Can moments of consumption growth explain risk premium variation across international stock markets?*

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Abstract

We find that consumption-weighted cross-sectional moments of countries' consumption growth are useful factors to explain variation in expected returns across international stock market indices. The skewness alone explains 32% of that variation. The first four moments explain a higher proportion compared to the three global Fama-French factors. However, these positive results are contrasted by two facts. First, identification of the prices of risk is rejected; second, prices of risk are not statistically significant and the factors explain only 2.5% of the variability of the ex-post model-free stochastic discount factor extracted from the asset menu.

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1 Introduction

This paper investigates if cross-sectional higher moments of countries' consumption growth are pricing factors that can explain heterogeneity in risk premium across international stock markets. We build on the heterogeneous agents' consumption-based asset pricing literature (Constantinides and Duffie, 1996; Constantinides and Ghosh, 2017). In our framework, each country representative agent faces the country specific consumption shocks which (s)he would like to smooth out by investing on international financial markets[1]. Thus, country stock indices can be viewed as assets in the consumer's investable universe. The question that arises is whether actual expected excess returns on country stock indices are reward for exposure to cross-sectional higher moments of countries' consumption growth.

Cross-sectional first and second moments of consumption growth (mean and dispersion) have previously been considered in the literature as pricing factors for returns on international equity and foreign exchange markets (Sarkissian, 2003; Darrat et al., 2011). The cross-sectional third moment has recently been considered for explaining the equity premium on the US stock market (Constantinides and Ghosh, 2017). Here, we extend these previous studies by considering, on one hand, the cross-sectional skewness and kurtosis of consumption growth and, on the other hand, the developed equity markets[2].

There are reasons to believe that higher-order cross-sectional moments of consumption growth across countries might be plausible pricing factors for international stock indices. A left-skewed distribution of countries' consumption growth portraits that country growth

[1] Indeed, by holding the country specific market portfolio, the consumer would remain exposed to the systematic risk which is negatively correlated with aggregate consumption growth. Foreign investment allows to achieve a more diversified portfolio than the ones offered by each country specific market portfolio. There is an increase of international financial markets integration. Nowadays, domestic investors can internationally diversify their portfolio by investing into foreign stock markets without further costs.

[2] We choose to focus on country specific stock market indices to avoid sample selection bias that could come from stock data availability and also to reduce the noise from the diversifiable risk components in our analysis.

rates worse than the global average are extreme. This happens when consumption is few countries falls sharply or grows poorly in a way to pull down the world average growth rate. This is a bad news for the global economy, and more so when the underperforming growth rates come from systemically important countries. Thus, the average global investor dislikes stock markets which tend to decline when the cross-sectional skewness of country consumption growth rates falls, i.e., positive covariation with skewness. Therefore (s)he would require a larger premium for investing in these stock indices. Likewise, a leptokurtic cross-sectional distribution of countries' consumption growth signals that enough countries have their consumption growth rates sufficiently lagged from the global average. This again represents a bad news for the world economy, against which the average global investor hedges herself by requiring an additional reward on stock indices that tend to decline simultaneously with increasing cross-sectional kurtosis of countries' consumption growth rates, i.e., negative covariation with kurtosis.

We first observe that developed countries display an heterogeneity in their stock market exposure to the different cross-sectional moments of the consumption growth. For example, the Norwegian stock market index shows a positive risk exposure to the cross-sectional mean of consumption growth while US stock market index appears to be negatively exposed to the cross-sectional skewness of consumption growth. It means that the Norwegian stock market might reward investors for holding its market portfolios because it performs poorly at the same time the world average consumption growth decreases, while the US stock market rewards investors for holding its market portfolio because it performs poorly when the skewness of the cross-section of countries consumption growth increases, meaning when a higher proportion of countries has a consumption growth realization above the average[3]. Indeed, the consumption growth for Norway is positively

[3]This explanation only makes sense if the price of the skewness risk is negative. With a positive price of skewness risk, the US stock market portfolio will appear as an insurance contract and the consumer will be paying a premium for holding the contract.

correlated with the world consumption growth while the US consumption growth is negatively correlated with world consumption skewness.

Second, we find that the higher order cross-sectional moments of the consumption growth have an important contribution in explaining the country levels of the equity risk premium. Our empirical analysis shows that the skewness factor yields the same explanatory power to the variability in expected stock market excess return as the combination of the mean and variance factors that have been considered previously. Furthermore, the four factors model with the first four cross-sectional moments of consumption growth improves on that two factors model by giving a smaller mean absolute pricing error. The cross-sectional skewness as a new pricing factor has a higher explanatory power for the cross-sectional average country equity returns than the cross-sectional dispersion which has previously been emphasized as the main factor that captures the effect of consumers heterogeneity on the risk premium level in heterogeneous agents CCAPM.

Our econometric modeling considers the recent developments in empirical assets pricing which aim at ruling out the spurious factors and providing credible statistical inference for the prices of risk. Indeed, Kleibergen, 2009; Kleibergen and Zhan, 2015 highlight the rank deficiency that occurs at the first stage of the Fama and MacBeth, 1973 regressions and which shows a weak identification of the prices of risk in the second stage of the regression. We observe a high absolute variability of countries stock markets exposures with respect to the first cross-sectional moment of consumption growth, which range from -0.07 to 2.01. However, the variability in their exposures to the higher order cross-sectional moments of consumption (variance, skewness and kurtosis) is lower; the betas vary respectively from -0.5 to 0.3, from -1.1 to 0.3 and from -0.14 to 0.14, for the variance, the skewness and the kurtosis of the cross-sectional distribution of consumption growth[4]. The lack of variability in the betas from the first pass regression even though

[4]The relative variability (the variability of the standardized beta) is similar across the risk factors ranging from -1.2 to 2.4, from -2.2 to 1.5, from -1.5 to 1.9 and from -2.5 to 1.8 for respectively the mean,

some are statistically different from zero is what makes the identifiability of the prices of risk difficult (Kleibergen and Zhan, 2019). This observation helps to better understand our regressions output and implies to be cautious in the interpretation of the results.

The remainder of the paper is organized as follows: In section 2, we provide a brief literature review in order to connect this paper to the heterogeneous agents models literature. Section 3 provides the theoretical background to establish the link between the equity risk premium and the cross-sectional higher order moments of consumption growth in a heterogeneous agents model. It also highlights the difference with the representative agent model. Section 4 presents the empirical approach. It presents the data and descriptive statistics. It describes the different econometric techniques (GMM, Fam-MacBeth regression and Bayesian MCMC) that are used in the estimation and it also provides the results of our estimations. Section 5 concludes. An appendix is provided in section 6 with Tables, Figures and details about the calculus.

2 Literature review

The understanding of the driving forces behind the observed levels and fluctuations of asset prices is still a challenging and very prolific area of research in finance. Since the seminal paper of Markowitz, 1952 that sets the building blocks of Modern Portfolio Theory, followed by the design of the capital asset pricing model (CAPM) by Sharpe, 1964, Lintner, 1965 and Mossin, 1966, and the seminal contribution of the consumption-based CAPM of Lucas, 1978 that connects asset prices to economic fundamentals (such as consumer preferences, aggregate consumption growth, etc.), researchers have learned a lot about those driving forces by confronting finance theories to observed macroeconomic and financial market data. Some puzzles have been raised from the discrepancy between

the variance, the skewness and the kurtosis factors.

the predictions of the proposed models and the observed asset prices. One of the well known puzzles is the equity premium and risk free rate puzzle that was pointed out in the standard consumption-based CAPM model, henceforth CCAPM, with a representative agent endowed with time separable utility function and log-normal consumption[5].

In response to these puzzles, a strand of the literature has proposed to move from the representative agent framework to the heterogeneous agents models where the cross-sectional dispersion in agents consumption matters in the determination of equilibrium risk premium (Constantinides and Duffie, 1996, Sarkissian, 2003). More recently, Constantinides and Ghosh, 2017 have shown that beyond the cross-sectional dispersion, the cross-sectional skewness in households consumption growth also matters for equilibrium asset prices. Indeed, in their framework economic agents have recursive preferences (Kreps and Porteus, 1978; Epstein and Zin, 1989) and households face labor income uninsurable risks that lead to left skewness in the cross-sectional consumption growth distribution, which is counter-cyclical and pushes investors to ask for a high compensation to hold risky assets. In an otherwise representative agent model, the log-normally distributed aggregate consumption they considered in their model would have generated the equity premium puzzle, however as they showed, the cross-sectional distribution in households consumption enables to create enough consumption risks and to alleviate the puzzle.

