Consumer heterogeneity, Firms characteristics and risks exposures.

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Abstract

We extend the firm-level consumption risk exposure measure provided by Dittmar and Lundblad (2017) to a heterogeneous consumer framework. By doing so, we capture additional dimensions of the firm consumption risk exposures related to the cross-sectional distribution of idiosyncratic consumption growth shocks across households. Using an updated sample, our empirical analysis confirms that aggregate consumption risk exposures explain a substantial variation in average returns across anomaly portfolios. However, we find that the heterogeneous agents multi-factor model with four cross-sectional moments of CEX consumption growth as risk factors does a better job, by explaining more than two-thirds of the cross-sectional variation in average returns across anomaly portfolios. These findings are robust to several model specifications.

Keywords: Asset Pricing, Consumption risk, Firms Characteristics, Factor model.

JEL Classification: G12

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1 Introduction

The asset pricing literature is roughly divided between the consumption-based strand, which is micro-founded but performs poorly in empirical tests, and factor models, which yield better statistical results but lack a foundation in economic theory. Recent work by Dittmar and Lundblad (2017) successfully put down the brigde to link these types of analysis, recasting firm characteristics as proxies for consumption risk. However, aggregate consumption growth may be insufficient for capturing the effect of household consumption risk on asset prices. Rather, heterogeneity in household consumption must be taken into account when designing consumption based risk factors for determining asset prices. This paper analyses the role of higher-order cross-sectional moments of the household consumption growth distribution in the relationship between firm-characteristics and stock returns. Thereby, we aim to create a more complete account of assets' exposures to consumption risks that drive their prices, relate these risks to firm characteristics, and provide an economically founded explanation for their cross-sectional variation. Such an analysis is new to the literature.

We test the pricing ability of cross-sectional moments of consumption growth with respect to two asset menus: The first asset menu labeled *anomaly portfolios*, is made of portfolios formed on firm characteristics whose average returns' variation is not explained by the CAPM model. The second asset menu denominated labeled *dissecting anomaly portfolios* following Clarke (2022), is made by portfolios sorted on predicted returns based on firm characteristics. This second asset menu presents the challenge that the pricing factors must not only capture systematic risks embedded in the assets, but also be valued in financial markets in order to be able to explain the cross-section of average returns. We find that the cross-sectional moments are valuable pricing factors for both asset menus because the estimated prices of risk are statistically significant. Furthermore, there is a substantial increase in the proportion of cross-sectional variation in average returns that can be explained compared to the single-factor model of aggregate consumption growth, and the multi-factor consumption risk model yields an explanatory performance comparable to or better than Fama-French 5 factor model. This can be interpreted as evidence that the cross-sectional distribution of consumption is relevant for asset pricing.

Following the methodology provided by Dittmar and Lundblad (2017), we map consumption risk exposures to firm characteristics at the portfolio level. Then, we use this mapping to compute the firm-level ex ante risk exposures to innovations in the cross-sectional moments of consumption growth. We show that these ex-ante risk exposures are priced, and they matter for the equity risk premium and the cost of capital for firms. We show that the multi-factor consumption risk exposures as predicted by firm characteristics comove with the business cycle, and that they generate a higher variation in the risk premiums across assets than aggregate consumption alone as pricing factor. Moreover, contrary to Dittmar and Lundblad (2017), we find that the multi-factor consumption risk model's performance in pricing the cross-section of portfolios formed on firm characteristics is robust to the inclusion of operating profitability as one of these characteristics. Finally, we illustrate the usefulness of our methodology in computing the cost of capital for industry portfolios and firms.

Empirical tests relating the cross-sectional distribution of household consumption to the cross-sectional distribution of asset prices have not featured prominently in the literature. Our paper contributes to fill this gap by using consumption factors derived from the cross-sectional distribution of household consumption growth, for pricing a cross-section of anomaly portfolios. Jacobs and Wang (2004) analyse a two-factor consumption-based asset pricing model for pricing the Fama and French (1992) 25 portfolios sorted on size and book-to-market portfolios. They find that their model outperforms the CAPM and compares favorably with the Fama-French three-factor model. While their study targets two CAPM anomalies (size and value), standards in the field are moving toward targeting a greater number of anomalies such as size, value, profitability, growth, accruals, net stock issues, and momentum anomalies (Fama and French, 2008).

The cross-sectional skewness of consumption was first analysed by Brav et al. (2002), though mainly to explain the equity premium puzzle rather than patterns in cross-section of average stock returns. Moreover, Constantinides and Ghosh (2017) design and estimate an heterogenous agent model that successfully explain the equity premium. They also analyse how well the cross-sectional skew and volatility of household consumption explain the cross-section of asset returns; their asset menu is made by Fama-French 25 portfolios and 30 industry-sorted portfolios, but the results are barely significant. A possible explanation could be that there is not enough variation in the portfolio exposures to risk factors in order to identify the risk prices. We believe that this empirical performance can be improved upon by changing the asset menu to a broader set of CAPM anomaly portfolios. Furthermore, Catherine (2021) argues that given the moderate effect that cyclical skewness has on aggregate demand for equity, it is unlikely to explain the level of the risk premium. Our paper contributes to this ongoing debate by considering the cross-sectional skewness of consumption growth among our pricing factors.

Tail risks in the cross-sectional distribution of household idiosynchratic income or consumption shocks have recently attracted the attention of researchers to understand how they translate into asset prices. Schmidt (2016) provides an asset pricing model that support an intuive mechanism for how recession amplifies the left tail of income distribution and reduces the right tail, therefore, implying for households a higher risk for holding stocks as they fall in advance and/or contemporaneously with increases in idiosyncratic tail risk. This mechanism gives the intuition for why exposures to household idiosyncratic tail risks should be rewarded in cross-section of assets by a higher risk premium. Our paper contributes in testing this idea by considering the cross-sectional kurtosis of consumption growth among our pricing factors.

To the best of our knowledge, we are the first paper to simultaneously consider the aggregate consumption growth, the cross-sectional variance, skewness and kurtosis of household consumption growth in a linear multi-factor consumption-based asset pricing model for explaining the cross-sectional variation of average returns in anomaly portfolios, and to map risk exposures to these factors into firm characteristics.

The rest of the paper is organized as follows. Section 2 presents the model specification and the mapping between risk exposure and firm characteristics. Section 3 presents the data and variables construction. Section 4 presents and discusses the results. It also illustrates the application of our pricing model for estimating firms and portfolios risk premiums. Section 6 concludes and explores possible routes for future research.

2 Model Specification

Consumption-based asset pricing is popular for providing micro-founded mechanisms for connecting a macroeconomic quantities such as consumption growth to stock market dynamics. However, these pricing models are hardly used by professional investors, who tend to rely on statistical factor models (Dittmar and Lundblad, 2017) or firm characteristics such as accounting ratios. This may be caused partially by the difficulty of measuring exposure to structural low-frequency consumption risk for individual stocks, especially at the disaggregate level. To bridge this gap, Dittmar and Lundblad (2017) recently provide a method for measuring the implicit aggregate consumption risk at portfolio and firm levels using several firm characteristics that have been identified as reliable predictors for excess returns. With this approach, they make a double contribution to the literature: first, the method gives a macroeconomic foundation for the influence of firm characteristics on stock prices by reinterpreting them as proxies for consumption risks. Second, the paper shows how a consumption-based asset pricing model can be used to measure asset exposure to consumption risks, and to predict risk-adjusted returns at disaggregated levels. However, the paper only considers shocks in aggregate consumption growth as the unique source of aggregate priced risk, which may be too restrictive. We propose to extend the sources of priced risk to the cross-sectional consumption growth distribution, where the first cross-sectional moment corresponds to aggregate consumption growth.

2.1 Multi-factor Consumption Risk Model

Consumers experience various idiosyncratic economic shocks in their daily lives, which affect their consumption and investment decisions. Whilst the consumption-based asset pricing literature has classically eliminated the impact of consumer heterogeneity on asset prices by assuming perfect risk sharing, recent research has been considering idiosyncratic risk as a potential economic driver of risk premiums in financial markets. This strand of literature expands the representative agent model, where only the preferences and intertemporal consumption distribution of the representative consumer affect the equity risk premium, by incorporating the cross-sectional distribution of consumption among consumers as a source of risks priced on the financial markets. This addition is justified by households facing uninsurable idiosyncratic consumption risks, such as job lay-offs or the death of a household's prime wage earner, due to incomplete financial markets. The lack of contingent securities to trade off such risks prevents households from fully hedging against these idiosyncratic consumption shocks, and there must be a reward for agreeing to bear them through investments in financial assets. Therefore, the cross-sectional distribution of consumption will matter for equilibrium asset prices (Constantinides and Duffie, 1996; Constantinides and Ghosh, 2017).

To take into account the heterogeneity in consumers' idiosyncratic risks and the incompleteness of financial markets, we propose an extension of the Dittmar and Lundblad (2017) framework that leads to a multi-factor model of consumption risk exposures. Firms are not only exposed to shocks in aggregate consumption growth (considered by the representative agent), but also to innovations in the cross-sectional moments of individual consumption growth. For example, when the economy moves from a normal state to a recession, we observe a downfall in aggregate consumption, which translates into lower returns for firms exposed to aggregate consumption risks. However, recessions may have a more heterogeneous impact on consumers, generating higher dispersion and negative skewness in households consumption growth distrbution, which could amplify the impact of the recession on asset prices. In the models of Constantinides and Duffie (1996) and Constantinides and Ghosh (2017), these dynamics are captured by a state variable called *household consumption risk*, which determines both the equilibrium stochastic discount and the cross-sectional moments of consumption growth. Following their approach, we formulate a stochastic discount factor that is a linear function of the cross-sectional moments of consumption growth. Applied to the cross-section of asset prices, such a model implies that the risk premium on any asset i can be expressed as:

$$E[R_{i,t+1} - R_{f,t}] = \lambda' \beta_i, \tag{1}$$

where for asset i we define β_i as the vector of asset exposures to consumption risks proxied by the innovations in the k-order cross-sectional moment of individual consumption growth, η^k, with the superscript ^{k} denoting an index, not an exponent. This implies that $\beta_i^k = Cov(r_{i,t+1}, \eta_{t+1}^k)/Var(\eta_{t+1}^k)$. The first-order moment is the aggregate consumption growth studied by Dittmar and Lundblad (2017), which captures the risk of a downfall in aggregate consumption. The second-order moment introduced by Constantinides and Duffie (1996) captures the risk of an increase in the dispersion of household consumption growth, which implies a higher chance of a relatively poor consumption realization for a given individual. The third-order moment emphasized by Constantinides and Ghosh (2017), has been shown to be important for explaining the average equity risk premium. It captures the countercyclical consumption risks implied by the higher (negative) skewness occurring in cross-sectional consumption growth distribution during recessions. The fourth-order moment apprehends the tails in the cross-sectional distribution of consumption growth. A positive shock to the cross-sectional kurtosis means higher chances that an individual household's consumption growth will deviate extremely from the cross-sectional average.

2.2 Firm Characteristics as Asset Pricing Factors

Empirical analysis of firm characteristics as asset pricing factors is a contentious topic. First of all, authors such as Cochrane (2005) point out that many such factor analyses lack a compelling economic story to motivate them. The innovation of Dittmar and Lundblad (2017) to reinterpret these firm characteristics as proxies for consumption risk aims to overcome this problem. Moreover, work by Lewellen (2015) has shown the sensitivity of empirical tests for factor-based asset pricing models to the choice of test assets. One notable approach to overcome this problem is provided by Clarke (2022), who considers a broad range of firm characteristics to predict one-period ahead stock returns, thus only capturing priced risk factors, and then creates portfolios based on a univariate sort of this predicted return. We employ both methods in our paper.

To estimate consumption-risk exposures, Dittmar and Lundblad (2017) use a set of anomaly portfolios sorted on six firm-level characteristics: growth in assets, log book-to-market ratio, log market capitalization (or value), past 12-month returns, stock issues, and total accruals. They also consider a seventh characteristic, operating profitability, but omit this from the analysis as it deteriorates their results. These seven factors have a rich history in the asset pricing literature and have been identified by Lewellen (2015) as robust predictors of returns; they imply a great (monotonic) variation of average return across portfolios sorted on each of them, and the average return spread between extreme portfolios represent anomalies with respect to the CAPM model's prediction[1]. Size (measured by market capitalisation) was first identified to affect returns by Banz (1981), whilst size and book-to-market ratio factors were jointly analysed in Fama and French (1992) and Fama and French (1993). The momentum factor (past returns) was first researched by Jegadeesh and Titman (1993) and popularised by Carhart (1997). Accruals were introduced by Sloan (1996). In Fama and French (2006), investment (asset growth) and (operating) profitability are introduced. Finally, Pontiff and Woodgate (2008) first analyse stock issuance.

3 Data and Variables

Our methodology is largely based on Dittmar and Lundblad (2017), while the analysis of disaggregate consumption data mostly follows Constantinides and Ghosh (2017). This section explains our method for constructing the factors we use to capture household consumption risk, the firm-characteristic based portfolios used to generate firm-level consumption risk exposures, and the "dissecting anomalies" portfolios borrowed from Clarke (2022).

[1]See Harvey et al. (2016) and Green et al. (2017) for a more complete overview of this literature.

3.1 Consumption

Our sample runs from 1984:Q1 to 2019:Q4, as dictated by the availability and reliability of public use microdata from the consumer expenditure survey (CEX). This dataset is provided by the Bureau of Labor Statistics (BLS), who interview around 6000 households per quarter regarding their consumption in the past three months. Households are part of the sample for five consecutive quarters, implying that every period around 20% of the sample is replaced. Following the National Income and Product Accounts (NIPA) classification, we define nondurable goods consumption as the sum of spending on food; alcohol; tobacco and smoking supplies; gasoline and motor oil; utilities, fuels and public services; apparel and services; public and other transportation; household operations; personal care; fees and admissions for entertainment; education; reading; life and other personal insurance; and health care. We then obtain per capita consumption by dividing this sum by the number of family members per household.

To select households, we require positive food and aggregate consumption for at least three consecutive periods, as well as a reference person between 18 and 75 years old, and the household must be marked as an urban household that is not a student house. Following amongst others Brav et al. (2002), we filter out extreme values by requiring that gross quarterly household consumption growth should always be between 20% and 500%. Furthermore, observations are omitted where household consumption halves in one period and doubles again in the next.

Following Balduzzi and Yao (2007), aggregate consumption growth is defined as the sum of household consumption in one quarter divided by total consumption in the previous quarter. This summation mitigates some of the measurement error that is propagated when taking a weighted average of individual household consumption growth. Then, relative household consumption growth is defined as the ratio of household consumption growth to aggregate consumption growth. From this panel, a time series of the cross-sectional variance, skewness and kurtosis is calculated. For the time series of aggregate consumption growth, instead, we use the NIPA data, which contains less measurement error (Balduzzi and Yao, 2007).

We explore three specifications of consumption risk models: Aggregate consumption growth as the unique pricing factor as in Dittmar and Lundblad (2017) (AC model), Aggregate consumption growth and the cross-sectional higher-order moments (variance, skewness and kurtosis) of consumption growth as a multivariate pricing factor (4M model), and Aggregate consumption growth and the first principle component of these three cross-sectional moments, along with innovations to this variable (PCA model). We limit the number of cross-sectional moments to four because above that number, the cross-sectional moments may not be defined[2] (Toda and Walsh, 2015). The motivation for using the principal component along with its first difference as a pricing kernel stems from Constantinides and Ghosh (2017), who construct a stochastic discount factor as the exponent of a linear function of aggregate consumption growth, a single state variable capturing what they call "household consumption risk", and a single lag of this state variable, the latter two of which can be combined into a first difference.

Table 1 reports summary statistics for these consumption pricing factors over K quarters. Innovations in the cross-sectional moments of consumption growth are more volatile as the moment order increases. The first principal component of the cross-sectional moments of consumption growth is also more volatile than the other components.

Figure 1 shows how aggregate consumption growth evolves over time, together with the cross-sectional variance, skewness and kurtosis of household consumption growth. Figure 2 presents the aggregate consumption growth next to the level and changes in household consumption risk proxied by the first principal component of these cross-sectional moments. The grey bars on both figures correspond to the NBER recessions. Overall, we observe that the cross-sectional moments of consumption growth do not covary perfectly, which implies that they might capture different economic shocks that could affect asset prices. Aggregate consumption growth decreases during recession periods and negatively correlates with cross-sectional kurtosis and the level of household

[2] Toda and Walsh (2015) show that the cross-sectional distributions of consumption and consumption growth with the CEX data follow a pareto distribution with a tail index estimated around 4, which means that cross-sectional moments of consumption growth will exist only up to the fourth order, and that fifth or higher-order cross-sectional moments are infinite.

consumption risk with respective correlation coefficients of -0.18 and -0.17.

3.2 Firm Characteristics and Anomaly Portfolios

To estimate the relation between firm characteristics and consumption risk exposures, we form characteristic portfolios using the six characteristics employed in Dittmar and Lundblad (2017): growth in assets (AG), log book-to-market ratio (BM), log market capitalization (or value) (MV), past 12-month returns (P12), stock issues (SI), and total accruals (TA). We compute these quantities using quarterly accounting information from Compustat and CRSP, largely following the definitions of Fama and French (2008). AG is computed by taking the change in the total asset (Compustat item *atq*). MV is computed by multiplying the number of common shares outstanding (Compustat item *cshoq*) by the share's price close (Compustat item *prccq*). BM is computed by taking the log of total common equity (Compustat item *ceqq*) to MV ratio. TA is computed as change in current assets (Compustat item *actq*) minus change in cash/cash equivalents and the difference between change in current liabilities and change in debt included in current liabilities minus change in income taxes payable minus depreciation and amortization expense. P12 is computed by compounding the past twelve-month returns from CRSP. We obtain the stock prices from Compustat's monthly security file and compute the total returns after adjusting for stock splits, ex-post stock dividends, reinvestment of dividends and the compounding effect of dividends paid on reinvested dividends. These variable definitions are summarised in Table 2.

Furthermore, we add operating profitability (OP) to the set of characteristics. OP is computed as the ratio of gross profit to total assets. This variable was omitted by Dittmar and Lundblad (2017) for reducing the performance of the model. However, the literature on factor pricing and firm characteristics has generally found operating profitability to contain priced information (Lewellen, 2015), and it is used as a pricing factor by many papers. This motivates our choice to include it our analysis, and to analyse whether the cross-sectional moments of consumption improve our ability to price these characteristic portfolios. Indeed, we find that our multifactor consumption risk model improves the fit of average returns across portfolios in our dataset, and that there is no need to exclude the portfolios sorted on operating profitability from our analysis.

Portfolios are formed based on deciles of the characteristic lagged by one period for all characteristics, except the stock issuance portfolios, which are based on quintiles due to the large number of firms issuing no shares in any given quarter, which would else need to be classified arbitrarily between the bottom deciles. Portfolios are value-weighted, with returns sampled at the quarterly frequency and converted to real terms using the personal consumption expenditure (PCE) deflator from the Bureau of Economic Analysis. Table 3 presents respectively the average returns of the 65 resulting anomaly portfolios. The pattern of average returns is not strictly monotonic with respect to characteristics. However, we observe that average returns generally tend to increase in the book-to-market ratio, past 12-month return and operational profitability, and decrease in asset growth, market value, total accruals, and stock issuance. Momentum creates the biggest dispersion across portfolios average returns. These results are consistent with the literature and similar to those of Dittmar and Lundblad (2017).

3.3 Dissecting Anomalies Portfolios

To analyse the cross-sectional asset pricing performance of our model, we consider some alternative portfolio sorting procedures. One of these procedures is the one recently proposed by Clarke (2022), who generates a univariate sort of what he calls "dissecting anomalies" portfolios. As these portfolios are sorted based on a broad set of characteristic, they are somewhat agnostic as to the underlying factors driving their return variation, and thus a good candidate for testing the viability of our model.

The method of Clarke (2022) for extracting pricing factors from firm characteristics consists in three steps: First, stock excess returns at time $t + 1$ are cross-sectionally regressed on a broad set of firm characteristics at time t. In the second step, stocks are sorted into portfolios based on the excess return predicted by the model estimated in the first step. This generates a cross-sectional dispersion of portfolios' exposures to priced risks, diversifying away unpriced factors. Therefore, only priced factors remain to explain the cross-sectional return variation of these portfolios. In the last step, principal component analysis is applied to the predicted excess return sorted portfolios to extract the pricing factors.

