to changes in the risk-free rate.

Hence, in this paper, I make three distinct contributions to the empirical consumption literature. First, in testing the cross-sectional accuracy of the various consumption measures, I relax the assumption of CRRA preferences. Specifically, for my empirical tests, I introduce a novel consumption-based stochastic discount factor based on the generalized disappointment aversion (GDA) model of Routledge and Zin (2010). According to the proposed model, which is termed the GDA-S model, investors are worried about losses more than they enjoy gains and their preferences are characterized by a piece-wise concave utility function with asymmetric utility around the disappointment reference point. Hence, the GDA-S model highlights the importance of downside consumption risk in explaining risk premia.

To compare the CRRA and GDA-S models, I also estimate the cross-sectional fit of alternative consumption measures using the non-separable discount factor of Epstein and Zin (1989). Unlike the single-parameter CRRA specification, in the Epstein-Zin model, risk aversion and intertemporal substitution are determined by two distinct coefficients. However, contrary to the GDA-S framework, the Epstein-Zin model does not allow for asymmetric preferences over gains and losses. The new tests with the GDA-S and Epstein-Zin specifications are important because they contrast the importance of non-standard preference specifications against that of non-standard consumption measures in improving the cross-sectional fit of the consumption paradigm.

Second, to assess the accuracy of the various consumption measures under different preference specifications, I use several cross-sections of equity, fixed income, and option portfolios as test assets. These tests are much more demanding than simply explaining the aggregate equity risk premium and shed new light on the cross-sectional implications of the alternative consumption processes.

Third, in addition to the cross-section of risk premia, the test moments in my empirical analysis include the mean and variance of the risk-free rate. Simultaneously fitting the cross-section of risk premia and the moments of the risk-free rate is a challenging hurdle for the various consumption-based models for two reasons. On the one hand, matching the mean of the risk-free rate restricts the mean of the consumption-based pricing kernel. On the other, fitting the variance of the risk-free rate constrains the parameter that determines the EIS. Thus, by matching the mean and variance of the risk-free rate, the various consumption models have limited degrees of freedom to confront the cross-section of risk premia.

Ultimately, the goal of this paper is not to identify the true functional form of the stochastic discount factor or to conduct a horse race between alternative consumption measures under a single pricing kernel specification. Instead, my empirical analysis is geared towards investigating whether the findings of the alternative consumption literature depend on its strong assumption of CRRA preferences or the fact that this literature tends to ignore the importance of fitting the cross-section of risk premia jointly with the moments of the risk-free rate.

To this end, for my empirical tests, I assess the performance of the alternative consumption measures under different preference specifications (CRRA, GDA-S, Epstein-Zin) using the generalized method of moments (GMM) of Hansen and Singleton (1982). The GMM output provides estimates of the structural parameters (risk aversion, disappointment aversion, EIS) for each pricing kernel as well as fitted values for the cross-section of risk premia and the moments of the risk-free rate. Based on this output, I evaluate the various consumption measures in terms of cross-sectional fit and plausibility of the estimated parameters.

In my baseline estimation, the test assets consist of the annual risk premia over the 1964-2013 period for the stock market and three value-weighted portfolio sorts: the 25 size/book-to-market, the 25 size/investment, and the 25 size/profitability portfolios. I use the above portfolios because they constitute the basis for a number of return-generated factors that are commonly used in the empirical asset pricing literature, e.g., SMB, HML, CMA, and RMW factors in Fama and French (1993, 2015). Additionally, as shown in Harvey et al. (2015) and Hou et al. (2015), the above portfolios are the basis for a wide range of established patterns in the cross-section of equity returns.

The results of the main tests indicate that the CRRA model fails to explain the cross-section of risk premia across almost all alternative consumption measures. The only notable exception is the unfiltered fourth quarter consumption of Kroencke (2017) that can perfectly fit the mean and variance of the risk-free rate while partially explaining the cross-sectional variation of asset returns. The poor performance of the CRRA model can be explained by the fact that in my tests, the risk aversion parameter, which in the CRRA model is also the inverse of the EIS, is identified by the variance of the risk-free rate and not by the cross-section of risk premia.

The cross-sectional fit of the consumption-based framework improves when I consider the non-separable model of Epstein and Zin (1989). This model disentangles risk aversion from intertemporal substitution. Interestingly, I find that within the Epstein-Zin specification, BEA consumption can perfectly match the mean and variance of the risk-free rate while outperforming the alternative consumption measures in terms of cross-sectional fit across all portfolio sorts. This finding runs against the results of the existing literature that highlight the improved performance of the alternative consumption measures within the CRRA framework. In terms of plausibility of the estimated parameters, even though the Epstein-Zin model with standard BEA consumption implies a large value for the risk aversion coefficient, the alternative consumption measures imply an extremely low EIS. Hence, the alternative consumption measures also imply implausible estimates for the preference parameters.

In my final tests, I examine the fit of the alternative consumption measures using the novel GDA-S framework with disappointment aversion. Similar to the results for the Epstein-Zin specification, I find that within the GDA-S model, the standard BEA consumption process exhibits the best cross-sectional fit among the various consumption measures across all portfolio sorts. Further, I find that for each consumption measure, the GDA-S model with asymmetric utility can fit the cross-section of risk premia and the moments of the risk-free rate better than the CRRA or Epstein-Zin specifications across almost all test assets. Surprisingly, the fit of the consumption-based GDA-S model with BEA consumption is superior to that of the Fama and French (1993, 2015) three- and five-factor models. This is very important given that the GDA-S model relies on a single macroeconomic factor, whereas the Fama-French models consist of several return generated factors.

I verify the above results with a series of robustness tests. First, I pool the three equity portfolio sorts into a single cross-section. Second, I extend the sample to include the Great Depression. Third, I augment the set of test assets to include portfolios of treasury bonds, corporate bonds, and equity index options. Finally, I test the cross-sectional fit of the various models and alternative consumption measures at the monthly frequency. The results from these tests confirm the findings of my main analysis. Namely, that within the CRRA model, the alternative consumption measures outperform the standard BEA consumption process in terms of cross-sectional fit and plausibility of preference parameters whereas in the GDA-S and Epstein-Zin specifications, BEA consumption can explain the cross-section of risk premia much better than the alternative measures of consumption.

Collectively, the results of this paper complement the asset pricing literature on alternative consumption measures (e.g., Parker and Julliard (2003), Jagannathan and Wang (2007), Savov (2011), Kroencke (2017)). Specifically, consistent with the existing literature, I find that within the standard CRRA framework, the alternative consumption measures exhibit a better fit than BEA consumption in the joint cross-section of risk premia and risk-free rate moments. However, when I consider non-standard preference specifications, such as the GDA-S or Epstein-Zin models, the standard BEA consumption process performs better than the alternative measures in explaining the cross-sectional of risk premia while yielding plausible estimation for the prices of risk.

These findings suggest that the conclusions of the alternative consumption literature, which are motivated by the measurement error in aggregate consumption and the decision-making process of the aggregate investor, rely heavily on the CRRA assumption. Further, my results indicate that the importance of the alternative consumption measures in generating more plausible prices of risk and improving the cross-sectional fit of the consumption framework vanishes when I consider models that disentangle time preferences from risk aversion (e.g., Epstein-Zin) or emphasize the role of downside consumption risk (e.g., GDA-S).

Finally, I extend the empirical results of the disappointment aversion literature (e.g., Routledge and Zin (2010), Bonomo et al. (2011), Delikouras (2017), Delikouras and Kostakis (2019), Schreindorfer (2019)) by combining it with the literature on alternative consumption. This is the first paper to test the cross-sectional performance of disappointment aversion models using alternative measures of consumption. Contrary to a number of results in the disappointment literature (e.g., Routledge and Zin (2010), Delikouras and Kostakis (2019)), which propose discount factors based on disappointment aversion alone, I show that a successful consumption-based model requires both asymmetric preferences (disappointment aversion) and a smooth utility function (risk aversion) to simultaneously fit the cross-section of risk premia and the moments of the risk-free rate.

2 Theoretical Background

In this section, I present the three consumption-based asset pricing models used in my empirical analysis and discuss the significance of including risk-free rate moments in cross-sectional tests of alternative consumption measures.

2.1 CRRA preferences and the cross-section of risk premia

The starting point of my analysis is the CRRA stochastic discount factor M_t^{CRRA}

$$M_t^{CRRA} = \beta\big(C_t/C_{t-1}\big)^{-\gamma}, \tag{1}$$

where γ ($\gamma > 0$) is the risk aversion coefficient and β ($\beta \in (0,1)$) is the rate of time preference.

Following the arguments in Cochrane (2001), the unconditional market risk premium and the implied risk aversion coefficient in the CRRA economy are given by

$$\mathbb{E}\big[R_{mt} - R_{ft}\big] \approx \gamma\rho_{m,c}\sigma_m\sigma_c \quad \Leftrightarrow \quad \gamma \approx \mathbb{E}\big[R_{mt} - R_{ft}\big]/(\rho_{m,c}\sigma_m\sigma_c). \tag{2}$$

The constant $\rho_{m,c}$ is the correlation of market excess returns to consumption growth, and σ_m and σ_c are the volatilities of market excess returns and consumption growth, respectively. Using the estimates for $\mathbb{E}[R_{mt} - R_{ft}]$, $\rho_{m,c}$, σ_m, and σ_c over the 1964-2013 period, the implied risk aversion coefficient according to equation (2) is approximately 75. As emphasized by

Mehra and Prescott (1985), this value is extremely large and impossible to reconcile with the results from experimental studies on risk preferences (e.g., Rabin (2000), Choi et al. (2007)) or the evidence from macroeconomic models (e.g., Lucas (1978)).

Equation (2) demonstrates how alternative consumption measures address the equity premium puzzle Mehra and Prescott (1985). Specifically, the existing literature (e.g., Savov (2011), Kroencke (2017)) has been able to identify alternative consumption processes (e.g., garbage, unfiltered consumption) that preserve the correlation with the stock market and are twice as volatile as the standard BEA consumption. In this case, according to equation (2), the implied risk aversion parameter would decrease in half. Nevertheless, a risk aversion coefficient around 20 is still implausibly large according to the arguments in Rabin (2000).

Moreover, the task of explaining the cross-section of expected returns is much more challenging than fitting the aggregate equity risk premium alone. Specifically, a multidimensional version of equation (2) for the cross-section of risk premia is given by the square of the Hansen and Jagannathan (1997) distance for the CRRA model

$$Dist = \left[\mathbb{E}[\mathbf{R}_t - R_{ft}] - \gamma\sigma_c diag[\mathbf{\Sigma}_r]^{1/2}\boldsymbol{\rho}_{r,c}\right]' \mathbf{\Sigma}_r^{-1} \left[\mathbb{E}[\mathbf{R}_t - R_{ft}] - \gamma\sigma_c diag[\mathbf{\Sigma}_r]^{1/2}\boldsymbol{\rho}_{r,c}\right]. \quad (3)$$

Above, $\mathbf{R}_t$ is the vector of asset returns, $\mathbf{\Sigma}_r$ is the covariance matrix of excess returns, $diag[\mathbf{\Sigma}_r]$ is the diagonal matrix of excess return variances, and $\boldsymbol{\rho}_{r,c}$ is the vector of correlations between excess returns and consumption growth.

Equation (3) highlights the fact that an alternative consumption process should be assessed along two dimensions. First, it should be able to decrease the implied risk aversion coefficient γ either by increasing the consumption growth to asset return correlations ($\boldsymbol{\rho}_{r,c}$) or by increasing consumption growth volatility (σ_c). Second, and more importantly, in order to generate low cross-sectional errors and improve the fit of the standard BEA consumption process, an alternative consumption measure should be able to properly align the vector of risk premia ($\mathbb{E}[\mathbf{R}_t - R_{ft}]$) to the vector of correlations between consumption growth and asset returns ($\boldsymbol{\rho}_{r,c}$). Based on this analysis, in this paper, I examine the performance of alternative consumption measures and preference specifications along these two dimensions: plausibility of the estimated structural parameters and cross-sectional fit.

2.2 Disappointment aversion and non-separable preferences

The existing literature on alternative consumption measures (e.g., Parker and Julliard (2003), Jagannathan and Wang (2007), Savov (2011), Kroencke (2017))) conducts its tests assuming CRRA preferences. Despite its simplicity, the CRRA utility function is not consistent with recent empirical evidence on how investors evaluate risky payoffs (e.g., Kahneman and Tversky (1979), Choi et al. (2007), Abeler et al. (2011)). Further, the CRRA utility limits the cross-sectional accuracy of consumption-based models because of its restrictive assumption that the risk aversion coefficient is the inverse of the EIS.

Motivated by the above shortcomings, for my empirical analysis, in addition to the CRRA model, I compare the plausibility of the estimated preference parameters and the cross-sectional fit of alternative consumption measures using two alternative models for investor preferences. Specifically, I first introduce a novel stochastic discount factor with asymmetric preferences, which is termed the GDA-S model. Additionally, for comparison with the CRRA and GDA-S models, I estimate the non-separable discount factor of Epstein and Zin (1989). I describe these two specifications below.

2.2.1 A novel stochastic discount factor based on disappointment aversion

Routledge and Zin (2010) combine the Epstein and Zin (1989) model with Gul's (1991) disappointment framework and derive the generalized disappointment aversion (GDA) model

$$M_t^{GDA} = \frac{\beta^{\frac{1-\gamma}{\rho}} \left(\frac{C_t}{C_{t-1}}\right)^{(1-\gamma)\frac{\rho-1}{\rho}} R_{wt}^{\frac{1-\gamma}{\rho}-1} \left(1 + \theta \mathbf{1}\left\{\beta^{\frac{1}{\rho}} \left(\frac{C_t}{C_{t-1}}\right)^{\frac{\rho-1}{\rho}} R_{wt}^{\frac{1}{\rho}} \leq \delta\right\}\right)}{1 - \theta(\delta^{\alpha} - 1)\mathbf{1}\{\delta > 1\} + \theta\delta^{1-\gamma}\mathbb{E}_{t-1}\left[\mathbf{1}\left\{\beta^{\frac{1}{\rho}} \left(\frac{C_t}{C_{t-1}}\right)^{\frac{\rho-1}{\rho}} R_{wt}^{\frac{1}{\rho}} \leq \delta\right\}\right]}. \quad (4)$$

The GDA pricing kernel is a function of the observable consumption growth process C_t and the unobservable wealth return R_{wt}. The constant γ is the coefficient of risk aversion, β is the rate of time preference, and ρ ($\rho < 1$) determines the EIS, which is equal to $1/(1-\rho)$. The novel parameters in the GDA pricing kernel are the disappointment aversion (DA) coefficient θ ($\theta > 0$), which affects the asymmetry in investor preferences around the disappointment threshold, and the GDA constant δ ($\delta > 0$), which determines the disappointment threshold.

In this paper, I use a variant of the GDA framework of equation (4), termed the GDA-S model, which is derived based on the following assumptions. First, I assume time-separable preferences, i.e., $\gamma = 1 - \rho$ in equation (4). The time-separability assumption facilitates the identification of the preference parameters under the alternative consumption measures.

Second, as shown in Lustig et al. (2013), returns on aggregate wealth are quite difficult to measure. Thus, using the methodology in Delikouras (2017), I impose additional structure on the consumption growth process to express returns on aggregate wealth as a function of aggregate consumption growth. Specifically, I follow the previous literature (e.g., Mehra and Prescott (1985), Routledge and Zin (2010)) and assume that log-consumption growth Δc_t is an autoregressive process (AR(1)) with constant volatility and i.i.d. $N(0,1)$ shocks $\epsilon_{c,t}$

$$\Delta c_t = \mu_c(1-\phi_c) + \phi_c \Delta c_{t-1} + \sqrt{1-\phi_c^2}\sigma_c \epsilon_{c,t}, \tag{5}$$

where μ_c, σ_c^2, and ϕ_c are the unconditional mean, variance, and first-order autocorrelation.

Based on these two additional assumptions, in Appendix A, I derive the GDA-S stochastic discount factor where the unobservable return on wealth in the GDA model has been replaced by the observable consumption growth Δc_t

$$\begin{aligned} M_t^{GDA-S} = \tilde{\beta} e^{(\rho-1)\Delta c_t} \times \Big(1 + \tilde{\theta} \mathbf{1}\big\{\Delta c_t \le \mu_c(1-\phi_c) + \phi_c \Delta c_{t-1} + d_1 \sqrt{1-\phi_c^2}\sigma_c\big\} \quad (6) \\ -\tilde{\theta}\mathbb{E}\big[\mathbf{1}\big\{\Delta c_t \le \mu_c(1-\phi_c) + \phi_c \Delta c_{t-1} + d_1\sqrt{1-\phi_c^2}\sigma_c\big\}\big]\Big). \end{aligned}$$

The constant $\tilde{\beta}$ above is the effective discount rate, which is a function of preference parameters and consumption growth moments.[1] The coefficient d_1, which depends on the GDA parameter δ from equation (4), determines the threshold for disappointment and is also the location of the asymmetry in the GDA utility function.[2] When $\tilde{\theta}$ is zero (symmetric utility) or d_1 tends to $-\infty$ (extremely low disappointment threshold) in equation (6), the GDA-S discount factor reduces to the traditional CRRA model of equation (1).

The derivation of the GDA-S model above is based on the normality assumption of log-consumption growth (equation (5)). However, the observed consumption growth deviates from normality. Thus, I re-center the disappointment indicator in the GDA-S model by subtracting its unconditional mean ($\mathbb{E}\big[\mathbf{1}\big\{\Delta c_t \le \mu_c(1-\phi_c) + \phi_c\Delta c_{t-1} + d_1\sqrt{1-\phi_c^2}\sigma_c\big\}\big]$) so

[1]See equation (30) in Appendix A for $\gamma = 1 - \rho$.

[2]The parameter d_1 is the threshold for disappointment expressed in terms of the consumption growth shocks $\epsilon_{c,t}$ of equation (5). Specifically, disappointment events in the GDA-S stochastic discount factor of equation (6) occur when consumption growth shocks are less than d_1, i.e., $\epsilon_{c,t} \le d_1$.

that the expectation of the normalized disappointment term $\left(1 + \tilde{\theta}(\mathbf{1}\{...\} - \mathbb{E}[\mathbf{1}\{...\}])\right)$ is 1.

The GDA-S discount in equation (6) includes two terms. The first one is the traditional power utility term ($e^{(\rho-1)\Delta c_t}$) that determines the EIS, i.e., the responsiveness of consumption growth to changes in the risk-free rate. This term adjusts future risky payoffs for timing. The second term is the disappointment indicator ($\tilde{\theta}\mathbf{1}\{...\}$) that determines preferences over risky payoffs. This term adjusts future risky payoffs for disappointing events in consumption growth. According to equation (6), these disappointment events happen when consumption growth is less than its certainty equivalent, i.e., $\Delta c_t \leq \mu_c(1 - \phi_c) + \phi_c \Delta c_{t-1} + d_1\sqrt{1 - \phi_c^2}\sigma_c$. The disappointment term highlights the importance of downside consumption risk as a key driver for the cross-sectional variation in risk premia.

2.2.2 The non-separable pricing kernel of Epstein and Zin (1989)

For comparison with the GDA-S and CRRA models, I also examine the cross-sectional fit of the alternative consumption measures using the Epstein and Zin (1989) framework. Contrary to the CRRA discount factor, Epstein and Zin propose a model where risk aversion and intertemporal substitution are determined by two distinct parameters. This non-separable stochastic discount factor is given by

$$M_t^{EZ} = \beta^{\frac{1-\gamma}{\rho}} \left(\frac{C_t}{C_{t-1}}\right)^{(1-\gamma)\frac{\rho-1}{\rho}} R_{wt}^{\frac{1-\gamma}{\rho}-1}. \tag{7}$$

The Epstein-Zin specification can also be derived from the Routledge-Zin model of equation (4) by assuming a symmetric utility function and setting θ equal to zero.