This paper investigates the cross-sectional differences in countries discount rates for risky investment projects. It aims at explaining the differences in countries risk premiums observed on financial markets. This question is connected to the literature that explains the country differences in currency excess return observed on the foreign exchange market. For example, Sarkissian, 2003 used the framework proposed by Constantinides and Duffie, 1996 to analyze the impact of imperfect consumption risk sharing in a multi-country world

[5]The puzzle arises from the fact that the observed equity premium is too high and the observed risk free rate is too low to be explained by a standard CCAPM model where the representative agent has a reasonable coefficient of relative risk aversion (below 10), given the smooth observed consumption growth (Mehra and Prescott, 1985; Rietz, 1988; Weil, 1989; Mehra, 2003 and see Mehra, 2003 for a review).

on the formation of time-varying risk premiums in foreign exchange market and on their cross-sectional differences. He found that the heterogeneous agent CCAPM model that accounts for the world consumption dispersion, enables to better explain the currency risk premiums observed on foreign exchange market than the representative agent CCAPM do. However, the empirical exercise also reveals some difficulties of the model to fully explain the forward premium puzzle. Some possible solutions suggested by the author was to account for within country consumption dispersion and to use wealth-based measure for world growth and dispersion in the asset pricing model instead of only consumption based ones. This paper will go in that direction by considering the consumption per capita weighted cross-sectional moments of country consumption growth instead of the equally weighted moments.[6]

Constantinides and Ghosh, 2017 extend the Constantinides and Duffie, 1996 framework by allowing agents to have identical recursive preferences and the idiosyncratic consumption shocks to be driven by a Poisson mixture of normal distribution. They show that this household consumption growth specification enables to generate counter-cyclical higher order moments of the cross-sectional consumption growth distribution even though the aggregate consumption process is log-normally distributed. The state variable (i.e. the household consumption risk) that drives the cross-sectional consumption growth distribution determines the market equity risk premium. Schmidt, 2016 has shown that the idiosyncratic distribution of household consumption is affected by tail events which also affect the equity premium in a heterogeneous agents model with incomplete markets. The cross-sectional kurtosis is considered in this paper to capture the tail events in the cross-sectional consumption growth distribution.

This paper also relates to the literature on international equity markets. Indeed, in segmented financial markets, there exist some specific markets risk premiums justified by

[6]The analysis presented along the paper is made with the weighted cross-sectional moments. We also consider the equally weighted cross-sectional moments and the results are similar.

the costs that the investor could incurred to retrieve his funds or the capital lost that could happen due to country specific political risks (Bekaert et al., 2016). In such a context, the country specific investor will face some idiosyncratic risks that (s)he would like to smooth out by investing internationally on financial markets; however by doing so (s)he will incurred the hosting countries specific political risks which (s)he can not diversify. In this paper, we choose to simplify the investor problem by ignoring the market segmentation. We behave as if the financial markets are fully integrated and there is no undiversifiable country specific risks incurred by investing abroad. Even though, this might sound as a strong assumption, it is still valuable to understand how the cross-sectional distribution of investor idiosyncratic risks might affect the equity risk premium and this paper contributes in doing that. Furthermore, we have recently seen a gradual increase in the international financial markets integration that facilitates the ownership of foreign assets by domestic investors without incurring much costs.

3 Theoretical background

3.1 International heterogeneous agents CCAPM

We assume the world is populated by n country representative consumers indexed by i. Each country's consumer receives a labor income and (s)he can trade on the international financial market. The proceedings from the labor income and the financial assets[7] is used to buy the amount of the single numeraire good that is consumed. Following, Constantinides and Ghosh, 2017; Constantinides and Duffie, 1996, we banned the consumer from being able to insure against income idiosyncratic shocks through the market. Thus, the markets are incomplete, meaning that for example there are no traded state contin-

[7] The financial assets are made by all kinds of existing traded assets (e.g. securities, bonds, derivatives, etc.)

gent goods to hedge against the possible consumption decline in country j due to state budget disagreement. The countries representative consumers have identical recursive preferences:

$$V_{i,t} = \left[(1-\delta)C_{i,t}^{1-1/\psi} + \delta\left(\mathrm{E}_t\left(V_{i,t+1}^{1-\gamma}\right)^{\frac{1-1/\psi}{1-\gamma}}\right)\right]^{\frac{1}{1-1/\psi}} \tag{1}$$

where δ is the subjective discount factor, γ is the relative risk aversion (RRA) coefficient and ψ is the elasticity of inter-temporal substitution (EIS). The heterogeneity amount the consumers comes from their specific consumption dynamics given by:

$$C_{it} = I_{it} + D_t = \delta_{it}C_t \tag{2}$$

where I_{it} is the consumer i labor income, C_t is the aggregate (world) consumption and D_t is the dividend paid by the market portfolio. δ_{it} captures the country idiosyncratic risk which comes from the labor income (or the aggregate output) of the country and evolves as follows.

$$\delta_{i,t} = \delta_{i,t-1}\exp\left(\eta_{i,t}\sigma\sqrt{d_t} - \sigma^2\frac{d_t}{2}\right) \tag{3}$$

where d_t is conditionally distributed Poisson process driving the occurrence of the consumer i idiosyncratic shocks at time t. Following Constantinides and Duffie, 1996, d_t can be viewed as the cross-country variation of countries consumption growth at time t. It can also summarize the combination of cross-sectional higher order moments conditional on information at time t that influences the dynamics of the consumer consumption risk and which drive asset prices. $\eta_{i,t}$ is an i.i.d standard normal capturing the idiosyncratic shock occurring in country i at time t. The consumer i consumption growth is then given by:

$$\Delta c_{i,t+1} = \eta_{i,t+1}\sigma\sqrt{d_{t+1}} - \sigma^2\frac{d_{t+1}}{2} + \Delta c_{t+1} \tag{4}$$

Its dynamic is driven by the country's income idiosyncratic shock and the world aggregate consumption dynamics. The aggregate consumption growth is i.i.d normal with mean μ and variance σ_c^2: $\Delta c_{t+1} = \mu + \sigma_c \epsilon_{t+1}$, $\epsilon_{t+1} \sim$ i.i.d$N(0,1)$. As shown in Epstein and Zin, 1989, the Stochastic Discount Factor (SDF) of consumer i is:

$$M_{i,t+1} = \exp\left(\theta \log \delta - \frac{\theta}{\psi} \Delta c_{i,t+1} + (\theta - 1)\, r_{i,c,t+1}\right) \tag{5}$$

where $\theta = \frac{1-\gamma}{1-1/\psi}$ and $r_{i,c,t+1}$ is the log-return on the aggregate wealth portfolio of consumer i. The wealth portfolio delivers consumption as dividend each period. We assume that the Poisson distribution followed by d_t is governed by the unique state variable of the model ω_t, which drives the consumers income shocks: Prob$(d_t = n)$=$e^{-\omega_t}\omega_t^n/n!$, $n = 0, 1, ...\infty, \mathbb{E}(d_t) = \omega_t$. Following Constantinides and Ghosh, 2017 to ease the computational exposure, we define the scaled state variable $x_t \equiv \left(e^{\gamma(\gamma-1)\sigma^2/2} - 1\right)\omega_t$. We assume that x_t follows an auto-regressive gamma process of order 1, ARG(1) (Gourieroux and Jasiak, 2006).

$$x_{t+1} = \nu\xi + \rho x_t + \varepsilon_{x,t+1}, \tag{6}$$

where $\nu > 0$, $\xi > 0$, and $\rho > 0$, $\varepsilon_{x,t+1}$ is a martingale difference sequence, $\mathbb{E}\left(x_{t+1}|x_t\right) = \nu\xi + \rho x_t$, and var $\left(x_{t+1}|x_t\right) = \nu\xi^2 + 2\rho\xi x_t$.

As shown by Constantinides and Ghosh, 2017, the above consumption dynamics delivers an autarchy equilibrium where country representative consumer consumption growth and SDF are independent on its consumption level. The SDF of consumer i depends on the return on its wealth portfolio which is unobservable. In order to compute the SDF, we assume that the consumer wealth-consumption ratio is an affine function of the state variable:

$$z_{i,c,t} = z_{c,t}\left(\omega_t\right) = A_0 + A_1 x_t \tag{7}$$

Using the Campbell and Shiller, 1988 approximation, we can expressed the log-return on its wealth portfolio as follows:

$$r_{i,c,t+1} = r_{c,t+1}(\omega_t) = \kappa_0 + \kappa_1 z_{c,t+1}(\omega_{t+1}) - z_{c,t}(\omega_t) + \Delta c_{i,t+1}$$

Substituting the expression of the SDF and the wealth portfolio return in the standard asset pricing Euler equation, we can solve for the unknown coefficients A_0 and A_1, which are obtained by solving the non-linear system of equations (36).

The consumers common SDF can be expressed in term of the state variable as follows:

$$\begin{aligned} M_{i,t+1} = \exp\Bigg(\theta \log\delta - \gamma\left(\eta_{i,t+1}\sigma\sqrt{d_{t+1}} - \sigma^2\frac{d_{t+1}}{2} + \Delta c_{t+1}\right) + (\theta-1)\left(\kappa_0 + \kappa_1\left[A_0 + A_1 x_{t+1}\right]\right) \\ - (\theta-1)\left[A_0 + A_1 x_t\right]\Bigg) \end{aligned} \tag{8}$$

Equation (8) shows that only shocks that affect the distribution of the aggregate consumption will be priced in equilibrium. There is a distinction between the time series distribution of the aggregate consumption and the evolution of cross-sectional distribution of the countries consumption. Both dimensions are sources of aggregate risk for country's representative consumers. On one hand, a drop in the aggregate level of consumption increases the marginal utility of the consumption good for every consumer; the effect is higher for a higher risk aversion coefficient. On the other hand, an increase in the cross-sectional dispersion of the consumption (combined with the idiosyncratic risk) will put each consumer at a higher risk of getting a low consumption, which also raises the SDF.