Following Clarke (2022), we run the following cross-sectional regression of excess stock returns on their past characteristics at each time period[3]:

$$\begin{aligned} XRet_{i,t+1} = \; & \beta_0 + \beta_1 LogSize_{i,t} + \beta_2 LogB/M_{i,t} + \beta_3 Mom_{i,t} + \beta_4 zeroSI_{i,t} + \beta_5 NS_{i,t} \\ & + \beta_6 negACC_{i,t} + \beta_7 posACC_{i,t} + \beta_8 dA/A_{i,t} + \beta_9 OP_{i,t} + e_{i,t} \end{aligned} \tag{2}$$

where $XRet_{i,t+1}$ is the stock return in excess of the risk-free rate in the following quarter, $LogSize_{i,t}$ the natural logarithm of the market value, $LogB/M_{i,t}$ the natural logarithm of the ratio of book equity to market equity, $Mom_{i,t}$ the momentum computed as the sum of the past twelve month returns, $zeroSI_{i,t}$ an indicator variable equal to one if no stock was issued, $NS_{i,t}$ the net stock issues, $negACC_{i,t}$ the negative accruals, $posACC_{i,t}$ the positive accruals, $dA/A_{i,t}$ the asset growth, and $OP_{i,t}$ the operating profitability. Following Clarke (2022), we estimate this equation separately for each quarter and for each size group of stocks: big-, small-, and micro-cap stocks defined by market values respectively greater than the 50% quantile, between the 20% to 50% quantiles, and below the 20% quantile of the sample. This separation of the predictive regressions by size group builds on the Fama and French (2008) findings that different size groups have different exposures to characteristics predictors.

[3] We slightly differ from Clarke (2022) in two ways: first, we do not split operating profitability into positive and negative variables because there are very few negative values for operating profitability, often resulting in a constant dummy variable for negative OP that only takes zeros, which implies that the coefficient on this variable is not identified. Second, for consistency purposes, we run the cross-sectional regressions at the quarterly frequency instead of the monthly frequency.

3.3.1 Relation between Consumption Pricing factors and Clarke's factors

To better understand the structure of these dissecting anomalies portfolios, we examine the relation between the cross-sectional moments of consumption and the Level, Slope and Curvature factors extracted from these portfolios by Clarke (2022). As he shows that these factors are not only correlated with systematic risks, but also priced on the market, such a relation would both be an additional indicator for the relevance of cross-sectional distribution of household consumption in asset pricing, and possibly provide an economic justification of these factors. We specify the following VAR model:

$$Y_t = AY_{t-1} + u_t \tag{3}$$

where $Y_t = [\text{Level}_t, \text{Slope}_t, \text{Curve}_t, \text{Cross.mean}_t, \text{Cross.var}_t, \text{Cross.skew}_t, \text{Cross.kurt}_t]'$ is a vector which contains the level, slope and curve factors and the the first four cross-sectional moments of consumption growth. After estimating the VAR model in order to capture the predictable component in the variables involved in the model, we use the residuals in the consumption factors as proxies for innovations to household consumption, and investigate whether they are correlated with the Level, Slope and Curvature factors.

Table 4 displays the results of the regressions of the Level, Slope and Curve factors on innovations in the cross-sectional moments of consumption. The Level appears to be positively correlated with innovations in aggregate consumption growth and the cross-sectional kurtosis of household consumption. The Slope factor also positively correlates with innovations in the cross-sectional kurtosis. Innovations in the consumption moments can explain up to 10% of the variation in the Level factor while they explain 4% of the variation in the Slope factor. Overall, these results show that shocks in the cross-sectional consumption growth moments are indeed priced by the market, in particular the kurtosis, which has not received much attention in previous studies.

4 Results

4.1 Estimating Risk Exposures and Risk Premiums

In this section, we estimate the consumption risk exposures of our characteristic-based testing portfolios using Fama and MacBeth (1973) regressions and analyse to which extent the different specifications of consumption risk explain their variation of average return.

4.1.1 Aggregate Consumption Growth

Table 5 shows the portfolio risk exposures to aggregate consumption growth estimated by regressing the time series of portfolio returns on aggregate consumption growth over the period from 1984 Q1 to 2019 Q4, for a one-year return horizon. The regression model is specified as:

$$\left[\prod_{j=0}^{K-1} R_{i,t-j}\right]^{1/K} - \left[\prod_{j=0}^{K-1} R_{f,t-j}\right]^{1/K} = a_i + \beta_{i,m}\left[\frac{1}{K}\sum_{j=0}^{K-1} \hat{\eta}_{m,t-j}\right] + e_{i,t}, \tag{4}$$

for different aggregation windows of K quarters, where $R_{i,t-j}$ is the gross real return on portfolio i in period $t-j$, $R_{f,t-j}$ is the gross risk-free rate, $\hat{\eta}_{m,t-j}$ is the innovation in aggregate consumption growth, measured as the real per capita consumption growth rate in non-durable goods and services using NIPA tables from the Bureau of Economic Analysis. As expected, the consumption risk exposures are generally positive, and while not being monotonic, they follow a pattern similar to the average returns. The notable exception is the series of operating profitability portfolios, which shows a very erratic distribution of consumption betas.

We next analyse the risk premium estimates from the second step Fama and MacBeth (1973) cross-sectional regression of portfolio average excess returns on consumption risk exposures specified as:

$$\bar{R}_i - \bar{R}_f = \gamma_0 + \gamma_m \beta_{i,m} + u_i, \tag{5}$$

where $\bar{R}_i$ is the average real quarterly portfolio return, $\bar{R}_f$ is the real quarterly compounded return on a Treasury bill closest to one month to maturity, and $\beta_{i,m}$ is the firm exposure to aggregate consumption growth risk as computed from equation (5). Table 6 reports the results of this regression, with t-statistics adjusted as prescribed by Shanken (1992), whilst panel A of Figure 3 shows the respective data and regression lines.

The estimated risk premiums are positive and significant for the aggregation windows of $K = 1, 2, 4$, and 8 quarters. Furthermore, the adjusted R-squared is significantly greater than the 95% quantile value of the adjusted R-squared distribution obtained from simulations under the null hypothesis that consumption growth has no predictive power. Thus, the consumption-CAPM statistically outperforms a constant-mean model in predicting average portfolio returns. These results are consistent with the consumption-based asset pricing theory and similar to the results obtained by Dittmar and Lundblad (2017) over the period from September 1953 through December 2012. However, the risk premiums are smaller in our sample and the estimated explanatory power of the model is much lower than the one reported in their paper: we find that consumption risk exposures explain less than 10% of the variation in average returns across portfolios.

In order to better compare our results to Dittmar and Lundblad (2017), we repeat this analysis while excluding operating profitability as a characteristic for portfolio construction. Table 7 shows the estimation without profitability-based portfolio sorts. Indeed, we observe a huge improvement in the goodness of fit. The adjusted R-squared has more than doubled compared to the case where profitability is included. The difference between these results could mean that the profitability risk premium is not captured by exposure to aggregate consumption growth risk. However, rather than concluding that the profitability risk premium is unrelated to consumption altogether, we argue that it is spanned by another household consumption risk factor orthogonal to aggregate consumption.

4.1.2 Cross-sectional Moments of Consumption Growth

We now examine the multi-factor consumption growth model, where the cross-sectional moments of consumption growth (variance, skewness and kurtosis) are added to explain portfolio returns. In addition to aggregate consumption growth risk, this model should capture undiversifiable idiosyncratic household consumption risk that arises from the market incompleteness, and which may affect asset prices. In a series of first step Fama and MacBeth (1973) regressions, we estimate a multiple regression equation given by:

$$\left[\prod_{j=0}^{K-1} R_{i,t-j}\right]^{1/K} - \left[\prod_{j=0}^{K-1} R_{f,t-j}\right]^{1/K} = a_i + \beta_{i,m}\left[\frac{1}{K}\sum_{j=0}^{K-1}\hat{\eta}_{m,t-j}\right] + \beta_{i,v}\left[\frac{1}{K}\sum_{j=0}^{K-1}\hat{\eta}_{v,t-j}\right] + \beta_{i,s}\left[\frac{1}{K}\sum_{j=0}^{K-1}\hat{\eta}_{s,t-j}\right] + \beta_{i,k}\left[\frac{1}{K}\sum_{j=0}^{K-1}\hat{\eta}_{k,t-j}\right] + e_{i,t}, \quad (6)$$

where $\hat{\eta}_{v,t-j}$, $\hat{\eta}_{s,t-j}$ and $\hat{\eta}_{k,t-j}$ denote innovations in the cross-sectional variance, skewness and kurtosis of household consumption growth respectively. Results are shown in Table 8. Next, we conduct the second step Fama and MacBeth (1973) regression given by:

$$\bar{R}_i - \bar{R}_f = \gamma_0 + \gamma_m\beta_{i,m} + \gamma_v\beta_{i,v} + \gamma_s\beta_{i,s} + \gamma_k\beta_{i,k} + u_i. \quad (7)$$

Table 9 and panel B of Figure 3 present the estimated risk premium from these second-step regressions of expected returns on consumption growth risk exposures for different aggregation horizons. The same set of 65 characteristic portfolios is used, formed on all seven firm characteristics. The estimated risk premiums are positive for the aggregate consumption growth and the cross-sectional skewness, and negative for the cross-sectional variance and kurtosis. Notably, this model explains around 68% of the cross-sectional variation of expected return for the one-year horizon, supporting our hypothesis that the cross-sectional moments of consumption growth capture priced dimensions of consumption risk not spanned by exposure to aggregate consumption growth.

Table 10 shows the estimated risk premiums when the profitability-sorted portfolios are excluded from the set of testing portfolios. Contrary to the single-factor model estimations, the results with and without the profitability portfolios are very similar. The risk premium estimates have the same signs, positive for the aggregate consumption growth and cross-sectional skewness, and negative for the cross-sectional variance and kurtosis. Furthermore, the model explains up to 76% of the cross-sectional variation in expected returns in the one-year horizon. This supports our claim that operating profitability captures risk in higher moments. Closer inspection of the betas in Table 8 reveals that especially the cross-sectional variance of consumption is captured by operating profitability.

4.1.3 Principal Component of Cross-sectional Consumption Risk

The multi-factor model applied in the previous section, although very informative, presents the limitation that it lacks a compelling economic story that restricts the range of factors used (see Cochrane (2005), chapter 7). Here we explore another factor model that builds on the previous works by Constantinides and Ghosh (2017); Tédongap and Tinang (2020). These papers present a heterogeneous agent consumption model in which the stochastic discount factor depends on the aggregate consumption growth, one unobservable state variable (household consumption risk) and its changes. This unique state variable also determines the cross-sectional distribution of consumption growth, where the cross-sectional conditional cumulants of consumption growth are a linear function of that state variable. Therefore, we use the principal component of the cross-sectional moments of consumption growth as a proxy for that latent state variable, which allows us to formulate and estimate a micro-founded three-factor model for pricing securities. Let $\beta_{i,m}$, $\beta_{i,x}$ and $\beta_{i,\Delta x}$ denote the betas obtained from the first stage Fama and MacBeth (1973) regressions of excess portfolio returns on aggregate consumption growth, the first principal component of the cross-sectional moments of consumption growth, and the first difference of this principal component. The regression equation for the second step is then given by:

$$\bar{R}_i - \bar{R}_f = \gamma_0 + \gamma_m \beta_{i,m} + \gamma_x \beta_{i,x} + \gamma_{\Delta x} \beta_{i,\Delta x} + u_i \tag{8}$$

Table 11 and panel C of Figure 3 reports the results from these second step Fama and MacBeth (1973) regressions. As can be expected, the model outperforms the univariate model, and underperforms with respect to the full-factor model, as information is lost when extracting the principal component. Nevertheless, the model is overall significant. As principle components are invariant to rotation, the negative sign of the coefficient cannot be readily interpreted, but the results indicate that the household consumption risk factor and its first difference seem to be more significant determinants of asset prices than aggregate consumption growth.

4.2 Firm Characteristics as Proxies for Household Consumption Risk

Next, we follow the methodology outlined in Dittmar and Lundblad (2017) to directly estimate the relation between firm-level characteristics and consumption risk exposures. Using the previously formed dataset of 65 characteristic portfolios, we re-estimate the various β coefficients from our three model specifications (AC, 4M, and PCA) over time using a rolling window approach, starting with the 50-quarter time frame from 1984Q1 until 1996Q2, and then extending this one quarter at a time. We denote $\hat{\beta}_{p,t}$ as the estimated beta of portfolio p over the rolling window from the start of the sample until time t, and the average of these betas as $\bar{\beta}_t$. Then, for every quarter we collect the value-weighted average firm characteristics of each portfolio in the vector $\mathbf{X}_{p,t}$, and the average from all stocks in $\bar{X}_t$. Over this entire panel, we then estimate the vector $\boldsymbol{\delta}$ relating characteristics to consumption risk exposures using the equation:

$$\left(\hat{\beta}_{p,t} - \bar{\beta}_t\right) = \delta_0 + \boldsymbol{\delta}\left(\mathbf{X}_{p,t} - \bar{X}_t\right) + \nu_{p,t} \tag{9}$$

Table 13 reports the estimates for the $\boldsymbol{\delta}$ coefficients in our three different model specifications. The top row mostly conforms to Dittmar and Lundblad (2017), with exception of the size (MV) factor. Moreover, all factors are significant with exception of accruals, and the R-squared coefficient is rather low.

4.2.1 Interpretation of Characteristics as Consumption Risk Proxies

We now take a closer look to the results in Table 13 which presents the coefficients of the linear regression models that relate portfolio characteristics to consumption risk exposures. These coefficients are worth of analysis, as they provide the basis for the argument that firm-level characteristics may proxy for consumption risk.

According to standard theory, asset growth, a proxy for investment, should be related to increased investment opportunities (Fama and French, 2008). These investment opportunities are often new projects adopted by the firm in question: however, the success of such a new project is always subject to macroeconomic conditions at the time of completion. Thus, when consumer demand is hit by a shock, a firm which has recently made a new large investment may now suddenly have a negative-NPV project on its hands. This explains how asset growth is positively related to exposure to shocks in aggregate consumption, as well as shocks in the variance and kurtosis.

Firms with a low book-to-market ratio are often called "growth" stocks, whereas high book-to-market ratio firms are considered as value stocks. Typical value stocks are utilities and other sectors where the fixed costs of production infrastructure are relatively high. As these firms usually use long term average demand forecasts to turn a profit, and because the goods and services these firms provide tend to be highly inelastic, it makes sense that they are less subject to consumption risks, either aggregate or cross-sectional. Growth stocks on the other hand often deal in products for which demand is much more fleeting, and might cater to specific subsets of the population, so their risk exposure should be higher. This is also what we see in the data, with the mean, volatility and skew of consumption very significantly negatively correlated with book/market.

We expect the coefficient of size to be negative, as larger firms have a more diversified set of activities, so their customers are likely to include both households, industry and government, which stabilizes their operating income with respect to demand shocks. Small firms on the other hand may find themselves in an "all or nothing" situation, where they are either entirely dependent of households demand for their revenue, or barely at all. As the effect of some firms losing all of their value strongly affects the average impact of demand shifts on small-cap stocks, small companies overall could be more exposed to consumption risks. This is indeed captured in the multi-factor model with cross-sectional moments of consumption growth where firm size reduces exposure to consumption risks, but not in the single-factor model. Dittmar and Lundblad (2017) however report a negative value for the consumption risk δ.

The best explanation for the momentum factor in terms of fundamentals is given by Moskowitz and Grinblatt (1999), who show that most of the momentum factor can be decomposed into industry momentum. In this sense, the momentum factor summarises which industries are currently experiencing a boom, which could very much be consumer demand driven in a similar way as the investment factor. Specifically, if a new product enters the market, or if a production innovation leads to significant cost and thus price reductions, the entire industry might experience a surge in consumer demand, which is reflected by the momentum factor. However, if aggregate consumption suffers a hit, the additional profits from the innovation are diminished. Moreover, new products are likely adopted first by wealthier consumers, which could explain why this factor has an even stronger positive relation to cross-sectional skewness of consumption growth.

Whilst stock issuance is often a sign of investment opportunities, which, according to the argument made for asset growth and momentum, should result in higher consumption risk exposure, on the one hand, an increase of stock issuance also implies a lower debt to equity ratio which reduces the exposure of the firm to a negative shock in the aggregate consumption. On the other hand, this variable also captures stock buybacks. Share repurchase typically occurs when a firm has a lot of cash lying around and instead of expanding decides to focus on its core business. This firm should then experience less aggregate consumption risk, but due to the lack of diversification of its activities, it may be more exposed to economic uncertainty. These arguments are supported by both a negative relation to aggregate consumption risk and a positive relation to cross-sectional volatility and kurtosis risks.

As the accruals factor has been explained in the literature as sloppy accounting by investors who fail to take the effect of accruals on earnings reports into account when making investment decisions (Sloan, 1996), this factor is unlikely to be directly related to consumption risk. Furthermore, Dechow and Dichev (2002) argued that the beneficial role of accruals as predictor of firm performance could be hindered by estimation errors. The data seems to reflect this as accruals have no effect on consumption risk exposures except for the cross-sectional variance to which they are negatively related.

High operating profitability should imply that the firm in question has a strong market position, and should thus be able to withstand most demand shocks. Firms with very low operating profitability on the other hand may lose their entire margin when subjected to a demand shock. This explains the dominant negative relation between operating profitability and exposure to consumption risks. By comparing Tables 13 and 14, the latter of which repeats the analysis without taking operating profitability into consideration, we find that the in- or exclusion of operating profitability has no qualitative effect on these interpretations, with all signs and orders of magnitude preserved between specifications.

4.3 Portfolios Formed on Ex Ante Consumption Risk Exposures

In this section, we analyse to which extent the consumption risk exposures as predicted by firm characteristics capture actual consumption risk exposures. For each of the three consumption factor models that we consider in our previous analysis (AC, 4M, and PCA), we compute the ex ante consumption betas at the firm level based on their characteristics using the estimated $\boldsymbol{\delta}$ from the model specified in equation (9)[4]. Next, for every consumption risk pricing factor in the models, we create univariate portfolio sorts of stocks based on quintiles of their ex ante risk exposure. The goal of this analysis is twofold: first, we want to examine to which extent these sorted portfolios capture a monotone progression in consumption risk premiums. Second, we are interested in how well the

[4]Because the sample contains very few observations for which all variables are available, especially in earlier periods, we compute three alternative estimates for $\boldsymbol{\delta}$, respectively without accruals, without profitability, and without either of these. We employ these alternative estimates to calculate implied consumption betas for firms and periods where one or both of these variables are missing.

ex ante consumption beta estimates inferred from firm characteristics correspond to the empirical consumption betas of these portfolios.

Table 15 shows the average return, the mean of the lagged ex ante betas (used for sorting the stocks into portfolios) and the mean of the ex post betas obtained by regressing the stock return on the consumption risk factors for these quintile portfolios. Panel A shows that for the representative agent model, average portfolio returns are not monotonic with respect to the ex ante betas, suggesting that the variation of risk premiums on these portfolios is not fully explained by their exposures to aggregate consumption risk. Furthermore, the pattern of average returns looks counter-intuitive as they seem to negatively co-move with the ex ante beta.

Panel B shows the results for four consumption risk factors in the heterogeneous agent model. For the aggregate consumption risk exposure, we observe an improvement in the alignment of portfolios' average returns with their risk exposures. The ex ante aggregate consumption betas appear to generate very nearly monotonic pattern in average returns, with only one deviation across quintiles. As expected, the average returns increase with the exposure to aggregate consumption risks. This result shows that the multi-factor consumption risk model enables a better measure the aggregate consumption risk exposure, which could come from a reduction in the omitted variable bias in the multi-factor model compared to the single consumption factor model. These results however do not carry over neatly to the PCA model, as shown in panel C. This indicates that controlling for the first principal component of the cross-sectional moments of household consumption and its first difference does not negate as much omitted variable bias as controlling explicitly for these four moments as in the 4M model.

5 Cross-sectional Asset Pricing Performance

In this section, we examine the cross-sectional pricing ability of the consumption factors derived from our heterogeneous agent framework for alternative portfolios to the characteristic-based sorts used to estimate consumption risk. First, we look at industry and firm-level risk exposures and cost of capital. Then, we analyse the ability of our model to price the dissecting anomalies portfolios of Clarke (2022).

5.1 Industry Costs of Capital

The estimation of industry cost of capital constitutes an interesting and challenging case to apply our methodology. Although the risk exposures of industry portfolios are difficult to estimate (Fama and French, 1997), they do offer some of the usual diversification benefits of noise reduction in stock return data, allowing us to better capture the exposure to systematic risks. Moreover, they also exhibit significant cross-sectional and time-series variation in industry characteristics and consumption risk exposures (Dittmar and Lundblad, 2017).

We compute the ex ante consumption betas from firm characteristics for three industry classification schemes: the Fama-French 12-industry and 48-industry classification schemes of Fama and French (1997), and the Global Industrial Classification System (GISC) of Standard and Poor obtained from Compustat. Tables 16, 17, and 18 provide the average value-weighted and equally-weighted returns for these industry portfolios, as well as some summary statistics regarding the fitted ex ante betas for our three models and consumption risk factors. We observe some variation of the average risk exposures across industries, with stable signs. Consumption risk exposures with respect to aggregate consumption and cross-sectional kurtosis seem to exhibit less time variation relative to their magnitude. We also observe that aggregate consumption risk exposures are more stable in the 4M model than in the other two models.

Table 19 displays the average firm-characteristic implied risk premiums of industry portfolios with their standard deviations as predicted by the different models. The risk premiums are estimated for each pricing model using the ex ante betas for consumption risk exposure and the price of risk estimated in the second step of Fama-MacBeth regressions with $K = 4$ in Tables 6, 11, and 9. The risk premiums predicted by the 4M model tend to be smaller and more volatile than in the other two models. These patters are stable across our different industry specifications.