Similar to the GDA-S model, in Appendix A, I show that when consumption growth follows an AR(1) process with constant volatility as in equation (5), the Epstein-Zin discount factor of equation (7) can be written as a function of observable consumption growth alone

$$M_t^{EZ} = \tilde{\beta} e^{\left(\rho - 1 - \frac{\rho-1+\gamma}{1-\kappa_{c,1}\phi_c}\right)\Delta c_t + \frac{\rho-1+\gamma}{1-\kappa_{c,1}\phi_c}\phi_c \Delta c_{t-1}}. \tag{8}$$

The constant $\tilde{\beta}$ above depends on preference parameters and consumption growth moments as in the GDA-S specification. The parameter $\kappa_{c,1}$ is a log-linearization constant that depends on the average log price-dividend ratio of the economy.[3] When the risk aversion parameter

[3] See equation (25) in Appendix A.

in equal to the inverse of the EIS, i.e., $\gamma = 1-\rho$ in equation (8), the Epstein-Zin specification reduces to the standard CRRA model.

2.3 The risk-free rate

For my empirical analysis, I estimate the various consumption-based models by augmenting the cross-section of risk premia with two key moments for the risk-free rate: the mean of the risk-free rate ($\mathbb{E}[R_{ft}]$) and the variance of the log-risk-free rate ($var(r_{ft})$). Including the mean and variance of the risk-free rate in cross-sectional tests of consumption models is important for two reasons. First, fitting the mean of the risk-free rate fixes the mean of the stochastic discount factor M_t at a realistic level since the unconditional Euler equation of the (conditionally) risk-free rate implies that

$$\mathbb{E}[R_{ft}] = \mathbb{E}[M_t]^{-1}\big(1 - Cov(R_{ft}, M_t)\big) \approx \mathbb{E}[M_t]^{-1}. \tag{9}$$

Second, and most importantly, the variance of the risk-free rate can uniquely identify the EIS coefficient. This is particularly useful for consumption-based models like the GDA-S and Epstein and Zin (1989) specifications, where risk attitudes and intertemporal substitution are determined by distinct parameters. In Appendix B, I show that based on the AR(1) assumption for log-consumption growth in equation (5), the variance of the log risk-free rate across all models used in this study (CRRA, GDA-S, Epstein-Zin) is equal to

$$var(r_{ft}) = (1-\rho)^2\phi_c^2\sigma_c^2. \tag{10}$$

Without the variance condition of equation (10), the GDA-S and Epstein-Zin models cannot be estimated because it is impossible to separately identify the EIS coefficient ρ from the risk and disappointment aversion parameters γ and $\tilde{\theta}$, respectively. For instance, in the Epstein-Zin pricing kernel of equation (8), the effective risk aversion coefficient depends on the additive term $\gamma+\rho$. Hence, the two parameters cannot be identified in this model unless the test assets include the variance of the risk-free rate.

For the CRRA model, the inverse of the EIS is equal to the risk aversion coefficient. Thus, for this model I can replace $1-\rho$ in equation (10) with γ to get

$$var(r_{ft}) = \gamma^2\phi_c^2\sigma_c^2. \tag{11}$$

Equation (11) highlights the tension in the CRRA discount factor between risk aversion and the EIS. Specifically, the risk aversion parameter implied by the risk-free rate volatility is

$$\gamma = vol(r_{ft})/(|\phi_c|\sigma_c). \tag{12}$$

Plugging the estimates over the 1964-2013 period for the volatility of the risk-free rate and the consumption growth moments into equation (12), the implied risk aversion parameter in the CRRA model is equal to 6.4. This number is a much smaller than the risk aversion coefficient ($\gamma = 75$) implied by the equity risk premium condition in equation (2).

One way to address this tension in the CRRA model is to use an alternative measure of aggregate consumption that is more volatile (large σ_c) and much less persistent ($\phi_c \approx 0$) than the standard BEA consumption. In this case, the implied risk aversion parameter from equation (2) will decrease, while the implied inverse EIS coefficient from equation (12) will increase. This is precisely the mechanism of the alternative consumption measures proposed by the literature (e.g., Savov (2011), Kroencke (2017)). However, these alternative consumption processes recast the equity premium puzzle as a risk-free rate puzzle (e.g., Weil (1989)) since they imply an almost zero EIS.

Contrary to the CRRA utility where the risk aversion parameter is also the inverse of the EIS, in the GDA-S and Epstein-Zin discount factors, risk (or disappointment) aversion and intertemporal substitution are determined by two distinct parameters. Thus, by disentangling risk attitudes from time preferences, the latter models provide another way to resolve the tension between fitting the variance of the risk-free rate and matching the cross-section of risk premia without necessarily resorting to alternative consumption measures.

3 Data and Estimation Methodology

In this section, I describe the data and estimation methodology used in the cross-sectional tests of the various consumption-based models.

3.1 Consumption data

In my empirical analysis, I use annual and monthly consumption data. For the annual tests, the benchmark aggregate consumption measure (SNonD) is defined on a per capita basis as services plus non-durables, with each component of aggregate consumption deflated by its corresponding price index (base year 2009). The seasonally adjusted personal consumption expenditures (PCE) and the PCE price index are from the BEA while population data is from the U.S. Census Bureau. In my tests, I also use two aggregate consumption growth measures that are defined separately for services (S-K) and non-durables (NonD-K). These two measures are from Tim Kroencke's website.

For the alternative consumption measures, I follow the empirical approach in Kroencke (2017). Specifically, I consider the three-year measure of ultimate consumption growth (Ult) of Parker and Julliard (2003) and the fourth quarter to fourth quarter (Q4) consumption growth process of Jagannathan and Wang (2007).[4] I also use the unfiltered consumption growth measures of Kroencke (2017) for services and non-durables (SNonD-U), non-durables (NonD-U), and fourth quarter non-durables (Q4NonD-U). The data for all these alternative consumption measures is from Tim Kroencke's website. Additionally, I calculate the garbage growth process from municipal waste data provided by the U.S. Environmental Protection Agency (EPA). This garbage-based measure of consumption was first introduced by Savov (2011). Finally, for the monthly tests I obtain aggregate consumption data for non-durables (NonDm) and services plus non durables (SNonDm) from the FRED website. I also construct the corresponding unfiltered monthly consumption measures (SNonD-Um, NonD-Um) following the methodology in Kroencke (2017).[5]

Summary statistics for the various consumption measures are reported in Table 1. According to the results in Panels A and C, the unfiltered measures of Kroencke (2017) (SnonD-U, NonD-U, Q4NonD-U) and the garbage measure of Savov (2011) are far more volatile than the standard BEA consumption growth process (SNonD). Further, as noted by Kroencke (2017), the unfiltered consumption measures are much less persistent than BEA consumption. In contrast, the Parker and Julliard (2003) consumption measure is the most persistent

[4]Parker and Julliard (2003) consider alternative horizons (from 1 to 15 quarters) for their ultimate consumption measure. Further, the three-year ultimate consumption process should be aligned with three-year returns. However, for comparison with the remaining consumption measures, I follow Kroencke (2017) and align Parker and Julliard's three-year consumption measure with annual returns.

[5]The only difference between the unfiltering procedure for monthly consumption and the one described in Kroencke (2017) for annual data is that for the monthly sample, I set the volatilities of the true consumption measure and the error process equal to the corresponding annual volatilities from Kroencke divided by $\sqrt{12}$ (annual volatilities = 2.5% and 2.8%; monthly volatilities = 0.71% and 0.82%, respectively). The remaining parameters in the monthly unfiltering procedure are identical to the ones used in Kroencke.

consumption process since it is calculated based on overlapping three-year intervals.

Panels E and F of Table 1 show results for monthly consumption. Similar to the annual sample, the monthly unfiltered consumption measures (SNonD-Um, NonD-Um) are much more volatile than standard consumption (SNonDm). However, contrary to the annual sample, at the monthly frequency, BEA consumption growth exhibits negative autocorrelation (mean reversion) and thus, the unfiltering process of Kroencke (2017) increases the absolute value of the autocorrelation coefficient instead of decreasing it. Consequently, at the monthly frequency, unfiltered consumption exhibits stronger mean reversion than BEA consumption.

3.2 Time alignment between consumption and asset returns

One of the most important issues in empirical consumption-based asset pricing is the time alignment between consumption growth and asset returns. This is an important issue due to the temporal aggregation bias that affects the time-series of aggregate consumption (e.g., Breeden et al. (1989)).

One way to address the time aggregation bias is by calculating annual consumption growth using end-of-period consumption flows from December to December (e.g., Breeden et al. (1989)) or from fourth quarter to fourth quarter (e.g. Jagannathan and Wang (2007)). Kroencke (2017) imposes an additional temporal correction for his unfiltered consumption growth processes using an autoregressive approximation of Hall (1988). Further, Cochrane (1996) and Kroencke (2017) address the time aggregation bias from the perspective of asset returns. Specifically, they calculate asset returns using annual averages of monthly prices ($R_t = \sum_{k=1}^{12} P_{kt} / \sum_{k=1}^{12} P_{k,t-1}$) instead of end-of-year prices ($R_t = P_{12t}/P_{12,t-1}$).

Contrary to Kroencke (2017), I calculate asset returns using the traditional methodology of end-of-year prices. I do not alter the timing convention of asset returns to be consistent with the majority of the asset pricing literature and to facilitate the replication of my results. Instead, I address the temporal aggregation bias by altering the timing convention in consumption. Specifically, for each consumption measure, I choose the timing convention that maximizes the correlation between stock market returns and consumption growth.

Panels A, C, and E of Table 1 report correlation coefficients between the various consumption growth measures and the excess return on the stock market under two timing conventions. The first one is the beginning-of-period convention where consumption growth at time t is aligned with market returns at time $t-1$. The beginning of period convention has been previously used in consumption-based asset pricing by Campbell (2003), Yogo (2006), and Savov (2011). The second convention is the end-of-period convention where consumption growth at time t is aligned with market returns at time t.

According to the correlation estimates in Panels A, C, and E of Table 1, the beginning-of-period convention yields higher correlation coefficients across all annual consumption measures with the exception of the ultimate consumption process of Parker and Julliard (2003) (Ult) and the unfiltered fourth quarter consumption of Kroencke (2017) (Q4NonD-U). Based on this finding, for my annual tests, I use the beginning-of-period convention for all consumption processes other than the Ult and Q4NonD-U measures. For the monthly tests, I use the end-of-period convention, consistent with the correlation estimates in Panel E of Table 1.

3.3 Test assets

The aim of my empirical analysis is to examine whether alternative consumption measures and preference specifications can explain stylized facts in the cross-section of asset returns. To this end, my test assets consist of the 25 portfolios sorted on size/book-to-market (size/bm), the 25 portfolios sorted on size/investment (size/in), and the 25 portfolios sorted on size/operating profitability (size/op). The returns for the equity portfolios and the risk-free asset are from Kenneth French's website. Following the results in Asparouhova et al. (2013), I focus on value-weighted returns.

The use of the above portfolios is motivated by three reasons. First, these sets of equity portfolios constitute the basis for a number of return-generated factors that are commonly used in the empirical asset pricing literature, such as the SMB, HML, CMA, and RMW factors in Fama and French (1993, 2015). Second, as shown in Harvey et al. (2015) and Hou et al. (2015), the above portfolios are also the basis for a wide range of well-established patterns in the cross-section of equity returns. Third, these portfolios are consistent with Kroencke (2017), who uses portfolios sorted on size, book-to-market, profitability, and investment for his cross-sectional tests.

To complement the findings of the alternative consumption literature, which has almost exclusively focused on equity returns, I also estimate the various consumption-based models with alternative consumption measures and preference specifications in an extended cross-section of alternative test assets. Specifically, I consider 6 Treasury bond portfolios sorted on maturity,[6] 5 corporate bond portfolios sorted on the basis of their credit ratings,[7] and 6 equity index option portfolios.[8]

Table 2 reports summary statistics for asset returns. Specifically, Panel A shows results for the 1964-2013 sample, Panel B reports statistics for the 1930-2013 sample, and Panel C shows results for monthly returns. Finally, summary statistics for the alternative test assets (treasury bond, corporate bond, and index option portfolios) are shown in Panel D of Table 2. These statistics are in line with the existing results in the asset pricing literature (e.g., Delikouras (2017), Delikouras and Kostakis (2019)).

3.4 Estimation methodology

In my empirical analysis, I use the first-stage GMM of Hansen and Singleton (1982) to estimate the various consumption-based models under alternative consumption measures and assess their cross-sectional fit. In addition to the cross-section of risk premia, the GMM objective function estimates the mean and volatility of the risk-free rate as well as consumption growth moments to verify the AR(1) assumption of equation (5).[9] The GMM vector reads

$$\begin{bmatrix} \mathbb{E}[\Delta c_t] - \mu_c \\ \mathbb{E}[\Delta c_t^2] - \mu_c^2 - \sigma_c^2 \\ \mathbb{E}[\Delta c_t \Delta c_{t-1}] - \mu_c^2 - \phi_c \sigma_c^2 \\ \mathbb{E}[(logR_{ft})^2] - \mathbb{E}[logR_{ft}]^2 - (1-\rho)^2 \phi_c^2 \sigma_c^2 \\ \mathbb{E}\big[R_{ft} M_t\big] - 1 \\ \mathbb{E}\big[\big(R_{mt} - R_{ft}\big) M_t\big] \\ \mathbb{E}\big[\big(R_{it} - R_{ft}\big) M_t\big] \quad \text{for} \quad i = 1, 2, ..., n. \end{bmatrix} = \mathbf{0}. \tag{13}$$

For the Epstein and Zin (1989) model alone, the GMM vector above includes an additional

[6] The Fama maturity portfolios are provided by the Center for Research in Security Prices (CRSP).

[7] These corporate bond portfolios have been constructed by Nozawa (2012), and they are available from Michael Weber's website: http://faculty.chicagobooth.edu/michael.weber/.

[8] In particular, we use the 30-day, put and call Standard & Poor's 500 (S&P 500) index option portfolios with moneyness levels of 90, 100, and 110%, respectively, of Constantinides, Jackwerth, and Savov (2013). These option portfolio returns are available from Alexi Savov's website: http://pages.stern.nyu.edu/ asavov/alexisavov/.

[9] The gradient of the GMM objective function is calculated analytically when this is possible and numerically in all other cases.

condition that identifies the log-linearization constant $\kappa_{c,1}$ in equation (8)

$$\mathbb{E}[pd_t] - log(1 + e^{\mathbb{E}[pd_t]}) - log\kappa_{c,1} = 0.$$

The variable pd_t in the above equation is the log price-dividend ratio of the stock market, which is used as an empirical proxy for the unobservable log price-dividend ratio of the claim on aggregate consumption (see equation (25) in Appendix A).

The weighting matrix for the GMM vector in equation (13) is a diagonal matrix that overweighs the moment conditions for consumption growth and the risk-free rate. This is because the consumption growth variance and auto-covariance as well as the variance of the log risk-free rate are much smaller in magnitude than risk premia. Further, by overweighing the consumption growth moments, I am not allowing the estimation procedure to fit portfolio premia at the expense of errors in the consumption growth process (e.g., inflating the variability or the persistence of consumption growth). Similarly, the GMM weighting matrix overweighs the moment conditions for the mean and variance of the risk-free rate because of their significance in fitting the mean of the stochastic discount factor and identifying the EIS, respectively.

To assess the cross-sectional accuracy of the alternative consumption measures and preference specifications, I use the cross-sectional r-square (R^2), and the root-mean-square-prediction error ($rmspe$), which is defined as

$$rmspe = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\big(\mathbb{E}[R_{it} - R_{ft}]_{\text{sample}} - \mathbb{E}[R_{it} - R_{ft}]_{\text{fitted}}\big)^2}. \tag{14}$$

Based on the representative investor's Euler equation, the fitted risk premia above are given by the covariances of asset excess returns with the stochastic discount factor M_t

$$\mathbb{E}[R_{it} - R_{ft}]_{\text{fitted}} = -Cov\big(R_{it} - R_{ft}, M_t\big)/\mathbb{E}[M_t], \text{ for } i = 1, ..., n. \tag{15}$$

I estimate the various consumption-based models and test their cross-sectional fit across two samples: 1964-2013 and 1930-2013. The 1964-2013 annual sample has limited time-series observations. However, this is the only period for which all the alternative consumption measures and portfolio sorts are available. Testing in this sample is also consistent with previous works (e.g., Savov (2011), Kroencke (2017)). The extended 1930-2013 sample facilitates the estimation of variances and covariances. However, in this sample, a number of consumption measures (e.g., Q4, garbage) and test assets (e.g., investment and profitability portfolios) are not available.

4 Estimation results for the cross-section of risk premia and the risk-free rate

In this section, I present the baseline results from estimating the various stochastic discount factors with different preference specifications and alternative consumption measures.

CRRA preferences

For my first set of tests, I estimate the CRRA model of equation (1) using different consumption growth measures in the 1964-2013 sample. Table 3 reports estimation results for the CRRA discount factor based on the risk premia of the three portfolio sorts (25 size/bm, 25 size/inv, 25 size/op) and the stock market as well as the mean and variance of the risk-free rate. The first important result in Table 3 is that the estimates of the consumption growth moments do not depend on the choice of test assets and are consistent with the estimates from Table 1. This finding implies that the GMM system of equation (13) does not fit risk premia at the expense of accuracy in consumption moments.

The second important result in Table 3 is that contrary to the findings of the existing literature (e.g., Mehra and Prescott (1985)), the estimated risk aversion coefficient for the standard BEA consumption measure (SNonD) is quite low (γ = 3.64, t-statistic = 2.01). This is because in my tests, the risk aversion parameter, which in the CRRA model is also the inverse of the EIS, is mainly identified through the moment condition for the variance of the log risk-free rate (equation (10)). This is also the reason why for each consumption process, the estimates of the risk aversion coefficient are identical across the three portfolio sorts. The risk premia do not affect the estimates of the risk aversion coefficient due to the choice of the GMM weighting matrix that emphasizes the importance of the risk-free rate by overweighing the corresponding moment conditions.

Contrary to the standard consumption processes (SNonD, S-K, NonD-K, Q4NonD-U), the alternative consumption measures (SNonD-U, NonD-U, garbage) yield relatively large risk aversion coefficients ($\gamma \approx 24$) despite the fact that in my tests, γ is estimated from the variance of the risk-free rate. This is because the alternative consumption measures are much less persistent ($\phi_c \approx 0$) than standard consumption. According to equation (11), a low autocorrelation coefficient requires a large risk aversion parameter in the CRRA model to fit the variance of the risk-free rate. In fact, because the alternative consumption growth processes exhibit almost zero persistence,[10] the risk aversion coefficients estimated from the variance of the risk-free rate are comparable to those that would have been obtained from the cross-section of risk premia.

In terms of model fit, the cross-sectional performance of the CRRA model with standard BEA consumption is characterized by highly negative R^2s and large prediction errors. This result can be explained by the very low estimates of the risk aversion coefficient, which is estimated from the variance of the risk-free rate. In contrast, the cross-sectional fit of the alternative consumption measures is much better than that of BEA consumption since for these alternative processes, the risk aversion coefficient that fits the variance of the risk-free rate is very similar to the risk aversion parameter implied by the cross-section of risk premia.

Despite the significant improvement in the cross-sectional fit relative to BEA consumption, the R^2s of the alternative consumption measures are negative and the prediction errors are large across all portfolio sorts. The only exception is the unfiltered fourth quarter consumption (Q4NonD-U) of Kroencke (2017). This measure is able to perfectly fit the mean and variance of the risk-free rate and partially explain the cross-sectional variation in risk premia for the three portfolio sorts yielding positive, albeit low, R^2s.

The results in Table 3 are also graphically summarized by Figure 1. According to this figure, the choice of the GMM weighting matrix forces the CRRA model to perfectly fit the mean and volatility of the risk-free rate across all consumption measures and portfolios sorts. However, the CRRA specification with standard BEA consumption cannot explain the cross-section of risk premia because the estimated risk aversion parameter implied by the variance of the risk-free rate is very low. In contrast, the alternative consumption measures perform better than BEA consumption in terms of cross-sectional fit because the zero autocorrelation of these processes implies that the risk aversion parameter required to match the

[10] The autocorrelation estimate from the GMM estimation is obtained by dividing the aucovariance estimate ($\phi_c\sigma_c$) by the variance estimate (σ_c).

variance of the risk-free rate (equation (11)) is comparable to the risk aversion parameter required to fit the cross-section of risk premia (equation (3)).