The log risk free rate can be obtained by taking the conditional expectation of the log SDF.

$$r_t^f = \Gamma_0^f + \Gamma_1^f x_t \tag{9}$$

where

$$\Gamma_0^f = -\theta \log \delta + \gamma\mu - \frac{1}{2}\gamma^2\sigma_c^2 - (\theta - 1)\left(\kappa_0 + (\kappa_1 - 1) A_0\right) - \lambda\nu\xi - \frac{1}{2}\lambda^2\nu\xi^2$$
$$\Gamma_1^f = -\left(\lambda\rho\left(1 + \lambda\xi\right) - (\theta - 1)A_1\right)$$

The first three terms in the expression of the risk free rate are very common especially when $\theta = 1$ as it is the case for the CRRA utility function. They show that the risk free rate will increase when the preference for the present is higher (δ closed to zero) or the consumption growth is positive; and the risk free rate will decrease when the consumption growth is more volatile (for precautionary saving motives). The new term that depends on the moment of the consumer risk (x_t) will reduce the risk free rate as expected. When the consumption risk increases, agents choose to increase their savings buffer thus lowering the risk free rate. As highlighted by Constantinides and Ghosh, 2017, the model predicts that the unconditional mean of the risk free rate will decrease with an increase in the consumer risk and its unconditional variance will increase; consistently with the observed data.

Let us now consider a risky project in country i that generates levered consumption dividends:

$$\Delta d_{i,t+1} = \mu_d + \beta_{d,i}\Delta c_{i,t+1} + \sigma_d \varepsilon_{i,d,t+1} \tag{10}$$

where $\varepsilon_{i,d,t+1} \sim$ i.i.d$N(0,1)$ and it is independent of all the other shocks. $\beta_{d,i}$ captures the exposure of the dividend growth to consumption growth.

To compute the equity return, we follow the same procedure used for the wealth

portfolio. We assume that the price-dividend ratio is an affine function of the state variable.

$$z_{i,m,t} = z_{m,t}\left(\omega_t\right) = A_{0m} + A_{1m} x_t$$

Substituting expression of the log-price dividend ratio in the standard Euler equation for the equity return allows to solve for the unknown coefficient and to obtain the expected stock market return as follows. The expected stock market return for consumer i is given by:

$$\mathbb{E}_t r_{i,m,t+1} = \Gamma_{0,i}^m + \Gamma_{1,i}^m x_t \tag{11}$$

where

$$\Gamma_{0,i}^m = \kappa_{0m} + \left(\kappa_{1m} - 1\right) A_{0m} + \left(\kappa_{1m} A_{1m} + \frac{\beta_{d,i}\sigma_d^2}{2\left(e^{\gamma(\gamma-1)\sigma^2/2} - 1\right)}\right)\nu\xi + \mu_d$$

$$\Gamma_{1,i}^m = \rho\left(\kappa_{1m} A_{1m} + \frac{\beta_{d,i}\sigma_d^2}{2\left(e^{\gamma(\gamma-1)\sigma^2/2} - 1\right)}\right) - A_{1m}$$

Finally, the market risk premium for consumer i can be deduced by subtracting the risk free rate in equation (9) from the expected stock market return in equation (11) to obtain:

$$rp_{i,m,t} = \mathbb{E}_t r_{i,m,t+1} - r_{f,t} = \Gamma_{0,i} + \Gamma_{1,i} x_t \tag{12}$$

where

$$\Gamma_{0,i} = \Gamma_{0,i}^m - \Gamma_0^f$$

$$\Gamma_{1,i} = \Gamma_{1,i}^m - \Gamma_1^f$$

At this stage, the reader may wonder how does the risk premium relate to the cross-sectional moments of consumption growth? And how do they explain the variation in average market returns across countries? The answer to the first question is given by the presence of the country consumption risk (x_t) in equation (12) that defines the risk premium and the answer to the second question of the reader is provided by the the risk exposure of the country dividend growth to the country consumption risk ($\beta_{d,i}$). Indeed, the cross-sectional moments of the countries consumption growth distribution are determined by the country consumption risk x_t as we can see from subsection 6. We can see that an increase in the consumption risk reduces the average consumption growth, increases the consumption growth cross-sectional volatility, reduces the consumption growth cross-sectional skewness and increases the consumption growth cross-sectional kurtosis. Furthermore, the higher the exposure of a country to the consumption risk, the higher its risk premium since the consumer in that country will face a higher risk that the returns on its risky asset will fall at the same time its consumption is at the bottom.

3.2 Model's estimation

We estimate the structural parameters of the model described above using the first and second order cross-sectional moments of the countries consumption growth and their market returns. We first compute the aggregate SDF which is obtained as the cross-sectional expectation of the individual stochastic discount factor in equation 8.

$$\begin{aligned} M_{t+1} &= E\left(M_{i,t+1}|I_{t+1}\right) \\ &= \exp\Bigg(\theta \log\delta - \gamma\Delta c_{t+1} + \gamma(\gamma+1)\sigma^2\frac{d_{t+1}}{2} + (\theta-1)\left(\kappa_0 + \kappa_1\left[A_0 + A_1 x_{t+1}\right]\right) \\ &\quad - (\theta-1)\left[A_0 + A_1 x_t\right]\Bigg) \end{aligned} \tag{13}$$

We remind that $\sigma^2 d_{t+1}$ is the cross-sectional variance of countries consumption growth as given by equation (4), which is obtained by taking the expectation conditional on the information at $t+1$ such that the remaining randomness is the one across countries. Let denote by $\hat{\sigma}\left(\Delta c_{i,t+1}\right)$ a consistent estimate of $\sigma^2 d_{t+1}$. As $x_t \equiv \left(e^{\gamma(\gamma-1)\sigma^2/2}-1\right)\omega_t$ and as we relate the cross-sectional centered moments of countries consumption growth to ω_t[8], we can compute an estimate $\hat{x}_t$ of x_t using these moments. We can now compute an estimate $\hat{M}_{t+1}$ of the aggregate SDF to price the set of countries market portfolio in our hands.

$$\begin{aligned}\hat{M}_{t+1} = \exp\Bigg(&\theta\log\delta - \gamma\Delta c_{t+1} + \frac{1}{2}\gamma(\gamma+1)\hat{\sigma}\left(\Delta c_{i,t+1}\right) + (\theta-1)\left(\kappa_0 + \kappa_1\left[A_0 + A_1\hat{x}_{t+1}\right]\right)\\ &-(\theta-1)\left[A_0 + A_1\hat{x}_t\right]\Bigg)\end{aligned} \tag{14}$$

The log-linearization coefficient κ_0 and κ_1 are obtained simultaneously with the affine coefficients of the wealth-consumption ratio (7) by solving the non-linear equation system and a fixed point problem that determines the mean wealth-consumption ratio.

$$\begin{cases} \theta A_0 &= \theta\log\delta + \theta\kappa_0 + \theta\kappa_1 A_0 + (1-\gamma)\mu + \frac{(1-\gamma)^2}{2}\sigma^2 + (1+\theta\kappa_1 A_1)\nu\xi\left(1+\frac{1}{2}\left[1+\theta\kappa_1 A_1\right]\xi\right)\\ \theta A_1 &= \rho\left(1+\theta\kappa_1 A_1\right)\left(1+\left[1+\theta\kappa_1 A_1\right]\xi\right)\\ \kappa_1 &= \frac{e^{\bar{z}_c}}{1+e^{\bar{z}_c}}\\ \kappa_0 &= \log\left(1+e^{\bar{z}_c}\right) - \kappa_1\bar{z}_c\\ \bar{z}_c &= A_0 + A_1\left(\frac{\nu\xi}{1-\rho}\right)\end{cases} \tag{15}$$

The last line is obtained by computing the unconditional expectation of x_t from equation

[8] See equation (39) - (42) in appendix.

(6). We stack all the parameters in one vector

$$\Theta = (\delta, \gamma, \psi, \mu, \sigma, \nu, \xi, \rho) \tag{16}$$

We use the developed countries market returns denote by R_s as test assets to estimate Θ. In order to put more discipline in the estimation of the parameters, we also add the US t-bill rate as the risk free asset (R_b). Let denote by $e_t(\Theta)$ the vector of model's pricing errors conditional on Θ:

$$e_t(\Theta) = 1 - \hat{M}_t \begin{pmatrix} R_{s,t} \\ R_{b,t} \end{pmatrix}$$

Then the moment conditions are given by:

$$E[e_t(\Theta)] = 0$$

We have 19 moment conditions to estimate 8 parameters and our model is over-identified. We use the identity matrix as the weighting matrix in the GMM in order to estimate Θ. By doing so, we take a stand for the unbiasness in the usual bias-efficiency trade-off (Cochrane, 2001.

4 Empirical Analysis

4.1 Data and Descriptive statistics

The data used for the empirical analysis are sourced from Datastream for consumption (PFCE), CPI, asset prices, and from the FRED database for OECD recession indicator. We use assets data from Morgan Stanley Capital International (MSCI) stock market indexes for 18 countries for which we also get the quarterly data on consumption: Aus-

tralia, Austria, Belgium, Canada, Denmark, France, Germany, Hong Kong, Italy, Japan, Netherlands, Norway, Singapore, Spain, Sweden, Switzerland, the UK, and the US. The data cover the period from 1970Q1 to 2018Q4. The indexes are value-weighted and adjusted for dividend reinvestment. We compute the real per capita consumption growth by subtracting inflation and population growth form the aggregate consumption growth. The excess return are computed by subtracting the US 1-month Tbill rate from the indexes returns[9]. The cross-sectional moments of consumption are weighted using the country consumption levels expressed in dollars as weights.