Figure 5 present the time series evolution of the ex ante consumption betas for the Frama French 12 industry portfolios[5]. On the one hand, we observe a co-movement in the industries' ex ante consumption risk exposures which also seem to follow the business cycles. In particular, we see that the consumption risk exposures drastically increase during recessions period and that they drop in the wake of recessions. On the other hand, there is a variation of consumption risk exposures across industries and it changes through time; some industries becoming more or less exposed to consumption risks compared to others before. The cross-sectional variation of risk exposures to aggregate consumption growth across industry, as observed on panels (a), (b), and (f) looks small relative to the time variation and diminishes through time, which may be a feature of increased estimation stability due to expansion of the rolling window used for estimation. More cross-industry variation can be found between risk exposures to other cross-sectional moments of consumption and the PCA-based factors. This suggests that expanding the aggregate consumption CAPM model to the heterogenous agent framework better captures the variation of risk exposures across assets, which improves consumption-based estimation of cost of capital at the industry level, whilst aggregate consumption is mostly fit for analysing time variation in the cost of capital.

Figure 6 show the time series evolution of the annualized risk premium in the Fama French 12 industry portfolios, estimated using ex ante consumption betas. We see that the risk premium patterns are similar across models: they all tend to follow the business cycle, with increasing risk premiums during recession periods, in particular during the 2008 recession. The 4M model shows a dip in risk premiums between 2004 and 2008, before returning to a path similar to the other models. A comparison with Figure 5 shows that this shock was mainly caused by a shock in the cross-sectional skew.

[5] The consumption risk exposures for the GICS 24 industry portfolios and the Fama french 48 industry portfolios exhibit very similar patterns.

5.2 Benchmarking

As a benchmark for computing the cost of equity, we compute the industry risk premium following the same procedure but replacing the ex ante consumption beta by rolling window betas for the market return and the factors of the Fama French 5-factor[6] (FF5) model (Fama and French, 2008). Figure 7 presents the risk premium predicted for the Fama French 12 Industry portfolios using the FF5 model. As we see, the estimated risk premiums do not seem to move with business cycles and remain counter-intuitively negative for some industries such as Business Equipment, providing further evidence that these factors despite their statistical performance do not reflect any macroeconomic conditions.

In order to analyse the performance of our models in pricing the cross-section, we also compute consumption risk exposures at the firm level. We consider several model specifications, combining our own consumption-based pricing factors and those from the Fama French 5-factor (FF5) model to see which survive in a horse race framework. For this, we also compute exposures to the FF5 factors at the firm level using rolling windows regressions of asset returns.

Table 21 show the results of second step Fama and MacBeth (1973) regressions for the ex ante betas relating to the various factors in our paper. Panel (a), (b), (c), and (d) present the results respectively for the Fama-French 12 industry portfolios, for the GICS 24 industry groups, for the Fama-French 48 industry portfolios, and for the firm-level (disaggregate) regression. Each panel contains the coefficients estimated on the eight models that we consider. The first two are single factor models: the AG model[7] and the standard CAPM model with respectively aggregate consumption growth and the market excess return as unique pricing factor. We then consider a two-factor model denoted AG-CAPM with proxied aggregate consumption growth and excess market return as pricing factors. The fourth and fifth models are the 4M and PCA models considered previously. Finally, we look at the Fama-French five-factors model, and consider extensions of the

[6]We only present this model as it is expected to yield the best results compared to CAPM or Fama French three factor model.

[7]This differs from the standard CCAPM model because we mediate consumption risk exposures through firm characteristics.

4M and PCA models with these factors included.

Panel (a) shows that at the Fama-French 12 industry portfolios level, the estimated price of risk for aggregate consumption growth is positive and statistically significant, whereas the market price of risk is unexpectedly negative, and it is not statistically significant. When putting the aggregate consumption growth and market risk exposures together, the price of risk remains positive and statistically significant for the former whereas it is still negative and insignificant for the latter. The consumption factors are also statistically significant in the 4M model, whereas the Fama-French 5 factors are not statistically significant. When we combine all factors, the exposures to consumption risks remain priced in cross-section, and seem to outcompete the Fama-French 5 factors. Panel (b) and Panel (c) show similar results but for the GICS 24 industry portfolios and the Fama-French 48 industry portfolios.

The results obtained at the firm-level and displayed on Panel (d) are similar to the ones at the portfolio levels, indicating that forming portfolios is not required to omit diversifiable idiosyncratic risk for showing the validity of the consumption factors. Our consumption risk exposures are priced in cross-section, whereas the market and Fama-French factor risk exposures seem to drop out. The exposures to aggregate consumption growth and the cross-sectional skewness of consumption growth are positively priced, whereas the cross-sectional variance and kurtosis consumption growth, have negative factor prices.

5.3 Dissecting Anomalies Portfolios

To conclude our paper, we analyse whether the dissecting anomalies portfolios of Clarke (2022) are priced accurately by our three consumption risk models (AC, 4M, and PCA), and whether we capture their return variation. We compute the firm-characteristic implied ex ante betas for these portfolios. We then use these together with estimated risk exposures for the FF5 factor model from Fama and French (2008) to run second-stage Fama and MacBeth (1973) regressions.

Table 22 and Figure 4 show results of these regressions. Each panel presents a total of four specifications for different return horizons of K quarters over which returns and consumption are compounded. The first panel represents the classical Consumption-CAPM (CCAPM), the second panel considers the first four cross-sectional moments of consumption as relevant pricing factors, the third panel uses the factors of the PCA model, and the fourth panel shows the performance of the Fama French 5-factor model as a benchmark. From these results, we see that whilst the classical CCAPM is still statistically significant for most return horizons, the multi-factor models performs similar to the FF5 model, and outperforms the FF5 model on longer return horizons. Intercepts, which according to theory should equal zero, are lower and less significant for the consumption-based models from $K \geq 2$. The adjusted R^2 values are very high for all multi-factor models. Notably, for the model based on the four cross-sectional moments, Kurtosis seems to be the most statistically significant risk factor for excess returns, having a large negative factor loading. This constitutes further evidence that the cross-sectional distribution of consumption is relevant for asset pricing.

6 Conclusion

The cross-sectional moments of consumption growth contain relevant pricing information for the cross-section of stocks. We show that the first four cross-sectional moments of household consumption growth as provided by the CEX survey explain a large share of the variation of expected returns across anomaly portfolios. Moreover, we show that these effects can effectively be captured by using firm-characteristics as proxies for predicting firm exposures to consumption risks. This helps to understand how consumers' idiosynchratic shocks translate into asset prices through firms'characteristics, and to bridge the gap between the heterogeneous agents consumption-based asset pricing literature, explaining asset prices from the investment behaviour of individual households, and the empirical relation between firm characteristics and stock returns. Indeed, we find that firms' exposures to the consumption risks as predicted by firms' characteristics comove with business cycles consistently with the sign of the risk prices. Exposures to aggregate consumtiopn growth and to the consumption growth cross-sectional skewness are countercyclical, whereas exposures to cross-sectional variance and cross-sectional kurtosis of consumption growth are procyclical.

By showing that the higher cross-sectional moments of consumption effectively explain the variation of expected returns across portfolios sorted by predicted return based on stock characteristics, we confirm that these factors do not only capture the systematic risk components across assets, but also that the captured risks are actually priced on the market. In Fama-MacBeth-style regressions with ex ante consumption risk exposures and firms exposures to common pricing factors such as market return or Fama-French 5 factors, we show that the consumption factors remain priced even when returns are adjusted for standard risks as implied by common pricing factors model. This confirms the validity of the mapping between consumption risk exposures and firm characteristics, and solidifies cross-sectional distribution of household's consumption idiosyncratic risk as a core determinant of asset prices.

Further research could look at how the firm exposures to consumption idiosyncratic risks react to the government provision of partial insurance against household shocks in times of high risk such as during the covid-19 pandemic, and how this translates into asset prices.

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A Tables

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
				$K = 1$			
Agg. Cons	144	0.000	0.004	−0.012	−0.002	0.002	0.009
Variance	144	0.000	0.036	−0.057	−0.020	0.014	0.309
Skew	144	−0.000	0.291	−0.814	−0.194	0.204	0.926
Kurtosis	144	0.000	0.824	−1.804	−0.618	0.641	1.954
PCA x	144	−0.016	1.414	−7.722	−0.921	1.011	3.079
Δx	144	−0.003	1.591	−8.107	−0.731	0.829	7.593
				$K = 2$			
Agg. Cons	143	0.00001	0.003	−0.010	−0.001	0.002	0.006
Variance	143	0.0003	0.029	−0.055	−0.017	0.013	0.180
Skew	143	0.001	0.210	−0.513	−0.143	0.127	0.686
Kurtosis	143	−0.017	0.647	−1.697	−0.532	0.423	1.530
PCA x	143	0.00001	1.506	−3.177	−1.101	0.997	4.833
Δx	143	−0.012	1.086	−4.094	−0.586	0.566	5.088
				$K = 4$			
Agg. Cons	141	−0.00001	0.003	−0.010	−0.001	0.002	0.006
Variance	141	0.0004	0.023	−0.034	−0.015	0.008	0.096
Skew	141	0.001	0.149	−0.399	−0.095	0.082	0.629
Kurtosis	141	−0.018	0.508	−1.082	−0.428	0.377	1.258
PCA x	141	−0.00001	1.695	−4.161	−1.358	1.256	3.358
Δx	141	−0.009	0.726	−3.083	−0.440	0.359	3.586
				$K = 8$			
Agg. Cons	137	−0.0001	0.003	−0.007	−0.002	0.002	0.004
Variance	137	0.001	0.018	−0.032	−0.011	0.008	0.046
Skew	137	0.004	0.107	−0.183	−0.065	0.049	0.428
Kurtosis	137	−0.013	0.456	−0.920	−0.326	0.387	0.783
PCA x	137	−0.0001	1.916	−3.512	−1.516	1.730	3.129
Δx	137	−0.011	0.494	−2.226	−0.276	0.265	2.374

Table 1: **Summary statistics of consumption data**

Summary statistics for the innovations of aggregate consumption growth, the cross-sectional Variance, Skewness and Kurtosis of consumption growth. x denotes the first principal component of the consumption growth cross-sectional second to fourth moments. Δx denotes the change in x between two consecutive periods. The sample consists of quarterly data from 1984Q1 to 2019Q4.

Variable	Label	Definition
Monthly return	MTR	MTR=(((((prccm/ajexm)*trfm)/((lag(prccm)/lag(ajexm) *shift(trfm)))) - 1)). The gross and net returns are respectively denoted R and r.
Log Market Capitalization	MV	This variable is computed as the natural logarithm of the product of common shares outanding and the stock close price. The deciles portfolios of quarter t are formed using previous quarter log-market capitalization.
Log Book-to-Market ratio	BM	This variable is computed as the natural logarithm of the ratio of book value of equity by market capitalization. We used Compustat item *ceq* to compute common equity value. The deciles portfolios of quarter t are formed using previous quarter value of the book-to-market ratio.
Asset growth	AG	This variable is computed as quarterly growth rate of the total asset. AG = (atq-lag(atq))/lag(atq). The deciles portfolios of quarter t are formed using previous quarter value.
Total Accruals	TA	Following Sloan (1996), this variable is computed as change in current assets minus change in cash/cash equivalents minus change in current liabilities, minus change in debt included in current liabilities, minus change in income taxes payable, minus depreciation and amortization expense. TA = ((actq-lag(actq)) - (chq-lag(chq)))-((lctq-lag(lctq)) - (dlcq-lag(dlcq))-(txpq-lag(txpq)))-dpq.
Operating Profitability	OP	OP is computed as the ratio of gross profit to total assets. Gross profit is calculated as follows GP = Income Before Extraodinary Items (ibq) + Selling, General and Administrative Expenses (xsgaq) + Depreciation and Amortization (dpq) + Interest and Related Expense (xintq) + Income Taxes (txtq) - Non-operating Inconme (nopiq) - Special items (spiq) + Noncontrolling Interest (miiq).
Stock Issues	SI	This variable is computed using the common shares oustanding and the lagged value is used to form quintile portfolios.

Table 2: **Variable definitions**

Decile or Quintile	AG	BM	MV	P12	SI	TA	OP
1	2.60	2.46	2.34	-1.44	2.64	2.78	-0.62
2	3.19	2.47	2.47	-0.02	2.36	3.03	0.78
3	2.40	1.91	2.36	1.02	2.36	3.13	1.07
4	2.36	2.36	2.00	1.31	2.60	2.27	1.55
5	2.16	2.21	1.47	1.90	2.28	1.57	1.93
6	2.14	2.00	0.97	2.25		1.57	2.44
7	2.27	2.31	0.49	2.32		1.40	3.01
8	2.27	2.18	0.15	2.90		2.18	2.49
9	1.85	2.36	-0.35	2.91		2.01	3.21
10	1.29	2.91	0.70	4.34		2.20	3.68

Table 3: **Average returns of characteristic portfolios**

This table shows average returns on a set of 65 characteristic portfolios formed on the basis of seven firm characteristics: asset growth (AG), book-to-market ratio (BM), market value (MV), past 12-month return (P12), net stock issues (SI), total accruals (TA), and operating profitability (OP). We form value-weighted portfolios based on quintiles of net stock issues and deciles of the other six characteristics. Portfolios are formed based on one-period lagged characteristics and returns are value-weighted using the one-period lagged market value of firms. Returns are deflated to real terms using the personal consumption expenditure deflator from the national income and product accounts at the Bureau of Economic Analysis. The sample consists of quarterly data from 1984Q1 to 2019Q4.

Dep. Variable	Level	Slope	Curve
(Intercept)	0.01	0.00	-0.00
	(0.04)	(0.01)	(0.01)
$u_{\text{Agg. Cons.}}$	40.15**	-5.51	1.75
	(13.44)	(3.97)	(2.79)
$u_{\text{CS-Variance}}$	12.52	2.13	-0.76
	(12.31)	(3.64)	(2.56)
$u_{\text{CS-Skew}}$	2.93	-0.80	3.58
	(11.42)	(3.37)	(2.37)
$u_{\text{CS-Kurtosis}}$	31.03*	6.15$^{\bullet}$	-1.57
	(12.19)	(3.60)	(2.53)
N	142	142	142
R^2	0.10	0.036	0.020

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; $\bullet$ $p < 0.1$.

Table 4: **Level, Slope and Curve factors regressed on innovations to consumption factors**

This table shows the regression of the Level, Slope and Curve factors on innovations in the cross-sectional moments of consumption, estimated as the residuals of these moments from the VAR model specified in equation (3). The sample consists of quarterly data from 1984Q1 to 2019Q4.

Decile or Quintile	AG	BM	MV	P12	SI	TA	OP
Panel A: Estimates							
1	3.05	-0.31	3.45	-1.01	3.41	2.76	4.86
2	3.96	0.97	1.16	1.10	1.60	2.77	2.48
3	3.76	2.26	1.56	1.70	2.12	3.28	3.76
4	3.40	0.35	1.35	0.03	2.40	3.20	2.55
5	2.79	1.96	1.82	0.62	3.19	2.11	3.35
6	3.18	2.27	0.87	1.29		3.17	1.72
7	1.23	2.83	1.85	0.86		0.79	3.29
8	0.29	2.76	1.45	3.64		0.68	1.49
9	2.59	2.79	2.31	5.09		2.02	1.51
10	1.91	3.57	3.57	6.94		2.98	2.55
Panel B: t -statistics							
1	0.93	-0.05	1.50	-0.16	0.88	0.98	1.14
2	1.49	0.21	0.37	0.23	0.51	0.88	0.66
3	1.45	0.73	0.48	0.52	0.64	1.07	1.29
4	1.62	0.16	0.39	0.01	0.72	0.89	0.87
5	1.34	0.67	0.54	0.21	1.38	0.51	1.14
6	1.19	0.91	0.22	0.53		0.88	0.58
7	0.45	1.14	0.41	0.32		0.31	1.20
8	0.10	1.10	0.31	1.39		0.20	0.60
9	0.79	1.10	0.47	1.82		0.68	0.59
10	0.66	0.95	0.69	1.86		1.42	0.76

Table 5: **Time series regressions of 65 characteristics portfolios on aggregate consumption growth**

This table shows the slope coefficients and t-statistics of the time series univariate regressions of 65 characteristics sorted portfolio returns on aggregate consumption growth. The estimated model is specified in equation (4), where $K = 4$ implying a yearly return horizon, $R_{i,t-j}$ is the gross real return on portfolio i in period $t-j$, $R_{f,t-j}$ is the gross risk-free rate, $\hat{\eta}_{m,t-j}$ is the innovation in aggregate consumption growth, measured as the real per capita consumption growth rate in non-durable goods and services using NIPA tables from the Bureau of Economic Analysis. The sample consists of quarterly data from 1984Q1 to 2019Q4.

	$K=1$	$K=2$	$K=4$	$K=8$
γ_0	1.63	1.01	0.82	0.63
t-FM	(2.74)	(1.67)	(1.49)	(1.37)
t-Sh	(2.71)	(1.41)	(1.10)	(0.91)
γ_m	0.06	0.21	0.26	0.28
t-FM	(0.66)	(2.58)	(3.32)	(4.69)
t-Sh	(0.65)	(2.21)	(2.51)	(3.24)
Adj. R^2	-0.88	5.37	8.77	8.93
Critical Value	(4.36)	(4.40)	(4.61)	(4.44)

Table 6: **Cross-sectional regression of expected excess returns on aggregate consumption betas**

This table shows the slope coefficients and t-statistics of the cross-sectional regression of 65 characteristics sorted portfolios excess returns on the betas associated with aggregate consumption growth. The estimated model is specified in equation (5). $\bar{R}_i$ is the average real quarterly return on a set of 65 portfolios formed on asset growth, book-to-market ratio, market value, past 12-month return, net stock issues, total accruals and operating profitability, and $\bar{R}_f$ is the real quarterly compounded return on a Treasury bill closest to one month to maturity. The independent variable $\beta_{i,m}$ is the slope coefficient from the first-stage time series regressions of portfolio returns on aggregate consumption growth, measured as the real per capita consumption growth rate in non-durable goods and services using NIPA tables from the Bureau of Economic Analysis. The standard errors account for both time and cross-sectional correlations of the error terms. The t-statistics with and without first stage Shanken (1992) correction for generated regressors are provided in brackets below the coefficient estimate. Beneath the adjusted R^2, we present 95% critical values for the adjusted R^2 from five thousand Monte-Carlo simulations under the null that the independent variables have no explanatory power for the returns. The sample consists of quarterly data from 1984Q1 to 2019Q4.

	$K=1$	$K=2$	$K=4$	$K=8$
γ_0	1.38	0.73	0.56	0.35
t-FM	(2.23)	(1.14)	(0.97)	(0.72)
t-Sh	(2.02)	(0.79)	(0.58)	(0.38)
γ_m	0.17	0.34	0.39	0.41
t-FM	(1.81)	(3.76)	(4.39)	(5.90)
t-Sh	(1.65)	(2.66)	(2.67)	(3.24)
Adj. R^2	4.77	19.33	24.97	23.20
Critical Value	(5.57)	(5.43)	(5.46)	(5.32)

Table 7: **Cross-sectional regression of expected excess returns on aggregate consumption betas – without operating profitability**

This table shows the slope coefficients and t-statistics of the cross-sectional regression of 55 characteristics sorted portfolios excess returns on the betas associated with aggregate consumption growth. The estimated model is specified in equation (5). $\bar{R}_i$ is the average real quarterly return on a set of 55 portfolios formed on asset growth, book-to-market ratio, market value, past 12-month return, net stock issues and total accruals (excluding operating profitability), and $\bar{R}_f$ is the real quarterly compounded return on a Treasury bill closest to one month to maturity. The independent variable $\beta_{i,m}$ is the slope coefficient from the first-stage time series regressions of portfolio returns on aggregate consumption growth, measured as the real per capita consumption growth rate in non-durable goods and services using NIPA tables from the Bureau of Economic Analysis. The standard errors account for both time and cross-sectional correlations of the error terms. The t-statistics with and without first stage Shanken (1992) correction for generated regressors are provided in brackets below the coefficient estimate. Beneath the adjusted R^2, we present 95% critical values for the adjusted R^2 from five thousand Monte-Carlo simulations under the null that the independent variables have no explanatory power for the returns. The sample consists of quarterly data from 1984Q1 to 2019Q4.