Epstein-Zin preferences

Table 4 reports estimation results for the Epstein and Zin (1989) discount factor of equation (8). This model disentangles risk aversion from intertemporal substitution. The first important finding in Table 4 is that the estimates of the consumption growth moments do not depend on the choice of test assets. In fact, these estimates are almost identical to the ones for the CRRA model from Table 3 and the summary statistics in Table 1. This result verifies that the choice of the GMM weighting matrix does not allow the various consumption-based models to fit risk premia at the expense of consumption moments.

Another important finding in Table 4 is that for each consumption process, the EIS coefficient ρ in the Epstein-Zin model is almost identical across the three portfolio sorts. This is because the EIS parameter ρ is identified by the variance of the risk-free rate, not the cross-section of risk premia due to the choice of the GMM weighting matrix.

Regarding the structural parameter estimates in Table 4, the standard BEA consumption process (SNonD) requires a large risk aversion parameter ($\gamma \approx 40$) to fit the cross-section of risk premia. This value is consistent with the ones suggested by Mehra and Prescott (1985) and Cochrane (2001), and is a direct indication of the equity premium puzzle. In contrast, the alternative consumption measures (SNonD-U, NonD-U, Q4NonD-U, Garbage) imply much smaller risk aversion coefficients for the Epstein-Zin model ($\gamma \approx 24$) than BEA consumption. This finding is consistent with the existing literature (e.g., Savov (2011), Kroencke (2017)) which shows that due to their increased volatility, the alternative consumption measures can resolve the equity premium puzzle of Mehra and Prescott (1985).

Nevertheless, the results in Table 4 show that the alternative consumption processes imply abnormally large, in absolute magnitude, EIS parameters ($|\rho| > 20$). This is because the alternative consumption measures exhibit very low persistence. Thus, according to equation (10), these measures require a large EIS parameters to align the variance of the risk-free rate with the variance and persistence of consumption growth. The existing literature on alternative consumption is silent on the plausibility of the EIS parameters because it has ignored the variance of the risk-free rate as a target moment. By including this moment in cross-sectional tests, I show that although the alternative consumption measures imply much lower risk aversion coefficients than BEA consumption, they require very large, in absolute value, EIS parameters.

With respect to the cross-sectional fit of the various consumption measures, the Epstein-Zin discount factor improves the performance of the consumption-based framework relative to the CRRA model across almost all consumption measures and portfolio sorts. For example, the cross-sectional R^2's of the Epstein-Zin model with BEA consumption (SNonD) range between 50.10% and 83.97% across the three portfolio sorts and the corresponding predictions errors are low. Equally importantly, within the Epstein-Zin specification, BEA consumption yields better cross-sectional fit than the alternative consumption measures across all three portfolio sorts. The only exception is the unfiltered fourth quarter consumption (Q4NonD-U) of Kroencke (2017) in the set of the 25 size/book-to-market portfolios.

The superior performance of the BEA consumption process within the Epstein-Zin framework can be explained by the fact that the alternative consumption measures (SNonD-U, NonD-U, Q4NonD-U, Garbage) require large, in absolute magnitude, values for the EIS parameter ρ to fit the variance of the risk-free rate (equation (10)). These large EIS estimates, which, according to the results in Table 4, are similar in magnitude to the corresponding γ estimates, combined with the low persistence of the alternative consumption growth processes imply that these processes cannot exploit the non-separability property of the Epstein-Zin model to fit the cross-section of risk premia as accurately as the standard BEA consumption process. In sum, the Epstein-Zin model with alternative consumption measures is equivalent to the standard CRRA utility function, which does not allow for non-separable preferences, due to the zero persistence of these measures. Hence, the alternative consumption processes do not perform well when combined with the Epstein-Zin discount factor.

The estimation results of Table 4 are further illustrated by Figure 2. Similar to the results in Figure 1 for the CRRA model, Figure 2 shows that the choice of the GMM weighting matrix forces the Epstein-Zin discount factor to perfectly fit the mean and volatility of the risk-free rate across all consumption measures and test assets. Confirming the results in Table 4, Figure 2 also shows that disentangling risk preferences from intertemporal substitution improves the fit of the consumption framework across all assets relative to the CRRA model. Most importantly, Figure 2 shows that within the Epstein-Zin framework, BEA consumption can fit the cross-section of risk premia better than the alternative consumption processes.

GDA-S preferences

In the final baseline tests, I estimate the novel GDA-S pricing kernel of equation (6) with alternative consumption measures. The key characteristic of this model is that it combines power utility with asymmetric preferences over disappointment events. Estimation results for the GDA-S model are reported in Table 5. The first important finding is that, consistent with the results for the CRRA and Epstein-Zin models, the estimated consumption moments in Table 5 do not depend on the set of test assets or the choice of discount factor.

Further, according to Table 5, the GDA-S specification with standard BEA consumption can perfectly match the mean and variance of the risk-free rate while exhibiting a good cross-sectional fit in the three portfolio sorts (R^2 = 72.35%, 70.80%, 76.13%). In fact, one of the most important findings in Table 5 is that within the GDA-S framework, BEA consumption can fit the moments of the risk-free rate and the cross-section of risk premia much better than the alternative consumption measures.

Surprisingly, the fit of the consumption-based GDA-S model is superior to the fit of the Fama-French three- and five-factor models (see Table A.1 in Appendix C). This is very important given that the GDA-S model relies on a singe macroeconomic factor, whereas the Fama-French models consist of several return generated factors. The cross-sectional performance of the GDA-S model can be explained by the unique combination of smooth preferences with asymmetric utility. Specifically, smooth concave utility, captured by the power utility term in equation (6), is crucial for fitting the moments of the risk-free rate, while asymmetric preferences, which are captured by the disappointment indicator in equation (6), are important for explaining the cross-section of risk premia.

Another important finding in Table 5 is that for each consumption measure, the GDA-S pricing kernel outperforms the CRRA and Epstein-Zin models in terms of cross-sectional accuracy across almost all test assets. The only notable cases where the GDA-S specification cannot explain the cross-section of risk premia better than the Epstein-Zin discount factor are the standard BEA consumption (SNonD), the non-durables consumption (NonD-K), and the unfiltered consumption processes of Kroencke (2017) (NonD-U) in the sample of the size/profitability portfolios. However, in these cases, the estimated risk aversion coefficients in the Epstein-Zin model are quite large whereas the estimated structural parameters in the GDA-S discount factor have plausible values.

Specifically, the estimates of the disappointment aversion coefficient $\tilde{\theta}$ for the GDA-S model with BEA consumption in Table 5 range between 2.63 and 3.94 and are mostly statistically significant (t-statistic = 1.47 to 2.05). These estimates are quite low and consistent with the findings from experimental studies on investor preferences over risky payoffs (e.g., Kahneman and Tversky (1979), Choi et al. (2007), Abeler et al. (2011)) or the calibration of macroeconomic models with disappointment aversion (e.g, Ang et al. (2005), Bonomo et al. (2011)). Similarly, the estimates of the disappointment threshold parameter d_1 for BEA consumption range between -0.55 and -0.31. These values imply that investors experience disappointment when the shocks to aggregate consumption growth, which are i.i.d. N(0,1) random variables, are negative and substantially lower than their mean.

The last important result in Table 5 is that the low persistence of the alternative consumption processes implies that the disappointment threshold in equation (6) is constant. Without time-variation in the disappointment threshold, the disappointment indicator is not able to align bad times in the stock market to disappointment events in consumption growth. Hence, the estimates of the disappointment aversion coefficient $\tilde{\theta}$ for alternative consummation measures become statistically insignificant. In sum, the GDA-S model with alternative consumption measures is equivalent to the standard CRRA utility function, which does not allow for asymmetric utility, due to the low persistence of the alternative consumption measures that translates into a constant disappointment threshold. Thus, the alternative consumption measures do not perform well when combined with the GDA-S discount factor.

The estimation results from Table 5 are graphically presented in Figure 3. Consistent with the results for the CRRA and Epstein-Zin models, the choice of the GMM weighting matrix forces the GDA-S discount factor to perfectly fit the mean and volatility of the risk-free rate across all test assets and consumption measures. Further, confirming the results in Table 5, Figure 3 shows that within the GDA-S framework, BEA consumption fits the cross-section of risk premia better than the alternative consumption processes. Finally, a comparison of Figures 1, 2, and 3 illustrates that for each consumption measure, the GDA-S specification can fit the cross-section of risk premia and the risk-free rate moments better than the CRRA or Epstein-Zin models across almost all portfolio sorts.

Overall, the findings in this section indicate that when the GMM system includes the moments of the risk-free rate then, within the canonical CRRA framework, the alternative consumption measures, especially the unfiltered fourth quarter consumption of Kroencke

(2017), are much more accurate than the standard BEA consumption in terms of cross-sectional fit. This result is consistent with the existing literature. However, when I disentangle risk aversion from intertemporal substitution using the Epstein-Zin discount factor, the cross-sectional fit of BEA consumption is better than that of the alternative consumption measures. Even though the Epstein-Zin model with BEA consumption requires a large risk aversion parameter to fit the cross-section of risk premia, the alternative consumption measures require large, in absolute magnitude, EIS coefficients to match the variance of the risk-free rate.

Last but not least, the GDA-S model introduced in this study, which combines smooth preferences with disappointment aversion (downside consumption risk), can successfully match the moments for the risk-free rate and explain the cross-section of risk premia using only one input: the standard BEA measure of consumption growth for non-durables and services. Importantly, within the GDA-S framework, BEA consumption can fit the cross-section of risk premia and the moments of the risk-free rate better than the alternative consumption processes while generating plausible estimates for the disappointment aversion and EIS coefficients.

Collectively, the results of my baseline tests suggest that the main findings of the alternative consumption literature rely heavily on the CRRA assumption for investor preferences. To the contrary, the economic significance of the alternative consumption measures in generating more plausible prices of risk and improving the cross-sectional fit of the consumption framework vanishes when I consider preference specifications that disentangle time preferences from risk aversion (e.g., Epstein-Zin) or highlight the importance of downside consumption risk (e.g., GDA-S).

5 Robustness Analysis

This section reports results from additional robustness tests that verify the main findings of the empirical analysis.

5.1 Joint cross-section

In the baseline analysis, I examine the fit of the various consumption measures using a single cross-section of equity portfolios for each test. Table 6 reports estimation results when the three portfolio sorts (size/bm, size/in, size/op) are pooled together in a joint cross-section. The results from these tests confirm the main findings. Specifically, Panel A of Table 6 reports that, irrespective of the consumption measure, the CRRA model fails when it is simultaneously confronted with the cross-section of risk premia and the variance of the risk-free rate. Nevertheless, within the CRRA framework, the alternative consumption measures (SNonD-U, NonD-U, Q4NonD-U, Garbage) perform much better in terms of cross-sectional fit than BEA consumption (SNonD).

The cross-sectional fit of the various consumption measures improves with the Epstein-Zin model, where risk aversion and intertemporal substitution are determined by distinct parameters. According to Panel B of Table 6, within the Epstein-Zin framework, BEA consumption performs better in fitting the cross-section of the 75 portfolios than the alternative consumption measures. Even though BEA consumption yields large risk aversion parameters ($\gamma \approx 40$), the alternative consumption processes imply extremely low EIS (EIS $\approx 1/26$).

Finally, Panel C of Table 6 reports estimation results for the GDA-S discount factor with alternative consumption measures. Similar to the findings from the baseline tests, for each consumption measure, the GDA-S model yields better cross-sectional fit than the CRRA or Epstein-Zin discount factors. Equally importantly, within the GDA-S model, BEA consumption exhibits the best cross-sectional performance, as measured by the cross-sectional R^2 and *rmspe*, while yielding plausible values for the disappointment aversion coefficient. Overall, the results from the joint cross-section of equity portfolios confirm that for the cross-sectional success of the consumption-based framework, relaxing the CRRA assumption is more important than using alternative consumption measures.

5.2 Extended sample: 1930 - 2013

To shed additional light on the cross-sectional performance of the alternative consumption measures, Table 7 reports GMM results for an extended sample that runs from 1930 through 2013 and includes the Great Depression.[11] For these tests, the fourth quarter to fourth quarter (Q4) and garbage measures are unavailable while the only available cross-section of test assets is the set of 25 size/book-to-market portfolios.

The results of these tests are in line with the baseline analysis. Specifically, the GDA-S

[11] The first year that consumption data is available in the BEA website is 1929.

model with BEA consumption is able to fit the mean and volatility of the risk-free rate as well as the cross-section of the risk premia while yielding plausible estimates for the preference parameters. Further, according to the results in Table 7, the fit of the GDA-S model is superior to that of the CRRA and Epstein-Zin models across all alternative consumption measures. More importantly, within the GDA-S model, the standard BEA consumption measure yields a much better fit than the alternative processes.

5.3 Alternative asset classes

Theoretically, a consumption-based model should explain risk premia across all financial markets. Nevertheless, the existing literature (e.g., Parker and Julliard (2003), Jagannathan and Wang (2007), Savov (2011)) tends to focus on equity portfolios and has not investigated the cross-sectional fit of alternative consumption measures in different markets.

From an empirical standpoint, expanding the set of test assets should address the critique in Lewellen, Nagel, and Shanken (2010) regarding the factor structure in size/bm portfolios. Hence, in this section, I estimate the various consumption models using an extended cross-section of test assets. In particular, I consider the 6 Fama maturity-sorted Treasury bond portfolios, the 5 corporate bond portfolios of Nozawa (2012) constructed on the basis of bonds' credit ratings, and the 6 30-day, put and call S&P 500 index option portfolios, with moneyness levels of 90, 100, and 110% of Constantinides et al. (2013).

Table 8 reports GMM results for the sample of alternative test assets using the canonical CRRA specification of equation (1) with alternative consumption measures and the novel GDA-S model of equation (6) with standard BEA consumption. For simplicity, in these tests, I only consider the standard BEA consumption process for the GDA-S and Epstein-Zin discount factors. According to the results in Table 8, the GDA-S pricing kernel with BEA consumption performs better than the CRRA model with alternative consumption measures across all test assets (treasury bonds, corporate bonds, options), both in terms of plausibility of the estimated parameters as well as accuracy of cross-sectional fit.

5.4 Monthly data

In all the previous tests, the sample frequency is annual. This is consistent with the existing literature (e.g., Savov (2011), Kroencke (2017)), which does not investigate the cross-sectional performance of alternative consumption measures in higher frequencies. To address this issue, this section uses monthly risk premia to compare the cross-sectional performance of the standard CRRA model with alternative consumption measures against the fit of the GDA-S and Epstein-Zin specifications with BEA consumption.

In the monthly sample, the Q4, Ult, and garbage-based consumption measures are not available. Further, in this sample the only free parameter in the GDA-S model is the disappointment aversion coefficient $\tilde{\theta}$. This is because following Delikouras and Kostakis (2019), I define disappointment months based on annual disappointment events. Specifically, based on the results for the 1964-2013 annual sample from Table 5, if year t is a disappointment year, then I assume that all months in year t are disappointment months. If year t is not a disappointment year, then none of the months in year t are disappointment months. For parsimony, in this sample, I focus on the 25 size/book-to-market portfolios.

The monthly results, which are reported in Table 9, indicate that the equity premium puzzle of Mehra and Prescott (1985) is more pronounced at the monthly frequency. Specifically, the estimated risk aversion parameter ($\gamma = 217.51$) of the Epstein-Zin model with standard consumption (SNonDm) in the monthly sample is much larger than that implied by annual risk premia in Table 4. Contrary to the results for the Epstein-Zin pricing kernel, the estimated disappointment aversion parameter ($\tilde{\theta} = 2.6$) for the GDA-S model in the monthly sample is almost identical to the estimates from the annual sample in Table 5. This finding implies that the magnitude of the estimated preference parameters in the GDA-S pricing kernel does not depend on the sample frequency.

In terms of cross-sectional fit, according to the results in Table 9, the CRRA specification with the unfiltered consumption measures (SNonD-Um, NonD-Um) yields negative cross-sectional R^2s and large prediction errors. This is because in the monthly sample, the unfiltered consumption processes exhibit strong mean reversion ($\phi_c \approx -0.5$ in Table 1). According to equation (11), a relatively large value for $|\phi_c|$ requires a low value for the risk aversion parameter to fit the variance of the risk-free rate. In turn, this low value for the risk aversion coefficient is not able to fit the cross-section of risk premia.

In contrast, the cross-sectional fit of the GDA-S discount factor with BEA consumption is superior to that of the CRRA and Epstein-Zin models for two reasons. First, the GDA-S pricing kernel disentangles risk attitudes (disappointment aversion) from timing preferences (EIS). Second, the asymmetry in the GDA-S utility function highlights the importance of downside consumption risk in explaining risk premia.

6 Conclusion

In this paper, I examine the ability of alternative consumption measures (e.g., garbage, unfiltered consumption, fourth quarter consumption, ultimate consumption) to explain the cross-section of risk premia and generate plausible prices of risk under different specifications for investor preferences. The goal of my empirical analysis is to investigate whether the conclusions of the alternative consumption literature depend on its strong assumption of CRRA preferences and the fact that this literature tends to ignore the importance of fitting the cross-section of risk premia jointly with the moments of the risk-free rate.

My results indicate that when the canonical CRRA model is simultaneously confronted with the cross-section of risk premia and the variance of the risk-free rate, the fit of the alternative consumption processes is quite poor. Despite the poor performance of the alternative consumption measures, their cross-sectional accuracy within the CRRA model is better than that of the traditional BEA consumption process. This finding is consistent with the results of the existing literature on alternative consumption measures.

In addition to the CRRA specification, I investigate the accuracy of the alternative consumption measures using a novel pricing kernel, termed the GDA-S model, which is based on the disappointment aversion framework of Routledge and Zin (2010). For comparison to the CRRA and GDA-S models, I also estimate the non-separable model of Epstein and Zin (1989). My tests show that the GDA-S specification exhibits better cross-sectional fit than the CRRA or Epstein-Zin discount factors across all consumption measures considered in this study. More importantly, within the GDA-S model, the standard BEA consumption process exhibits the best cross-sectional fit among the various measures of aggregate consumption. Similar results also hold for the Epstein-Zin discount factor.

Collectively, my findings suggest that the significance of the alternative consumption measures in improving the cross-sectional fit of the consumption framework and generating plausible prices of risk vanishes when I consider models that disentangle time preferences from risk aversion (e.g., Epstein-Zin) or highlight the importance of downside consumption risk (e.g., GDA-S). Overall, I conclude that replacing the CRRA utility function with theoretically richer and empirically more plausible preference specifications has a greater impact on the cross-sectional accuracy of consumption-based models than using alternative measures of aggregate consumption.

Appendix

Appendix A Explicit solutions for the GDA and Epstein-Zin discount factors

To derive explicit solutions for the GDA model, I combine the linear structure of the disappointment aversion framework in Routledge and Zin (2010) with the AR(1) dynamics for consumption growth. The proof follows the one in Delikouras (2017) and consists of two steps. First, I express the price-dividend ratio of the claim on aggregate consumption as a linear function of consumption growth. Second, I solve the GDA discount factor in terms of consumption growth.