The descriptive statistics presented in Table 2 show an annualized average excess return of 4.3% on the world portfolio with a standard deviation of 33.32%. There is a huge dispersion in the country portfolio excess returns; the minimum average excess return is 1.3% observed in Austria and the maximum in 9.4% in Hong Kong. As usual, consumption growth is much smoother than equity returns. The dispersion is less pronounced for the average consumption growth across country. The annualized world average consumption growth is 2% with a standard deviation of 1.4%. The minimum value for the country average consumption growth is 1% observed in Switzerland and the maximum is 4.9% observed in New Zealand.

It is interesting to look at the correlation matrix between the excess returns on country market portfolios, the recession indicator and the cross-sectional moments of consumption growth. We observe that the country market excess returns are negatively correlated with recession indicator and positively correlated with world excess market return, meaning that country excess return drops during recession period and it increases with the world market portfolio return. Furthermore, as expected there is a negative correlation between the cross-sectional mean of consumption growth and recession indicator; and a positive correlation between the recession indicator and the cross-sectional variance. Thus, the

[9]We used the MSCI return index denominated in US dollar instead of in local currency. By doing so we adopt the view point of a US investor and we can easily compare foreign assets.

cross-sectional average of country consumption growth drops during recessions, while the dispersion between countries consumption growth increases.

More surprisingly, we observe a positive correlation between cross-sectional skewness and recession indicator, meaning that the distribution of country consumption growth is more likely to be positively skewed during recessions compared to normal times. This observation contrasts with one made by Constantinides and Ghosh, 2017 in the US where they found a negative correlation between recessions and cross-sectional household consumption growth skewness. In their case, the household consumption growth distribution is more negatively skewed during recessions compared to normal times since a higher proportions of households are more likely to experience a drop in their consumption during recession periods compared to normal times.

Then, what could explain the different behavior of the consumption growth distribution we observe at the country level during recession? A possible answer can come from the fact that our sample is made by developed countries whose consumption growth rate is more stable. To make the parallel with the US case, this will correspond to look at the consumption growth distribution in the upper quantile of the household consumption distribution. The richest country are more likely to be less affected by recessions and during those periods, to have a consumption growth that will not differ too much from the one they have during normal times, but the less rich country are the one more likely to experience a negative consumption growth. Thus, if among the countries we sample there is a high proportion of rich and more stable countries compared to less stable and rich one, them we expect to see a positive shift of the cross-sectional consumption growth distribution (to the right) during recession period because the few number of countries experiencing a negative consumption growth will lower the cross-sectional average consumption growth. However, the median country consumption growth driven by the higher proportion of rich countries will be above the mean, hence a positive skewness

in the country consumption growth distribution during recessions is lower compared to those with a mo increase with an increase and the cross-sectional variance. This hypothesis is corroborated by the negative correlation we observe between cross-sectional average consumption growth and cross-sectional consumption growth skewness conditional on recessions.

Finally, We observe that the cross-sectional skewness of consumption growth is positively correlated with the cross-sectional mean; it is negatively correlated with both the cross-sectional variance and the cross-sectional kurtosis. This observation seems to align more with the commonly admitted business cycles co-movements where during recessions, average consumption growth drops, cross-sectional dispersion increases, cross-sectional skewness becomes more negative and cross-sectional kurtosis increases. However, since the cross-sectional skewness is positively correlated with the recession indicator, the correlations between the cross-sectional skewness and the other cross-sectional moments go in the opposite direction compared to the common business cycles co-movements.

Thus, there are two antagonistic forces driving the co-movements between the business cycles and the cross-sectional consumption growth moments; one that comes from the sample of developed countries under study as explained in the previous section and the other commonly admitted co-movements where the cross-sectional dispersion of consumption growth increases during recessions, cross-sectional consumption mean drops, while cross-sectional skewness decreases and cross-sectional kurtosis increases. Therefore, the analysis needs to be push further to determine how the cross-sectional moments of consumption growth relate to the countries expected excess returns.

4.2 Linear Factor Model

Assuming the absence of arbitrage and the law of one price on financial markets, we know that there exist a positive SDF that enables to price any assets (Cochrane, 2001). The

return on a given asset i in excess of the return on the risk free asset should satisfy the standard Euler asset pricing equation given by:

$$\mathbb{E}_t \left[M_{t+1} R^e_{i,t+1} \right] = 0 \tag{17}$$

Moreover, we assume that the SDF is a linear combination of K underlying factors, that is:

$$-\frac{M_{t+1}}{\mathbb{E}(M_{t+1})} = k + b' f_{t+1} \tag{18}$$

where b is the vector of coefficients that define the SDF as a linear function of the factors. Plugging the SDF equation (18) in the Euler equation (17), we can compute the expected excess return as follows:

$$\begin{aligned} \mathbb{E}_t \left[R^e_{i,t+1} \right] &= cov_t \left[-\frac{M_{t+1}}{\mathbb{E}(M_{t+1})}, R^e_{i,t+1} \right] \\ &= \mathbb{E}_t \left[R^e_{i,t+1} \left(f_{t+1} - \mu_f \right)' b \right] \end{aligned} \tag{19}$$

where $\mu_f = \mathbb{E}\left[f_{t+1} \right]$. We can estimate the parameters of the model (b, μ_f) by GMM[10] using the following moment conditions:

$$e(z_t, \theta) = \begin{bmatrix} R^e_t - R^e_t \left(f_t - \mu_f \right)' b \\ f_t - \mu_f \end{bmatrix} \otimes Z_t \tag{20}$$

where $\otimes$ refers to the Kronecker product and Z_t is the vector of instruments.

The standard Euler asset pricing equation enables to obtain the beta formulation of

[10] See appendix 6 for more details.

expected return as follows:

$$\begin{aligned}\mathbb{E}\left[R^e_{i,t+1}\right] &= cov\left[-\frac{M_{t+1}}{\mathbb{E}(M_{t+1})}R^e_{i,t+1}\right] \\ &= b^{'}cov(f_{t+1}, R^e_{i,t+1}) \\ &= \lambda^{'}\beta_i \end{aligned} \tag{21}$$

where $\lambda = \Sigma_{ff}b$ and $\beta_i = \Sigma_{ff}^{-1}\Sigma_{fi}$ with $\mu_f = \mathbb{E}\left[f_{t+1}\right]$, $\Sigma_{ff} = \mathbb{E}\Big[\left(f_{t+1} - \mu_f\right)\left(f_{t+1} - \mu_f\right)^{'}\Big]$ and $\Sigma_{fi} = \mathbb{E}\big[\left(f_{t+1} - \mu_f\right)R^e_{i,t+1}\big]$. λ and β_i are respectively the factors risk premium and the quantities of factors risk embedded in the asset i.

We follow the Fama and MacBeth, 1973 cross sectional regressions procedure to estimate the quantities of risk and the risk premium attached to each factor. In short, in a first step we do a time series regression of the excess returns on the factors to obtain an estimate of β_i for each asset.

$$R^e_{i,t} = a_i + \beta_i^{'}f_t + \epsilon_{i,t} \tag{22}$$

In a second step, for each time period t, we do a cross-sectional regression[11] of excess return on the beta to get a time series estimate of risk premium vector λ and a time series estimates of the pricing errors α_i. From the beta formulation in equation (21), the excess return on asset i for each time period can be expressed as follows:

$$R^e_{i,t} = \lambda_t^{'}\beta_i + \alpha_{i,t},\ \ i = 1, 2, ..., N \text{ for each } t. \tag{23}$$

In the case where the expected asset returns are fully spanned by the betas of the specified

[11] There is always a question of whether to include the intercept or not in this regression. This has to do with the trade-off between statistical efficiency and the clarity and economically interpretability of the results often faced in empirical asset pricing (Cochrane, 2001, p. 293). Indeed, as highlighted by Savov, 2011, including the intercept gives the model more freedom but it can lead to poorly estimated factor premia when there is little variation in betas. Furthermore, even-though it improves the goodness of fits, including the intercept also implies a paradoxical risk-free rate that has non-zero excess return relative to itself.

risk factors, the average pricing error $\alpha_i \equiv \mathbb{E}(\alpha_{i,t})$ should be equal to zero. Otherwise, $\alpha_i \neq 0$ and the model is considered as misspecified.

Table 7 reports the risk exposures of the tested assets to the risk factors in the different models that we consider: the standard CCAPM model with the cross-sectional mean of consumption as the unique factor, the two factors model with cross-sectional mean and variance of consumption growth considered by DLP, the Skewness only model with the cross-sectional skewness as the unique factor and the HWCCAPM model with the first four cross-sectional moments of consumption growth as pricing factors. We also report the pseudo R-squared of the regression and the test statistics for testing the rank deficiency of the $\mathbf{B}$ matrix of betas from the first stage of the FM regressions (see Kleibergen and Zhan, 2019).