Portfolios	Slope coefficients				t-statistics			
	β_m	β_v	β_s	β_k	$t(\beta_m)$	$t(\beta_v)$	$t(\beta_s)$	$t(\beta_k)$
AG1	5.04	2.74	1.89	6.38	1.44	1.50	0.65	2.11
AG2	5.23	1.09	0.80	3.94	1.93	0.93	0.37	1.63
AG3	4.84	1.73	0.66	3.87	1.64	2.04	0.43	1.77
AG4	3.96	2.07	-1.06	3.74	1.61	2.48	-0.77	2.00
AG5	3.68	0.75	-1.23	3.98	1.47	0.83	-0.86	1.79
AG6	3.58	0.83	-1.10	2.48	1.11	1.04	-0.85	1.27
AG7	2.32	1.03	1.29	3.02	0.81	1.23	0.74	1.74
AG8	1.07	2.03	-0.20	3.78	0.33	2.12	-0.12	1.88
AG9	3.84	2.71	-0.52	5.83	1.14	1.54	-0.24	1.88
AG10	3.17	2.38	-1.17	6.10	1.08	1.77	-0.57	1.88
BM1	1.38	2.90	1.85	5.63	0.24	0.89	0.63	1.26
BM2	1.15	4.13	-1.17	4.04	0.23	1.28	-0.43	1.00
BM3	3.84	0.44	-1.03	5.68	1.14	0.32	-0.48	2.00
BM4	0.75	3.34	0.22	3.22	0.31	1.47	0.15	1.32
BM5	2.37	1.85	-1.72	3.61	0.67	0.91	-0.83	1.89
BM6	3.21	2.27	0.06	4.25	1.10	2.64	0.04	2.42
BM7	3.79	0.78	-1.06	4.07	1.32	1.08	-1.20	2.01
BM8	3.59	1.05	-0.93	3.80	1.23	1.21	-0.69	2.07
BM9	3.55	0.27	-0.64	2.85	1.18	0.27	-0.30	1.17
BM10	5.09	1.82	1.15	4.88	1.39	0.99	0.38	1.73
MV1	4.33	1.22	-0.30	3.61	1.63	1.49	-0.19	1.69
MV2	2.26	2.33	0.16	4.66	0.66	2.18	0.10	2.07
MV3	2.96	2.68	1.08	5.14	0.84	2.26	0.65	2.20
MV4	2.80	3.22	0.71	5.89	0.76	2.30	0.36	2.42
MV5	3.12	4.54	0.71	6.32	0.89	2.83	0.32	2.46
MV6	2.28	4.59	0.95	6.53	0.56	2.15	0.36	2.25
MV7	3.20	5.68	1.47	6.67	0.68	2.39	0.53	1.99
MV8	3.13	5.75	1.03	8.02	0.65	1.86	0.34	2.32
MV9	3.98	7.36	1.32	8.85	0.79	2.36	0.41	2.56
MV10	5.81	7.48	1.65	10.39	1.06	2.00	0.50	2.78
P121	1.43	4.62	-0.59	10.63	0.24	1.27	-0.17	1.99
P122	1.63	4.60	-2.29	6.14	0.33	1.38	-0.82	1.27
P123	2.53	3.09	-1.82	5.74	0.73	1.37	-0.92	1.68
P124	0.39	1.07	-1.38	2.73	0.12	0.76	-1.00	1.06
P125	1.55	0.89	-0.88	3.94	0.48	1.01	-0.65	2.00
P126	1.89	0.69	-1.65	3.36	0.69	0.86	-1.31	1.94
P127	1.80	0.70	-0.89	3.87	0.58	0.78	-0.54	1.82
P128	4.38	1.75	0.81	2.78	1.44	1.64	0.45	1.29
P129	6.83	1.46	2.65	4.29	2.29	1.61	1.32	1.78
P1210	9.08	3.11	2.61	6.57	2.17	1.50	0.78	1.75
SI1	5.68	-2.44	-0.03	5.12	1.46	-1.52	-0.01	1.87
SI2	2.98	2.58	0.93	5.14	0.87	2.70	0.53	2.57
SI3	3.53	2.56	0.77	5.30	0.97	2.16	0.41	2.30
SI4	3.81	2.46	0.44	5.49	1.07	2.21	0.23	2.30
SI5	4.07	1.45	-0.20	3.70	1.53	1.73	-0.13	1.73
TA1	3.88	1.00	0.90	3.34	1.22	1.14	0.51	1.67
TA2	3.89	3.08	0.40	5.06	1.13	3.13	0.21	2.63
TA3	4.29	2.97	0.96	4.27	1.20	2.83	0.46	2.17
TA4	4.41	3.36	-0.37	6.03	1.13	2.33	-0.17	2.34
TA5	4.18	1.68	1.32	6.34	0.93	1.19	0.63	3.13
TA6	4.58	3.59	0.42	6.25	1.14	2.25	0.19	2.41
TA7	2.16	2.31	1.00	4.89	0.81	1.65	0.48	1.98
TA8	2.30	2.28	0.94	5.63	0.65	1.89	0.50	2.70
TA9	3.13	1.42	0.03	4.18	0.96	1.50	0.02	1.96
TA10	3.68	1.39	-0.74	3.49	1.53	1.66	-0.52	1.66
OP1	6.75	6.50	0.93	9.20	1.87	2.48	0.24	2.45
OP2	3.27	4.11	-1.06	5.75	0.90	1.84	-0.49	1.64
OP3	4.16	3.06	0.21	3.04	1.09	1.78	0.10	1.16
OP4	3.37	2.72	1.34	3.28	0.99	1.64	0.75	1.26
OP5	4.56	2.45	1.23	4.35	1.36	2.04	0.77	1.85
OP6	2.69	2.20	-0.05	4.34	0.79	1.31	-0.03	1.91
OP7	4.14	1.49	-0.41	3.75	1.33	1.20	-0.20	1.72
OP8	2.67	1.63	0.01	4.55	0.97	1.42	0.00	1.91
OP9	2.60	2.14	-0.09	4.70	1.10	1.67	-0.04	2.34
OP10	3.20	-0.23	0.56	1.39	0.91	-0.18	0.25	0.70

Table 8: **Time series regressions of 65 characteristics portfolios on the cross-sectional moments of consumption growth**

This table shows the slope coefficients and t-statistics of the time series multiple regressions of 65 characteristics sorted portfolio returns on the cross-sectional moments of consumption growth (mean, variance, skewness and kurtosis). The estimated model is specified in equation (6) where $K = 4$, implying a yearly return horizon, $R_{i,t-j}$ is the gross real return on portfolio i in period $t-j$, $R_{f,t-j}$ is the gross risk-free rate, $\hat{\eta}_{m,t-j}$ is the innovation in aggregate consumption growth, and $\hat{\eta}_{v,t-j}$, $\hat{\eta}_{s,t-j}$ and $\hat{\eta}_{k,t-j}$ stand for the innovations in the cross-sectional variance, skew and kurtosis of consumption growth respectively. Aggregate consumption growth is measured as the real per capita consumption growth rate in non-durable goods and services using NIPA tables from the Bureau of Economic Analysis. The higher-order cross-sectional moments of consumption growth are computed using the CEX survey data. The innovations in the higher-order moments are rescaled to have the same variance as the consumption growth mean in order to make the risk exposures and risk premiums directly comparable. The sample consists of quarterly data from 1984Q1 to 2019Q4.

	$K=1$	$K=2$	$K=4$	$K=8$
γ_0	3.14	3.10	3.16	2.35
t-FM	(5.08)	(6.06)	(7.14)	(6.09)
t-Sh	(3.80)	(3.92)	(3.67)	(3.72)
γ_m	0.03	-0.02	0.15	0.27
t-FM	(0.38)	(-0.29)	(1.88)	(3.72)
t-Sh	(0.29)	(-0.20)	(1.03)	(2.41)
γ_v	0.06	-0.09	-0.20	-0.21
t-FM	(0.56)	(-1.01)	(-2.30)	(-2.59)
t-Sh	(0.43)	(-0.68)	(-1.24)	(-1.66)
γ_s	0.10	0.20	0.26	-0.04
t-FM	(0.91)	(2.20)	(3.22)	(-0.43)
t-Sh	(0.70)	(1.47)	(1.75)	(-0.27)
γ_k	-0.30	-0.31	-0.37	-0.27
t-FM	(-3.10)	(-3.20)	(-4.33)	(-4.53)
t-Sh	(-2.37)	(-2.14)	(-2.34)	(-3.04)
Adj. R^2	54.09	66.69	67.98	56.08
Critical Value	(8.46)	(8.74)	(8.76)	(8.76)

Table 9: **Cross-sectional regression of expected excess returns on betas of cross-sectional moments of consumption growth**

This table shows the slope coefficients and t-statistics of the cross-sectional regression of 65 characteristics sorted portfolios excess returns on the betas associated with the cross-sectional moments of consumption growth. The estimated model is specified in equation (7). $\bar{R}_i$ is the average real quarterly return on a set of 65 portfolios formed on asset growth, book-to-market ratio, market value, past 12-month return, net stock issues, total accruals and operating profitability, and $\bar{R}_f$ is the real quarterly compounded return on a Treasury bill closest to one month to maturity. The independent variables, $\beta_{i,m}$, $\beta_{i,v}$, $\beta_{i,s}$, and $\beta_{i,k}$ are the slope coefficients from the first-stage multivariate time series regressions of portfolio returns on the aggregate average consumption growth and its cross-sectional variance, skewness and kurtosis respectively. Aggregate consumption growth is measured as the real per capita consumption growth rate in non-durable goods and services using NIPA tables from the Bureau of Economic Analysis. The cross-sectional moments of consumption growth are computed using the CEX survey data. The standard errors account for both time and cross-sectional correlations of the error terms. The t-statistics with and without first stage Shanken (1992) correction for generated regressors are provided in brackets below the coefficient estimate. Beneath the adjusted R^2, we present 95% critical values for the adjusted R^2 from five thousand Monte-Carlo simulations under the null that the independent variables have no explanatory power for the returns. The sample consists of quarterly data from 1984Q1 to 2019Q4.

	$K=1$	$K=2$	$K=4$	$K=8$
γ_0	2.81	2.77	3.04	2.25
t-FM	(4.17)	(4.89)	(6.53)	(5.18)
t-Sh	(3.09)	(3.38)	(3.28)	(2.94)
γ_m	0.16	0.11	0.25	0.37
t-FM	(1.65)	(1.41)	(2.96)	(4.78)
t-Sh	(1.26)	(1.02)	(1.57)	(2.86)
γ_v	0.09	-0.00	-0.07	-0.09
t-FM	(0.85)	(-0.0)5	(-0.82)	(-1.11)
t-Sh	(0.64)	(-0.03)	(-0.43)	(-0.66)
γ_s	-0.00	0.09	0.24	-0.04
t-FM	(-0.04)	(0.99)	(2.96)	(-0.42)
t-Sh	(-0.03)	(0.70)	(1.57)	(-0.24)
γ_k	-0.32	-0.34	-0.46	-0.37
t-FM	(-3.03)	(-3.30)	(-4.92)	(-5.82)
t-Sh	(-2.29)	(-2.34)	(-2.58)	(-3.60)
Adj. R^2	56.22	67.91	76.25	60.53
Critical Value	(10.62)	(10.12)	(10.43)	(10.40)

Table 10: **Cross-sectional regression of expected excess returns on betas of cross-sectional moments of consumption growth – without operating profitability**

This table shows the slope coefficients and t-statistics of the cross-sectional regression of 55 characteristics sorted portfolios excess returns on the betas associated with the cross-sectional moments of consumption growth. The estimated model is specified in equation (7). $\bar{R}_i$ is the average real quarterly return on a set of 55 portfolios formed on asset growth, book-to-market ratio, market value, past 12-month return, net stock issues and total accruals (excluding operating profitability), and $\bar{R}_f$ is the real quarterly compounded return on a Treasury bill closest to one month to maturity. The independent variables, $\beta_{i,m}$, $\beta_{i,v}$, $\beta_{i,s}$, and $\beta_{i,k}$ are the slope coefficients from the first-stage multivariate time series regressions of portfolio returns on the aggregate average consumption growth and its cross-sectional variance, skewness and kurtosis respectively. Aggregate consumption growth is measured as the real per capita consumption growth rate in non-durable goods and services using NIPA tables from the Bureau of Economic Analysis. The cross-sectional moments of consumption growth are computed using the CEX survey data. The standard errors account for both time and cross-sectional correlations of the error terms. The t-statistics with and without first stage Shanken (1992) correction for generated regressors are provided in brackets below the coefficient estimate. Beneath the adjusted R^2, we present 95% critical values for the adjusted R^2 from five thousand Monte-Carlo simulations under the null that the independent variables have no explanatory power for the returns. The sample consists of quarterly data from 1984Q1 to 2019Q4.

	$K=1$	$K=2$	$K=4$	$K=8$
γ_0	3.50	2.49	1.77	1.04
t-FM	(5.45)	(4.72)	(3.81)	(2.48)
t-Sh	(2.55)	(2.09)	(1.41)	(0.43)
γ_m	0.10	0.24	0.32	0.31
t-FM	(1.14)	(2.93)	(4.06)	(4.93)
t-Sh	(0.56)	(1.36)	(1.56)	(0.92)
γ_x	-0.78	-0.64	-0.52	0.20
t-FM	(-3.42)	(-3.58)	(-3.64)	(2.30)
t-Sh	(-1.62)	(-1.60)	(-1.37)	(0.42)
$\gamma_{\Delta x}$	-0.50	-0.53	-0.67	1.29
t-FM	(-2.99)	(-2.92)	(-2.97)	(5.01)
t-Sh	(-1.42)	(-1.31)	(-1.10)	(0.88)
Adj. R^2	39.75	33.58	14.66	27.13
Critical Value	(7.41)	(7.64)	(7.65)	(7.70)

Table 11: **Cross-sectional regression of expected excess returns on betas of the principal component of cross-sectional consumption growth**

This table shows the slope coefficients and t-statistics of the cross-sectional regression of 65 characteristics sorted portfolios excess returns on the betas associated with the cross-sectional moments of consumption growth. The estimated model is specified in equation (8). $\bar{R}_i$ is the average real quarterly return on a set of 65 portfolios formed on asset growth, book-to-market ratio, market value, past 12-month return, net stock issues, total accruals and operating profitability, and $\bar{R}_f$ is the real quarterly compounded return on a Treasury bill closest to one month to maturity. The independent variables, $\beta_{i,m}$, $\beta_{i,x}$, and $\beta_{i,\Delta x}$ are the slope coefficients from the first-stage multivariate time series regressions of portfolio returns on the aggregate average consumption growth, the first principal component of the cross-sectional variance, skewness and kurtosis, of consumption growth, and the first difference of this principal component respectively. Aggregate consumption growth is measured as the real per capita consumption growth rate in non-durable goods and services using NIPA tables from the Bureau of Economic Analysis. The cross-sectional moments of consumption growth are computed using the CEX survey data. The standard errors account for both time and cross-sectional correlations of the error terms. The t-statistics with and without first stage Shanken (1992) correction for generated regressors are provided in brackets below the coefficient estimate. Beneath the adjusted R^2, we present 95% critical values for the adjusted R^2 from five thousand Monte-Carlo simulations under the null that the independent variables have no explanatory power for the returns. The sample consists of quarterly data from 1984Q1 to 2019Q4.

	$K=1$	$K=2$	$K=4$	$K=8$
γ_0	3.36	2.24	1.78	0.58
t-FM	(4.79)	(4.04)	(3.76)	(1.27)
t-Sh	(2.23)	(1.72)	(1.10)	(0.43)
γ_m	0.17	0.35	0.49	0.39
t-FM	(1.85)	(3.84)	(5.08)	(6.60)
t-Sh	(0.90)	(1.70)	(1.53)	(2.37)
γ_x	-0.78	-0.65	-0.72	-0.06
t-FM	(-3.15)	(-3.41)	(-4.13)	(-0.64)
t-Sh	(-1.48)	(-1.47)	(-1.22)	(-0.22)
γ_{Dx}	-0.51	-0.52	-0.84	0.49
t-FM	(-2.70)	(-2.70)	(-3.18)	(1.78)
t-Sh	(-1.27)	(-1.16)	(-0.93)	(0.60)
Adj. R^2	47.03	48.12	37.98	23.18
Critical Value	(8.92)	(8.82)	(8.52)	(9.08)

Table 12: **Cross-sectional regression of expected excess returns on betas of the principal component of cross-sectional consumption growth – without operating profitability**

This table shows the slope coefficients and t-statistics of the cross-sectional regression of 55 characteristics sorted portfolios excess returns on the betas associated with the cross-sectional moments of consumption growth. The estimated model is specified in equation (8). $\bar{R}_i$ is the average real quarterly return on a set of 55 portfolios formed on asset growth, book-to-market ratio, market value, past 12-month return, net stock issues and total accruals (excluding operating profitability), and $\bar{R}_f$ is the real quarterly compounded return on a Treasury bill closest to one month to maturity. The independent variables, $\beta_{i,m}$, $\beta_{i,x}$, and $\beta_{i,\Delta x}$ are the slope coefficients from the first-stage multivariate time series regressions of portfolio returns on the aggregate average consumption growth, the first principal component of the cross-sectional variance, skewness and kurtosis, of consumption growth, and the first difference of this principal component respectively. Aggregate consumption growth is measured as the real per capita consumption growth rate in non-durable goods and services using NIPA tables from the Bureau of Economic Analysis. The cross-sectional moments of consumption growth are computed using the CEX survey data. The standard errors account for both time and cross-sectional correlations of the error terms. The t-statistics with and without first stage Shanken (1992) correction for generated regressors are provided in brackets below the coefficient estimate. Beneath the adjusted R^2, we present 95% critical values for the adjusted R^2 from five thousand Monte-Carlo simulations under the null that the independent variables have no explanatory power for the returns. The sample consists of quarterly data from 1984Q1 to 2019Q4.

	AG	BM	MV	P12	SI	TA	OP	Adj.R^2
Panel A: AC Model								
δ_m	0.15	-0.41	0.46	0.17	-0.24	-0.01	-0.57	13.22
t.stat	6.79	-14.88	13.75	8.06	-8.29	-0.36	-23.20	
Panel B: 4M Model								
δ_m	0.17	-0.38	-0.07	0.31	-0.17	0.01	-0.43	10.78
t.stat	6.60	-11.88	-1.77	12.85	-5.05	0.22	-14.74	
δ_v	0.05	-0.83	-1.37	0.04	0.47	-0.05	-0.35	46.52
t.stat	2.89	-38.98	-53.52	2.55	20.77	-3.24	-18.26	
δ_s	0.02	-0.39	-0.49	0.30	-0.01	-0.03	0.25	27.05
t.stat	0.90	-16.97	-17.72	17.67	-0.32	-1.38	12.11	
δ_k	0.10	0.36	-1.23	-0.05	0.20	0.03	-0.30	40.58
t.stat	3.80	11.23	-32.12	-2.23	5.82	1.26	-10.42	
Panel C: PCA Model								
δ_m	0.16	-0.23	0.34	0.21	-0.27	0.01	-0.52	9.01
t.stat	6.66	-7.88	9.38	9.29	-8.53	0.33	-19.44	
δ_x	0.03	0.55	-0.17	0.11	-0.20	0.05	0.23	19.39
t.stat	1.63	23.33	-5.99	6.32	-8.11	2.76	10.68	
$\delta_{\Delta x}$	0.02	-0.19	-0.16	0.00	0.22	-0.03	-0.19	10.49
t.stat	1.54	-16.01	-10.62	0.54	17.07	-2.77	-17.38	

Table 13: **Relation between portfolio betas and characteristics**

This table presents results of panel data regressions of betas on characteristics at the portfolio level. The estimated model is given in equation (9), where $\hat{\beta}_{p,t}$ is the portfolio exposure to cumulative consumption risk estimated using data from time 0 through time t and $\mathbf{X}_{p,t}$ is a vector of portfolio characteristics at time t. In Panel A, we only consider the $\hat{\beta}_{p,t}$ coefficients of aggregate consumption growth innovations. In Panel B, the cross-sectional moments of consumption growth are used to measure consumption risks. Therefore, we have multiple $\hat{\beta}_{i,p,t}$ coefficients and corresponding δ_i, where $i = m$ for aggregate consumption growth, $i = v$ for its cross-sectional variance, $i = s$ for its cross-sectional skewness and $i = k$ for its cross-sectional kurtosis. Panel C presents the estimated δ_i for the consumption risk exposures obtained in a model with aggregate consumption growth, the first principal component of the higher order cross-sectional moments of consumption growth ($i = x$), and the first difference of this principal component ($i = \Delta x$). The characteristics are those used to form portfolios: asset growth (AG), book-to-market ratio (BM), market value (MV), past 12-month return (P12), stock issuance (SI), total accruals (TA), and operating profitability (OP). The table reports estimates $\hat{\delta}$ and associated t-statistics. The sample consists of quarterly data from 1984Q1 to 2019Q4.