Price-dividend ratio of a claim on aggregate consumption

The representative investor chooses consumption C_t and portfolio weights $\{w_{it}\}_{i=1}^n$ to maximize lifetime utility V_t. The investor's maximization problem is given by

$$
\begin{aligned}
V_t \ &= \max_{C_t,\ \{w_{it}\}_{i=1}^n} \left[(1-\beta)C_t^\rho + \beta\mu_t(V_{t+1})^\rho\right]^{\frac{1}{\rho}}, \quad \text{such that} \qquad (16)\\
W_{t+1} &= (W_t - C_t)R_{w,t+1}\\
R_{w,t+1} &= \sum_{i=1}^n w_{it}(R_{i,t+1} - R_{f,t+1})\\
\mu_t(V_{t+1}) &= \mathbb{E}_t\Big[\frac{V_{t+1}^{1-\gamma}\ (1+\theta\mathbf{1}\{V_{t+1}\ \le\ \delta\mu_t(V_{t+1})\})}{1-\theta(\delta^{1-\gamma}-1)\mathbf{1}\{\delta>1\}+\theta\delta^{1-\gamma}\mathbb{E}_t[\mathbf{1}\{V_{t+1}\ \le\ \delta\mu_t(V_{t+1})\}]}\Big]^{\frac{1}{1-\gamma}}. \qquad (17)
\end{aligned}
$$

Above, W_t denotes aggregate wealth and $R_{w,t+1}$ is the return on aggregate wealth. Using the linear homogeneity of the objective function and the budget constraint for $\rho \neq 0$, equation (16) can be written as

$$J_tW_t = \max_{C_t,\ \{w_{i,t}\}_{i=1}^n} \left[(1-\beta)C_t^\rho + \beta(W_t - C_t)^\rho\mu_t(J_{t+1}R_{w,t+1})^\rho\right]^{\frac{1}{\rho}},$$

where J_t is marginal lifetime utility. The first-order condition for C_t reads

$$(1-\beta)C_t^{\rho-1} - \beta(W_t - C_t)^{\rho-1}\mu_t(J_{t+1}R_{w,t+1})^\rho = 0.$$

Dividing by $W_t^{\rho-1}$, we obtain

$$(1-\beta)\Big(\frac{C_t}{W_t}\Big)^{\rho-1} - \beta\Big(1-\frac{C_t}{W_t}\Big)^{\rho-1}\mu_t(J_{t+1}R_{w,t+1})^\rho = 0. \qquad (18)$$

Along an optimal consumption path, the following holds

$$J_t^\rho W_t^\rho = (1-\beta)C_t^\rho + \beta(W_t - C_t)^\rho \mu_t (J_{t+1} R_{w,t+1})^\rho.$$

Dividing by W_t^ρ, we get that

$$J_t^\rho = (1-\beta)\Big(\frac{C_t}{W_t}\Big)^\rho + \beta\Big(1 - \frac{C_t}{W_t}\Big)^\rho \mu_t (J_{t+1} R_{w,t+1})^\rho. \tag{19}$$

Equations (18) and (19) imply that

$$J_t^\rho = (1-\beta)\Big(\frac{C_t}{W_t}\Big)^{\rho-1}. \tag{20}$$

I can substitute the above relation into equation (18) to get

$$(1-\beta)\Big(\frac{C_t}{W_t}\Big)^{\rho-1} - \beta(1-\beta)\Big(1-\frac{C_t}{W_t}\Big)^{\rho-1}\mu_t\Big[\Big(\frac{C_{t+1}}{W_{t+1}}\Big)^{(\rho-1)/\rho} R_{w,t+1}\Big]^\rho = 0.$$

Using the budget constraint, the first-order condition for consumption simplifies into

$$\beta\mu_t\Big[\Big(\frac{C_{t+1}}{C_t}\Big)^{(\rho-1)/\rho} R_{w,t+1}^{1/\rho}\Big]^\rho = 1. \tag{21}$$

Let $P_{c,t} = W_t - C_t$ be the price for a claim on aggregate consumption. We can use the price-dividend identity in Campbell and Shiller (1988)

$$R_{w,t+1} = \frac{C_{t+1}}{C_t}\frac{P_{c,t+1}/C_{t+1} + 1}{P_{c,t}/C_t}, \tag{22}$$

to recast equation (21) as

$$\frac{1}{\beta}^{\frac{1}{\rho}}\Big(\frac{P_{c,t}}{C_t}\Big)^{\frac{1}{\rho}} = \mu_t\Big[\frac{C_{t+1}}{C_t}\Big(\frac{P_{c,t+1}}{C_{t+1}} + 1\Big)^{1/\rho}\Big]. \tag{23}$$

A log-linear approximation to the price-dividend identity in equation (22) is given by

$$r_{w,t+1} = \kappa_{c,0} + \kappa_{c,1} p_{c,t+1} - p_{c,t} + \Delta c_{t+1}, \tag{24}$$

where $p_{c,t} = log\frac{P_{c,t}}{C_t}$, $\overline{pc} = \mathbb{E}[p_{c,t}]$, and the parameters

$$\kappa_{c,1} = \frac{e^{\overline{pc}}}{1+e^{\overline{pc}}} \in (0,1) \quad \text{and} \quad \kappa_{c,0} = log(1+e^{\overline{pc}}) - \kappa_{c,1}\overline{pc}$$

are log-linearization constants.

I conjecture that the log price-dividend ratio is linear in consumption growth:

$$p_{c,t} = \mu_v + \phi_v \Delta c_t \quad \text{with} 1 + \frac{1}{\rho}\kappa_{c,1}\phi_v > 0.$$

Using the definition of the DA certainty equivalent from equation (17), equation (23) becomes

$$-\frac{1-\gamma}{\rho}(log\beta - pc_t) = log\mathbb{E}_t\Big[e^{(1-\gamma)\Delta c_{t+1} + \frac{1-\gamma}{\rho}(\kappa_{c,0}+\kappa_{c,1}pc_{t+1})} \times$$
$$\frac{1+\theta\mathbf{1}\Big\{\frac{C_{t+1}}{C_t}\big(\frac{P_{c,t+1}}{C_{t+1}}+1\big)^{\frac{1}{\rho}} \ \leq\ \delta\mu_t\big[\frac{C_{t+1}}{C_t}\big(\frac{P_{c,t+1}}{C_{t+1}}+1\big)^{\frac{1}{\rho}}\big]\Big\}}{1-\theta(\delta^{1-\gamma}-1)\mathbf{1}\{\delta>1\}+\theta\delta^{1-\gamma}\mathbb{E}_t\Big[\mathbf{1}\Big\{\frac{C_{t+1}}{C_t}\big(\frac{P_{c,t+1}}{C_{t+1}}+1\big)^{\frac{1}{\rho}} \ \leq\ \delta\mu_t\big[\frac{C_{t+1}}{C_t}\big(\frac{P_{c,t+1}}{C_{t+1}}+1\big)^{\frac{1}{\rho}}\big]\Big\}\Big]}\Big].$$

Next, I use equation (23) to pin down the certainty equivalent and equation (24) to simplify the expression inside the disappointment indicator. The partial moments property for a standard normal variable $\epsilon_{c,t+1}$ and real numbers $\big[\gamma,\rho,\kappa_{c,1},\phi_v,\phi_c,\sigma_c,d_1\big]$ implies that

$$\mathbb{E}_t\big[e^{\big(\frac{1-\gamma}{\rho}\kappa_{c,1}\phi_v+1-\gamma\big)\sqrt{1-\phi_c^2}\sigma_c\epsilon_{c,t+1}}\mathbf{1}\{\epsilon_{c,t+1} \ \leq\ d_1\}\big] =$$
$$e^{\frac{1}{2}\big[\big(\frac{1-\gamma}{\rho}\kappa_{c,1}\phi_v+1-\gamma\big)\sqrt{1-\phi_c^2}\sigma_c\big]^2}N\Big(d_1-(1-\gamma)\big(\frac{\kappa_{c,1}\phi_v}{\rho}+1\big)\sqrt{1-\phi_c^2}\sigma_c\Big).$$

Using the above result, the conjectures that $pc_{c,t} = \mu_v + \phi_v\Delta c_t$ and $1+\frac{1}{\rho}\kappa_{c,1}\phi_v > 0$, and the AR(1) dynamics for consumption growth from equation (5), equation (23) becomes

$$\begin{aligned}
&-\frac{1-\gamma}{\rho}log\beta + \frac{1-\gamma}{\rho}(\mu_v+\phi_v\Delta c_t) = (1-\gamma)\big(\mu_c(1-\phi_c)+\phi_c\Delta c_t\big) + \frac{1-\gamma}{\rho}\kappa_{c,0} + \frac{1-\gamma}{\rho}\kappa_{c,1}\mu_v \\
&+\frac{1-\gamma}{\rho}\kappa_{c,1}\phi_v\mu_c(1-\phi_c) + \frac{1-\gamma}{\rho}\kappa_{c,1}\phi_v\phi_c\Delta c_t + log\Big(1+\theta N\big(d_1-\big(\frac{1-\gamma}{\rho}\kappa_{c,1}\phi_v+1-\gamma\big)\sqrt{1-\phi_c^2}\sigma_c\big)\Big) \\
&-log\Big(1-\theta(\delta^{1-\gamma}-1)\mathbf{1}\{\delta>1\}+\theta\delta^{1-\gamma}N(d_1)\Big) + \frac{1}{2}\big[\big(\frac{1-\gamma}{\rho}\kappa_{c,1}\phi_v+1-\gamma\big)\sqrt{1-\phi_c^2}\sigma_c\big]^2,
\end{aligned} \tag{25}$$

where $N()$ is the standard normal c.d.f., and d_1 is the disappointment threshold defined as

$$d_1 = \frac{log\delta - \log\beta + \mu_v + \phi_v \Delta c_t - \kappa_{c,0} - \kappa_{c,1}\mu_v - (\kappa_{c,1}\phi_v + \rho)[\mu_c(1-\phi_c) + \phi_c \Delta c_t]}{(\kappa_{c,1}\phi_v + \rho)\sqrt{1-\phi_c^2}\sigma_c}. \quad (26)$$

I can now use the method of undetermined coefficients to find the values for μ_v and ϕ_v. First, I collect consumption growth terms ignoring the terms $log\Big(1 - \theta(\delta^{1-\gamma} - 1)\mathbf{1}\{\delta > 1\} + \theta\delta^{1-\gamma} N\big(d_1 - \big(\frac{1-\gamma}{\rho}\kappa_{c,1}\phi_v + 1 - \gamma\big)\sqrt{1-\phi_c^2}\sigma_c\big)\Big)$ and $log\Big(1 + \theta N(d_1)\Big)$ in equation (25). Then, I solve for ϕ_v to get

$$\phi_v = \frac{\rho\phi_c}{1 - \kappa_{c,1}\phi_c}. \quad (27)$$

For the above value of ϕ_v, all Δc_t terms in equation (26) vanish, and d_1 becomes a function of constant terms alone. Also, for the above value of ϕ_v and stationary consumption growth process, i.e, $-1 < \phi_c < 1$, the conjecture $1 + \frac{1}{\rho}\kappa_{c,1}\phi_v > 0$ is satisfied since $\kappa_{c,1} = \frac{e^{\overline{pc}}}{1+e^{\overline{pc}}} < 1$.

Collecting constant terms in equation (25), the solution for μ_v is given by

$$\begin{aligned}\mu_v = \frac{1}{1-\kappa_{c,1}}\Big[& log\beta + \kappa_{c,0} + (\kappa_{c,1}\phi_v + \rho)\mu_c(1-\phi_c) + \frac{1}{2}\frac{1-\gamma}{\rho}\big[(\kappa_{c,1}\phi_v + \rho)\sqrt{1-\phi_c^2}\sigma_c\big]^2 \\ &+ \frac{\rho}{1-\gamma} log\Big(1 - \theta(\delta^{1-\gamma} - 1)\mathbf{1}\{\delta > 1\} + \theta\delta^{1-\gamma} N\big(d_1 + \frac{1-\gamma}{\rho}(\kappa_{c,1}\phi_v + \rho)\sqrt{1-\phi_c^2}\sigma_c\big)\Big) \\ &- \frac{\rho}{1-\gamma} log\Big(1 + \theta N(d_1)\Big)\Big],\end{aligned}$$

and d_1 in equation (26) becomes the solution to the fixed-point problem

$$d_1 = \frac{log\delta}{(\kappa_{c,1}\phi_v + 1)\sqrt{1-\phi_c^2}\sigma_c} + \frac{1}{2}\frac{1-\gamma}{\rho}(\kappa_{c,1}\phi_v + \rho)\sqrt{1-\phi_c^2}\sigma_c + \frac{log\left(\frac{1+\theta N\left(d_1 - \frac{1-\gamma}{\rho}(\kappa_{c,1}\phi_v+\rho)\sqrt{1-\phi_c^2}\sigma_c\right)}{1-\theta(\delta^{1-\gamma}-1)\mathbf{1}\{\delta>1\}+\theta\delta^{1-\gamma}N(d_1)}\right)}{\frac{1-\gamma}{\rho}(\kappa_{c,1}\phi_v + \rho)\sqrt{1-\phi_c^2}\sigma_c}.$$

Using the solution for ϕ_v, the fixed-point problem for d_1 does not depend on ρ

$$d_1 = \frac{log\delta}{(\kappa_{c,1}\phi_v + 1)\sqrt{1-\phi_c^2}\sigma_c} + \frac{1}{2}\frac{1-\gamma}{1-\kappa_{c,1}\phi_c}\sqrt{1-\phi_c^2}\sigma_c + \frac{log\left(\frac{1+\theta N\left(d_1 - \frac{1-\gamma}{1-\kappa_{c,1}\phi_c}\sqrt{1-\phi_c^2}\sigma_c\right)}{1-\theta(\delta^{1-\gamma}-1)\mathbf{1}\{\delta>1\}+\theta\delta^{1-\gamma}N(d_1)}\right)}{\frac{1-\gamma}{1-\kappa_{c,1}\phi_c}\sqrt{1-\phi_c^2}\sigma_c}, \quad (28)$$

and I can rewrite μ_v as

$$\mu_v = \frac{1}{1-\kappa_{c,1}}\big[log\beta + \kappa_{c,0} + (\kappa_{c,1}\phi_v + \rho)\mu_c(1-\phi_c) + d_1(\kappa_{c,1}\phi_v + \rho)\sqrt{1-\phi_c^2}\sigma_c - log\delta\big].$$

Explicit solutions for the disappointment aversion stochastic discount factor

From Routledge and Zin (2010), the GDA stochastic discount factor can be written as

$$M_{t+1} = \beta^{\frac{1-\gamma}{\rho}} \big(\frac{C_{t+1}}{C_t}\big)^{1-\gamma\frac{\rho-1}{\rho}} R_{w,t+1}^{\frac{1-\gamma}{\rho}-1} \frac{1+\theta\mathbf{1}\big\{\beta^{\frac{1}{\rho}}\big(\frac{C_{t+1}}{C_t}\big)^{\frac{\rho-1}{\rho}} R_{w,t+1}^{1/\rho} \leq \delta\big\}}{\mathbb{E}_t\Big[1-\theta(\delta^{1-\gamma}-1)\mathbf{1}\{\delta>1\}+\theta\delta^{1-\gamma}\mathbf{1}\Big\{\beta^{\frac{1}{\rho}}\big(\frac{C_{t+1}}{C_t}\big)^{\frac{\rho-1}{\rho}} R_{w,t+1}^{\frac{1}{\rho}} \leq \delta\Big\}\Big]}.$$

Based on the log-linearized price-dividend identity for returns on total wealth (equation (24)), the stochastic discount factor can be further expressed as

$$\begin{aligned} M_{t+1} &= e^{\frac{1-\gamma}{\rho}log\beta+\frac{1-\gamma}{\rho}(\rho-1)\Delta c_{t+1}+(\frac{1-\gamma}{\rho}-1)[\kappa_{c,0}+\kappa_{c,1}(\mu_v+\phi_v\Delta c_{t+1})-(\mu_v+\phi_v\Delta c_t)+\Delta c_{t+1}]} \\ &\times \frac{1+\theta\mathbf{1}\{\frac{1}{\rho}log\beta+\frac{1}{\rho}(\rho-1)\Delta c_{t+1}+\frac{1}{\rho}[\kappa_{c,0}+\kappa_{c,1}(\mu_v+\phi_v\Delta c_{t+1})-(\mu_v+\phi_v\Delta c_t)+\Delta c_{t+1}]\leq log\delta\}}{1-\theta(\delta^{1-\gamma}-1)\mathbf{1}\{\delta>1\}+\theta\delta^{1-\gamma}\mathbb{E}_t[\mathbf{1}\{\frac{1}{\rho}log\beta+\frac{1}{\rho}(\rho-1)\Delta c_{t+1}+\frac{1}{\rho}[\kappa_{c,0}+\kappa_{c,1}(\mu_v+\phi_v\Delta c_{t+1})-(\mu_v+\phi_v\Delta c_t)+\Delta c_{t+1}]\leq log\delta\}]}. \end{aligned}$$

Using the solutions for ϕ_v and μ_v, I conclude that

$$\begin{aligned} M_{t+1} &= e^{log\beta+(\rho-1)\Delta c_{t+1}+\frac{\rho-1+\gamma}{1-\kappa_{c,1}\phi_c}\mu_c(1-\phi_c)+\frac{\rho-1+\gamma}{1-\kappa_{c,1}\phi_c}d_1\sqrt{1-\phi_c^2}\sigma_c-\frac{\rho-1+\gamma}{1-\kappa_{c,1}\phi_c}\Delta c_{t+1}+\frac{(\rho-1+\gamma)\phi_c}{1-\kappa_{c,1}\phi_c}\Delta c_t} \\ &\times \frac{1+\theta\mathbf{1}\{\Delta c_{t+1}\leq\mu_c(1-\phi_c)+\phi_c\Delta c_t+d_1\sqrt{1-\phi_c^2}\sigma_c\}}{1-\theta(\delta^{1-\gamma}-1)\mathbf{1}\{\delta>1\}+\theta\delta^{1-\gamma}\mathbb{E}_t[\mathbf{1}\{\Delta c_{t+1}\leq\mu_c(1-\phi_c)+\phi_c\Delta c_t+d_1\sqrt{1-\phi_c^2}\sigma_c\}]}. \end{aligned} \tag{29}$$

Based on the AR(1) dynamics from equation (5), the conditional expectation in the denominator above can be written as

$$\mathbb{E}_t[\mathbf{1}\{\epsilon_{c,t+1}\leq d_1\}],$$

which is constant and equal to the unconditional expectation since consumption growth shocks $\epsilon_{c,t+1}$ are assumed i.i.d.. Hence, I can write the discount factor from equation (29) as

$$\begin{aligned} M_{t+1} &= e^{log\beta+(\rho-1)\Delta c_{t+1}+\frac{\rho-1+\gamma}{1-\kappa_{c,1}\phi_c}\mu_c(1-\phi_c)+\frac{\rho-1+\gamma}{1-\kappa_{c,1}\phi_c}d_1\sqrt{1-\phi_c^2}\sigma_c-\frac{\rho-1+\gamma}{1-\kappa_{c,1}\phi_c}\Delta c_{t+1}+\frac{(\rho-1+\gamma)\phi_c}{1-\kappa_{c,1}\phi_c}\Delta c_t} \\ &\times \frac{1+\theta\mathbf{1}\{\Delta c_{t+1}\leq\mu_c(1-\phi_c)+\phi_c\Delta c_t+d_1\sqrt{1-\phi_c^2}\sigma_c\}}{1-\theta(\delta^{1-\gamma}-1)\mathbf{1}\{\delta>1\}+\theta\delta^{1-\gamma}\mathbb{E}[\mathbf{1}\{\Delta c_{t+1}\leq\mu_c(1-\phi_c)+\phi_c\Delta c_t+d_1\sqrt{1-\phi_c^2}\sigma_c\}]}. \end{aligned} \tag{30}$$

Setting all the constant terms equal to $\tilde{\beta}$, I conclude that

$$M_{t+1} = \tilde{\beta}e^{(\rho-1)\Delta c_{t+1}-\frac{\rho-1+\gamma}{1-\kappa_{c,1}\phi_c}\Delta c_{t+1}+\frac{(\rho-1+\gamma)\phi_c}{1-\kappa_{c,1}\phi_c}\Delta c_t} \times \big(1+\theta\mathbf{1}\{\Delta c_{t+1}\leq\mu_c(1-\phi_c)+\phi_c\Delta c_t+d_1\sqrt{1-\phi_c^2}\sigma_c\}\big).$$

By setting $\gamma = 1-\rho$ in the above expression and re-centering the disappointment indicator around its unconditional mean ($\mathbb{E}\big[\mathbf{1}\big\{\Delta c_t \leq \mu_c(1-\phi_c)+\phi_c\Delta c_{t-1}+d_1\sqrt{1-\phi_c^2}\sigma_c\big\}\big]$), I obtain the GDA-S model of equation (6). Further, by setting θ equal to zero above, I obtain the explicit solution for the Epstein and Zin (1989) model of equation (8).