Finally, following Cochrane, 2001, p. 246, λ and α_i can be estimated as the time average of the cross-sectional regressions estimates.

$$\hat{\lambda} = \frac{1}{T}\sum_{t=1}^{T}\lambda_t, \qquad \hat{\alpha}_i = \frac{1}{T}\sum_{t=1}^{T}\hat{\alpha}_{it}. \tag{24}$$

and their sampling errors are given by:

$$\sigma^2\left(\hat{\lambda}\right) = \frac{1}{T^2}\sum_{t=1}^{T}\left(\hat{\lambda}_t - \hat{\lambda}\right)^2, \qquad \sigma^2\left(\hat{\alpha}_i\right) = \frac{1}{T^2}\sum_{t=1}^{T}\left(\hat{\alpha}_{it} - \hat{\alpha}_i\right)^2. \tag{25}$$

The joint significance of the pricing errors can be tested using the chi-squared asymptotic distribution as follows:

$$\alpha^{'}\hat{\Omega}^{-1}\alpha \sim \chi^2\left(N-K\right) \tag{26}$$

where

$$\hat{\Omega} = \frac{1}{T^2}\sum_{t=1}^{T}\left(\hat{\alpha}_{it} - \hat{\alpha}_i\right)\left(\hat{\alpha}_{it} - \hat{\alpha}_i\right)^{'}$$

Recently, We also provide two measures of fit that are commonly used in the literature

(Campbell and Vuolteenaho, 2004; Yogo, 2006; Darrat et al., 2011), the mean absolute pricing error (MAE) which the sum of the absolute pricing errors divided by the time-series sample length and the a adjusted r-squared ($\bar{R}^2$) from the cross-sectional regression of average excess returns of our test assets onto the fitted values from the model.

$$MAE = \frac{1}{T}\sum_{i=1}^{N}\sum_{t=1}^{T}|e_{it}| \text{ and } \bar{R}^2 = 1 - \left(\frac{N-1}{N-2}\right)\left(\frac{\bar{e}'\bar{e}}{\left(\bar{R}^e - \sum_i \bar{R}^e\right)'\left(\bar{R}^e - \sum_i \bar{R}^e\right)}\right) \tag{27}$$

where e_{it} is the pricing error of asset i at time t, $\bar{e}$ is the vector of time average of pricing errors.

The skewness only model yields a mean absolute pricing errors that is lower than the one achieved by the standard CCAPM model and which is not statistically different from the one obtained in the DLP model with two factors (the cross-sectional mean and dispersion). The adjusted R-squared of 32% achieved by this model also shows how powerful is the cross-sectional skewness factor in explaining the cross-sectional variability in average excess return. This adjusted R-squared can be contrasted to 1% yield by the standard CCAPM, the 5% of the DLP model and the 50% achieved by the fourth cross-sectional moments factor model. On the other side the CAPM model and the 3 Fama-French model yield adjusted R-squared of 9% and 32% respectively, and have considerably reduced the mean absolute pricing error.

The skewness price of risk is negative even-though not statistically significant. In fact, none of the consumption based factor appear to be significant once we adjust the t-stat by the Shanken's correction or we use the weak identification robust statistic to build the confidence sets. However, the market factor is positively priced and the HML factor is negatively priced. The price of the size factor is not statistically different from zero.

4.3 Weak identification robust test for linear factor model

The FM t-test used to test the significance of the risk prices in Table 9 is valid when the sample size is large and the matrix of betas, $\mathbf{B}$ is not rank deficient. However, from the result in table 7, we see that the later assumption might not be satisfied. Kleibergen and Zhan, 2019 propose an extension to the GRS test that jointly test the equality of the risk prices to a specified value and the correct specification of the factor model without assuming a rank condition on $\mathbf{B}$. Furthermore, this testing procedure allows to avoid the pretest bias that could arise from first testing the rank deficiency of $\mathbf{B}$ and then use the FM test if the null hypothesis of the previous test is rejected. Under the null hypothesis $\mathrm{H}_0 : \lambda_f = \lambda_{f,0}$, rewriting equation 23 in the matrix form, the model can be expressed as follows:

$$\begin{aligned} \mathbf{R}_t &= \alpha\left(\lambda_{f,0}\right) + \mathbf{B}\left(\bar{f}_t + \lambda_{f,0}\right) + \epsilon_t \\ E\left(\mathbf{R}_t\right) &= \mathbf{B}\lambda_{f,0}, \end{aligned} \tag{28}$$

Where $\bar{f}_t = f_t - \mu_f$ is the demeaned factor and the sample counterpart of μ_f is $\bar{f} = \frac{1}{T}\sum_{t=1}^{T} f_t$. As presented by Kleibergen and Zhan, 2019, the procedure for testing the good specification of the model given the pre-specified value of the risk price i.e $\mathrm{H}_0 : \alpha\left(\lambda_{f,0}\right) = \alpha - \mathbf{B}\left(\lambda_{f,0} - \mu_f\right)$ consist of regressing each excess returns on a constant term and $\bar{f}_t + \lambda_{f,0}$, then test the joint significance of constant terms at the pre-specified value of $\lambda_{f,0}$ using the GRS test. The test statistic for that is given by:

$$\text{GRS-FAR}\left(\lambda_{f,0}\right) = \frac{T}{1 + \lambda_{f,0}'\hat{Q}\left(\lambda_{f,0}\right)^{-1}\lambda_{f,0}}\hat{\alpha}\left(\lambda_{f,0}\right)'\hat{\Sigma}^{-1}\hat{\alpha}\left(\lambda_{f,0}\right) \tag{29}$$

where $\hat{\alpha}\left(\lambda_{f,0}\right) = \bar{\mathbf{R}} - \tilde{\mathbf{B}}\left(\lambda_{f,0}\right)\lambda_{f,0}$, $\tilde{\mathbf{B}}\left(\lambda_{f,0}\right) = \frac{1}{T}\sum_{t=1}^{T}\mathbf{R}_t\left(\bar{f}_t + \lambda_{f,0}\right)'\hat{Q}\left(\lambda_{f,0}\right)^{-1}$ and $\hat{Q}\left(\lambda_{f,0}\right) = \frac{1}{T}\sum_{t=1}^{T}\left(\bar{f}_t + \lambda_{f,0}\right)\left(\bar{f}_t + \lambda_{f,0}\right)'$.

As the sample size goes to infinity, the GRS-FAR statistics converges to a chi-squared distribution with $N-1$. In finite sample, under the normality assumption, the $100 \times (1-\alpha)\%$ confidence set of λ_f denoted $CS_{\lambda_f}(\alpha)$ consist of all values of $\lambda_{f,0}$ for which the GRS-FAR test does not reject using the $100 \times (1-\alpha)\%$ critical value that results from the F-distribution.

$$CS_{\lambda_f}(\alpha) = \left\{ \lambda_{f,0} : \frac{T-k-N+1}{T(N-1)} \times \text{GRS-FAR}\left(\lambda_{f,0}\right) \leq F_\alpha\left(N-1, T-k-N+1\right) \right\} \tag{30}$$

The confidence set of the risk prices are given in Table 8. Globally the prices of the consumption risk factors are not statistically different from zero. Contrary to previous findings on the statistical inference about the price of consumption risk factor in the U.S where the 95% confidence intervals are unbounded (see Kleibergen, 2009; Kleibergen and Zhan, 2015, 2019), here the 95% confidence set of the risk prices of consumption factors are bounded. They contain the value zero, meaning that we can not reject the hypothesis that the consumption based pricing factors do not generate any risk premium for the test assets.

More surprisingly, the 95% confidence set sometime does not contain the value that has been estimated in the data. This apparent contradiction of the confidence interval not containing the estimated value might be explained by the weak identification of the risk price in the case of the skewness only model. Indeed, the weak identification of the risk price can lead to a bias and inconsistent estimate when using the Fama-McBeth regressions. This observation further emphasize how misleading can be the standard procedure of estimation and inference in a context where the rank deficiency of the first stage regressions beta matrix is not rejected and thus the risk price might be weakly identified. However, for the standard CCAPM model, this observation still remains puzzling since the rank deficiency test rejected the null of weak or no identifiability of the risk price.

Taking the 3 Fama-French pair by pair, we can reject the null hypothesis that the market and the Book-to-Market ratio factors are jointly priceless. The same happens for the combination of the market and the size factors. However, the 95% confidence set for the risk prices of the Book-to-Market ratio and the size factor contains zero, meaning that we can not reject the null hypothesis of zero price for those risk factors. In the case of the consumption-based factors, all the joint confidence sets of risk prices contain zero.

4.4 Estimation of the structural parameters using the countries returns

In this section, we reconsider the stochastic discount factor that was derived in the modeling part (section 3.2). Our aim is to use the cross-section of country's market portfolio returns and the cross-sectional moments of international consumption growth to back out the latent variable driving the agent's consumption growth risk and the structural parameters of the model .

Let denote by $\Theta = (\delta, \gamma, \mu, \omega, \sigma)$. Considering the sdf defined by equation 14 and given the 18 observed country market returns, we use the Euler pricing formula for each asset and the moments of the cross-sectional distribution to estimate the structural parameters of the model.

We used the cross-sectional variance in consumption to back out the latent variable of agent consumption risk. The results of the estimation are given in Table 1.

Table 1: Structural parameters estimation

Par.	δ	γ	ψ	μ	σ	ν	ξ	ρ	MSE*
Est.	0.992	1.769	0.967	-0.003	0.761	0.098	2.776e-05	0.900	0.136
Std.Er.	0.219	0.636	0.693	0.475	0.642	0.710	0.505	0.505	pseudo-R^2 0.41

*The MSE provided by the constant mean model is given by 0.229.