	AG	BM	MV	P12	SI	TA	Adj.R^2
Panel A: Representative Agent Model							
δ_m	0.18	-0.21	0.43	0.17	-0.16	-0.02	9.13
t.stat	7.27	-8.26	11.56	7.28	-4.81	-0.88	
Panel B: Heterogenous Agent Model							
δ_m	0.19	-0.27	-0.08	0.32	-0.13	0.02	9.73
t.stat	6.68	-9.12	-1.95	12.20	-3.47	0.81	
δ_v	0.06	-0.71	-1.48	0.03	0.49	-0.10	47.91
t.stat	3.27	-36.57	-52.25	1.64	19.73	-5.07	
δ_s	0.01	-0.60	-0.51	0.33	-0.06	0.01	29.43
t.stat	0.63	-27.69	-16.34	17.18	-2.18	0.39	
δ_k	0.10	0.59	-1.23	-0.07	0.17	0.06	41.44
t.stat	3.64	20.29	-29.16	-2.58	4.46	2.14	
Panel C: Heterogenous Agent Model - Household consumption risk							
δ_m	0.19	-0.05	0.33	0.21	-0.21	0.01	4.35
t.stat	7.05	-1.85	8.17	8.58	-5.85	0.51	
δ_x	0.02	0.49	-0.09	0.13	-0.28	0.12	20.81
t.stat	0.83	22.27	-2.95	6.42	-9.78	5.58	
δ_{Dx}	0.04	-0.13	-0.20	0.00	0.25	-0.06	8.83
t.stat	3.62	-11.59	-12.26	0.03	16.82	-5.61	

Table 14: **Relation between portfolio betas and characteristics – without operating profitability**

This table presents results of panel data regressions of betas on characteristics at the portfolio level. The estimated model is given in equation (9), where $\hat{\beta}_{p,t}$ is the portfolio exposure to cumulative consumption risk estimated using data from time 0 through time t and $\mathbf{X}_{p,t}$ is a vector of portfolio characteristics at time t. In Panel A, we only consider the $\hat{\beta}_{p,t}$ coefficients of aggregate consumption growth innovations. In Panel B, the cross-sectional moments of consumption growth are used to measure consumption risks. Therefore, we have multiple $\hat{\beta}_{i,p,t}$ coefficients and corresponding δ_i, where $i = m$ for aggregate consumption growth, $i = v$ for its cross-sectional variance, $i = s$ for its cross-sectional skewness and $i = k$ for its cross-sectional kurtosis. Panel C presents the estimated δ_i for the consumption risk exposures obtained in a model with aggregate consumption growth, the first principal component of the higher order cross-sectional moments of consumption growth ($i = x$), and the first difference of this principal component ($i = \Delta x$). The characteristics are those used to form portfolios: asset growth (AG), book-to-market ratio (BM), market value (MV), past 12-month return (P12), stock issuance (SI) and total accruals (TA) (excluding operating profitability). The table reports estimates $\hat{\delta}$ and associated t-statistics. The sample consists of quarterly data from 1984Q1 to 2019Q4.

Quintile	Mean	Mean β	Ex post β	Quintile	Mean	Mean β	Ex post β
Panel A: AC Model				Panel B: 4M Model			
Exposure to Aggregate consumption growth				Exposure to Aggregate consumption growth			
1	1.98	3.21	4.57	1	2.26	3.30	6.06
2	1.92	2.29	3.83	2	2.05	2.65	3.31
3	2.65	1.58	3.86	3	1.66	2.14	4.92
4	2.03	0.90	3.27	4	2.33	1.71	4.38
5	2.70	-0.48	6.60	5	1.48	-1.67	5.55
Panel C: PCA Model							
Exposure to Aggregate consumption growth				Exposure to cross-sectional variance			
1	2.12	4.14	7.93	1	1.08	4.95	-0.60
2	1.79	3.11	6.89	2	2.05	1.52	-2.14
3	2.46	2.39	7.58	3	2.43	0.74	2.08
4	2.13	1.74	7.90	4	2.21	-0.02	1.16
5	1.32	-2.60	9.17	5	2.02	-1.16	1.03
Exposure to first principal component				Exposure to cross-sectional skewness			
1	2.09	2.81	3.91	1	3.35	0.25	3.28
2	1.88	2.02	1.34	2	2.86	-0.62	3.19
3	2.65	1.74	1.30	3	2.85	-1.04	1.28
4	2.37	1.44	1.82	4	2.22	-1.45	1.16
5	1.70	-0.89	4.28	5	1.65	-2.58	0.43
Exposure to change in principal component				Exposure to cross-sectional kurtosis			
1	1.92	1.02	-0.60	1	1.48	6.51	8.84
2	2.12	0.54	-2.41	2	1.08	5.50	8.17
3	2.48	0.43	-0.34	3	1.68	4.59	6.25
4	2.59	0.36	-1.87	4	1.86	3.69	4.72
5	1.41	-0.73	-3.12	5	2.00	1.30	3.32

Table 15: **Portfolios sorted on implied firm-level ex ante betas**

This table presents the value-weighted portfolios of stocks sorted by ex ante predicted exposure to consumption risks. Panel A shows the results for the representative agent model with aggregate consumption growth as the unique pricing factor. Panel B shows the results for the 4M model with aggregate consumption growth, cross-sectional variance, skewness, and kurtosis as pricing factors. Panel C shows the results for the PCA model with aggregate consumption growth, the principal component of the cross-sectional moments of consumption growth and the first differences of this principal component as pricing factors. The ex ante β coefficients are obtained by using the linear relationship between characteristics and consumption risk exposures estimated at the portfolio level from equation (9) to predict the consumption risk exposures at the firm level based on observed firm characteristics. Then the firms are sorted into quintile portfolios based on their ex ante predicted beta. The columns display the portfolio quintile, the average return (equally-weighted) for each portfolio, the average ex ante beta (used for sorting), and the average ex post beta. The ex post beta is computed by regressing firm returns on the consumption risk factors of their respective models.

				(a) CCAPM		(b) HCCAPM								(c) HPCA					
	Industry	$\bar{R}_{VW}$	$\bar{R}_{EW}$	β_c	σ_{β_c}	β_m	σ_{β_m}	β_v	σ_{β_v}	β_s	σ_{β_s}	β_k	σ_{β_k}	β_m	σ_{β_m}	β_x	σ_{β_x}	β_{Dx}	$\sigma_{\beta_{Dx}}$
1	Consumer Nondurables	1.85	1.94	1.29	0.88	1.98	0.70	0.79	0.89	-1.00	0.89	5.01	2.46	2.19	0.85	1.96	0.82	0.19	0.27
2	Consumer Durables	1.23	2.02	1.34	0.83	2.02	0.97	0.76	0.92	-1.04	1.11	4.94	2.22	2.26	0.94	1.95	0.82	0.22	0.28
3	Manufacturing	1.75	2.28	1.36	0.83	2.03	0.63	0.75	0.87	-1.05	0.90	5.04	2.24	2.27	0.78	1.98	0.77	0.21	0.26
4	Energy	0.70	1.98	1.58	0.76	2.11	0.85	0.67	0.98	-1.20	1.06	4.85	2.06	2.42	0.84	1.89	0.82	0.21	0.27
5	Chemicals	1.71	2.33	1.63	0.91	2.11	0.84	0.68	0.95	-1.00	1.05	4.23	2.47	2.41	0.90	1.77	0.87	0.25	0.25
6	Business Equipment	2.53	2.48	1.29	0.87	1.98	0.62	1.08	0.90	-0.67	0.97	4.58	2.29	2.05	0.82	1.72	0.79	0.20	0.29
7	Telecom	1.36	3.12	1.80	0.79	2.13	1.13	0.63	0.97	-1.25	1.27	3.89	2.21	2.51	1.01	1.73	0.94	0.30	0.30
8	Utils	1.37	2.59	1.91	0.62	2.28	0.38	0.09	0.72	-1.66	0.76	4.26	1.60	2.91	0.67	2.36	0.61	0.49	0.29
9	Shops	2.33	1.92	1.27	0.87	1.95	0.69	0.72	0.85	-1.01	0.89	5.00	2.36	2.18	0.80	2.00	0.82	0.18	0.25
10	Healthcare	1.91	2.25	1.30	0.83	2.01	0.70	1.36	0.95	-0.28	1.09	4.08	2.24	1.94	0.81	1.55	0.79	0.19	0.31
11	Finance	1.37	2.12	1.38	0.87	1.99	0.66	0.72	0.87	-1.22	0.91	5.51	2.09	2.26	0.92	1.91	0.72	0.24	0.36
12	Other	1.58	1.99	1.39	0.75	2.05	0.76	0.91	0.94	-0.92	1.03	4.97	2.16	2.23	0.83	1.86	0.80	0.22	0.29

Table 16: **Average returns and consumption risk exposures of FF12 industry portfolios**

This table shows average returns and ex ante consumption risk exposures of Fama-French 12 industry portfolios. Panel (a) presents the ex ante consumption risk exposure as predicted by the CCAPM model with aggregate consumption growth as the single pricing factor. Panel (b) presents the ex ante consumption risk exposures as predicted by the Heterogenous agent CCAPM model with aggregate consumption growth, cross-sectional variance, skewness and kurtosis as the pricing factors. Panel (c) presents the ex ante consumption risk exposures as predicted by the Heterogenous agent CCAPM model with aggregate consumption growth, the principal component of cross-sectional variance, skewness and kurtosis, and its change as the pricing factors. The standard deviation of the consumption risk exposure is provided in the column next to it. The ex ante betas at the portoflio level are computed as value weighted averages of the firms ex ante risk betas. The firm ex ante betas are computed using the firm characteristics and the model in equation (9) estimated at the portfolio level. The sample consists of quarterly data from 1984Q1 to 2019Q4.

				(a) CCAPM		(b) HCCAPM								(c) HPCA					
	Industry	$\bar{R}_{VW}$	$\bar{R}_{EW}$	β_c	σ_{β_c}	β_m	σ_{β_m}	β_v	σ_{β_v}	β_s	σ_{β_s}	β_k	σ_{β_k}	β_m	σ_{β_m}	β_x	σ_{β_x}	β_{Dx}	$\sigma_{\beta_{Dx}}$
1	Energy	0.73	2.09	1.56	0.75	2.06	1.04	0.68	1.07	-1.10	1.24	4.68	2.27	2.35	1.11	1.86	0.95	0.21	0.35
2	Materials	0.77	2.28	1.52	0.73	2.09	0.66	0.78	0.95	-1.06	1.05	4.81	2.06	2.35	0.73	1.85	0.78	0.24	0.25
3	Capital Goods	1.82	2.24	1.31	0.81	1.99	0.61	0.85	0.92	-0.97	0.87	5.03	2.23	2.20	0.81	1.92	0.77	0.21	0.28
4	Commercial & Professional Services	1.76	1.85	1.24	0.83	1.94	0.51	0.97	0.83	-0.83	0.83	5.15	2.26	2.06	0.72	1.87	0.77	0.17	0.24
5	Transportation	1.73	1.95	1.48	0.77	2.09	0.85	0.50	0.75	-1.28	0.88	4.88	2.14	2.47	0.82	2.08	0.68	0.28	0.26
6	Automobiles & Components	1.32	3.07	1.44	0.80	2.03	1.20	0.68	1.00	-1.20	1.26	5.00	2.18	2.33	1.05	1.95	0.84	0.22	0.30
7	Consumer Durables & Apparel	1.20	1.51	1.07	0.82	1.91	0.76	0.83	0.81	-1.04	0.91	5.62	2.34	2.09	0.79	2.04	0.77	0.18	0.26
8	Consumer Services	4.63	2.11	1.33	0.82	2.02	0.65	0.99	0.88	-0.79	0.96	4.84	2.41	2.14	0.77	1.81	0.82	0.22	0.26
9	Retailing	2.95	1.76	1.23	0.87	1.90	0.80	0.63	0.80	-1.01	0.95	4.85	2.47	2.15	0.81	2.00	0.86	0.18	0.26
10	Food & Staples Retailing	2.08	2.16	1.48	0.89	1.96	0.50	0.36	0.84	-1.31	0.69	4.36	2.22	2.39	0.79	1.98	0.81	0.25	0.27
11	Food, Beverage & Tobacco	1.99	2.08	1.38	0.87	1.99	0.61	0.78	0.99	-1.01	0.94	4.74	2.50	2.22	0.86	1.88	0.86	0.21	0.29
12	Household & Personal Products	2.08	2.18	1.01	0.89	1.89	0.85	1.24	0.94	-0.44	1.10	4.51	2.80	1.85	0.89	1.77	0.95	0.20	0.32
13	Health Care Equipment & Services	2.55	2.45	1.25	0.82	2.01	0.59	1.16	0.98	-0.54	1.03	4.44	2.20	2.04	0.79	1.70	0.78	0.24	0.28
14	Pharmaceuticals, Biotechnology & Life Sciences	1.79	2.21	1.48	0.81	2.03	0.73	1.39	0.96	-0.21	1.12	3.76	2.24	1.95	0.82	1.46	0.78	0.18	0.33
15	Banks	1.24	2.83	0.85	0.33	1.88	0.46	0.89	0.74	-1.21	0.65	6.06	1.75	2.07	0.75	1.76	0.60	0.17	0.31
16	Diversified Financials	1.59	2.22	1.34	0.87	2.04	0.78	0.67	0.91	-1.21	1.07	5.18	2.41	2.35	0.88	1.97	0.73	0.29	0.35
17	Insurance	1.32	2.53	1.01	0.62	2.15	0.54	0.15	0.77	-1.77	0.76	5.19	1.73	2.75	0.75	2.31	0.59	0.46	0.31
18	Software & Services	2.60	2.66	1.30	0.85	1.99	0.65	1.19	0.91	-0.47	1.00	4.19	2.33	2.01	0.81	1.62	0.78	0.22	0.29
19	Technology Hardware & Equipment	1.50	2.12	1.09	0.83	1.88	0.52	1.11	0.90	-0.80	0.92	5.28	2.19	1.95	0.76	1.85	0.77	0.16	0.26
20	Semiconductors & Semiconductor Equipment	2.54	3.55	1.53	0.77	2.02	0.53	0.79	0.79	-1.00	0.80	4.49	2.08	2.26	0.70	1.76	0.71	0.25	0.24
21	Telecommunication Services	0.96	3.28	1.71	0.78	2.05	0.93	0.68	1.00	-1.26	1.22	3.82	2.24	2.42	0.91	1.69	0.99	0.31	0.34
22	Media & Entertainment	2.67	2.47	1.66	0.83	2.12	0.98	0.66	0.93	-1.05	1.16	4.12	2.22	2.44	0.93	1.79	0.83	0.28	0.28
23	Utilities	1.34	2.53	1.69	0.60	2.22	0.45	0.17	0.77	-1.61	0.79	4.39	1.58	2.81	0.69	2.29	0.63	0.45	0.29
24	Real Estate	1.57	2.12	1.59	0.82	2.14	0.56	0.47	0.77	-1.30	0.80	4.78	1.91	2.55	0.70	2.11	0.60	0.36	0.27

Table 17: **Average returns and consumption risk exposures of GICS industry portfolios**

This table shows average returns and ex ante consumption risk exposures of 24 industry groups are defined according to Global Industrial Classification Standard Codes (GICS) obtained from Compustat. Panel (a) presents the ex ante consumption risk exposure as predicted by the CCAPM model with aggregate consumption growth as the single pricing factor. Panel (b) presents the ex ante consumption risk exposures as predicted by the Heterogenous agent CCAPM model with aggregate consumption growth, cross-sectional variance, skewnness and kurtosis as the pricing factors. Panel (c) presents the ex ante consumption risk exposures as predicted by the Heterogenous agent CCAPM model with aggregate consumption growth, the principal component of cross-sectional variance, skewnness and kurtosis, and its change as the pricing factors. The standard deviation of the consumption risk exposure is provided in the column next to it. The ex ante betas at the portoflio level are computed as value weighted averages of the firms ex ante risk betas. The firm ex ante betas are computed using the firm characteristics and the model in equation (9) estimated at the portfolio level. The sample consists of quarterly data from 1984Q1 to 2019Q4.

				(a) CCAPM		(b) HCCAPM								(c) HPCA					
	Industry	$\bar{R}_{VW}$	$\bar{R}_{EW}$	β_c	σ_{β_c}	β_m	σ_{β_m}	β_v	σ_{β_v}	β_s	σ_{β_s}	β_k	σ_{β_k}	β_m	σ_{β_m}	β_x	σ_{β_x}	β_{Dx}	$\sigma_{\beta_{Dx}}$
1	Agriculture	1.86	0.55	1.16	0.82	1.99	0.98	0.90	0.84	-1.04	1.07	5.74	2.56	2.16	0.84	2.04	0.85	0.17	0.27
2	Food Products	1.55	2.36	1.36	0.87	2.01	0.44	0.76	0.85	-0.97	0.83	4.76	2.37	2.24	0.75	1.92	0.76	0.21	0.24
3	Candy & Soda	1.74	2.33	1.61	0.90	2.04	0.59	0.86	1.22	-0.80	1.10	3.63	1.93	2.24	1.00	1.57	0.86	0.25	0.33
4	Beer & Liquor	2.03	1.93	1.38	0.95	1.96	0.67	0.76	1.24	-1.12	0.88	4.81	2.58	2.22	1.11	1.93	1.03	0.17	0.41
5	Tobacco Products	3.40	4.10	2.54	0.46	2.22	0.60	0.73	1.16	-0.99	1.25	1.43	2.68	2.61	0.88	1.06	1.41	0.40	0.41
6	Recreation	1.45	1.04	0.88	0.76	1.84	0.50	1.07	0.83	-0.85	0.91	5.67	2.20	1.91	0.73	2.04	0.79	0.15	0.26
7	Entertainment	2.29	1.91	1.46	0.81	2.06	1.05	0.93	0.90	-0.87	1.10	4.93	2.33	2.22	0.94	1.79	0.86	0.20	0.30
8	Printing and Publishing	0.04	1.60	1.38	0.80	2.03	0.46	0.71	0.76	-0.98	0.81	4.67	2.29	2.29	0.69	1.95	0.73	0.23	0.24
9	Consumer Goods	2.02	1.95	1.28	0.94	1.96	0.58	0.79	0.86	-0.93	0.96	4.77	2.82	2.16	0.78	1.94	0.87	0.19	0.26
10	Apparel	1.41	2.17	1.15	0.86	1.93	1.08	0.77	0.76	-0.97	0.92	5.37	2.39	2.11	0.93	2.05	0.78	0.16	0.24
11	Healthcare	1.39	2.51	1.22	0.82	1.99	0.49	1.05	0.90	-0.72	0.93	4.86	2.03	2.08	0.75	1.82	0.71	0.21	0.25
12	Medical Equipment	2.79	2.33	1.21	0.82	1.99	0.52	1.31	0.96	-0.36	0.98	4.32	2.19	1.94	0.76	1.62	0.78	0.22	0.28
13	Pharmaceutical Products	1.75	2.13	1.39	0.83	2.02	0.80	1.46	0.94	-0.15	1.13	3.79	2.25	1.90	0.85	1.45	0.79	0.17	0.34
14	Chemicals	1.42	2.31	1.72	0.85	2.15	0.89	0.61	0.94	-1.08	1.03	4.28	2.24	2.49	0.88	1.76	0.84	0.26	0.24
15	Rubber and Plastic Products	1.77	2.36	1.02	0.78	1.94	0.80	1.09	0.80	-0.77	0.89	5.45	2.14	2.00	0.80	2.01	0.78	0.18	0.28
16	Textiles	0.35	1.38	1.13	0.74	1.89	0.44	0.75	0.71	-1.29	0.74	6.36	2.04	2.13	0.58	2.18	0.73	0.11	0.20
17	Construction Materials	1.57	2.24	1.32	0.77	2.01	0.49	0.77	0.81	-1.06	0.86	5.24	2.13	2.24	0.69	2.00	0.71	0.20	0.24
18	Construction	1.26	1.80	1.26	0.69	2.02	0.55	0.67	0.80	-1.23	0.81	5.58	2.05	2.31	0.71	2.06	0.65	0.24	0.27
19	Steel Works Etc	0.39	2.05	1.54	0.76	2.08	0.64	0.42	0.77	-1.49	0.85	5.40	1.96	2.51	0.71	2.14	0.72	0.20	0.28
20	Fabricated Products	0.20	1.52	1.09	0.70	1.88	0.35	0.98	0.65	-1.03	0.58	6.17	1.91	2.00	0.59	2.04	0.66	0.10	0.20
21	Machinery	2.31	2.46	1.38	0.85	2.03	0.51	0.80	0.86	-0.95	0.81	4.82	2.21	2.25	0.76	1.92	0.72	0.21	0.24
22	Electrical Equipment	1.48	1.87	1.17	0.81	1.96	0.69	1.12	0.91	-0.74	1.00	5.11	2.27	2.03	0.81	1.85	0.82	0.20	0.29
23	Automobiles and Trucks	1.29	3.06	1.48	0.79	2.09	1.22	0.67	0.97	-1.15	1.27	4.72	2.16	2.40	1.04	1.94	0.85	0.25	0.30
24	Aircraft	2.20	2.53	1.55	0.84	2.16	0.35	0.51	0.88	-1.24	0.76	4.32	2.25	2.57	0.74	2.01	0.74	0.33	0.26
25	Shipbuilding, Railroad Equipment	2.18	2.00	1.24	0.72	2.03	0.29	0.82	0.76	-0.97	0.73	5.04	1.71	2.25	0.58	1.97	0.56	0.25	0.20
26	Defense	3.29	3.26	1.55	0.67	2.18	0.57	0.80	0.77	-0.75	0.83	3.75	2.19	2.41	0.71	1.84	0.65	0.30	0.23
27	Precious Metals	-0.64	2.02	1.51	0.62	2.12	0.51	1.01	0.89	-0.89	0.97	4.81	1.77	2.27	0.60	1.74	0.70	0.23	0.23
28	Mines	-0.04	2.36	1.45	0.64	2.11	0.61	1.15	1.00	-0.75	1.11	4.77	1.86	2.18	0.69	1.67	0.77	0.24	0.27
29	Coal	-0.79	1.72	1.66	0.71	2.20	0.59	0.82	0.90	-0.89	1.05	4.51	2.45	2.42	0.61	1.75	0.86	0.24	0.24
30	Petroleum and Natural Gas	0.70	1.98	1.57	0.76	2.10	0.86	0.66	0.98	-1.21	1.06	4.86	2.04	2.42	0.85	1.90	0.82	0.21	0.27
31	Utilities	1.37	2.59	1.91	0.62	2.28	0.38	0.09	0.72	-1.66	0.76	4.26	1.60	2.91	0.67	2.36	0.61	0.49	0.29
32	Communication	1.36	3.12	1.80	0.79	2.13	1.13	0.63	0.97	-1.25	1.27	3.89	2.21	2.51	1.01	1.73	0.94	0.30	0.30
33	Personal Services	1.87	1.89	1.32	0.75	2.02	0.42	0.88	0.77	-0.83	0.86	4.72	2.32	2.19	0.68	1.88	0.72	0.22	0.25
34	Business Services	2.89	2.53	1.31	0.85	2.00	0.71	1.10	0.89	-0.57	1.01	4.39	2.34	2.06	0.84	1.69	0.80	0.21	0.30
35	Computers	0.52	2.07	1.27	0.85	1.95	0.58	1.13	0.92	-0.66	0.98	4.55	2.22	2.01	0.81	1.69	0.78	0.19	0.29
36	Electronic Equipment	2.73	2.43	1.27	0.86	1.95	0.51	0.96	0.87	-0.91	0.88	5.04	2.20	2.10	0.77	1.83	0.76	0.19	0.25
37	Measuring and Control Equipment	2.67	2.71	1.21	0.92	1.94	0.51	1.06	0.87	-0.71	0.79	4.98	2.24	2.02	0.80	1.81	0.73	0.18	0.25
38	Business Supplies	1.69	1.88	1.45	0.84	2.06	1.04	0.48	0.83	-1.34	1.01	5.18	2.37	2.44	0.94	2.09	0.89	0.20	0.27
39	Shipping Containers	1.56	2.05	1.98	0.67	2.26	0.29	0.43	0.70	-1.18	0.78	3.91	1.97	2.70	0.50	1.71	0.77	0.32	0.20
40	Transportation	3.46	2.30	1.59	0.74	2.12	0.83	0.49	0.75	-1.27	0.90	4.90	2.16	2.51	0.80	2.05	0.74	0.24	0.27
41	Wholesale	1.67	2.13	1.23	0.84	1.94	0.52	0.82	0.86	-1.00	0.85	5.40	2.25	2.13	0.74	2.02	0.76	0.16	0.23
42	Retail	2.44	1.91	1.33	0.89	1.95	0.85	0.53	0.80	-1.09	0.92	4.70	2.37	2.25	0.85	2.02	0.86	0.19	0.26
43	Restaurants, Hotels, Motels	2.35	1.48	1.20	0.86	2.00	0.56	1.04	0.90	-0.81	0.90	5.06	2.46	2.11	0.77	1.90	0.84	0.22	0.27
44	Banking	1.22	2.73	1.28	0.82	1.90	0.50	0.88	0.75	-1.19	0.69	5.97	1.82	2.10	0.77	1.78	0.61	0.17	0.32
45	Insurance	1.67	2.74	1.61	0.82	2.20	0.67	0.20	0.81	-1.67	0.88	5.04	1.83	2.76	0.81	2.28	0.69	0.44	0.33
46	Real Estate	0.99	1.24	1.11	0.79	1.92	0.63	1.14	0.90	-0.87	0.98	5.97	2.12	1.97	0.75	1.75	0.69	0.14	0.29
47	Trading	1.48	1.56	1.43	0.89	2.07	0.85	0.61	0.97	-1.12	1.17	4.76	2.39	2.39	1.12	2.00	0.86	0.31	0.39
48	Other	1.02	1.23	1.16	0.80	1.97	0.97	1.14	1.18	-0.87	1.20	5.41	2.20	2.04	1.07	1.82	0.96	0.20	0.41