Appendix B The volatility of the risk-free rate

In this section, I derive the expression for the volatility of the risk-free rate across the difference preference specifications used in this study (GDA-S, Epstein-Zin, CRRA). Consider the conditional Euler equation for the return of the conditionally risk-free asset R_{ft} according to the GDA-S specification of equation (6)

$$\mathbb{E}_t\Big[\tilde{\beta}e^{(\rho-1)\Delta c_{t+1}}\Big(1+\tilde{\theta}\mathbf{1}\big\{\Delta c_{t+1}\leq \mu_c(1-\phi_c)+\phi_c\Delta c_t+d_1\sqrt{1-\phi_c^2}\sigma_c\big\}$$
$$-\tilde{\theta}\mathbb{E}[\mathbf{1}\big\{\Delta c_{t+1}\leq \mu_c(1-\phi_c)+\phi_c\Delta c_t+d_1\sqrt{1-\phi_c^2}\sigma_c\big\}]\Big)R_{f,t+1}\Big]=1.$$

Using equation (5) for consumption growth, the above equation becomes

$$e^{-r_{f,t+1}}=\mathbb{E}_t\big[\tilde{\beta}e^{(\rho-1)\left(\mu_c(1-\phi_c)+\phi_c\Delta c_t+\sqrt{1-\phi_c^2}\sigma_c\epsilon_{c,t+1}\right)}\big(1-\tilde{\theta}N(d_1)+\tilde{\theta}\mathbf{1}\big\{\epsilon_{c,t+1}\leq d_1\big\}\big)\big].$$

Using the partial moments property of normally distributed random variables, I can write the above expression as

$$\tilde{\beta}e^{(\rho-1)\left(\mu_c(1-\phi_c)+\phi_c\Delta c_t+\frac{1}{2}(\rho-1)(1-\phi_c^2)\sigma_c^2\right)}\big(1-\tilde{\theta}N(d_1)+\tilde{\theta}N(d_1-(\rho-1)\sqrt{1-\phi_c^2}\sigma_c)\big)\big]=e^{-r_{f,t+1}}.$$

I conclude that

$$var(r_{f,t+1})=(1-\rho)^2\phi_c^2\sigma_c^2.$$

Similarly, the conditional Euler equation for the risk-free asset according to the Epstein-Zin model of equation (8) reads

$$\mathbb{E}_t\big[\tilde{\beta}e^{\left(\rho-1+\frac{1-\rho-\gamma}{1-\kappa_{c,1}\phi_c}\right)\Delta c_{t+1}+\frac{(\rho-1+\gamma)}{1-\kappa_{c,1}\phi_c}\phi_c\Delta c_t}R_{f,t+1}\big]=0.$$

Using the AR(1) assumption for log-consumption growth from equation (5), the above relation for the log risk-free rate $r_{f,t+1}$ becomes

$$\mathbb{E}_t\big[\tilde{\beta}e^{\left(\rho-1+\frac{1-\rho-\gamma}{1-\kappa_{c,1}\phi_c}\right)\mu_c(1-\phi_c)+(\rho-1)\phi_c\Delta c_t+\left(\rho-1+\frac{1-\rho-\gamma}{1-\kappa_{c,1}\phi_c}\right)\sqrt{1-\phi_c^2}\sigma_c\epsilon_{c,t+1}}\big]=e^{-r_{f,t+1}}.$$

Using the properties of the normal distribution for the consumption growth shocks $\epsilon_{c,t+1}$, the above conditional expectation can be written as

$$\tilde{\beta} e^{\left(\rho-1+\frac{1-\rho-\gamma}{1-\kappa_{c,1}\phi_c}\right)\mu_c(1-\phi_c)+(\rho-1)\phi_c\Delta c_t+\frac{1}{2}\left(\rho-1+\frac{1-\rho-\gamma}{1-\kappa_{c,1}\phi_c}\right)^2(1-\phi_c^2)\sigma_c^2} = e^{-r_{f,t+1}}.$$

It immediately follows that

$$var(r_{f,t+1}) = (1-\rho)^2\phi_c^2\sigma_c^2.$$

The proof for the CRRA specification is the same as above, since the CRRA discount factor is nested by the Epstein-Zin model for $\gamma = 1-\rho$.

Appendix C The Fama-French three- and five-factor models

For comparison with the consumption-based models in the main text, in this section, I estimate the return-based discount factors of Fama and French (1993, 2015)

$$M_t^{FF3} = -b_m(R_{mt}-R_{ft}) - b_{smb}R_{smb,t} - b_{hml}R_{hml,t}, \tag{31}$$
$$M_t^{FF5} = -b_m(R_{mt}-R_{ft}) - b_{smb}R_{smb,t} - b_{hml}R_{hml,t} - b_{rmw}R_{rmw,t} - b_{cma}R_{cma,t}. \tag{32}$$

The factors in the Fama-French models are traded assets. Hence, in addition to the various portfolio sorts, the Fama-French pricing kernels should be able to perfectly price their respective factors. To this end, I estimate the Fama-French models using an over-identified GMM system that includes both factor returns and asset risk premia as test assets

$$\left[\begin{array}{l} \mathbb{E}\left[\mathbf{f}_t^{FF}(1-\mathbb{E}[M_t^{FF}]+M_t^{FF})\right] \\ \mathbb{E}\left[(R_{it}-R_{ft})(1-\mathbb{E}[M_t^{FF}]+M_t^{FF})\right] \text{ for } i=1,..,n \end{array}\right] = \mathbf{0}, \tag{33}$$

where $\mathbf{f}_t^{FF}$ is the vector of the Fama-French factors.

I augment the Fama-French pricing kernels specified in equations (31) and (32) by the term $1-\mathbb{E}[M_t^{FF}]$ to rule out a zero solution for the prices of risk since I am testing linear pricing kernels on excess returns. Finally, I assume that the weighting matrix for the GMM system of the Fama-French factors is a diagonal matrix whose leading three (five) diagonal elements, which correspond to the Euler equations for the factor returns, are large numbers and the remaining elements are equal to 1. This weighting matrix ensures that the Fama-French models can price their factors.[12]

[12] The GMM weighting matrix used in these tests sets the vector of coefficients $\mathbf{b}$ in the Fama-French models equal to $\mathbf{\Sigma}_{FF}^{-1}\mathbb{E}[\mathbf{f}_t^{FF}]$, where $\mathbb{E}[\mathbf{f}_t^{FF}]$ is the vector of factor means and $\mathbf{\Sigma}_{FF}$ is the matrix of factor covariances.

Table A.1 GMM estimation results for the Fama-French factor models

Table A.1 reports GMM results for the Fama and French (1993, 2015) three- and five-factor models (FF3, FF5) from equations (31) and (32), respectively, using the augmented GMM system from equation (33). The test assets include the risk premia of the following portfolio sorts: 25 size/book-to-market portfolios, 25 size/investment portfolios, and 25 size/operating profitability portfolios, as well as the joint cross-section. The test assets also include the 6 Fama Treasury bond portfolios (TBond) sorted on maturity, the 5 corporate bond portfolios (CBond) of Nozawa (2012) constructed on the basis of bonds' credit ratings, and the 6 equity index option portfolios (Option) of Constantinides et al. (2013). In all cases, the test assets also include the stock market risk premium.

Panel A: FF3 model

	25 size/bm (1930-2013)	25 size/bm	25 size/in	25 size/op	Joint	TBond	CBond	Option	25 size/bm (monthly)
$RmRf$	1.43	2.50	2.50	2.50	2.50	2.37	3.29	2.65	3.02
	(2.00)	(2.26)	(2.26)	(2.26)	(2.26)	(2.09)	(2.16)	(1.75)	(2.74)
SMB	0.97	1.07	1.07	1.07	1.07	1.07	1.76	0.20	2.63
	(1.06)	(0.94)	(0.94)	(0.94)	(0.94)	(0.94)	(0.98)	(0.11)	(1.89)
HML	2.13	3.59	3.59	3.59	3.59	3.51	3.50	2.30	6.62
	(2.60)	(3.09)	(3.09)	(3.09)	(3.09)	(3.07)	(2.63)	(1.63)	(4.23)
χ^2	97.06	68.14	153.73	106.07	642.23	35.89	8.82	28.77	97.65
dof	25	25	25	25	75	6	5	6	25
p	0	0	0	0	0	0	0.11	0	0
R^2	63.36%	69.85%	55.55%	56.57%	60.33%	51.62%	84.49%	38.33%	58.79%
rmspe	1.93%	1.66%	1.82%	1.70%	1.74%	1.11%	1.10%	7.08%	0.14%

Panel B: FF5 model

	25 size/bm	25 size/in	25 size/op	Joint	TBond	CBond	Option	25 size/bm (monthly)
$RmRf$	4.36	4.36	4.36	4.36	4.18	6.45	7.54	5.23
	(3.49)	(3.49)	(3.49)	(3.49)	(3.30)	(4.41)	(4.37)	(4.29)
SMB	2.08	2.08	2.08	2.08	2.05	3.86	1.74	4.73
	(1.36)	(1.36)	(1.36)	(1.36)	(1.37)	(1.80)	(0.84)	(3.03)
HML	-1.25	-1.25	-1.25	-1.25	-1.23	-2.37	-6.81	-0.20
	(-0.44)	(-0.44)	(-0.44)	(-0.44)	(-0.44)	(-0.71)	(-1.61)	(-0.09)
CMA	7.45	7.45	7.45	7.45	7.34	10.15	12.75	10.61
	(2.50)	(2.50)	(2.50)	(2.50)	(2.50)	(3.54)	(3.77)	(4.66)
RMW	9.62	9.62	9.62	9.62	9.41	9.88	12.78	14.24
	(2.73)	(2.73)	(2.73)	(2.73)	(2.72)	(2.41)	(2.60)	(4.35)
χ^2	80.89	76.71	100.62	2,013.32	42.37	16.18	13.40	77.57
dof	25	25	25	25	6	5	6	25
p	0	0	0	0	0	0.01	0.04	0
R^2	67.88%	69.11%	64.04%	66.22%	98.26%	88.26%	1.00%	69.20%
rmspe	1.71%	1.52%	1.54%	1.61%	0.21%	0.96%	8.97%	0.12%

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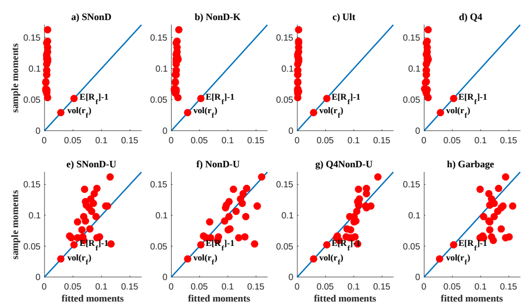
Figures

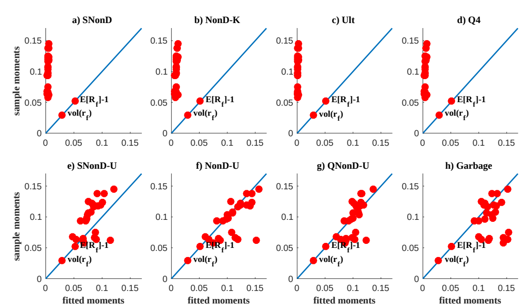
Figure 1. Fitted risk premia and risk-free rate moments for the CRRA model

Figure 1 shows sample and fitted risk premia for the 25 size/book-to-market (Panel A), the 25 size/investment (Panel B), and the 25 size/profitability portfolios (Panel C). In all Panels, the set of test assets also includes the stock market risk premium as well as the mean and variance of the risk-free rate. Fitted moments are based on the CRRA model of equation (1) with alternative consumption measures. The fitted average risk-free rate ($\mathbb{E}[R_{f,t}] - 1$) is estimated according to equation (9), and the fitted volatility of the log risk-free rate ($vol(r_{f,t})$) is estimated according to the square root of equation (10). Fitted risk premia are estimated according to equation (15). Estimation results are shown in Table 3. The sample is from 1964 to 2013.

Panel A: 25 size/book-to-market portfolios



Panel B: 25 size/investment portfolios



Panel C: 25 size/profitability portfolios

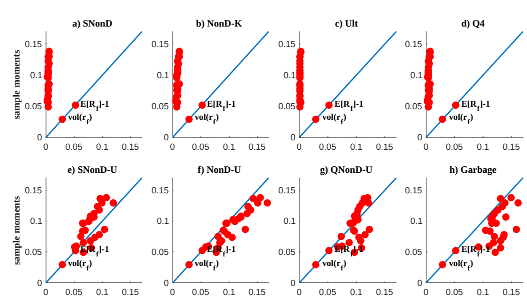
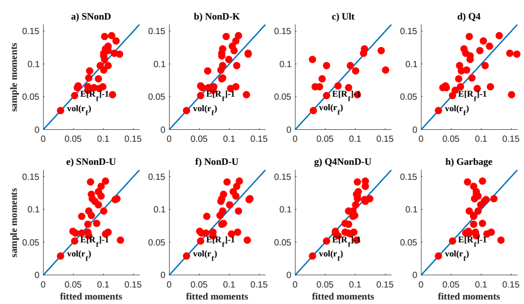


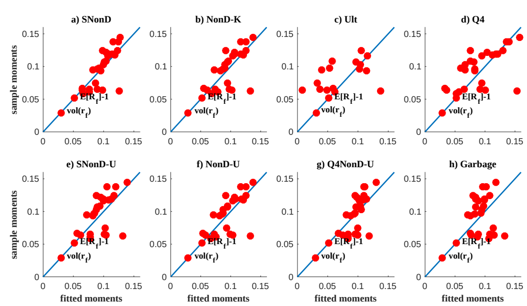
Figure 2. Fitted risk premia and risk-free rate moments for the Epstein-Zin model

Figure 2 shows sample and fitted risk premia for the 25 size/book-to-market (Panel A), the 25 size/investment (Panel B), and the 25 size/profitability portfolios (Panel C). In all Panels, the set of test assets also includes the stock market risk premium as well as the mean and variance of the risk-free rate. Fitted moments are based on the Epstein and Zin (1989) specification of equation (8) with alternative consumption measures. The fitted average risk-free rate ($\mathbb{E}[R_{f,t}]-1$) is estimated according to equation (9), and the fitted volatility of the log risk-free rate ($vol(r_{f,t})$) is estimated according to the square root of equation (10). Fitted risk premia are estimated according to equation (15). Estimation results are shown in Table 4. The sample period is from 1964 to 2013.

Panel A: 25 size/book-to-market portfolios



Panel B: 25 size/investment portfolios



Panel C: 25 size/profitability portfolios

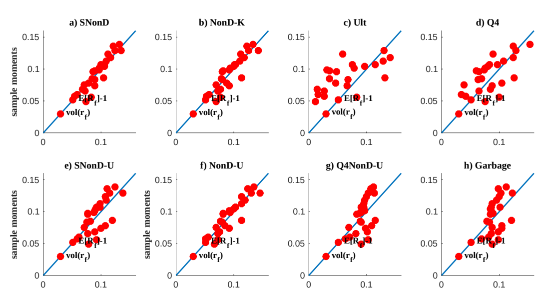
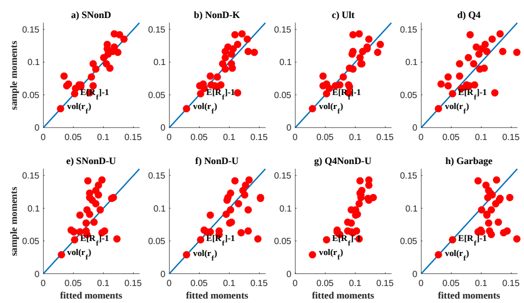


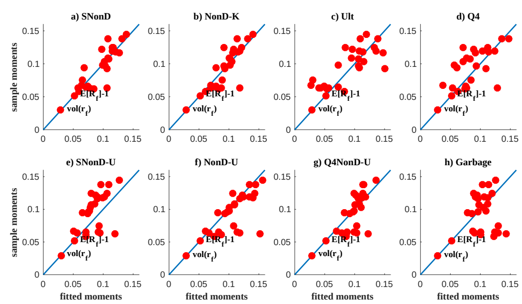
Figure 3. Fitted risk premia and risk-free rate moments for the GDA-S model

Figure 3 shows sample and fitted risk premia for the 25 size/book-to-market (Panel A), the 25 size/investment (Panel B), and the 25 size/profitability portfolios (Panel C). In all Panels, the set of test assets also includes the stock market risk premium as well as the mean and variance of the risk-free rate. Fitted moments are based on the GDA-S specification of equation (6) with alternative consumption measures. The fitted average risk-free rate ($\mathbb{E}[R_{f,t}] - 1$) is estimated according to equation (9), and the fitted volatility of the log risk-free rate ($vol(r_{f,t})$) is estimated from the square root of equation (10). Fitted risk premia are estimated according to equation (15). Estimation results are shown in Table 5. The sample is from 1964 to 2013.

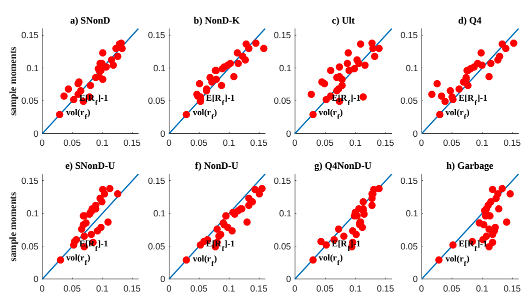
Panel A: 25 size/book-to-market portfolios



Panel B: 25 size/investment portfolios



Panel C: 25 size/profitability portfolios



Tables

Table 1. Summary statistics for consumption growth measures

Table 1 reports summary statistics and cross-correlations for the various measures of aggregate consumption growth. Panels A and B show annual results for the 1965-2014 period and Panels C and D show annual results for the 1931-2014 sample. $SNonD$ is the benchmark real aggregate consumption growth measure for services and non-durables from the Bureau of Economic Analysis. $SNonDm$ and $NonDm$ are the monthly real aggregate consumption growth measures for services and non-durables, and non-durables, respectively from the FRED website. $SNonD$-Um and $NonD$-Um are the unfiltered monthly real aggregate consumption growth measures for services and non-durables, and non-durables, respectively. The construction of $SNonD$, $SNonDm$, $NonDm$, $SNonD$-Um, and $NonD$-Um is discussed in Section 3. S-K and $NonD$-K are the real aggregate consumption growth measures for services and non-durables, respectively, from Kroencke (2017). Ult is the Parker and Julliard (2003) three-year measure of ultimate consumption growth. $Q4$ is the fourth quarter to fourth quarter consumption growth measure for non-durables and services of Jagannathan and Wang (2007). $SNonD$-U and $NonD$-U are the unfiltered real aggregate consumption growth measures for services and non-durables, and non-durables, respectively, from Kroencke (2017). $Q4NonD$-U is the unfiltered fourth quarter to fourth quarter consumption growth measure for non-durables of Kroencke (2017). The data for the consumption measures S-K, $NonD$-K, Ult, $Q4$, $SNonD$-U, $NonD$-U, $Q4NonD$-U is from Tim Kroencke's website. $Garbage$ is the garbage-based consumption growth measure of Savov (2011). The data for the $Garbage$ measure is from the U.S. Environment Protection Agency (EPA). In calculating the correlations of the various consumption growth measures with stock market excess returns, the beginning-of-period convention (beg.) aligns date t consumption growth with date $t-1$ excess stock market return. The end of the period convention (end) aligns date t consumption growth with date t excess market return.