4.5 Non-parametric extraction of the SDF

In the previous section, we assume the existence of the stochastic discount factor and that it was a linear function of some factors such as the cross-sectional moments of the country consumption growth, for which we estimate the coefficients. In this section, we go the other way round by only assuming the existence of a stochastic discount factor. We then use a Bayesian Markov chain Monte Carlo (MCMC) method to non-parametrically extract the ex-post stochastic discount factor that has been used in a unified global financial market to price the set of observed country specific market portfolios. Our aim is to relate this model free SDF to the cross-sectional moments of consumption growth in order see how this model free ex-post sdf co-moves with the cross-sectional consumption moments. We closely follow the method provided by Gallant and Hong, 2007; Gallant and Tauchen, 2018. We start by admitting the existence of a SDF that is used to price all the existing assets on the market[12]. Our objective is to estimate the ex-post sdf denotes by $\{\theta_t\}_{t=1,\ldots,T}$ that has been used to price the set of observed stocks, here the 18 country specific market portfolios and the risk free asset, here the US 3-month Tbill rate. The conditional pricing errors are given by:

$$e_{t,t-1}(\theta_t) = 1 - \theta_t \begin{pmatrix} R_{s,t} \\ R_{b,t} \end{pmatrix} \tag{31}$$

[12]The existence of a (positive) sdf is guaranteed by the (absence of arbitrage) law of one price. By admitting the law of one price and the absence of arbitrage, we can use stochastic discount factors without implicitly assuming anything about utility functions, aggregation, complete markets, and so on. (Cochrane, 2001)

where 1 denotes a vector of 1's of length nineteen. The following instruments are used to obtain the unconditional moment restrictions:

$$V_t = \begin{pmatrix} R_{s,t} - 1 \\ R_{b,t} - 1 \\ \Delta c_t^W \\ TS_t \\ cay_t \\ 1 \end{pmatrix} \tag{32}$$

owhere Δc_t^W is the world consumption growth rate, TS_t is the US term spread computed as the difference between the 10-years and the 1-month T-bill rates and cay_t is the US log consumption -aggregate wealth ratio obtained from Martin Lettau's website. The unconditional moment restriction are given by:

$$m\left(x_t, x_{t-1}, \theta_t\right) = V_{t-1} \otimes e_{t,t-1}\left(\theta\right) \tag{33}$$

where $\otimes$ denotes the Kronecker product.

The Bayesian inference assumes that the parameter of interest is a random variable and there exist a joint distribution of the observable and the parameters $(x_t; \theta_t)$. By the Bayes's rule,

$$p(x, \theta) = p(x|\theta)p(\theta) = p(\theta|x)p(x) \tag{34}$$

Thus, the posterior distribution $\pi(\theta) = p(\theta|x)$ of the sdf $\{\theta_t\}_{t=1,\ldots,T}$ is proportional to the product of two components.

$$\pi(\theta) \propto \ell(\theta)p(\theta) \tag{35}$$

Where $\ell(\theta) = p(x|\theta)$ is the likelihood which gives the chances that the sdf θ_t has been used to price assets given the observed returns. $p(\theta)$ is the prior probability of θ. The prior probability about θ comes from the information contained in the US bond yield curve. Indeed, we assume that the ex-post sdf we are estimating has been used to price the risk free asset in US and we provide the connection that follows between the sdf and the bond yield curve in appendix 6 as well as the prior probability.

Figure 11 presents the evolution of the ex-post SDF from 1970Q1 to 2018Q4. On the same graph, the OECD-NonOECD recession indicator is also represented. We observe that the ex-post SDF captures the business cycles; the inter-temporal marginal rate of substitution shoots up before or during recession periods. This means that given the expected drop in consumption, investors are willing to pay a higher price for the risk free asset to hedge against the drop in stock prices and in respond to the increase in the marginal utility.

5 Conclusion

Heterogeneous agents consumption-based capital asset pricing model has recently received a renewal of attention in order to explain the market level and the cross-sectional variation in the equity risk premium. This model is motivated by the presence of uninsurable idiosyncratic income risk faced by economic agents and, it emphasizes on the cross-sectional distribution of this idiosyncratic risk as an important factor to explain the equity risk premium and the cross-sectional variation in assets expected returns. In this paper, we investigate these hypothesis in an integrated world financial market with country representative heterogeneous agents. More specifically, we examine whether the higher order cross-sectional moments of country consumption growth can serve as pricing factors in an international heterogeneous agents CCAPM. The descriptive statistics show that the

first central cross-sectional moment of country consumption growth co-moves negatively with recessions indicator while the central second order cross-sectional moments co-moves positively. Unexpectedly, the third order central cross-sectional moment also co-moves positively with recessions indicator. However, this apparent counter-cyclical behavior is explained by the sample of developed countries under study and it is counterbalanced by the negative correlation with the second order cross-sectional moment. The further exploration of the role of the higher order cross-sectional moments as pricing factors reveals that they have a high explanatory power with respect to the cross-sectional variation in country average risk premium. However, we remain cautious about the explanatory power of the higher order consumption growth cross sectional moments since the prices of risk failed to pass the identification test in most of the cases (Kleibergen, 2009; Kleibergen and Zhan, 2015) and the factors risk prices are not statistically different from zero. Finally, we non-parametrically extract a model-free ex-post stochastic discount factor that has been used to price the observed country market portfolios and relate that SDF to the cross-sectional central moments of countries consumption growth. We find that the model free SDF is not predicted by the later variables, which cast more doubt on the importance of the higher order cross-sectional moments in pricing international assets. As future research, it would be interesting to look at the importance of these factors for pricing disaggregate international stocks or mutual funds.

6 Appendix

Appendix A: Solution of the Theoretical CCAPM.

The consumers common SDF can be expressed in term of the state variable as follows:

$$
\begin{aligned}
M_{i,t+1} &= \exp\left(\theta \log\delta - \gamma\left(\eta_{i,t+1}\sigma\sqrt{d_{t+1}} - \sigma^2\frac{d_{t+1}}{2} + \Delta c_{t+1}\right) + (\theta-1)\left(\kappa_0 + \kappa_1 z_{c,t+1}(\omega_{t+1}) - z_{c,t}\left(\omega_t\right)\right)\right) \\
&= \exp\left(\theta\log\delta - \gamma\mu + (\theta-1)\left(\kappa_0 + (\kappa_1-1)A_0 + \kappa_1 A_1 \nu\xi\right) + (\theta-1)\left(\rho\kappa_1 - 1\right)A_1 x_t\right. \\
&\left. + (\theta-1)\kappa_1 A_1 \varepsilon_{x,t+1} - \gamma\left(\eta_{i,t+1}\sigma\sqrt{d_{t+1}} - \sigma^2\frac{d_{t+1}}{2} + \sigma_c\varepsilon_{c,t+1}\right)\right)
\end{aligned}
$$

The log risk free rate can be obtained by taking the conditional expectation of the log SDF.

$$
\begin{aligned}
r_t^f &= -\log\mathbb{E}_t\left(M_{i,t+1}\right) \\
&\approx -\theta\log\delta + \gamma\mu - \frac{1}{2}\gamma^2\sigma_c^2 - (\theta-1)\left(\kappa_0 + (\kappa_1-1)A_0\right) - \lambda\nu\xi - \frac{1}{2}\lambda^2\nu\xi^2 \\
&- \left(\lambda\rho\left(1+\lambda\xi\right) - (\theta-1)A_1\right)x_t
\end{aligned}
$$

where

$$
\lambda = \frac{e^{\frac{\gamma(\gamma+1)}{2}\sigma^2} - 1}{e^{\frac{\gamma(\gamma-1)}{2}\sigma^2} - 1} + (\theta-1)\kappa_1 A_1
$$

The standard asset pricing Euler equation for the consumer i, in particular for the return on the wealth portfolio gives:

$$
\mathbb{E}_t\left[M_{i,t+1}R_{i,c,t+1}\right] = 1 \iff \mathbb{E}_t\left[\exp\left(m_{i,t+1} + r_{i,c,t+1}\right)\right] = 1
$$

where $M_{i,t+1}$ is given by equation (5) and

$$r_{i,c,t+1} = \log(R_{i,c,t+1}) = \log\left(\frac{P_{i,c,t+1} + C_{i,t+1}}{P_{i,c,t}}\right)$$

which implies that

$$\begin{aligned} e^{\theta(A_0+A_1x_t)} &= \mathbb{E}_t \exp\left(\theta \log\delta + (1-\gamma)\,\Delta c_{i,t+1} + \theta\left(\kappa_0 + \kappa_1\left(A_0 + A_1 x_{t+1}\right)\right)\right) \\ &\approx e^{\theta\log\delta+\theta\kappa_0+\theta\kappa_1A_0+(1-\gamma)\mu+\frac{(1-\gamma)^2}{2}\sigma_c^2+[1+\theta\kappa_1A_1]\mathbb{E}(x_{t+1}|x_t)+\frac{1}{2}[1+\theta\kappa_1A_1]^2\mathrm{var}(x_{t+1}|x_t)} \end{aligned}$$

Thus, with $\mathbb{E}\left(x_{t+1}|x_t\right) = \nu\xi + \rho x_t$ and $\mathrm{var}\left(x_{t+1}|x_t\right) = \nu\xi^2 + 2\rho\xi x_t$, we deduce that:

$$\begin{cases} \theta A_0 &= \theta\log\delta + \theta\kappa_0 + \theta\kappa_1 A_0 + (1-\gamma)\,\mu + \frac{(1-\gamma)^2}{2}\sigma^2 + (1+\theta\kappa_1 A_1)\,\nu\xi\left(1 + \frac{1}{2}\left[1+\theta\kappa_1 A_1\right]\xi\right) \\ \\ \theta A_1 &= \rho\,(1+\theta\kappa_1 A_1)\,(1 + [1+\theta\kappa_1 A_1]\,\xi) \end{cases} \tag{36}$$

The coefficients A_0 and A_1 can be obtained by solving the non-linear system of equations (36).