Table 18: **Average returns and consumption risk exposures of FF48 industry portfolios**

This table shows average returns and ex ante consumption risk exposures of Fama-French 48 industry portfolios. Panel (a) presents the ex ante consumption risk exposure as predicted by the CCAPM model with aggregate consumption growth as the single pricing factor. Panel (b) presents the ex ante consumption risk exposures as predicted by the Heterogenous agent CCAPM model with aggregate consumption growth, cross-sectional variance, skewness and kurtosis as the pricing factors. Panel (c) presents the ex ante consumption risk exposures as predicted by the Heterogenous agent CCAPM model with aggregate consumption growth, the principal component of cross-sectional variance, skewness and kurtosis, and its change as the pricing factors. The standard deviation of the consumption risk exposure is provided in the column next to it. The ex ante betas at the portoflio level are computed as value weighted averages of the firms ex ante risk betas. The firm ex ante betas are computed using the firm characteristics and the model in equation (9) estimated at the portfolio level. The sample consists of quarterly data from 1984Q1 to 2019Q4.

		CCAPM		HCCAPM		HPCA	
	Industry	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
	(a) Fama French 12 Industry Portfolios						
1	Consumer.Nondurables	6.93	1.77	6.64	2.14	7.13	1.68
2	Consumer.Durables	6.92	1.70	5.37	1.98	6.77	1.50
3	Manufacturing	6.99	1.62	6.34	2.01	6.97	1.30
4	Energy	6.69	1.84	5.23	1.74	7.12	1.39
5	Chemicals	7.10	1.66	6.71	1.90	7.37	1.46
6	Business.Equipment	6.65	1.78	6.08	1.98	7.04	1.51
7	Telecom	6.71	1.62	5.57	1.94	6.98	1.42
8	Utils	7.01	1.63	5.47	1.97	6.41	1.29
9	Shops	6.76	1.86	6.50	2.42	7.18	1.49
10	Healthcare	6.74	1.87	6.59	1.98	7.12	1.48
11	Finance	7.01	1.66	4.95	1.70	6.35	1.28
12	Other	6.88	1.60	5.36	2.02	6.67	1.42
	(b) GICS 24 Industry Portfolios						
1	Energy	6.79	1.75	5.36	1.80	7.06	1.41
2	Materials	6.97	1.60	5.75	1.84	7.19	1.32
3	Capital Goods	6.67	1.85	5.33	2.47	6.75	1.50
4	Commercial Services	6.94	1.68	6.19	1.92	6.94	1.34
5	Transportation	7.12	1.67	6.23	2.28	6.57	1.40
6	Automobiles Components	7.01	1.72	5.20	2.09	6.77	1.57
7	Consumer Durables	6.87	1.69	6.05	2.16	6.72	1.38
8	Consumer Services	7.02	1.71	6.87	2.32	7.01	1.46
9	Retailing	6.99	1.74	6.93	2.43	7.34	1.58
10	Food and Staples Retail	6.61	2.03	5.86	2.59	7.12	1.51
11	Food, Beverage and Tobacco	6.84	1.94	6.66	2.19	7.19	1.75
12	Household Products	7.01	1.70	7.42	2.00	7.16	1.77
13	Healthcare	7.07	1.73	6.59	1.92	6.98	1.53
14	Pharmaceuticals	6.75	1.85	6.56	2.06	7.16	1.52
15	Banks	6.64	1.49	4.41	1.68	6.25	1.29
16	Diversified Financials	7.16	1.64	5.81	1.69	6.39	1.33
17	Insurance	7.08	1.66	5.07	1.80	6.31	1.31
18	Software Services	6.58	1.72	6.21	2.22	7.00	1.66
19	Technology Hardware	6.59	1.73	5.72	1.78	6.98	1.62
20	Semiconductors	6.57	1.74	5.76	2.07	7.16	1.29
21	Telecommunications	6.59	1.76	5.69	1.92	6.94	1.50
22	Media	7.03	1.68	6.06	2.28	7.11	1.35
23	Utilities	7.10	1.63	5.35	1.94	6.35	1.31
24	Real Estate	7.03	1.65	5.85	2.08	6.48	1.39

	Industry	CCAPM		HCCAPM		HPCA	
		Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
	(a) Fama French 12 Industry Portfolios						
1	Agriculture	7.00	1.77	6.56	2.27	7.23	2.00
2	Food Products	7.07	1.67	6.66	1.75	6.98	1.55
3	Candy & Soda	6.54	2.20	6.42	2.50	7.05	2.05
4	Beer & Liquor	6.89	1.87	6.69	2.22	7.30	1.58
5	Tobacco Products	6.85	2.17	7.30	3.27	7.78	2.22
6	Recreation	6.96	1.65	6.03	2.09	6.59	1.56
7	Entertainment	6.97	1.67	6.73	2.16	7.28	1.48
8	Printing and Publishing	6.80	1.53	5.91	1.72	6.66	1.30
9	Consumer Goods	6.99	1.70	7.04	1.97	7.03	1.74
10	Apparel	6.88	1.71	6.41	2.16	6.76	1.40
11	Healthcare	7.01	1.69	5.95	1.93	6.95	1.53
12	Medical Equipment	7.04	1.77	6.84	1.84	6.99	1.54
13	Pharmaceutical Products	6.74	1.84	6.58	2.09	7.16	1.52
14	Chemicals	7.12	1.70	6.39	1.96	7.57	1.39
15	Rubber and Plastic Products	6.79	1.64	6.16	2.18	6.76	1.52
16	Textiles	6.80	1.72	5.17	2.05	6.73	1.39
17	Construction Materials	6.91	1.64	5.98	1.74	6.67	1.45
18	Construction	6.83	1.67	5.60	2.52	6.46	1.40
19	Steel Works Etc	6.97	1.64	4.97	1.78	6.74	1.31
20	Fabricated Products	6.53	1.68	5.17	2.04	6.44	1.47
21	Machinery	7.06	1.67	6.36	1.98	6.90	1.40
22	Electrical Equipment	6.90	1.63	5.87	1.81	6.73	1.43
23	Automobiles and Trucks	7.00	1.72	5.23	2.09	6.74	1.56
24	Aircraft	7.18	1.67	6.90	2.37	7.05	1.32
25	Shipbuilding, Railroad Equipment	6.75	1.60	5.54	2.00	6.51	1.30
26	Defense	7.19	1.65	7.94	3.27	6.40	1.30
27	Precious Metals	6.91	1.65	5.46	1.87	7.04	1.26
28	Mines	6.70	1.47	5.05	1.61	6.91	1.48
29	Coal	6.76	1.68	5.78	1.98	6.85	1.48
30	Petroleum and Natural Gas	6.75	1.75	5.25	1.78	7.11	1.43
31	Utilities	7.12	1.64	5.50	2.01	6.39	1.33
32	Communication	6.69	1.74	5.60	1.98	6.97	1.46
33	Personal Services	6.90	1.61	6.55	2.07	6.58	1.35
34	Business Services	6.72	1.76	6.38	2.11	7.00	1.60
35	Computers	6.53	1.75	5.77	1.77	6.66	1.46
36	Electronic Equipment	6.69	1.69	5.82	1.95	7.28	1.48
37	Measuring and Control Equipment	7.07	1.68	6.58	1.92	6.96	1.49
38	Business Supplies	7.11	1.63	6.65	2.28	7.52	1.40
39	Shipping Containers	6.96	1.65	6.18	2.22	7.05	1.53
40	Transportation	7.11	1.65	6.14	2.19	6.69	1.35
41	Wholesale	6.95	1.67	6.18	2.02	6.85	1.45
42	Retail	6.82	1.88	6.47	2.55	7.28	1.55
43	Restaurants, Hotels, Motels	7.04	1.77	7.07	2.60	6.85	1.54
44	Banking	6.69	1.50	4.59	1.66	6.26	1.29
45	Insurance	7.10	1.66	5.25	1.84	6.44	1.35
46	Real Estate	6.69	1.76	5.40	2.01	6.44	1.40
47	Trading	7.04	1.64	5.76	1.90	6.41	1.35
48	Other	6.56	1.92	4.39	2.11	6.40	1.43

Table 19: **Average risk premiums of industry portfolios**

This table shows average risk premiums of industry portfolios and their standard deviations. The risk premium is computed using ex ante consumption risk exposures and the price of risk estimated in the second stage Fama-MacBeth regressions for K=4 (see Tables 6, 9 11) Panel (a), (b), and (c) present the average risk premium respectively for the Fama French 12 industry portfolios, the GICS 24 Industry portfolios, and the Fama French 48 industry portfolios. The standard deviation of the risk premium is provided in the column next to it. The ex ante betas at the portoflio level are computed as value weighted averages of the firms ex ante risk betas. The firm ex ante betas are computed using the firm characteristics and the model in equation (9) estimated at the portfolio level. The sample consists of quarterly data from 1984Q1 to 2019Q4.

	CAPM		FF3						FF3									
(a) Fama French 12 Industry portfolios																		
	β_{Mkt}	$\sigma_{\beta_{Mkt}}$	β_{Mkt}	$\sigma_{\beta_{Mkt}}$	β_{HML}	$\sigma_{\beta_{HML}}$	β_{SMB}	$\sigma_{\beta_{SMB}}$	β_{Mkt}	$\sigma_{\beta_{Mkt}}$	β_{HML}	$\sigma_{\beta_{HML}}$	β_{SMB}	$\sigma_{\beta_{SMB}}$	β_{CMA}	$\sigma_{\beta_{CMA}}$	β_{RMW}	$\sigma_{\beta_{RMW}}$
1	0.95	0.56	-0.09	0.34	0.17	0.54	0.59	0.34	-0.40	0.31	0.12	0.57	0.84	0.20	-0.29	0.50	-0.77	0.16
2	-0.76	0.38	0.66	0.48	-0.12	0.35	-0.45	0.34	1.01	0.45	-0.01	0.30	-0.69	0.28	0.81	0.33	0.51	0.31
3	0.29	0.69	-0.05	0.48	-0.11	0.17	0.15	0.29	0.22	0.38	-0.07	0.17	-0.23	0.19	0.21	0.34	0.64	0.18
4	0.08	0.89	-0.00	0.73	1.34	0.20	0.02	0.26	0.30	0.51	1.32	0.19	-0.25	0.29	0.07	0.67	0.60	0.33
5	0.95	0.66	0.03	0.30	0.94	0.36	0.68	0.36	0.88	0.23	1.05	0.31	-0.38	0.41	0.73	0.34	1.50	0.19
6	-1.22	0.36	-2.22	0.87	-1.70	0.47	-2.44	0.59	-1.99	1.04	-1.73	0.56	-2.04	0.34	-0.84	0.60	0.68	0.27
7	0.27	1.30	-0.05	0.58	-0.47	0.45	0.71	0.71	-0.72	0.72	-0.56	0.43	1.14	0.37	-0.77	0.45	-1.13	0.56
8	-0.22	0.48	0.95	0.43	1.24	0.34	1.19	0.16	0.22	0.40	1.11	0.29	1.47	0.34	-0.67	0.42	-1.11	0.53
9	0.96	0.82	-0.34	0.37	-0.99	0.20	-0.15	0.66	0.14	0.91	-0.81	0.14	-0.21	0.11	1.48	0.98	-0.11	0.57
10	-0.55	0.39	1.10	0.29	-0.91	0.41	-0.10	0.23	0.36	0.26	-1.03	0.41	0.34	0.20	-1.18	0.45	-0.61	0.28
11	-0.60	0.24	-0.34	0.45	0.65	0.12	0.05	0.23	-0.47	0.57	0.71	0.11	0.62	0.42	0.99	0.17	-1.17	0.29
12	-0.13	0.55	0.36	0.51	-0.04	0.16	-0.27	0.22	0.43	0.39	-0.09	0.11	-0.61	0.15	-0.54	0.36	0.95	0.29
(b) GICS 24 Industry portfolios																		
	β_{Mkt}	$\sigma_{\beta_{Mkt}}$	β_{Mkt}	$\sigma_{\beta_{Mkt}}$	β_{HML}	$\sigma_{\beta_{HML}}$	β_{SMB}	$\sigma_{\beta_{SMB}}$	β_{Mkt}	$\sigma_{\beta_{Mkt}}$	β_{HML}	$\sigma_{\beta_{HML}}$	β_{SMB}	$\sigma_{\beta_{SMB}}$	β_{CMA}	$\sigma_{\beta_{CMA}}$	β_{RMW}	$\sigma_{\beta_{RMW}}$
1010	0.27	0.66	0.16	0.56	1.35	0.18	0.18	0.22	0.38	0.49	1.28	0.19	-0.17	0.27	-0.07	0.65	0.72	0.33
1510	-0.32	0.60	0.34	0.40	0.80	0.23	0.55	0.29	1.11	0.41	0.91	0.16	-0.39	0.48	0.72	0.33	1.51	0.28
2010	0.30	0.37	0.33	0.37	0.13	0.09	0.17	0.08	0.26	0.28	0.06	0.09	0.01	0.14	-0.49	0.15	0.34	0.11
2020	-0.49	0.22	0.19	0.44	-0.01	0.34	0.19	0.18	-0.21	0.44	-0.10	0.35	0.51	0.21	-0.50	0.23	-0.67	0.18
2030	0.36	0.49	-0.31	0.24	0.42	0.23	0.70	0.44	0.31	0.21	0.56	0.20	0.07	0.41	0.96	0.20	0.78	0.31
2510	-0.85	0.31	0.71	0.46	0.34	0.40	-0.12	0.53	1.05	0.51	0.41	0.39	-0.42	0.36	0.56	0.27	0.49	0.39
2520	-0.73	0.55	0.05	0.33	-0.54	0.25	0.30	0.66	0.30	0.95	-0.38	0.36	0.34	0.17	1.13	0.79	-0.47	0.65
2530	1.53	0.81	0.37	0.44	-0.05	0.37	0.63	0.21	0.30	0.34	-0.02	0.46	0.77	0.22	0.27	0.75	-0.77	0.25
2550	0.55	0.52	-0.84	0.30	-1.44	0.30	-0.24	0.35	-0.07	0.69	-1.13	0.14	-0.57	0.41	1.67	1.09	0.36	0.84
3010	0.11	0.47	0.13	0.37	-0.55	0.25	-0.15	0.66	0.49	0.48	-0.42	0.22	-0.39	0.40	0.64	0.35	0.45	0.33
3020	1.16	0.38	0.01	0.33	0.30	0.54	0.58	0.20	-0.40	0.35	0.19	0.53	0.86	0.21	-0.59	0.35	-0.76	0.16
3030	2.04	0.43	-0.23	0.60	0.78	0.34	0.72	0.30	0.23	0.48	0.76	0.32	-0.09	0.36	-0.06	0.47	1.33	0.43
3510	1.05	0.40	-0.27	0.50	0.13	0.34	-0.28	0.31	-0.42	0.49	0.05	0.31	-0.16	0.14	-0.47	0.26	0.08	0.29
3520	-0.44	0.33	1.23	0.20	-0.74	0.39	0.25	0.20	0.58	0.41	-0.87	0.37	0.63	0.22	-1.18	0.39	-0.69	0.35
4010	-0.41	0.34	-0.21	0.64	1.46	0.23	0.35	0.28	-0.27	0.58	1.49	0.18	0.81	0.36	1.14	0.14	-1.31	0.25
4020	-0.38	0.19	-0.00	0.41	0.20	0.17	0.06	0.35	-0.15	0.52	0.16	0.16	0.21	0.55	0.05	0.51	-0.17	0.45
4030	-0.15	0.46	0.58	0.70	-0.11	0.19	0.46	0.10	0.15	0.61	-0.11	0.16	0.91	0.13	0.08	0.53	-1.05	0.24
4510	-0.16	0.29	-2.76	0.56	-0.13	0.54	-1.37	0.16	-2.16	0.83	-0.02	0.61	-1.64	0.28	0.31	0.39	1.06	0.42
4520	-1.31	0.46	-1.03	0.85	-1.98	0.43	-2.28	0.85	-1.28	1.04	-2.05	0.52	-1.96	0.52	-1.38	0.70	0.86	0.27
4530	-0.71	0.25	-1.30	0.63	-2.19	0.28	-2.80	0.35	-1.68	0.45	-2.31	0.34	-2.32	0.43	-1.69	0.81	0.92	0.53
5010	0.27	1.34	0.36	0.26	-0.46	0.58	0.67	0.82	-0.51	0.75	-0.58	0.60	1.35	0.34	-0.97	0.57	-1.69	1.06
5020	0.20	0.51	0.01	0.45	0.07	0.16	-0.03	0.10	0.21	0.37	0.08	0.14	-0.30	0.11	0.07	0.48	0.47	0.24
5510	-0.33	0.48	0.86	0.34	1.12	0.34	0.94	0.14	0.32	0.34	0.96	0.31	1.23	0.36	-0.60	0.42	-0.97	0.59
6010	-1.56	0.31	1.62	0.37	1.10	0.35	0.51	0.13	1.45	0.48	1.07	0.41	0.73	0.23	0.39	0.54	-0.82	0.22

Table 20: **Rolling window betas of industry portfolios with respect to market return and Fama French factors**

This table shows the 50-quarter rolling window estimates of industry portfolio betas with respect CRSP index return denoted CAPM, Fama French three and five factors models, respectively denoted FF3 and FF5. The standard deviation of the risk premium is provided in the column next to it. The sample consists of quarterly data from 1984Q1 to 2019Q4.