Panel A: Consumption growth measures (1965-2014)

	SNonD	S-K	NonD-K	Ult	Q4	SNonD-U	NonD-U	Q4NonD-U	Garbage
mean	1.93%	1.35%	2.20%	5.57%	1.89%	1.86%	1.34%	1.34%	1.12%
standard deviation	1.35%	1.60%	1.37%	3.15%	1.48%	2.59%	2.70%	2.91%	3.01%
autocorrelation AR(1)	0.52	0.34	0.56	0.82	0.37	-0.02	-0.01	-0.09	-0.06
stock market correl. (beg.)	0.36	0.48	0.28	0.11	0.31	0.44	0.43	0.19	0.60
stock market correl. (end)	0.07	0.15	-0.04	0.15	0.30	0.23	0.30	0.50	-0.23

Panel B: Cross-correlations of consumption growth measures (1965-2014)

	SNonD	S-K	NonD-K	Ult	Q4	SNonD-U	NonD-U	Q4NonD-U	Garbage
SNonD	1								
S-K	0.84	1							
NonD-K	0.92	0.70	1						
Ult	0.74	0.59	0.73	1					
Q4	0.86	0.79	0.85	0.75	1				
SNonD-U	0.78	0.77	0.75	0.61	0.87	1			
NonD-U	0.70	0.89	0.54	0.52	0.76	0.86	1		
Q4NonD-U	0.52	0.62	0.42	0.50	0.78	0.74	0.81	1	
Garbage	0.56	0.54	0.53	0.32	0.43	0.45	0.43	0.16	1

Panel C: Consumption growth measures (1931-2014)

	SNonD	S-K	NonD-K	Ult	SNonD-U	NonD-U
mean	1.94%	1.18%	2.20%	5.95%	2.01%	1.53%
standard deviation	2.05%	2.52%	2.05%	4.35%	3.66%	3.82%
autocorrelation AR(1)	0.46	0.30	0.55	0.72	-0.06	-0.05
stock market correl. (beg.)	0.60	0.60	0.53	0.36	0.60	0.55
stock market correl. (end)	0.08	0.12	0.03	0.31	0.19	0.21

Panel D: Cross-correlations of consumption growth measures (1931-2014)

	SNonD	S-K	NonD-K	Ult	SNonD-U	NonD-U
SNonD	1					
S-K	0.88	1				
NonD-K	0.93	0.68	1			
Ult	0.72	0.61	0.69	1		
SNonD-U	0.81	0.84	0.69	0.62	1	
NonD-U	0.74	0.91	0.52	0.53	0.93	1

Panel E: Consumption growth measures (monthly, January 1964 - December 2013)

	SNonDm	NonDm	SNonD-Um	NonD-Um
mean	0.16%	0.18%	0.17%	0.13%
standard deviation	0.33%	0.25%	0.92%	2.36%
autocorrelation AR(1)	-0.17	-0.10	-0.55	-0.59
stock market correl. (beg.)	0.08	0.11	-0.01	-0.04
stock market correl. (end)	0.17	0.11	0.11	0.12

Panel F: Consumption growth cross-correlations (monthly, January 1964 - December 2013)

	SNonDm	NonDm	SNonD-Um	NonD-Um
SNonDm	1			
NonDm	0.77	1		
SNonD-Um	0.89	0.66	1	
NonD-Um	0.68	0.13	0.76	1

Table 2. Summary statistics for asset returns

Table 2 reports summary statistics for the asset returns used in this study. I consider the following value-weighted equity portfolio sorts: the 25 size/book-to-market portfolios (size/bm), the 25 size/investment portfolios (size/in), and the 25 size/operating profitability portfolios (size/op). $\tilde{R}_m$ denotes the return on the aggregate stock market portfolio and $\tilde{R}_f$ is the risk-free rate. The returns for the size/bm, size/in, and size/op portfolios, the aggregate stock market portfolio, and the risk-free rate are from Kenneth French's website. Panel A shows summary statistics over the 1964-2013 period and in Panel B, the sample is from 1930 to 2013. Panel C shows monthly summary statistics for value-weighted equity portfolio returns during the January 1964 to December 2013 sample. Panel D shows summary statistics for the annual excess returns of the alternative test assets. These assets consist of the following portfolio sorts: the 6 Fama Treasury bond portfolios (TBond) sorted on maturity, the 5 corporate bond portfolios (CBond) of Nozawa (2012) constructed on the basis of bonds' credit ratings, and the 6 equity index option portfolios (Option) of Constantinides et al. (2013). The sample period for the Treasury bond portfolios is from 1964 to 2012. The sample for the corporate bond portfolios is from 1976 to 2009, and the sample period for the equity index option portfolios is from 1987 to 2011.

Panel A: Equity portfolio returns annual, (1964-2013)

	size1/bm5	size5/bm1	size1/in1	size5/in5	size1/op5	size5/op1	$\tilde{R}_m$	$\tilde{R}_f$
mean	21.40%	11.12%	19.63%	10.96%	18.10%	10.79%	11.68%	5.16%
standard deviation	28.62%	19.47%	34.08%	23.22%	31.13%	24.25%	17.82%	3.12%

Panel B: Equity portfolio returns (annual, 1930-2013)

	size1/bm1	size5/bm1	$\tilde{R}_m$	$\tilde{R}_f$
mean	22.49%	10.94%	11.65%	3.54%
standard deviation	37.89%	20.28%	20.29%	3.18%

Panel C: Equity portfolio returns (monthly, January 1964 - December 2013)

	size1/bm1	size5/bm1	$\tilde{R}_m$	$\tilde{R}_f$
mean	1.56%	0.86%	0.91%	0.42%
standard deviation	6.09%	4.69%	4.49%	0.25%

Panel D: Alternative asset classes (annual, excess returns)

	TBond		CBond		Option	
	TBond1	TBond6	CBond1	CBond5	OTM_CALL	OTM_PUT
mean	0.66%	2.38%	-0.08%	5.79%	1.94%	25.49%
standard deviation	1.01%	7.36%	6.10%	15.10%	14.96%	26.46%

Table 3. GMM estimation results for annual risk premia and risk-free rate moments: CRRA discount factor

Table 3 reports GMM results for the CRRA model of equation (1) for alternative consumption measures at the annual frequency. The test assets consist of the risk premia for the 25 size/book-to-market (Panel A), the 25 size/investment (Panel B), and the 25 size/profitability portfolios (Panel C). In all Panels, the set of test assets also includes the stock market risk premium as well as the mean and variance of the risk-free rate. I estimate the CRRA model using the over-identified GMM system in equation (13). γ is the risk-aversion parameter and β is the rate of time preference. I also estimate the consumption growth mean, variance, and autocovariance (μ_c, σ_c^2, and $\phi_c\sigma_c^2$). $SNonD$ is the benchmark real aggregate consumption growth measure for services and non-durables from the BEA. *S-K* and $NonD$*-K* are the real aggregate consumption growth measures for services and non-durables, respectively, from Kroencke (2017). Ult is the Parker and Julliard (2003) three-year measure of ultimkate consumption growth. $Q4$ is the fourth quarter to fourth quarter consumption growth measure for non-durables and services of Jagannathan and Wang (2007). $SNonD$*-U* and $NonD$*-U* are the unfiltered real aggregate consumption growth measures for services and non-durables, and non-durables, respectively, from Kroencke (2017). $Q4NonD$*-U* is the unfiltered fourth quarter to fourth quarter consumption growth measure for non-durables of Kroencke (2017). *Garbage* is the garbage-based consumption growth measure of Savov (2011). I use the beginning of period alignment convention between consumption growth and asset returns for all consumption growth measures other than Ult and $Q4NonD$*-U*. χ^2, dof, and p are the first-stage χ^2-test, degrees of freedom, and p-value that all moment conditions are jointly zero. R^2 and $rmspe$ are the cross-sectional r-square and root-mean-square pricing error for the risk premia of the stock market and the cross-section of portfolios. The sample period is from 1964 to 2013.

Panel A: 25 size/book-to-market portfolios

	SNonD	S-K	NonD-K	Ult	Q4	SNonD-U	NonD-U	Q4NonD-U	Garbage
γ	3.64	3.28	4.77	1.04	4.29	24.51	26.95	24.11	25.69
	(2.01)	(1.98)	(1.92)	(2.65)	(1.63)	(0.20)	(0.43)	(0.29)	(0.32)
β	1.01	1.02	1.00	1.00	1.02	1.19	0.97	1.01	0.89
	(29.38)	(28.13)	(30.15)	(50.61)	(20.25)	(8.02)	(1.26)	(1.17)	(0.70)
μ_c ($\times$100)	1.91	2.17	1.33	5.59	1.86	1.81	1.29	1.39	1.07
	(10.25)	(11.49)	(5.95)	(12.96)	(9.14)	(5.05)	(3.43)	(3.34)	(2.55)
σ_c^2 ($\times$100)	0.017	0.017	0.024	0.092	0.020	0.063	0.071	0.086	0.087
	(4.89)	(5.10)	(4.09)	(5.21)	(4.95)	(4.58)	(3.93)	(5.02)	(4.14)
$\phi_c\sigma_c^2$ ($\times$100)	0.010	0.011	0.009	0.085	0.009	0.000	0.000	-0.000	-0.000
	(2.38)	(2.47)	(2.03)	(4.07)	(1.87)	(0.20)	(0.35)	(-0.25)	(-0.25)
χ^2	177.46	177.25	176.48	178.87	176.40	224.92	386.00	350.15	452.19
dof	26	26	26	26	26	26	26	26	26
p	0	0	0	0	0	0	0	0	0
R^2	-965.36%	-994.29%	-871.04%	-1024.49%	-955.39%	-29.28%	-6.91%	53.92%	-119.99%
rmspe	9.84%	9.97%	9.39%	10.11%	9.79%	3.43%	3.12%	2.05%	4.47%

Panel B: 25 size/investment portfolios

	SNonD	S-K	NonD-K	Ult	Q4	SNonD-U	NonD-U	Q4NonD-U	Garbage
γ	3.64	3.28	4.77	1.04	4.29	24.51	27.04	24.18	25.57
	(2.01)	(1.98)	(1.92)	(2.65)	(1.63)	(0.20)	(0.43)	(0.28)	(0.32)
β	1.01	1.02	1.00	1.00	1.02	1.19	0.96	1.00	0.89
	(29.38)	(28.13)	(30.15)	(50.61)	(20.25)	(8.02)	(1.25)	(1.14)	(0.71)
μ_c ($\times 100$)	1.91	2.17	1.33	5.59	1.86	1.81	1.29	1.39	1.07
	(10.25)	(11.49)	(5.95)	(12.96)	(9.14)	(5.05)	(3.43)	(3.34)	(2.55)
σ_c^2 ($\times 100$)	0.017	0.017	0.024	0.092	0.020	0.063	0.071	0.086	0.087
	(4.89)	(5.10)	(4.09)	(5.21)	(4.95)	(4.58)	(3.93)	(5.02)	(4.14)
$\phi_c\sigma_c^2$ ($\times 100$)	0.010	0.011	0.009	0.085	0.009	0.000	0.000	-0.000	-0.000
	(2.38)	(2.47)	(2.03)	(4.07)	(1.87)	(0.20)	(0.35)	(-0.25)	(-0.25)
χ^2	216.89	215.68	217.47	216.35	211.60	300.23	445.25	436.53	292.77
dof	26	26	26	26	26	26	26	26	26
p	0	0	0	0	0	0	0	0	0
R^2	-1180.74%	-1212.99%	-1061.47%	-1251.88%	-1165.29%	-11.11%	9.91%	36.67%	-164.87%
rmspe	9.78%	9.90%	9.31%	10.05%	9.72%	2.88%	2.59%	2.18%	4.45%

Panel C: 25 size/profitability portfolios

	SNonD	S-K	NonD-K	Ult	Q4	SNonD-U	NonD-U	Q4NonD-U	Garbage
γ	3.64	3.28	4.77	1.04	4.29	24.51	26.89	24.03	25.42
	(2.01)	(1.98)	(1.92)	(2.65)	(1.63)	(0.20)	(0.43)	(0.28)	(0.32)
β	1.01	1.02	1.00	1.00	1.02	1.19	0.97	1.01	0.90
	(29.39)	(28.14)	(30.16)	(50.61)	(20.25)	(8.02)	(1.26)	(1.17)	(0.72)
μ_c ($\times 100$)	1.91	2.17	1.33	5.58	1.86	1.81	1.29	1.39	1.07
	(10.25)	(11.49)	(5.95)	(12.96)	(9.14)	(5.05)	(3.43)	(3.34)	(2.55)
σ_c^2 ($\times 100$)	0.017	0.017	0.024	0.092	0.020	0.063	0.071	0.086	0.087
	(4.89)	(5.10)	(4.09)	(5.21)	(4.95)	(4.58)	(3.93)	(5.02)	(4.14)
$\phi_c\sigma_c^2$ ($\times 100$)	0.010	0.011	0.009	0.085	0.009	0.000	0.000	-0.000	-0.000
	(2.38)	(2.47)	(2.03)	(4.07)	(1.87)	(0.20)	(0.35)	(-0.25)	(-0.25)
χ^2	143.17	142.66	141.91	144.66	141.66	168.68	238.54	239.55	225.25
dof	26	26	26	26	26	26	26	26	26
p	0	0	0	0	0	0	0	0	0
R^2	-1211.28%	-1248.54%	-1082.94%	-1290.68%	-1196.16%	21.44%	46.31%	22.62%	-137.85%
rmspe	9.33%	9.46%	8.86%	9.60%	9.27%	2.28%	1.89%	2.27%	3.97%

Table 4. GMM estimation results for annual risk premia and risk-free rate moments: Epstein-Zin discount factor

Table 4 reports GMM results for the Epstein-Zin model of equation (8) for alternative consumption measures at the annual frequency. The test assets consist of the risk premia for the 25 size/book-to-market (Panel A), the 25 size/investment (Panel B), and the 25 size/profitability portfolios (Panel C). In all Panels, the set of test assets also includes the stock market risk premium as well as the mean and variance of the risk-free rate. I estimate the Epstein and Zin (1989) model using the over-identified GMM system in equation (13). γ is the risk-aversion parameter, ρ is the EIS coefficient, and β is the rate of time preference. I also estimate the consumption growth mean, variance, and autocovariance (μ_c, σ_c^2, and $\phi_c\sigma_c^2$), as well as the log-linearization constant $\kappa_{c,1}$ for the aggregate price-dividend ratio . *SNonD* is the benchmark real aggregate consumption growth measure for services and non-durables from the BEA. *S-K* and *NonD-K* are the real aggregate consumption growth measures for services and non-durables, respectively, from Kroencke (2017). *Ult* is the Parker and Julliard (2003) three-year measure of ultimate consumption growth. *Q4* is the fourth quarter to fourth quarter consumption growth measure for non-durables and services of Jagannathan and Wang (2007). *SNonD-U* and *NonD-U* are the unfiltered real aggregate consumption growth measures for services and non-durables, and non-durables, respectively, from Kroencke (2017). *Q4NonD-U* is the unfiltered fourth quarter to fourth quarter consumption growth measure for non-durables of Kroencke (2017). *Garbage* is the garbage-based consumption growth measure of Savov (2011). I use the beginning of period alignment convention between consumption growth and asset returns for all consumption growth measures other than *Ult* and *Q4NonD-U*. χ^2, dof, and p are the first-stage χ^2-test, degrees of freedom, and p-value that all moment conditions are jointly zero. M denotes an extremely large number. R^2 and $rmspe$ are the cross-sectional r-square and root-mean-square pricing error for the risk premia of the stock market and the cross-section of portfolios. The sample period is from 1964 to 2013.

Panel A: 25 size/book-to-market portfolios

	SNonD	S-K	NonD-K	Ult	Q4	SNonD-U	NonD-U	Q4NonD-U	Garbage
γ	39.40	42.86	31.80	68.13	85.74	26.57	24.61	23.17	20.56
	(2.00)	(1.86)	(2.34)	(2.48)	(1.47)	(2.17)	(2.30)	(1.97)	(2.01)
ρ	-2.63	-2.28	-3.73	-0.09	-3.29	-23.56	-28.69	-23.57	-29.12
	(-1.46)	(-1.37)	(-1.51)	(-0.24)	(-1.25)	(-0.18)	(-0.20)	(-0.18)	(-0.15)
β	0.94	0.93	0.93	0.13	1.08	1.17	1.02	1.02	0.98
	(5.27)	(3.19)	(12.81)	(0.15)	(2.76)	(0.80)	(1.50)	(1.76)	(2.23)
μ_c ($\times100$)	1.91	2.17	1.33	5.59	1.86	1.80	1.29	1.39	1.07
	(10.25)	(11.49)	(5.95)	(12.96)	(9.14)	(5.05)	(3.43)	(3.34)	(2.55)
σ_c^2 ($\times100$)	0.017	0.018	0.024	0.093	0.020	0.063	0.071	0.086	0.087
	(4.89)	(5.11)	(4.09)	(5.22)	(4.96)	(4.58)	(3.93)	(5.02)	(4.13)
$\phi_c\sigma_c^2$ ($\times100$)	0.010	0.011	0.009	0.085	0.009	0.000	0.000	-0.000	-0.000
	(2.37)	(2.47)	(2.03)	(4.06)	(1.87)	(0.09)	(0.21)	(-0.19)	(-0.15)
$\kappa_{c,1}$	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)
χ^2	260.29	228.24	325.88	M	1,423.84	M	M	M	335.42
dof	25	25	25	25	25	25	25	25	25
p	0	0	0	0	0	0	0	0	0
R^2	50.11%	-31.51%	20.94%	-373.58%	-34.28%	-7.09%	17.63%	56.47%	-21.42%
rmspe	2.13%	3.46%	2.68%	6.56%	3.49%	3.12%	2.74%	1.99%	3.32%

Panel B: 25 size/investment portfolios

	SNonD	S-K	NonD-K	Ult	Q4	SNonD-U	NonD-U	Q4NonD-U	Garbage
γ	40.03	42.51	32.00	76.79	85.72	27.55	24.53	23.37	20.29
	(1.98)	(1.84)	(2.35)	(2.55)	(1.49)	(2.23)	(2.29)	(1.94)	(2.01)
ρ	-2.63	-2.27	-3.73	-0.12	-3.28	-22.99	-28.30	-23.51	-29.12
	(-1.46)	(-1.37)	(-1.51)	(-0.31)	(-1.25)	(-0.19)	(-0.20)	(-0.18)	(-0.15)
β	0.93	0.93	0.93	0.10	1.08	1.15	1.02	1.02	0.98
	(5.14)	(3.24)	(12.70)	(0.12)	(2.71)	(0.87)	(1.53)	(1.78)	(2.13)
μ_c ($\times 100$)	1.90	2.17	1.33	5.59	1.86	1.81	1.29	1.39	1.07
	(10.25)	(11.49)	(5.95)	(12.96)	(9.14)	(5.05)	(3.43)	(3.34)	(2.55)
σ_c^2 ($\times 100$)	0.017	0.017	0.024	0.092	0.020	0.063	0.071	0.086	0.087
	(4.89)	(5.11)	(4.09)	(5.22)	(4.96)	(4.58)	(3.93)	(5.02)	(4.13)
$\phi_c\sigma_c^2$ ($\times 100$)	0.010	0.011	0.009	0.085	0.009	0.000	0.000	-0.000	-0.000
	(2.38)	(2.47)	(2.03)	(4.06)	(1.87)	(0.20)	(0.21)	(-0.19)	(-0.15)
$\kappa_{c,1}$	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)
χ^2	381.34	391.06	372.77	M	1,663.65	M	M	M	238.27
dof	25	25	25	25	25	25	25	25	25
p	0	0	0	0	0	0	0	0	0
R^2	54.70%	-4.66%	37.98%	-428.16%	-12.46%	21.58%	37.42%	38.89%	-37.00%
rmspe	1.84%	2.39%	2.15%	6.28%	2.90%	2.42%	2.16%	2.14%	3.20%