To compute the equity return, we follow the same procedure used for the wealth portfolio. We assume that the price-dividend ratio is an affine function of the state variable.

$$z_{i,m,t} = z_{m,t}\left(\omega_t\right) = A_{0m} + A_{1m}x_t$$

Substituting expression of the log-price dividend ratio in the standard Euler equation for the equity return allows to solve for the unknown coefficient and to obtain the expected stock market return as follows.

$$\mathbb{E}_t\left[M_{i,t+1}R_{i,m,t+1}\right] = 1 \iff \mathbb{E}_t\left[\exp\left(m_{i,t+1} + r_{i,m,t+1}\right)\right] = 1$$

where $M_{i,t+1}$ is given by equation (5) and

$$r_{i,m,t+1} = \log(R_{i,m,t+1}) = \log\left(\frac{P_{i,m,t+1} + D_{i,t+1}}{P_{i,m,t}}\right)$$

which implies that

$$\begin{aligned} e^{z_{m,t}(\omega_t)} =& \mathbb{E}_t \exp\left(\theta \log\delta - \frac{\theta}{\psi}\Delta c_{i,t+1} + (\theta-1)\, r_{i,c,t+1} + \kappa_{0m} + \kappa_{1m} z_{m,t+1}(\omega_{t+1}) + \Delta d_{i,t+1}\right) \\ \approx& e^{\theta\log\delta + (\theta-1)\kappa_0 + (\theta-1)(\kappa_1-1)A_0 + \kappa_{0m} + \kappa_{1m}A_{0m} + \mu_d - (\theta-1)A_1 x_t + \frac{1}{2}\sigma_d^2 + (\beta_d-\gamma)\mu + \frac{1}{2}(\beta_d-\gamma)^2\sigma_c^2} \\ & \times e^{\lambda_m(\nu\xi + \rho x_t) + \frac{1}{2}\lambda_m^2\left(\nu\xi^2 + 2\rho\xi x_t\right)} \end{aligned}$$

where

$$\lambda_m = \frac{e^{(\beta_d-\gamma)(\beta_d-\gamma-1)\frac{\sigma^2}{2}} - 1}{e^{\frac{\gamma(\gamma-1)}{2}\sigma^2} - 1} + \left((\theta-1)\,\kappa_1 A_1 + \kappa_{1m}A_{1m}\right)$$

Thus, A_{0m} and A_{1m} should satisfy:

$$\begin{cases} A_{0m} & = \theta\log\delta + (\theta-1)\kappa_0 + (\theta-1)\,(\kappa_1-1)A_0 + \kappa_{0m} + \kappa_{1m}A_{0m} + \mu_d \\ & \quad + \frac{1}{2}\sigma_d^2 + (\beta_d-\gamma)\,\mu + \frac{1}{2}\,(\beta_d-\gamma)^2\,\sigma_c^2 + \lambda_m\nu\xi\left(1 + \frac{1}{2}\lambda_m\xi\right) \\ A_{1m} & = \rho\lambda_m\,(1+\lambda_m\xi) - (\theta-1)A_1 \end{cases} \tag{37}$$

The expected stock market return for consumer i is given by:

$$\begin{aligned} \mathbb{E}_t r_{i,m,t+1} &= \kappa_{0m} + \kappa_{1m}\mathbb{E}_t z_{m,t+1}(\omega_{t+1}) - z_{m,t}\,(\omega_t) + \mathbb{E}_t\Delta d_{i,t+1} \\ &= \kappa_{0m} + (\kappa_{1m}-1)\,A_{0m} + \left(\kappa_{1m}A_{1m} + \frac{\beta_d\sigma_d^2}{2\left(e^{\gamma(\gamma-1)\sigma^2/2} - 1\right)}\right)\nu\xi + \mu_d \\ &\quad + \left(\rho\left(\kappa_{1m}A_{1m} + \frac{\beta_d\sigma_d^2}{2\left(e^{\gamma(\gamma-1)\sigma^2/2} - 1\right)}\right) - A_{1m}\right)x_t \end{aligned}$$

Appendix B: Derivation of the cross-sectional moments of consumption growth distribution.

The derivation of the cross-sectional moments of the consumption growth distribution closely follows Constantinides and Ghosh, 2017. This derivation uses the following identity:

$$e^{-\omega}\sum_{k=0}^{\infty} e^{kn}\omega^n/n! = e^{-\omega}\sum_{k=0}^{\infty}\left(e^k\omega\right)^n/n! = e^{-\omega}e^{e^k\omega}. \tag{38}$$

Differentiating one, two, three and four times with respect to k and setting $k=0$, we obtain:

$$\begin{aligned}
e^{-\omega}\sum_{k=0}^{\infty} n\omega^n/n! &= \omega \\
e^{-\omega}\sum_{k=0}^{\infty} n^2\omega^n/n! &= \omega^2+\omega \\
e^{-\omega}\sum_{k=0}^{\infty} n^3\omega^n/n! &= \omega^3+3\omega^2+\omega \\
e^{-\omega}\sum_{k=0}^{\infty} n^4\omega^n/n! &= \omega^4+6\omega^3+7\omega^2+\omega
\end{aligned}$$

The country relative consumption growth defined in equation (2) satisfies:

$$\begin{aligned}
\ln\left(\frac{C_{i,t+1}/C_{t+1}}{C_{i,t}/C_t}\right) &= \ln\left(\delta_{i,t+1}\right) - \ln\left(\delta_{i,t}\right) \\
&= \eta_{i,t+1}\sigma\sqrt{d_{t+1}} - \sigma^2\frac{d_{t+1}}{2}
\end{aligned}$$

Thus, the cross-sectional centered first to fourth moments are given by:

$$\mu_1\left[\ln\left(\frac{C_{i,t+1}/C_{t+1}}{C_{i,t}/C_t}\right)|\omega_{t+1}\right] = \mathbb{E}\left(\eta_{i,t+1}\sigma\sqrt{d_{t+1}} - \sigma^2\frac{d_{t+1}}{2}|\omega_{t+1}\right)$$
$$= \mathbb{E}\left(\mathbb{E}\left(\eta_{i,t+1}\sigma\sqrt{d_{t+1}} - \sigma^2\frac{d_{t+1}}{2}|d_{t+1}\right)|\omega_{t+1}\right)$$
$$= -\left(\sigma^2/2\right)\omega_{t+1} \tag{39}$$

$$\mu_2\left[\ln\left(\frac{C_{i,t+1}/C_{t+1}}{C_{i,t}/C_t}\right)|\omega_{t+1}\right] = \mathbb{E}\left(\left[\eta_{i,t+1}\sigma\sqrt{d_{t+1}} - \sigma^2\frac{d_{t+1}}{2} - \mu_1\left[\ln\left(\frac{C_{i,t+1}/C_{t+1}}{C_{i,t}/C_t}\right)|\omega_{t+1}\right]\right]^2|\omega_{t+1}\right)$$
$$= \left(\sigma^2 + \sigma^4/4\right)\omega_{t+1} \tag{40}$$

$$\mu_3\left[\ln\left(\frac{C_{i,t+1}/C_{t+1}}{C_{i,t}/C_t}\right)|\omega_{t+1}\right] = \mathbb{E}\left(\left[\eta_{i,t+1}\sigma\sqrt{d_{t+1}} - \sigma^2\frac{d_{t+1}}{2} - \mu_1\left[\ln\left(\frac{C_{i,t+1}/C_{t+1}}{C_{i,t}/C_t}\right)|\omega_{t+1}\right]\right]^3|\omega_{t+1}\right)$$
$$= -\left(\left(3/2\right)\sigma^4 + \left(1/8\right)\sigma^6\right)\omega_{t+1} \tag{41}$$

$$\mu_4\left[\ln\left(\frac{C_{i,t+1}/C_{t+1}}{C_{i,t}/C_t}\right)|\omega_{t+1}\right] = \mathbb{E}\left(\left[\eta_{i,t+1}\sigma\sqrt{d_{t+1}} - \sigma^2\frac{d_{t+1}}{2} - \mu_1\left[\ln\left(\frac{C_{i,t+1}/C_{t+1}}{C_{i,t}/C_t}\right)|\omega_{t+1}\right]\right]^4|\omega_{t+1}\right)$$
$$= \left(3\sigma^4 + \left(3/2\right)\sigma^6 + \left(1/16\right)\sigma^8\right)\omega_{t+1} + \left(3\sigma^4 + \left(3/2\right)\sigma^6 + \left(3/16\right)\sigma^8\right)\omega_{t+1}^2 \tag{42}$$