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(a) Fama French 12

	CCAPM 1	CAPM 2	A-CAPM 3	HCCAPM 4	HPCA 5	FF-HPCA 6	FF5 7	FF-HCCAPM 8
Mean γ_0	-1.49	1.81	-1.06	-28.13	-0.42	-4.06	1.27	-40.97
t.stat.	-0.52	2.52	-0.33	-2.07	-0.17	-0.79	1.43	-1.87
Mean γ_m	2.04		1.90	15.20	0.77	2.09		24.59
t.stat	2.29		1.95	3.25	0.63	1.06		2.61
Mean γ_v				5.94				10.05
t.stat				3.14				2.76
Mean γ_s				-4.64				-6.30
t.stat				-2.89				-2.00
Mean γ_k				-1.96				-1.61
t.stat				-2.55				-1.39
Mean γ_x					-0.73	-0.43		
t.stat					-1.25	-0.49		
Mean γ_{Dx}					1.20	-0.51		
t.stat					0.76	-0.22		
Mean γ_{Mkt}		-2.34	-2.75			-4.85	-3.50	6.87
t.stat		-0.97	-1.15			-0.90	-1.23	1.34
Mean γ_{HML}						0.09	0.39	-4.68
t.stat						0.04	0.22	-1.54
Mean γ_{SMB}						-2.27	-2.06	2.83
t.stat..9						-0.88	-1.11	0.87
Mean γ_{CMA}						0.12	1.09	-3.45
t.stat						0.05	0.84	-1.57
Mean γ_{RMW}						-0.17	-0.40	1.31
t.stat						-0.12	-0.34	0.67

(b) GICS 24

	CCAPM 9	CAPM 10	A-CAPM 11	HCCAPM 12	HPCA 13	FF-HPCA 14	FF5 15	FF-HCCAPM 16
Mean γ_0	-3.53	2.00	-4.02	-17.06	-2.19	-4.86	1.68	-11.82
t.stat.	-1.42	2.71	-1.58	-1.84	-1.30	-2.16	2.06	-1.27
Mean γ_m	2.05		2.29	13.28	2.13	1.88		10.15
t.stat	2.43		2.74	4.34	3.03	2.22		3.64
Mean γ_v				5.04				3.77
t.stat				3.97				3.35
Mean γ_s				-2.29				-1.48
t.stat				-2.41				-1.45
Mean γ_k				-1.27				-1.15
t.stat				-2.67				-2.27
Mean γ_x					-1.48	-1.27		
t.stat					-2.96	-2.73		
Mean γ_{Dx}					0.40	0.66		
t.stat					0.55	0.81		
Mean γ_{Mkt}		-2.56	-3.14			-2.64	-1.92	-0.52
t.stat		-1.21	-1.55			-1.56	-1.16	-0.28
Mean γ_{HML}						-0.17	-0.13	-1.16
t.stat						-0.12	-0.09	-0.97
Mean γ_{SMB}						-0.03	-0.82	0.71
t.stat..9						-0.03	-0.70	0.58
Mean γ_{CMA}						-0.67	-0.04	-1.10
t.stat						-0.81	-0.05	-1.44
Mean γ_{RMW}						0.51	0.21	0.63
t.stat						0.59	0.28	0.76

(c) Fama French 48

	CCAPM 17	CAPM 18	A-CAPM 19	HCCAPM 20	HPCA 21	FF-HPCA 22	FF5 23	FF-HCCAPM 24
Mean γ_0	-5.33	1.77	-5.28	-28.55	0.29	0.43	1.19	-35.24
t.stat.	-1.58	2.18	-1.58	-3.00	0.12	0.17	1.37	-3.47
Mean γ_m	3.43		3.23	14.43	0.07	0.10		14.63
t.stat	3.72		3.53	5.11	0.07	0.12		5.07
Mean γ_v				5.36				5.58
t.stat				5.19				5.33
Mean γ_s				-2.83				-3.18
t.stat				-3.57				-3.88
Mean γ_k				-1.22				-1.11
t.stat				-2.89				-2.63
Mean γ_x					-0.99	-0.82		
t.stat					-2.23	-1.91		
Mean γ_{Dx}					2.89	2.40		
t.stat					3.94	4.02		
Mean γ_{Mkt}		-4.00	-3.14			-3.47	-4.29	-1.78
t.stat		-2.85	-2.30			-2.30	-2.82	-1.17
Mean γ_{HML}						0.07	0.81	-1.56
t.stat						0.05	0.59	-1.22
Mean γ_{SMB}						-1.17	-1.76	0.19
t.stat..9						-1.23	-1.74	0.19
Mean γ_{CMA}						0.37	0.73	-0.41
t.stat						0.59	1.15	-0.66
Mean γ_{RMW}						0.98	1.00	1.68
t.stat						1.95	1.88	3.22

(d) Firm-level

	CCAPM 25	CAPM 26	A-CAPM 27	HCCAPM 28	HPCA 29	FF-HPCA 30	FF5 31	FF-HCCAPM 32
Mean γ_0	2.50	2.61	2.47	2.68	2.74	2.72	2.55	2.68
t.stat.	2.31	2.44	2.31	2.46	2.52	2.78	2.62	2.74
Mean γ_m	2.76		2.74	4.52	2.15	2.03		4.19
t.stat	6.69		7.04	4.82	4.01	4.12		5.01
Mean γ_v				-0.87				-0.79
t.stat				-2.16				-2.30
Mean γ_s				3.27				2.92
t.stat				7.70				7.98
Mean γ_k				-0.80				-0.81
t.stat				-3.73				-4.04
Mean γ_x					3.86	3.31		
t.stat					3.03	3.20		
Mean γ_{Dx}					15.20	13.57		
t.stat					4.97	5.81		
Mean γ_{Mkt}		-0.56	-0.14			-0.31	-0.46	-0.17
t.stat		-0.73	-0.18			-0.52	-0.72	-0.28
Mean γ_{HML}						-0.07	-0.13	-0.07
t.stat						-0.13	-0.25	-0.14
Mean γ_{SMB}						0.15	-0.07	0.19
t.stat..9						0.38	-0.18	0.49
Mean γ_{CMA}						0.02	0.01	-0.01
t.stat						0.06	0.02	-0.02
Mean γ_{RMW}						0.07	-0.03	0.00
t.stat						0.23	-0.10	0.02

Table 21: **Industry and firm-level second step Fama and MacBeth (1973) regressions**

This table shows the average of the coefficients from second step Fama and MacBeth (1973) regressions of excess return on ex ante consumption exposures and/or rolling betas of Fama-French factors. We estimate coefficients of the following model specification at each time t.

$$R_{i,t} = \gamma_{0,t} + \boldsymbol{\gamma}_t^{\prime} \boldsymbol{\beta}_{i,t} + u_{i,t}$$

where $\boldsymbol{\beta}_{i,t}$ is the vector of portfolio ex ante consumption risk exposure. $\boldsymbol{\beta} = \beta_m$ for the CCAPM model with aggregate consumption growth, $\boldsymbol{\beta} = \{\beta_m, \beta_v, \beta_s, \beta_k\}$ for the HCCAPM model with aggregate consumption growth, cross-sectional variance, skewness and kurtosis as the pricing factors, and $\boldsymbol{\beta} = \{\beta_m, \beta_x, \beta_{Dx}\}$ for the HPCA model with aggregate consumption growth, the principal component of cross-sectional variance, skewness and kurtosis, and its change as the pricing factors. $\boldsymbol{\beta} = \{\beta_{Mkt}\}$ for the HPCA model with aggregate consumption growth, the principal component of cross-sectional variance, skewness and kurtosis, and its change as the pricing factors. $\boldsymbol{\beta} = \{\beta_{Mkt}, \beta_{HML}, \beta_{SMB}, \beta_{CMA}, \beta_{RMW}\}$ for the Fama-French 5 factors (FF5) model with Market excess return, High Minus Low (value) factor, Small Minus Big (size) factor, Conservative Minus Agressive (investment) factor, and Robust Minus Weak (profitability) factor. Panel (a) presents the results for the Fama-French 12 industry portfolios. Panel (b) presents the results for the GICs 24 industry portfolios. Panel (c) presents the results for the Fama-French 48 industry portfolios. Panel (d) presents the results for firm-level estimations. The ex ante betas at the portoflio level are computed as value weighted averages of the firms ex ante risk betas. The firm ex ante betas are computed using the firm characteristics and the model in equation (9) estimated at the portfolio level. The table presents the time averages of $\boldsymbol{\gamma}_t^{\prime}$ and their t-statistics. The FF5 factors and industry groups (Fama-French 12 and 48 industry portfolios) are obtained from Prof. Kenneth French websiteThe industry groups defined according to Global Industrial Classification Standard Codes (GICS) are obtained from Compustat. The sample consists of quarterly data from 1984Q1 to 2019Q4.

CCAPM				
	$K=1$	$K=2$	$K=4$	$K=8$
γ_0	-0.26	0.93	0.87	-0.83
t-FM	-0.39	1.57	1.70	-1.68
t-Sh	-0.12	0.57	0.44	-0.26
γ_m	1.13	0.83	1.10	1.62
t-FM	9.32	7.81	9.31	12.65
t-Sh	2.98	2.92	2.43	1.98
Adj. R^2	18.87	5.57	13.00	41.82
Critical Value	12.04	11.94	11.94	11.58

HCCAPM				
	$K=1$	$K=2$	$K=4$	$K=8$
γ_0	9.99	6.28	1.57	0.91
t-FM	14.63	11.91	3.11	2.21
t-Sh	2.43	2.03	0.62	0.52
γ_m	1.00	0.56	0.48	0.60
t-FM	8.71	5.55	5.50	7.57
t-Sh	1.50	0.99	1.17	1.93
γ_v	0.84	1.53	1.17	1.18
t-FM	5.35	9.75	9.05	11.48
t-Sh	0.91	1.69	1.85	2.83
γ_s	-0.18	0.14	0.91	0.68
t-FM	-2.39	1.33	9.88	9.14
t-Sh	-0.43	0.24	2.08	2.36
γ_k	-2.10	-1.87	-1.32	-0.90
t-FM	-12.44	-12.47	-10.90	-9.16
t-Sh	-2.10	-2.17	-2.24	-2.27
Adj. R^2	62.21	64.75	75.55	76.38
Critical Value	23.23	23.47	23.70	23.31

HPCA				
	$K=1$	$K=2$	$K=4$	$K=8$
γ_0	2.54	4.80	3.15	4.94
t-FM	3.93	7.95	6.34	14.02
t-Sh	0.72	1.41	0.91	1.46
γ_m	0.50	0.42	0.09	0.25
t-FM	5.21	4.98	1.25	4.06
t-Sh	1.00	0.93	0.19	0.45
γ_x	-0.87	-1.84	-1.20	-0.93
t-FM	-5.61	-11.77	-8.93	-10.39
t-Sh	-1.05	-2.13	-1.31	-1.13
γ_{Dx}	0.99	0.05	1.44	2.17
t-FM	6.03	0.38	11.07	11.72
t-Sh	1.12	0.07	1.61	1.23
Adj. R^2	65.80	65.35	63.14	76.25
Critical Value	21.09	20.98	20.85	20.60

FF5				
	$K=1$	$K=2$	$K=4$	$K=8$
γ_0	2.53	13.29	12.85	9.89
t-FM	3.69	18.33	17.45	18.15
t-Sh	0.69	3.25	3.05	2.59
γ_{MktRf}	-36.97	-29.23	-20.75	-10.76
t-FM	-10.88	-16.50	-17.05	-18.70
t-Sh	-2.08	-3.04	-3.09	-2.92
γ_{SMB}	1.19	-0.54	1.73	-2.09
t-FM	1.19	-0.72	3.24	-5.70
t-Sh	0.24	-0.14	0.61	-0.89
γ_{HML}	11.27	2.74	1.26	6.34
t-FM	7.91	2.65	1.92	9.62
t-Sh	1.57	0.50	0.37	1.43
γ_{RMW}	8.63	5.48	4.22	2.45
t-FM	9.87	10.66	10.56	10.48
t-Sh	2.04	2.25	2.19	1.93
γ_{CMA}	13.00	7.30	3.75	5.04
t-FM	11.33	9.39	7.51	10.88
t-Sh	2.22	1.75	1.40	1.62
Adj. R^2	73.39	86.11	86.96	84.47
Critical Value	26.67	26.26	26.43	26.22

Table 22: **Second stage Fama and MacBeth (1973) regressions on dissecting anomaly portfolios**

This table shows the slope coefficients and t-statistics of the cross-sectional regressions of 25 Dissecting Anomaly Portfolios sorted predicted excess returns on the exposures to candidate pricing factors. Aggregate consumption growth is the single pricing factor in the CCAPM panel. Consumption growth first four cross-sectional moments are used as pricing factors in the HCCAPM panel. Aggregate consumption growth, Household consumption risk, and its changes are used as pricing factors in the HPCA panel. Fama-French 5 factors are used for the FF5 panel. The independent variable, β_i, is the slope coefficient from the first stage time series multivariate regressions of portfolio returns on the factors. The standard errors which account for time and cross-sectional correlations of the error terms are computed. The t-statistics with and without first stage Shanken (1992) correction for generated regressors are provided in brackets below the coefficient estimate. The aggregate consumption growth is measured as the real per capita consumption growth rate in non-durable goods and services using NIPA tables from the Bureau of Economic Analysis. The household consumption risk is proxied by the first principal component of consumption growth higher order cross-sectional moments. Beneath the adjusted R^2, we present 95% critical values for adjusted R^2 from five thousand Monte Carlo simulations under the null that the independent variables have no explanatory power for the returns. The sample consists of quarterly data from 1984Q1 to 2019Q4.

B Figures

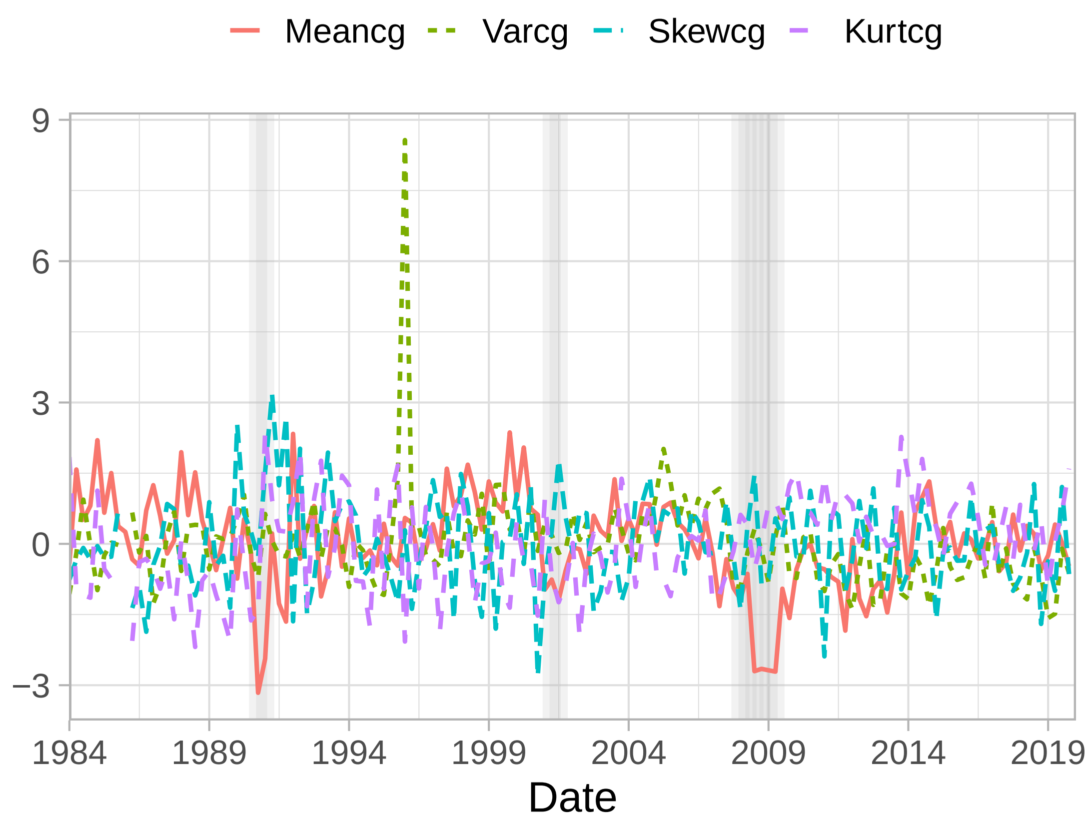


Figure 1: **Time-series of the cross-sectional moments of consumption**
This figure represents the evolution over time of the first four cross-sectional moments of household consumption growth.

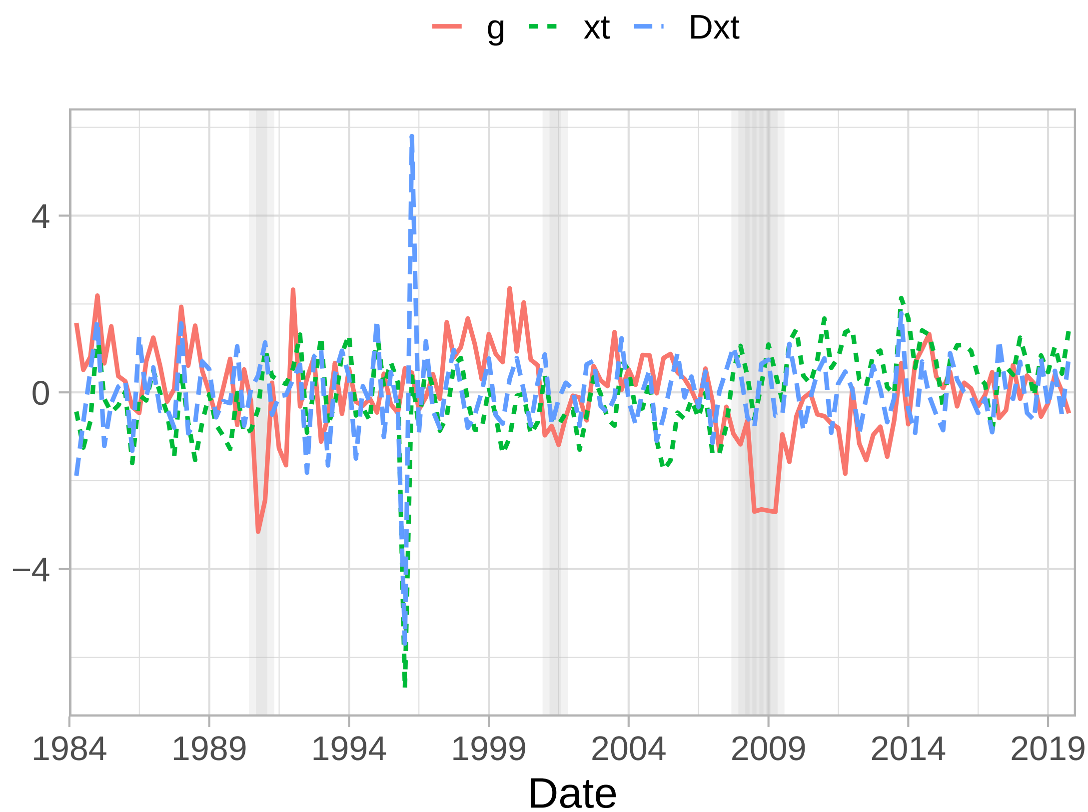


Figure 2: **Time-series of the first principal component of cross-sectional moment of household consumption growth**
This figure represents the evolution over time of aggregate consumption, the first principal component of the first four cross-sectional moments of household consumption growth, and the first difference of this first principal component.