Panel C: 25 size/profitability portfolios

	SNonD	S-K	NonD-K	Ult	Q4	SNonD-U	NonD-U	Q4NonD-U	Garbage
γ	39.03	41.36	31.52	49.54	84.57	27.49	24.45	22.81	19.94
	(1.96)	(1.81)	(2.32)	(3.05)	(1.51)	(2.21)	(2.27)	(1.89)	(1.98)
ρ	-2.63	-2.27	-3.73	-0.08	-3.28	-23.72	-28.55	-23.51	-29.12
	(-1.46)	(-1.37)	(-1.51)	(-0.21)	(-1.25)	(-0.18)	(-0.20)	(-0.18)	(-0.15)
β	0.94	0.93	0.93	0.20	1.07	1.61	1.02	1.02	0.99
	(5.39)	(3.37)	(13.07)	(0.24)	(2.74)	(0.82)	(1.48)	(1.69)	(2.01)
μ_c ($\times 100$)	1.91	2.17	1.33	5.59	1.86	1.81	1.29	1.39	1.07
	(10.25)	(11.49)	(5.95)	(12.96)	(9.14)	(5.05)	(3.43)	(3.34)	(2.55)
σ_c^2 ($\times 100$)	0.017	0.017	0.024	0.093	0.020	0.063	0.071	0.086	0.087
	(4.89)	(5.12)	(4.09)	(5.21)	(4.96)	(4.58)	(3.93)	(5.02)	(4.13)
$\phi_c\sigma_c^2$ ($\times 100$)	0.010	0.011	0.009	0.085	0.009	0.000	0.000	-0.000	-0.000
	(2.38)	(2.47)	(2.03)	(4.07)	(1.87)	(0.19)	(0.21)	(-0.19)	(-0.15)
$\kappa_{c,1}$	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)
χ^2	224.56	203.55	202.45	M	1,114.92	M	204.58	223.12	177.68
dof	25	25	25	25	25	25	25	25	25
p	0	0	0	0	0	0	0	0	0
R^2	83.97%	-15.50%	79.86%	-19.70%	2.66%	50.06%	82.36%	28.17%	17.33%
rmspe	1.03%	2.77%	1.16%	4.41%	2.54%	1.82%	1.08%	2.18%	2.34%

Table 5. GMM estimation results for annual risk premia and risk-free rate moments: GDA-S discount factor

Table 5 reports GMM results for the GDA-S model of equation (6) for alternative consumption measures at the annual frequency. The test assets consist of the risk premia for the 25 size/book-to-market (Panel A), the 25 size/investment (Panel B), and the 25 size/profitability portfolios (Panel C). In all Panels, the set of test assets also includes the stock market risk premium as well as the mean and variance of the risk-free rate. I estimate the disappointment aversion coefficient $\tilde{\theta}$, the disappointment threshold d_1, the EIS coefficient ρ, and the rate of time preference β for the GDA-S consumption-based model using the augmented GMM system from equation (13). I also estimate the consumption growth mean, variance, and autocovariance (μ_c, σ_c^2, and $\phi_c\sigma_c^2$). *SNonD* is the benchmark real aggregate consumption growth measure for services and non-durables from the BEA. *S-K* and *NonD-K* are the real aggregate consumption growth measures for services and non-durables, respectively, from Kroencke (2017). *Ult* is the Parker and Julliard (2003) three-year measure of ultimate consumption growth. *Q4* is the fourth quarter to fourth quarter consumption growth measure for non-durables and services of Jagannathan and Wang (2007). *SNonD-U* and *NonD-U* are the unfiltered real aggregate consumption growth measures for services and non-durables, and non-durables, respectively, from Kroencke (2017). *Q4NonD-U* is the unfiltered fourth quarter to fourth quarter consumption growth measure for non-durables of Kroencke (2017). *Garbage* is the garbage-based consumption growth measure of Savov (2011). I use the beginning of period alignment convention between consumption growth and asset returns for all consumption growth measures other than *Ult* and *Q4NonD-U*. χ^2, dof, and p are the first-stage χ^2-test, degrees of freedom, and p-value that all moment conditions are jointly zero. M denotes an extremely large number. R^2 and $rmspe$ are the cross-sectional r-square and root-mean-square pricing error for the risk premia of the stock market and the cross-section of portfolios. The sample period is from 1964 to 2013.

Panel A: 25 size/book-to-market portfolios

	SNonD	S-K	NonD-K	Ult	Q4	SNonD-U	NonD-U	Q4NonD-U	Garbage
$\tilde{\theta}$	2.63	3.72	2.70	5.52	5.19	-0.02	-0.00	-0.00	-0.18
	(2.05)	(1.60)	(1.64)	(1.62)	(1.16)	(0)	(-0.00)	(-0.00)	(-0.01)
d_1	-0.31	-1.02	-0.73	-1.37	-0.66	-13.97	-1.41	-1.03	-0.39
	(-2.15)	(-4.72)	(-6.59)	(-4.18)	(-3.00)	(0)	(-177.26)	(-0.00)	(-0.11)
ρ	-2.60	-2.27	-3.73	-0.04	-3.27	-24.60	-25.95	-23.11	-25.63
	(-1.45)	(-1.37)	(-1.51)	(-0.10)	(-1.25)	(-0.26)	(-0.22)	(-0.19)	(-0.16)
β	0.97	0.98	0.95	0.97	0.92	1.19	0.97	1.01	0.94
	(5.39)	(4.99)	(6.89)	(3.06)	(2.97)	(10.20)	(0.91)	(1.11)	(0.36)
μ_c ($\times100$)	1.91	2.17	1.33	5.59	1.86	1.81	1.29	1.39	1.07
	(10.25)	(11.49)	(5.95)	(12.96)	(9.14)	(5.05)	(3.43)	(3.34)	(2.55)
σ_c^2 ($\times100$)	0.017	0.017	0.024	0.092	0.020	0.063	0.071	0.086	0.087
	(4.89)	(5.10)	(4.09)	(5.21)	(4.95)	(4.58)	(3.93)	(5.02)	(4.14)
$\phi_c\sigma_c^2$ ($\times100$)	0.010	0.011	0.009	0.085	0.009	0.000	0.000	-0.000	-0.000
	(2.39)	(2.47)	(2.03)	(4.07)	(1.87)	(0.25)	(0.23)	(-0.20)	(-0.17)
χ^2	12,780.76	652.13	431.63	1,660.64	348.08	233.52	360.54	344.96	369.88
dof	24	24	24	24	24	24	24	24	24
p	0	0	0	0	0	0	0	0	0
R^2	72.35%	2.55%	59.48%	59.61%	17.46%	-15.37%	-6.78%	53.93%	-81.33%
rmspe	1.59%	2.99%	1.92%	1.92%	2.74%	3.24%	3.12%	2.05%	4.06%

Panel B: 25 size/investment portfolios

	SNonD	S-K	NonD-K	Ult	Q4	SNonD-U	NonD-U	Q4NonD-U	Garbage
$\tilde{\theta}$	3.94	3.65	3.35	5.69	5.12	-0.02	-0.00	-0.00	-0.41
	(1.98)	(1.64)	(1.46)	(1.09)	(1.14)	(0)	(-0.00)	(-0.00)	(-0.03)
d_1	-0.46	-1.04	-1.43	0.00	-0.60	-4.10	-1.73	-1.32	-0.40
	(-3.70)	(-5.45)	(-2.15)	(0.00)	(-4.09)	(0)	(-0.00)	(-109.32)	(-0.09)
ρ	-2.63	-2.27	-3.73	-0.04	-3.30	-24.61	-26.04	-23.19	-26.28
	(-1.46)	(-1.37)	(-1.51)	(-0.10)	(-1.25)	(-0.26)	(-0.22)	(-0.19)	(-0.16)
β	0.96	0.98	0.94	0.97	0.92	1.19	0.97	1.01	1.01
	(3.84)	(5.07)	(6.81)	(2.45)	(3.00)	(10.20)	(0.78)	(1.24)	(0.30)
μ_c ($\times$100)	1.91	2.17	1.32	5.59	1.86	1.81	1.29	1.39	1.07
	(10.25)	(11.49)	(5.95)	(12.96)	(9.14)	(5.05)	(3.43)	(3.34)	(2.55)
σ_c^2 ($\times$100)	0.017	0.017	0.024	0.092	0.020	0.063	0.071	0.086	0.08
	(4.89)	(5.10)	(4.09)	(5.21)	(4.95)	(4.58)	(3.93)	(5.02)	(4.13)
$\phi_c\sigma_c^2$ ($\times$100)	0.010	0.011	0.009	0.085	0.009	0.000	0.000	-0.000	-0.000
	(2.38)	(2.47)	(2.03)	(4.07)	(1.87)	(0.25)	(0.21)	(-0.20)	(-0.16)
χ^2	2,998.43	882.72	457.91	29.97	504.43	313.26	442.77	426.73	256.38
dof	24	24	24	24	24	24	24	24	24
p	0	0	0	0.18	0	0	0	0	0
R^2	70.80%	20.04%	63.07%	21.28%	12.12%	5.97%	10.13%	36.87%	-60.65%
rmspe	1.48%	2.44%	1.66%	2.42%	2.56%	2.65%	2.59%	2.17%	3.46%

Panel C: 25 size/profitability portfolios

	SNonD	S-K	NonD-K	Ult	Q4	SNonD-U	NonD-U	Q4NonD-U	Garbage
$\tilde{\theta}$	3.55	4.81	6.48	5.10	6.37	-0.00	-0.00	8.39	-0.34
	(1.47)	(1.40)	(1.34)	(1.59)	(1.57)	(0)	(-0.00)	(0.47)	(-0.02)
d_1	-0.55	-2.02	-1.97	-1.40	-1.79	-4.73	-2.60	-1.45	-0.38
	(-3.37)	(-43.93)	(-36.91)	(-3.51)	('-37.30)	(0)	(-0.00)	(-4.39)	(-0.04)
ρ	-2.63	-2.27	-3.73	-0.05	-3.27	-24.44	-25.90	26.38	-26.42
	(-1.46)	(-1.37)	(-151)	(-0.13)	(-1.25)	(-0.26)	(-0.22)	(0.20)	(-0.16)
β	0.97	1.00	0.95	0.97	0.98	1.19	0.97	1.65	0.98
	(4.49)	(6.99)	(5.50)	(3.31)	(4.81)	(10.22)	(2.21)	(0.21)	(0.31)
μ_c ($\times$100)	1.91	2.17	1.33	5.59	1.86	1.81	1.29	1.39	1.07
	(10.25)	(11.49)	(5.95)	(12.96)	(9.14)	(5.05)	(3.43)	(3.34)	(2.55)
σ_c^2 ($\times$100)	0.017	0.017	0.024	0.092	0.020	0.063	0.071	0.086	0.087
	(4.89)	(5.10)	(4.09)	(5.21)	(4.95)	(4.58)	(3.93)	(5.02)	(4.14)
$\phi_c\sigma_c^2$ ($\times$100)	0.010	0.011	0.009	0.085	0.009	0.000	0.000	-0.000	-0.000
	(2.38)	(2.47)	(2.03)	(4.07)	(1.87)	(0.24)	(0.23)	(-0.19)	(-0.16)
χ^2	3,329.28	194.52	233.86	4,556.37	305.43	173.72	234.23	547.32	202.19
dof	24	24	24	24	24	24	24	24	24
p	0	0	0	0	0	0	0	0	0
R^2	76.13%	52.78%	75.86%	27.35%	35.57%	35.46%	46.77%	47.82%	-41.11%
rmspe	1.26%	1.77%	1.27%	2.20%	2.07%	2.07%	1.88%	1.86%	3.06%

Table 6. GMM estimation results for annual risk premia and risk-free rate moments: Joint cross-section

Table 6 reports GMM results for alternative consumption-based pricing kernels and consumption measures at the annual frequency. The set of test assets consists of the joint cross-section of the risk premia for the 25 size/book-to-market, 25 size/investment, the 25 size/profitability portfoliosand the stock market as well as the mean and variance of the risk-free rate. In Panel A, I estimate the CRRA model of equation (1). In Panel B, I estimate the Epstein and Zin (1989) model of equation (8), and in Panel C, I estimate the GDA-S pricing kernel from equation (6). γ is the risk-aversion parameter and β is the rate of time preference. In Panel B, ρ is the EIS coefficient and $\kappa_{c,1}$ is the log-linearization constant for the price-dividend ratio in the Epstein-Zin model. In Panel C, $\tilde{\theta}$ is the disappointment aversion coefficient and d_1 is the disappointment threshold of the GDA-S model. I also estimate the consumption growth mean, variance, and autocovariance (μ_c, σ_c^2, and $\phi_c\sigma_c^2$) using the augmented GMM system from equation (13). *SNonD* is the benchmark real aggregate consumption growth measure for services and non-durables from the BEA. *S-K* and *NonD-K* are the real aggregate consumption growth measures for services and non-durables, respectively, from Kroencke (2017). *Ult* is the Parker and Julliard (2003) three-year measure of ultimate consumption growth. *Q4* is the fourth quarter to fourth quarter consumption growth measure for non-durables and services of Jagannathan and Wang (2007). *SNonD-U* and *NonD-U* are the unfiltered real aggregate consumption growth measures for services and non-durables, and non-durables, respectively, from Kroencke (2017). *Q4NonD-U* is the unfiltered fourth quarter to fourth quarter consumption growth measure for non-durables of Kroencke (2017). *Garbage* is the garbage-based consumption growth measure of Savov (2011). I use the beginning of period alignment convention between consumption growth and asset returns for all consumption growth measures other than *Ult* and *Q4NonD-U*. χ^2, dof, and p are the first-stage χ^2-test, degrees of freedom, and p-value that all moment conditions are jointly zero. M denotes an extremely large number. R^2 and $rmspe$ are the cross-sectional r-square and root-mean-square pricing error for the risk premia of the stock market and the cross-section of portfolios. The sample period is from 1964 to 2013.

Panel A: CRRA model

	SNonD	S-K	NonD-K	Ult	Q4	SNonD-U	NonD-U	Q4NonD-U	Garbage
γ	3.67	3.30	4.85	1.04	4.33	24.51	25.83	23.81	23.59
	(2.02)	(1.98)	(1.92)	(2.66)	(1.64)	(0.20)	(0.73)	(0.45)	(0.55)
β	1.01	1.02	1.01	1.00	1.02	1.19	0.98	1.01	0.92
	(29.19)	(28.03)	(29.59)	(50.62)	(20.09)	(8.02)	(2.68)	(1.83)	(1.48)
μ_c ($\times$100)	1.91	2.16	1.33	5.59	1.86	1.81	1.29	1.39	1.07
	(10.25)	(11.49)	(5.95)	(12.96)	(9.14)	(5.05)	(3.43)	(3.34)	(2.55)
σ_c^2 ($\times$100)	0.017	0.017	0.024	0.092	0.020	0.063	0.071	0.086	0.087
	(4.89)	(5.10)	(4.10)	(5.21)	(4.95)	(4.58)	(3.93)	(5.03)	(4.14)
$\phi_c\sigma_c^2$ ($\times$100)	0.010	0.011	0.009	0.085	0.009	0.000	0.000	-0.000	-0.000
	(2.37)	(2.47)	(2.02)	(4.07)	(1.87)	(0.20)	(0.47)	(-0.33)	(-0.32)
χ^2	391.26	389.24	391.78	388.89	384.88	834.8	1,129.81	1,315.22	1,092.03
dof	76	76	76	76	76	76	76	76	76
p	0	0	0	0	0	0	0	0	0
R^2	-1125.99%	-1159.36%	-1009.35%	-1196.55%	-1112.29%	-12.06%	32.10%	40.71%	-59.27%
rmspe	8.96%	9.85%	9.25%	10.00%	9.67%	2.94%	2.29%	2.14%	3.50%

Panel B: Epstein-Zin model

	SNonD	S-K	NonD-K	Ult	Q4	SNonD-U	NonD-U	Q4NonD-U	Garbage
γ	39.60	42.33	31.81	34.15	84.87	30.24	24.48	23.19	20.36
	(1.98)	(1.84)	(2.34)	(1.85)	(1.51)	(2.34)	(2.29)	(1.94)	(2.00)
ρ	-2.62	-2.28	-3.74	-0.07	-3.31	-26.13	-28.53	-23.52	-29.12
	(-1.46)	(-1.37)	(-1.51)	(-0.19)	(-1.26)	(-0.16)	(-0.20)	(-0.18)	(-0.15)
β	0.93	0.93	0.93	0.40	1.08	1.15	1.02	1.02	0.98
	(5.26)	(3.26)	(12.85)	(0.45)	(2.80)	(0.70)	(1.51)	(1.76)	(2.16)
μ_c ($\times$100)	1.91	2.17	1.33	5.59	1.86	1.81	1.29	1.39	1.07
	(10.25)	(11.49)	(5.95)	(12.96)	(9.14)	(5.05)	(3.43)	(3.34)	(2.55)
σ_c^2 ($\times$100)	0.017	0.017	0.024	0.093	0.020	0.063	0.071	0.086	0.087
	(4.89)	(5.11)	(4.09)	(5.22)	(4.97)	(4.58)	(3.3)	(5.02)	(4.13)
$\phi_c\sigma_c^2$ ($\times$100)	0.010	0.011	0.009	0.084	0.009	0.000	0.000	-0.000	-0.000
	(2.38)	(2.47)	(2.03)	(4.07)	(1.88)	(0.16)	(0.21)	(-0.19)	(-0.15)
$\kappa_{c,1}$	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)	(14.30)
χ^2	1,497.14	2,273.92	918.89	M	M	1,296.27	940.59	1,092.98	692.57
dof	75	75	75	75	75	75	75	75	75
p	0	0	0	0	0	0	0	0	0
R^2	60.19%	-20.96%	41.80%	-140.82%	-18.99%	5.57%	40.98%	41.94%	-17.06%
rmspe	1.75%	3.05%	2.12%	4.31%	3.03%	2.70%	2.13%	2.12%	3.00%

Panel C: GDA-S model

	SNonD	S-K	NonD-K	Ult	Q4	SNonD-U	NonD-U	Q4NonD-U	Garbage
$\tilde{\theta}$	3.06	4.87	2.92	5.53	6.47	-0.00	-0.22	8.07	-0.47
	(1.68)	(1.40)	(1.58)	(1.93)	(1.62)	(-0.00)	(-0.02)	(0.42)	(-0.03)
d_1	-0.78	-1.97	-0.91	-1.21	-1.74	6.87	-1.30	-1.62	-0.14
	(-1.88)	(-75.93)	(-6.76)	(-15.64)	(-56.38)	(0.00)	(-0.13)	(-2.15)	(-0.03)
ρ	-2.63	-2.27	-3.74	-0.04	-3.28	-25.59	-26.7	25.27	-25.32
	(-1.46)	(-1.37)	(-1.51)	(-0.11)	(-1.25)	(-0.42)	(-0.22)	(0.20)	(-0.16)
β	0.98	1.00	0.95	0.97	0.98	1.19	1.02	1.52	1.04
	(5.49)	(6.91)	(6.75)	(3.05)	(4.42)	(9.90)	(0.74)	(0.25)	(0.36)
μ_c ($\times$100)	1.91	2.17	1.33	5.60	1.86	1.81	1.29	1.39	1.07
	(10.25)	(11.49)	(5.95)	(12.96)	(9.14)	(5.05)	(3.43)	(3.34)	(2.55)
σ_c^2 ($\times$100)	0.017	0.017	0.024	0.092	0.020	0.063	0.071	0.086	0.087
	(4.89)	(5.10)	(4.09)	(5.21)	(4.95)	(4.58)	(3.93)	(5.02)	(4.13)
$\phi_c\sigma_c^2$ ($\times$100)	0.010	0.011	0.009	0.085	0.009	0.000	0.000	-0.000	-0.000
	(2.38)	(2.47)	(2.03)	(4.07)	(1.87)	(0.34)	(0.22)	(-0.20)	(-0.17)
χ^2	1,947.97	598.63	1,131.74	5,489.58	987.54	978.23	1,107.86	1,935.83	M
dof	74	74	74	74	74	74	74	74	74
p	0	0	0	0	0	0	0	0	0
R^2	68.46%	14.86%	63.69%	27.86%	9.62%	13.67%	35.63%	64.82%	-23.54%
rmspe	1.56%	2.56%	1.67%	2.36%	2.64%	2.58%	2.23%	1.65%	3.09%

Table 7. GMM estimation results for annual risk premia and risk-free rate moments: 1930-2013 sample

Table 7 reports GMM results for alternative consumption-based pricing kernels and consumption measures at the annual frequency. The test assets consist of the risk premia for the 25 size/book-to-market portfolios and the stock market, as well as the mean and variance of the risk-free rate. In Panel A, I estimate the CRRA consumption-based model of equation (1). In Panel B, I estimate the Epstein and Zin (1989) model of equation (8), and in Panel C, I estimate the GDA-S pricing kernel from equation (6). γ is the risk-aversion parameter and β is the rate of time preference. In Panel B, ρ is the EIS coefficient and $\kappa_{c,1}$ is the log-linearization constant for the price-dividend ratio in the Epstein-Zin model. In Panel C, $\tilde{\theta}$ is the disappointment aversion coefficient and d_1 is the disappointment threshold in the GDA-S model. For the various consumption models, I also estimate the consumption growth mean, variance, and autocovariance (μ_c, σ_c^2, and $\phi_c\sigma_c^2$) using the augmented GMM system from equation (13). *SNonD* is the benchmark real aggregate consumption growth measure for services and non-durables from the BEA. *S-K* and *NonD-K* are the real aggregate consumption growth measures for services and non-durables, respectively, from Kroencke (2017). *Ult* is the Parker and Julliard (2003) three-year measure of ultimate consumption growth. *Q4* is the fourth quarter to fourth quarter consumption growth measure for non-durables and services of Jagannathan and Wang (2007). *SNonD-U* and *NonD-U* are the unfiltered real aggregate consumption growth measures for services and non-durables, and non-durables, respectively, from Kroencke (2017). *Q4NonD-U* is the unfiltered fourth quarter to fourth quarter consumption growth measure for non-durables of Kroencke (2017). *Garbage* is the garbage-based consumption growth measure of Savov (2011). I use the beginning of period alignment convention between consumption growth and asset returns for all consumption growth measures other than *Ult* and *Q4NonD-U*. χ^2, dof, and p are the first-stage χ^2-test, degrees of freedom, and p-value that all moment conditions are jointly zero. M denotes a very large number. R^2 and *rmspe* are the cross-sectional r-square and root-mean-square pricing error for the risk premia of the stock market and the cross-section of portfolios. The sample period is from 1930 to 2013.

Panel A: CRRA model

	SNonD	S-K	NonD-K	Ult	SNonD-U	NonD-U
γ	2.98	2.54	3.69	0.82	12.42	9.78
	(2.21)	(2.39)	(2.39)	(3.16)	(0.64)	(0.75)
β	1.02	1.01	1.01	1.00	1.08	1.03
	(36.44)	(40.99)	(45.24)	(67.67)	(9.24)	(15.12)
μ_c ($\times 100$)	1.90	2.15	1.37	5.49	1.92	1.44
	(8.58)	(9.73)	(5.10)	(10.62)	(4.88)	(3.51)
σ_c^2 ($\times 100$)	0.041	0.041	0.061	0.22	0.13	0.14
	(3.25)	(3.54)	(3.40)	(3.20)	(3.70)	(3.83)
$\phi_c\sigma_c^2$ ($\times 100$)	0.020	0.024	0.020	0.170	0.000	-0.01
	(2.01)	(2.14)	(2.25)	(2.82)	(-0.59)	(-0.74)
χ^2	153.27	154.75	147.47	156.86	117.75	122.29
dof	26	26	26	26	26	26
p	0	0	0	0	0	0
R^2	-1,116.61%	-1,173.68%	-1,005.84%	-1,249.69%	-32.15%	31.43%
rmspe	11.11%	11.36%	10.59%	11.70%	3.66%	5.79%

Panel B: Epstein-Zin model

	SNonD	S-K	NonD-K	Ult	SNonD-U	NonD-U
γ	19.84	20.48	18.77	9.25	14.93	15.26
	(2.86)	(3.00)	(2.83)	(2.03)	(2.69)	(2.67)
ρ	-1.95	-1.53	-2.64	0.17	-11.04	-8.43
	(-1.46)	(-1.44)	(-1.72)	(0.68)	(-0.51)	(-0.63)
β	0.98	0.99	0.96	0.93	1.04	0.95
	(19.17)	(16.79)	(26.41)	(7.63)	(4.47)	(14.16)
μ_c ($\times 100$)	1.90	2.15	1.37	5.49	1.92	1.44
	(8.58)	(9.73)	(5.10)	(10.68)	(4.88)	(3.51)
σ_c^2 ($\times 100$)	0.041	0.041	0.061	0.22	0.13	0.14
	(3.25)	(3.54)	(3.40)	(3.20)	(3.69)	(3.83)
$\phi_c \sigma_c^2$ ($\times 100$)	0.020	0.024	0.020	0.17	-0.00	-0.01
	(2.01)	(2.15)	(2.25)	(2.82)	(-0.57)	(-0.74)
$\kappa_{c,1}$	0.70	0.70	0.70	0.70	0.70	0.70
	(16.01)	(16.01)	(16.01)	(16.01)	(16.01)	(16.01)
χ^2	139.80	135.84	138.61	202.94	123.03	134.29
dof	25	25	25	25	25	25
p	0	0	0	0	0	0
R^2	42.41%	39.66%	31.01%	36.21%	33.08%	32.49%
rmspe	2.41%	2.47%	2.64%	2.54%	2.60%	2.61%

Panel C: GDA-S model

	SNonD	S-K	NonD-K	Ult	SNonD-U	NonD-U
$\tilde{\theta}$	2.20	5.89	3.22	5.74	0.41	1.12
	(2.96)	(1.72)	(1.92)	(2.18)	(0.10)	(0.30)
d_1	-0.22	-2.34	-1.08	-1.01	-0.46	-0.80
	(-2.86)	(-4.66)	(-12.59)	(-13.69)	(-0.51)	(-1.83)
ρ	-1.95	-1.53	-2.64	0.17	-11.03	-8.43
	(-1.46)	(-1.44)	(-1.73)	(0.66)	(-0.51)	(-0.63)
β	0.98	0.99	0.95	0.98	1.01	0.92
	(8.69)	(8.15)	(9.52)	(6.12)	(2.90)	(9.45)
μ_c ($\times 100$)	1.90	2.15	1.37	5.49	1.92	1.44
	(8.58)	(9.73)	(5.10)	(10.68)	(4.88)	(3.51)
σ_c^2 ($\times 100$)	0.041	0.041	0.061	0.220	0.13	0.14
	(3.25)	(3.54)	(3.40)	(3.20)	(3.69)	(3.83)
$\phi_c \sigma_c^2$ ($\times 100$)	0.020	0.024	0.020	0.170	-0.00	-0.01
	(2.02)	(2.15)	(2.25)	(2.82)	(-0.57)	(-0.74)
χ^2	124.93	M	133.64	257.14	M	124.64
dof	24	24	24	24	24	74
p	0	0	0	0	0	0
R^2	67.53%	42.19%	43.13%	41.20%	33.08%	38.21%
rmspe	1.75%	2.15%	2.40%	2.44%	2.51%	2.21%

Table 8. GMM estimation results for alternative asset classes

Table 8 reports GMM results for alternative asset classes at the annual frequency. The test assets consist of the 6 Fama Treasury bond portfolios (TBond) sorted on maturity (Panel A), the 5 corporate bond portfolios (CBond) of Nozawa (2012) constructed on the basis of bonds' credit ratings (Panel B), and the 6 equity index option portfolios (Option) of Constantinides et al. (2013) (Panel C). In all cases, the test moments also include the stock market risk premium, the mean of the risk-free rate, the volatility of the log risk-free rate, as well as the mean, variance, and autocovariance (μ_c, σ_c^2, and $\phi_c\sigma_c^2$) of consumption growth. In columns (i) through (ix), I estimate the CRRA consumption-based model of equation (1) for alternative consumption measures using the over-identified GMM system of equation (13). $SNonD$ is the benchmark real aggregate consumption growth measure for services and non-durables from the BEA. S-K and $NonD$-K are the real aggregate consumption growth measures for services and non-durables, respectively, from Kroencke (2017). Ult is the Parker and Julliard (2003) three-year measure of ultimate consumption growth. $Q4$ is the fourth quarter to fourth quarter consumption growth measure for non-durables and services of Jagannathan and Wang (2007). $SNonD$-U and $NonD$-U are the unfiltered real aggregate consumption growth measures for services and non-durables, and non-durables, respectively, from Kroencke (2017). $Q4NonD$-U is the unfiltered fourth quarter to fourth quarter consumption growth measure for non-durables of Kroencke (2017). $Garbage$ is the garbage-based consumption growth measure of Savov (2011). I use the beginning of period alignment convention between consumption growth and asset returns for all consumption growth measures other than Ult and $Q4NonD$-U. In column (x), I estimate the Epstein and Zin (1989) model of equation (8), and in column (xi), I estimate the GDA-S pricing kernel from equation (6). For the Epstein-Zin and GDA-S models, I only use the real aggregate consumption growth measure for services and non-durables ($SNonD$) from the BEA. γ is the risk-aversion parameter and β is the rate of time preference. ρ is the EIS coefficient and $\kappa_{c,1}$ is the log-linearization constant for the price-dividend ratio in the Epstein-Zin model. $\tilde{\theta}$ is the disappointment aversion coefficient and d_1 is the disappointment threshold in the GDA-S model. χ^2, dof, and p are the first-stage χ^2-test, degrees of freedom, and p-value that all moment conditions are jointly zero. R^2 and $rmspe$ are the cross-sectional r-square and root-mean-square pricing error. The sample period is from 1964 to 2012 for the Treasury bond portfolios, from 1976 to 2009 for the corporate bond portfolios, and from 1987 to 2011 for the equity index option portfolios.

Panel A: 6 Treasury bond portfolios (1964-2012)

	CRRA									EZ	GDA-S
	SNonD (i)	S-K (ii)	NonD-K (iii)	Ult (iv)	Q4 (v)	SNonD-U (vi)	NonD-U (vii)	Q4NonD-U (viii)	Garbage (ix)	SNonD (x)	SNonD (xi)
γ	3.36	3.19	4.59	1.03	4.17	25.38	30.83	29.17	28.47	34.61	
	(2.02)	(1.92)	(1.88)	(2.53)	(1.60)	(0.18)	(0.20)	(0.16)	(0.16)	(1.79)	
β	1.01	1.01	1.00	1.00	1.02	1.19	0.90	0.94	0.84	0.92	0.97
	(32.14)	(27.93)	(30.73)	(48.48)	(20.31)	(9.30)	(0.35)	(0.37)	(0.26)	(5.25)	(4.35)
ρ										-2.36	-2.36
										(-1.42)	(-1.42)
$\kappa_{c,1}$										0.75	
										(14.14)	
$\tilde{\theta}$											3.48
											(0.39)
d_1											-0.87
											(-0.60)
μ_c ($\times 100$)	1.91	2.18	1.33	5.60	1.86	1.81	1.30	1.37	1.07	1.91	1.91
	(10.08)	(11.40)	(5.85)	(13.00)	(9.00)	(4.97)	(3.37)	(3.23)	(2.52)	(10.08)	(10.08)
σ_c^2 ($\times 100$)	0.017	0.017	0.025	0.092	0.021	0.065	0.072	0.088	0.089	0.017	0.017
	(4.90)	(5.04)	(4.10)	(5.04)	(4.96)	(4.60)	(3.94)	(5.04)	(4.14)	(4.90)	(4.90)
$\phi_c\sigma_c^2$ ($\times 100$)	0.011	0.012	0.009	0.084	0.009	0.000	0.000	-0.000	-0.000	0.011	0.011
	(2.51)	(2.43)	(2.03)	(3.91)	(1.85)	(0.18)	(0.20)	(-0.16)	(-0.16)	(2.51)	(2.51)
χ^2	51.59	52.03	51.23	49.82	52.96	81.78	120.80	61.97	57.04	99.20	223.25
dof	7	7	7	7	7	7	7	7	7	6	5
p	0	0	0	0	0	0	0	0	0	0	0
R^2	-174.76%	-180.20%	-152.79%	-187.78%	-171.05%	9.01%	-36.43%	-149.83%	-281.62%	36.46%	63.16%
rmspe	2.64%	2.67%	2.54%	2.71%	2.63%	1.52%	1.86%	2.52%	3.12%	1.27%	0.96%

Panel B: 5 Corporate bond portfolios (1976-2009)

	CRRA									EZ	GDA-S
	SNonD	S-K	NonD-K	Ult	Q4	SNonD-U	NonD-U	Q4NonD-U	Garbage	SNonD	SNonD
γ	3.56	3.65	3.99	1.09	3.73	12.81	12.15	7.27	(46.17)	43.55	
	(1.70)	(1.53)	(1.78)	(2.03)	(1.59)	(0.34)	(0.42)	(0.74)	(-0.11)	(1.31)	
β	1.00	1.01	0.99	1.00	1	1.11	1.04	1.02	0.25	0.89	0.95
	(27.69)	(21.57)	(35.07)	(38.74)	(24.96)	(2.74)	(5.86)	(10.25)	(0.04)	(2.68)	(3.74)
ρ										-2.56	-2.55
										(-1.22)	(-1.22)
$\kappa_{c,1}$										0.75	
										(10.65)	
$\tilde{\theta}$											3.05
											(1.18)
d_1											-0.005
											(-0.01)
μ_c ($\times 100$)	1.76	1.94	1.25	5.21	1.70	1.62	1.20	1.27	0.95	1.76	1.76
	(8.28)	(8.62)	(5.05)	(10.09)	(7.52)	(4.02)	(2.98)	(3.03)	(2.00)	(8.28)	(8.28)
σ_c^2 ($\times 100$)	0.015	0.017	0.020	0.090	0.017	0.055	0.055	0.06	0.076	0.015	0.015
	(3.49)	(3.88)	(3.56)	(4.17)	(4.31)	(4.14)	(4.39)	(4.00)	(3.84)	(3.49)	(3.49)
$\phi_c \sigma_c^2$ ($\times 100$)	0.010	0.010	0.010	0.081	0.010	0.000	0.000	0.010	0.000	0.010	0.010
	(2.10)	(1.96)	(1.98)	(3.24)	(1.96)	(0.34)	(0.42)	(0.77)	(0.11)	(2.10)	(2.10)
χ^2	20.26	20.63	19.47	21.12	20.49	6.98	10.04	11.44	139.77	14.26	2.31
dof	5	5	5	5	5	0.22	5	5	5	4	3
p	0.001	0	0.001	0	0.001	0	0	0.04	0	0.006	0.50
R^2	-45.68%	-44.98%	-40.35%	-52.62%	-45.27%	37.56%	16.31%	-8.29%	-572.59%	86.12%	98.40%
rmspe	3.21%	3.21%	3.15%	3.29%	3.21%	2.10%	2.44%	2.77%	6.91%	0.99%	0.31%

Panel C: 6 Equity index option portfolios (1987-2011)

	CRRA									EZ	GDA-S
	SNonD	S-K	NonD-K	Ult	Q4	SNonD-U	NonD-U	Q4NonD-U	Garbage	SNonD	SNonD
γ	2.63	2.51	2.88	0.80	2.92	6.46	4.38	8.62	9.84	52.70	
	(2.06)	(2.02)	(1.84)	(2.69)	(1.74)	(0.43)	(0.75)	(0.50)	(0.48)	(1.44)	
β	0.99	1.00	0.99	0.99	1.00	1.03	1.00	1.03	0.98	0.77	0.96
	(51.12)	(48.06)	(49.51)	(79.62)	(38.62)	(5.89)	(15.44)	(8.28)	(21.58)	(1.58)	(2.77)
ρ										-1.63	-1.63
										(-1.27)	(-1.27)
$\kappa_{c,1}$										0.80	
										(12.33)	
$\tilde{\theta}$											5.51
											(1.23)
d_1											-1.92
											(-4.83)
μ_c ($\times 100$)	1.46	1.59	1.14	4.43	1.44	1.35	1.12	1.08	0.53	1.46	1.46
	(6.14)	(6.73)	(3.86)	(7.82)	(5.57)	(3.05)	(2.38)	(2.16)	(1.03)	(6.14)	(6.14)
σ_c^2 ($\times 100$)	0.014	0.014	0.021	0.080	0.016	0.048	0.055	0.063	0.065	0.014	0.014
	(2.86)	(2.92)	(3.02)	(3.52)	(3.85)	(3.82)	(3.70)	(3.86)	(2.61)	(2.86)	(2.86)
$\phi_c \sigma_c^2$ ($\times 100$)	0.009	0.010	0.011	0.007	0.009	0.007	0.011	0.006	0.005	0.009	0.009
	(2.12)	(2.14)	(1.75)	(3.26)	(1.77)	(0.43)	(0.73)	(0.48)	(0.46)	(2.12)	(2.12)
χ^2	41.43	41.86	41.02	41.79	41.65	41.89	41.89	37.97	48.21	32.42	20.86
dof	6	6	6	6	6	6	6	6	6	5	4
p	0	0	0	0	0	0	0	0	0	0	0
R^2	-37.13%	-37.11%	-35.34%	-39.98%	-36.05%	-12.78%	-26.04%	0.04%	4.63%	59.50%	75.83%
rmspe	11.40%	11.40%	11.32%	11.52%	11.35%	10.34%	10.93%	9.73%	9.51%	6.19%	4.78%

Table 9. GMM estimation results for monthly returns

Table 9 reports GMM results for different asset pricing models at the monthly frequency. In columns (i) through (iv), I estimate the CRRA consumption-based model of equation (1) for alternative consumption measures. $SNonDm$ and $NonDm$ are the monthly real aggregate consumption growth measures for services and non-durables, services, and non-durables, respectively. $SNonD\text{-}Um$ and $NonD\text{-}Um$ are the monthly unfiltered real aggregate consumption growth measures for services and non-durables, and non-durables, respectively. The construction of the $SNonDm$, $NonDm$, $SNonD\text{-}Um$, and $NonD\text{-}Um$ consumption growth measures is discussed in Section 3. In column (v), I estimate the Epstein and Zin (1989) model of equation (8) and in column (vi), I estimate the GDA-S model from equation (6). For the Epstein-Zin and GDA-S models, I only use the real aggregate consumption growth measure for services and non-durables ($SNonDm$). γ is the risk-aversion parameter and β is the rate of time preference. ρ is the EIS coefficient and $\kappa_{c,1}$ is the log-linearization constant for the price-dividend ratio in the Epstein-Zin model. $\tilde{\theta}$ is the disappointment aversion coefficient in the GDA-S model. In the monthly sample, the disappointment threshold parameter d_1 in the GDA-S model is restricted since monthly disappointment events are based on the annual estimation results reported in Table 5. Specifically, based on the results in Table 5 for the 1964-2013 sample, if year t is a disappointment year, then I assume that all months in year t are disappointment months. If year t is not a disappointment year, then none of the months in year t are disappointment months. I estimate the CRRA, Epstein-Zin, and GDA-S models using the over-identified GMM system from equation (13). χ^2, dof, and p are the first-stage χ^2-test, degrees of freedom, and p-value that all moment conditions are jointly zero. M denotes an extremely large number. R^2 and $rmspe$ are the cross-sectional r-square and root-mean-square pricing error. The sample is January 1964 to December 2013.

	CRRA				EZ	GDA-S
	SNonDm	NonDm	SNonD-Um	NonD-Um	SNonDm	SNonDm
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
γ	5.19	1.02	0.51	0.23	217.51	
	(2.98)	(6.52)	(8.81)	(8.94)	(2.98)	
β	1.00	0.99	0.99	0.99	0.99	0.99
	(394.13)	(M)	(M)	(M)	(82.43)	(11.45)
ρ					-3.52	-3.55
					(-2.36)	(-0.03)
$\kappa_{c,1}$					0.97	
					(51.90)	
$\tilde{\theta}$						2.61
						(2.60)
μ_c ($\times100$)	0.16	0.11	0.16	0.11	0.16	0.16
	(12.19)	(3.79)	(4.36)	(1.47)	(12.19)	(12.19)
σ_c^2 ($\times100$)	0.001	0.005	0.008	0.037	0.001	0.001
	(13.57)	(11.27)	(14.04)	(11.41)	(13.57)	(13.57)
$\phi_c\sigma_c^2$ ($\times100$)	-0.000	-0.001	-0.004	-0.021	-0.000	-0.000
	(-2.97)	(-6.44)	(-9.50)	(-9.45)	(-2.99)	(-118.29)
χ^2	127.48	127.59	127.89	127.82	94.46	34.3
dof	26	26	26	26	25	25
p	0	0	0	0	0	0
R^2	-1018.60%	-1045.17%	-1056.80%	-1055.80%	-38.47%	56.05%
rmspe	0.74%	0.75%	0.75%	0.75%	0.26%	0.14%