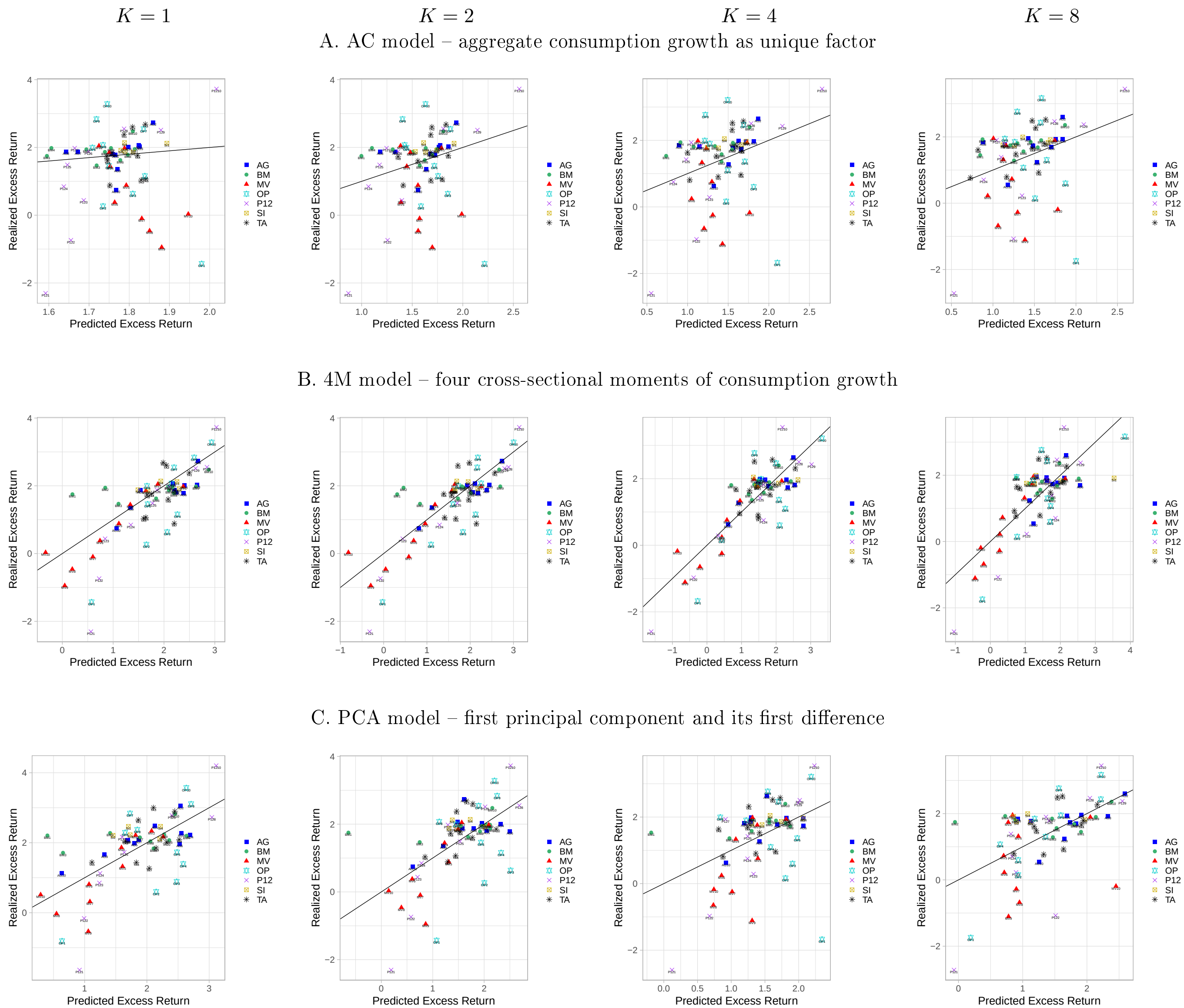


Figure 3: **Realized and predicted expected excess returns of characteristic portfolios**

These figure shows the realized average excess return of characteristic portfolios against the predicted average excess return for different horizons of K quarters. Panel A (AC model) uses the standard CCAPM model with the aggregate consumption growth as single pricing factor to predict returns. Panel B (4M model) uses aggregate consumption growth, the cross-sectional variance, the cross-sectional skewness and the cross-sectional kurtosis of consumption growth as pricing factors. Panel C (PCA model) uses aggregate consumption growth, the principal component of the cross-sectional moments of consumption growth, and its first-order differences as pricing factors. The fitted line from the second stage Fama and MacBeth (1973) regressions is included.

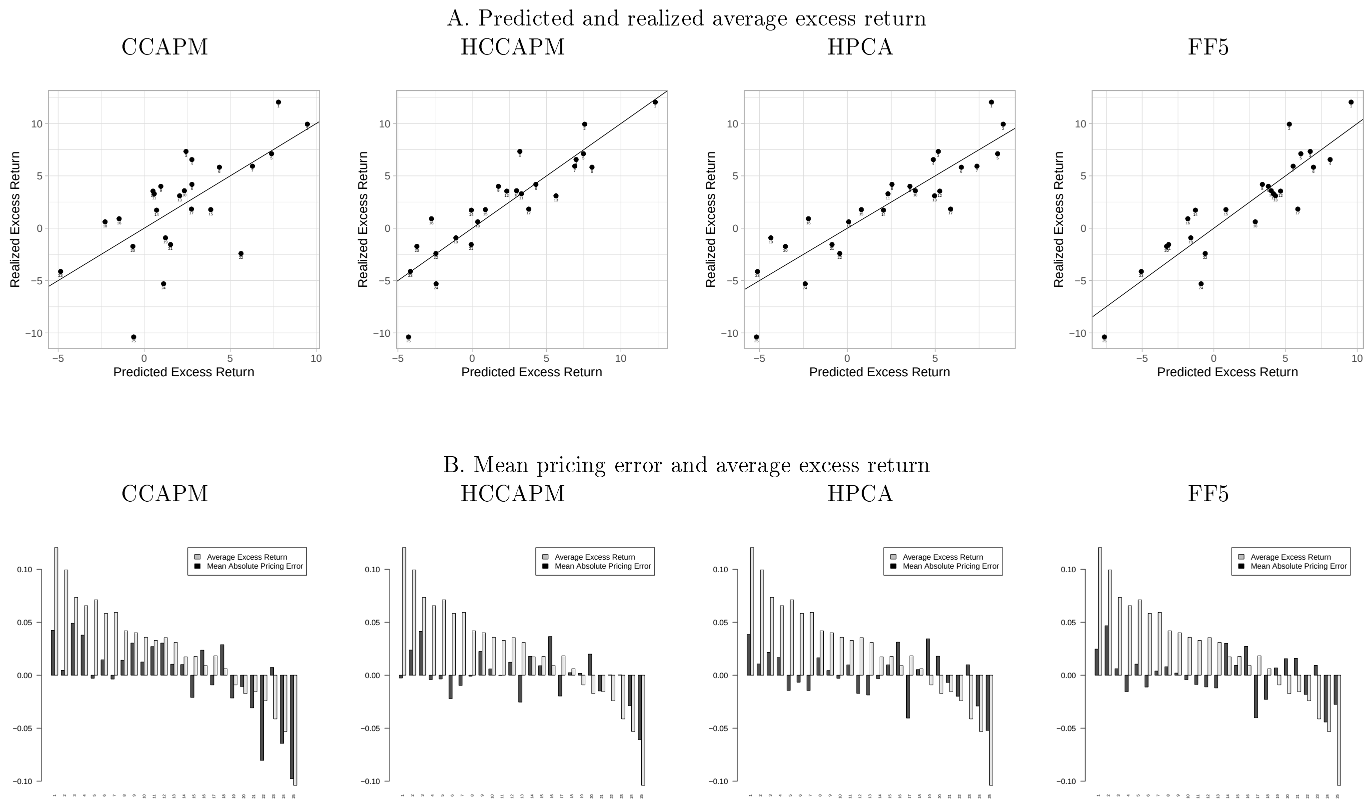


Figure 4: **Model fit and pricing errors**

This figure shows the model fits and pricing errors for four pricing models (CCAPM, HCCAPM, HPCA, and FF5) with the dissecting anomaly (DA) portfolios. We consider the standard consumption CAPM with the aggregate consumption growth as single pricing factor (CCAPM), the heterogeneous agent consumption CAPM with the aggregate consumption growth and second through fourth cross-sectional moments of household consumption growth as pricing factors (HCCAPM), the heterogeneous agent consumption CAPM with the aggregate consumption growth, household consumption risk and its changes as pricing factors (HPCA), and the Fama-French five factors model. Panel A shows the realized average excess return of DA portfolios against the predicted average excess return. Panel B shows the average excess return and average pricing errors.

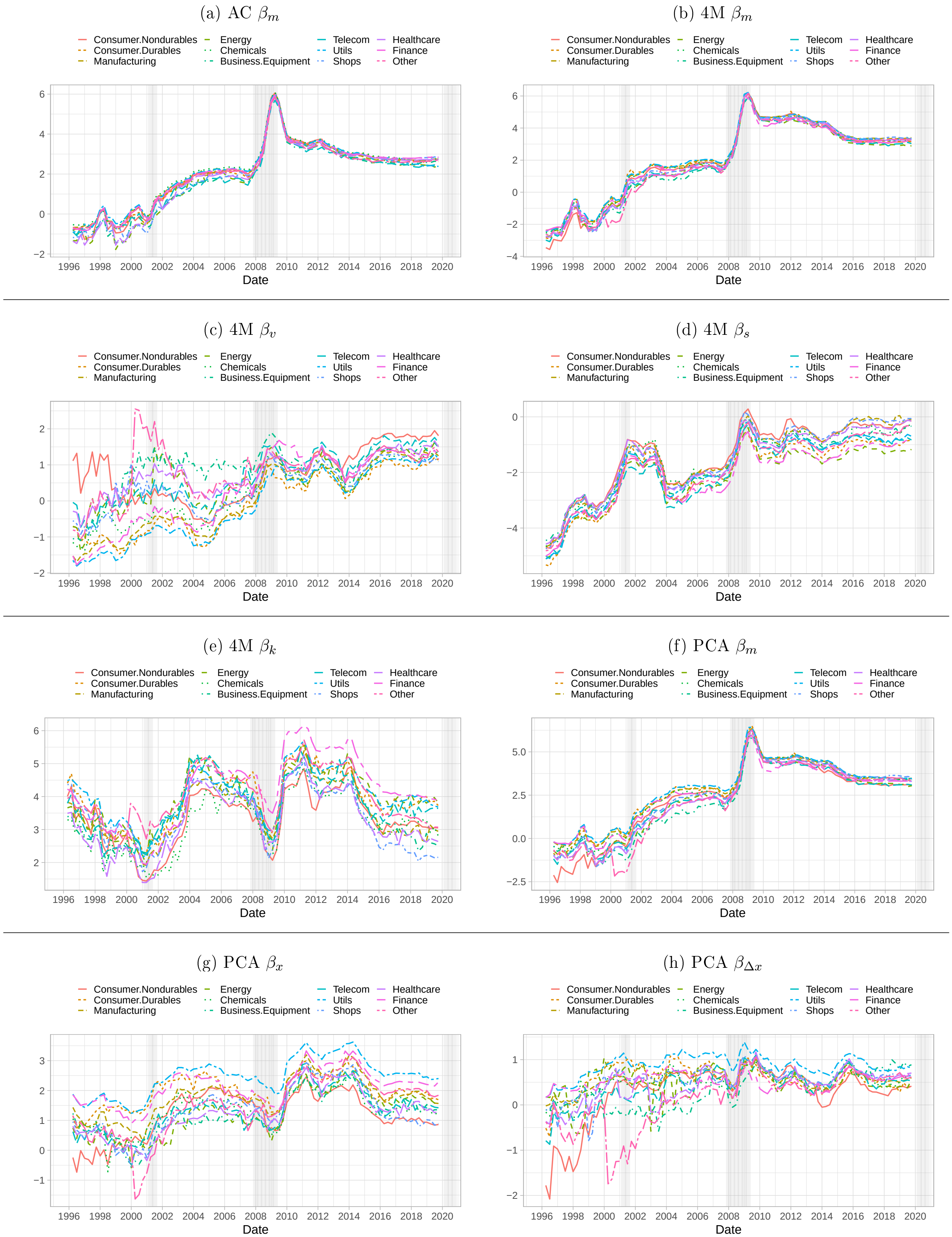
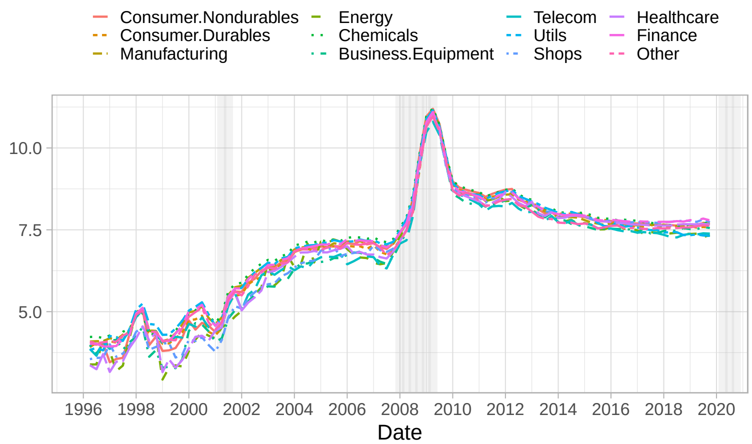


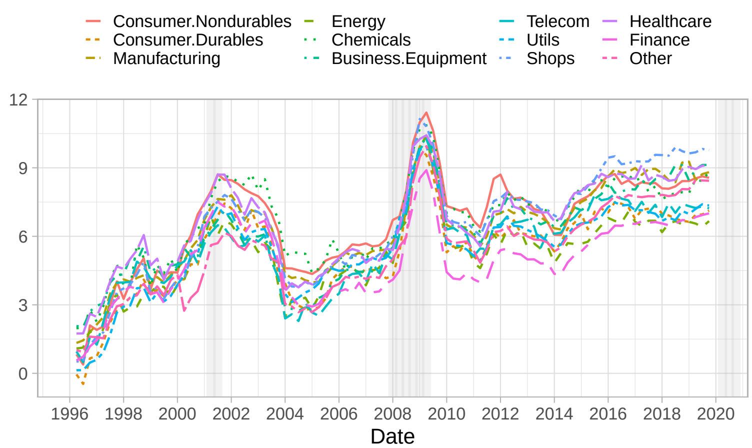
Figure 5: **Industry risk exposures**

This figure shows the evolution of the ex ante consumption risk exposures of Fama-French 12 industry portfolios. Plots (a), (b), (c) and (d) present the ex ante consumption risk exposures as predicted by the Heterogenous agent CCAPM model with aggregate consumption growth, cross-sectional variance, skewness and kurtosis as the pricing factors. Plots (e), (f), and (g) present the ex ante consumption risk exposures as predicted by the Heterogenous agent CCAPM model with aggregate consumption growth, the principal component of cross-sectional variance, skewness and kurtosis, and its change as the pricing factors. Plot (h) presents the ex ante consumption risk exposure as predicted by the CCAPM model with aggregate consumption growth as the single pricing factor. The standard deviation of the consumption risk exposure is provided in the column next to it. The ex ante betas at the portoflio level are computed as value weighted averages of firms ex ante risk betas. The firm ex ante betas are computed using the firm characteristics and the model in equation (9) estimated at the portfolio level. We used quarterly data from 1984Q1 to 2019Q4.

(a) AC model



(b) 4M model



(c) PCA model

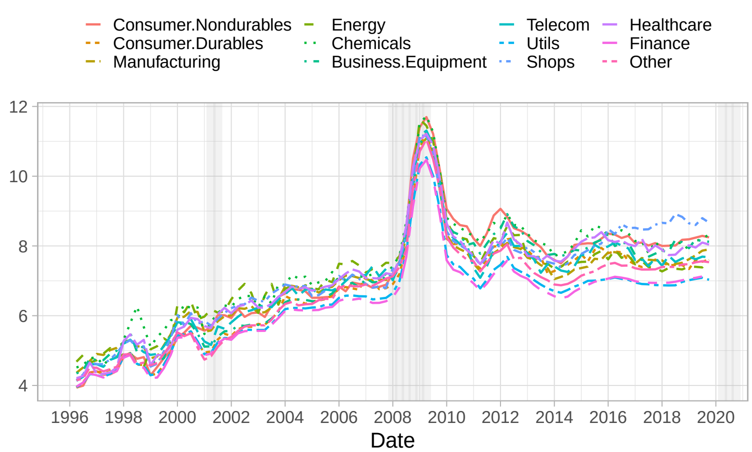


Figure 6: **Industry risk premiums over time**
This figure shows the evolution of the annualized industry risk premiums of the Fama-French 12 industry portfolios. Plots (a), (b), and (c) represent the risk premium as predicted respectively by the AC model with aggregate consumption growth as the single pricing factor, the 4M model with aggregate consumption growth and the cross-sectional variance, skewness and kurtosis of consumption as pricing factors, and the PCA model with aggregate consumption growth, the principal component of the cross-sectional variance, skewness and kurtosis of consumption growth, and the component's first differences as the pricing factors. The risk premium is computed using the ex ante portfolio betas and the estimated prices of risk in the second step Fama-Macbeth regressions following as in equation (7). The ex ante betas at the portfolio level are computed as value weighted averages of firms ex ante risk betas.

(a) Industry Risk Premia (Fama-French 5 factors)

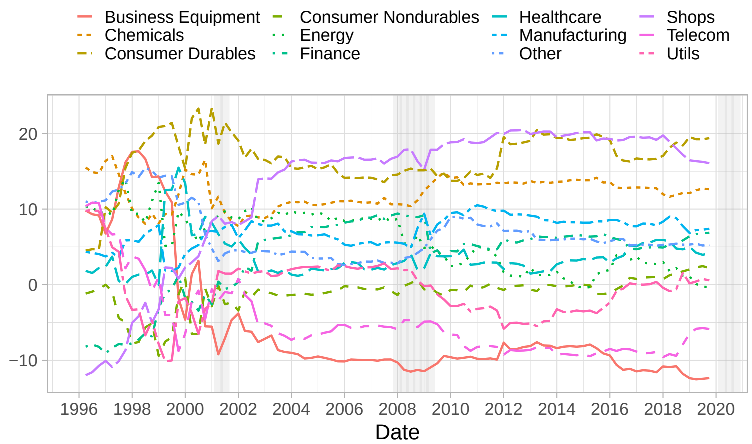


Figure 7: **Industry risk premiums with Fama-French 5-factor model**
This figure shows the evolution of the annualized industry risk premia of Fama-French 12 industry portfolios. We use the Fama-French five factors model to estimate the rolling portfolio exposures to the pricing factors. The risk premium is computed using the estimated prices of risk in the second step Fama-Macbeth regressions following as in equation (7).

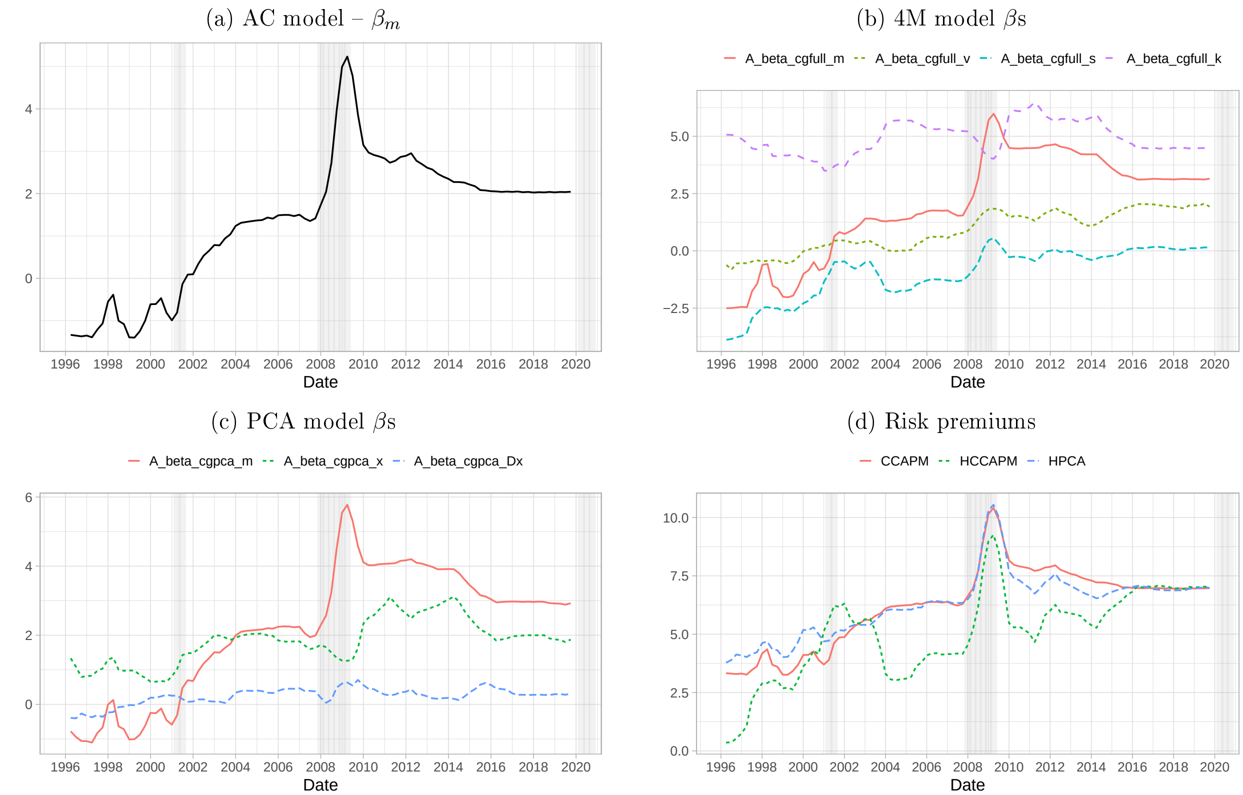


Figure 8: **Firm-level average risk exposures and risk premium**
This figure shows the evolution of the average of firm's ex ante consumption risk exposures. Plots (a), (b), and (c) present respectively the ex ante consumption risk exposures as predicted by the CCAPM model with aggregate consumption growth as the single pricing factor, by the Heterogenous agent CCAPM model with aggregate consumption growth, cross-sectional variance, skewness and kurtosis as the pricing factors, and by the Heterogenous agent CCAPM model with aggregate consumption growth, the principal component of cross-sectional variance, skewness and kurtosis, and its change as the pricing factors. Plot (d) presents the risk premium implied by risk exposures and the prices of risks estimated in Tables 6, 9, 11 for K=4.