GMM estimation of the linear factor models

Following Cochrane, 2001; Yogo, 2006, the linear factor model can be expressed in terms of pricing errors and the GMM (Hansen, 1982) can be applied to estimate the coefficients (b) that define the SDF as a linear combination of the pricing factors. From the asset pricing Euler equation (17) and the linear SDF formulation (18), the pricing errors at

time t can be expressed as a $(N+F)K \times 1$ vector of moment function as follows:

$$e(z_t, \theta) = \begin{bmatrix} R_t^e - R_t^e \left(f_t - \mu_f\right)' b \\ f_t - \mu_f \end{bmatrix} \otimes Z_t$$

where $\theta = (b', \mu_f')'$ is a $(2F) \times 1$ vector of parameters, Z_t is a $K \times 1$ vector of instruments, f_t is a $F \times 1$ vector of factors, R_t^e is a $N \times 1$ vector of excess returns and $z_t = (R_t^{e'}, f_t', Z_t')'$ stacks all the variables together. From the asset pricing Euler equation (17), the moment function satisfies the moment restriction $\mathbb{E}\left[e\left(z_t, \theta_0\right)\right] = 0$, for some $\theta_0 \in \Theta$. The parameters are estimated by 2-Step GMM and obtained by minimizing the criterion function:

$$S_T(\theta; \bar{\theta}_T(\theta)) = T. \left(e_T(z_t, \theta)\right)' W_T(\bar{\theta}_T(\theta)) \left(e_T(z_t, \theta)\right)$$

Where $e_T(z_t, \theta)$ is the time average of $e(z_t, \theta)$, $W_T(\bar{\theta}_T(\theta))$ is a positive semi-definite weighting matrix and $\bar{\theta}_T(\theta)$ is the value of the parameters used to compute W_T. In the first step, we use the identity matrix as the weighting matrix, $W_T = I_{(N+F)K}$. For the second step, we use the optimal weighting matrix computed with $\bar{\theta}_T(\theta)$ fixed to the value estimated in the first step. The optimal weighting matrix is the inverse of the asymptotic variance-covariance matrix of $\sqrt{T} e_T(z_t, \theta)$ and it can be consistently estimated using a kernel based estimator (Newey and West, 1987; Andrews, 1991) by:

$$\widehat{\Omega}(\theta) = \widehat{\Omega}_0 + \sum_{j=1}^{m} \bar{k}_j \left(\widehat{\Omega}_j + \widehat{\Omega}_j'\right) \tag{43}$$

where $\widehat{\Omega}_j = T^{-1} \sum_{t=j+1}^{T} \left(e(z_t, \theta) - e_T(z_t, \theta)\right) \left(e(z_{t-j}, \theta) - e_T(z_t, \theta)\right)'$and $\bar{k}_j$ is a kernel function (e.g: Bartlett, Quadratic Spectral, Parzen, Truncated, etc.). We use the Bartlett kernel with bandwidth m,$\bar{k}_j = \begin{cases} (1 - \frac{j}{m+1}) \; if \; 0 \leq j \leq m \\ 0 \quad if \quad Not \end{cases}$. Newey and West, 1994 showed how to automatically select the bandwidth or number of lag ($m = parameter \times T^{1/3}$) to include in the summation in equation (43).

We test over-identifying restrictions of the model by using the Hansen, 1982 J-test. The degree of over-identification is $(N+F)K-2F$.

Appendix B1: The likelihood of θ.

Let consider the normalized average moment condition defined on the probability space $(\chi \times \Theta, \mathcal{C}^o, P^o)$ defined by:

$$Z(x,\theta) = \sqrt{n} S_n^{-1/2}(\theta) (U_v \otimes U_e)' \bar{m}(x,\theta) \tag{44}$$

where U_e (resp. U_v) is a set of orthogonal vectors used to diagonalize $\Sigma_e = Var[e_{t,t-1}]$ (resp. $\Sigma_v = Var[V_t]$) and $S_n(\theta)$ is a diagonal matrix defined below by equation (46). Indeed, given the vector

$$H_t(\theta) = (U_v \otimes U_e)' m(x_t, x_{t-1}, \theta_t) \tag{45}$$

with elements $h_{i,t}(\theta)$, we have that:

$$\begin{aligned} Var[H_t(\theta)] &= (U_v \otimes U_e)' \Sigma_m (U_v \otimes U_e) \\ &= (U_v \otimes U_e)' (\Sigma_v \otimes \Sigma_e)(U_v \otimes U_e) = D_v \otimes D_e \end{aligned}$$

Thus, $Var[H_t(\theta)]$ can be estimated by a diagonal matrix $S_n(\theta)$ with elements:

$$s_i(\theta) = \frac{1}{n}\sum_{t=2}^{n}\left[h_{i,t}(\theta) - \frac{1}{n}\sum_{t=2}^{n} h_{t,i}(\theta)\right]^2 \tag{46}$$

There exist a probability space $(\chi \times \Theta, \mathcal{C}^*, P^*)$ on which the conditional density of x given θ is $f(x|\theta) = \phi[Z(x,\theta)]$ (Gallant, 2015), where $\phi(.)$ denotes the pdf of the Gaussian

distribution. Thus, the likelihood of θ is proportional to the euclidean norm of $Z(x,\theta)$.

$$\ell(\theta) \propto \exp(-Z(x,\theta)'Z(x,\theta)) \tag{47}$$

Appendix B2: Bond Yield curve and Prior probability of θ.

Let's assume we observe the ex-post SDF $\{\theta_t\}_{t=1,..,T}$ that has been used to price the existing assets. For the risk free asset, the present value of the contract that pays 1 unit of consumption n-period later is given by:

$$PV_{t,n}(1) = \exp\left[E\left(\sum_{s=1}^{n} sdf_{t+s-1,t+s}\right) + \frac{1}{2}Var\left(\sum_{s=1}^{n} sdf_{t+s-1,t+s}\right)\right] \tag{48}$$

where $sdf_{t-1,t} = \log(\theta_t)$. Now, let's assume that the $w_t = \left(\log(\theta_t), \Delta c_t^W\right)$ follows an Vector Auto-regression process of order 1 (VAR(1)), then we can write:

$$w_t = d_0 + Dw_{t-1} + u_t \tag{49}$$

The coefficients (d_0, D, Σ_u) of this VAR(1) model can be estimated by least squares. Plugging the estimates in the bond present value equation (48), we can deduce the yield curve as a linear function of sdf as follows:

$$\begin{aligned} Y_{n,t}^* &= -\log[PV_{t,n}(1)]/n \\ &= \frac{-1}{n}\left[\sum_{s=1}^{n}(n+1-s)\hat{D}^{s-1}\hat{d}_0 + \left(\sum_{s=1}^{n}\hat{D}^s\right)w_t\right]_{(1)} \\ &- \left[\frac{1}{2n}\sum_{s=1}^{n}\left(\sum_{u=1}^{s}\hat{D}^{u-1}\right)\hat{\Sigma}_d\left(\sum_{u=1}^{s}\hat{D}^{u-1}\right)'\right]_{(1,1)} \end{aligned}$$

and we can compute the prior probability of θ using the mean and variance of the 1-year and 30-year bond yields as follows:

$$p(\theta) = \prod_{t=1}^{n} \phi\left[\left(Y_{1,t}^{*} - 0.00896\right)/0.01\right] \phi\left[\left(Y_{30,t}^{*} - 0.02\right)/0.01\right]$$

Appendix B3: Metropolis-Hastings MCMC inference of θ.

The algorithm proceeds as follows (see Gamerman and Lopes, 2006, chapter 6.):

1. Initialize the iteration counter $i = 1$ and set an arbitrary initial value $\theta^{(0)}$ e.g. $\theta_t^0 \sim i.i.d\aleph(0, 4)$

2. Move the chain to a new value θ^{i+1} generated from the density $q(\theta^i, .)$.

3. Here we use a random walk to move to get a candidate ϕ: e.g. $\phi = \theta_t^i + i.i.d\aleph(0, 4)$

4. Compute the prior probability $p(\phi)$ and likelihood $\ell(\phi)$ as described above.

5. Compute the posterior probability of $\pi(\phi)$

6. Evaluate the acceptance probability of the move $\alpha = min\{1, \frac{\pi(\phi)}{\pi(\theta^i)}\}$. If the move is accepted, $\theta^{i+1} = \phi$. If it is not accepted,$\theta^{i+1} = \theta^i$ and the chain does not move.

7. Change the counter from i to $i+1$ and return to step 2 until convergence is reached.

Appendix C: Data, descriptive statistics and additional tables.

Table 2: Summary statistics: Excess return on the MSCI country index

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
World	196	1.074	8.335	−27.590	−1.655	5.487	21.865
Pacific_U	196	0.999	10.884	−37.745	−4.523	7.811	29.128
EAFE_U	196	1.024	9.313	−25.676	−2.613	6.308	26.510
Europe_U	196	1.127	9.304	−26.300	−2.852	6.767	29.391
Australia	196	1.144	9.789	−48.594	−4.037	6.893	23.578
Austria	196	0.314	11.754	−55.584	−4.379	5.827	41.424
Belguim	196	1.176	10.161	−45.173	−3.797	6.292	33.824
Canada	196	1.085	8.478	−26.791	−2.063	6.098	21.627
Denmark	196	1.743	9.820	−32.250	−4.161	7.854	31.400
France	196	1.154	10.883	−36.803	−3.328	7.256	28.109
Germany	196	0.639	11.077	−46.004	−4.182	6.672	28.758
Hong_Kong	196	2.342	17.150	−72.426	−4.754	11.790	55.147
Italy	196	0.556	12.355	−33.224	−6.095	7.420	46.768
Japan	196	0.375	10.551	−40.804	−5.600	7.033	26.878
Netherlands	196	1.281	9.450	−37.573	−3.285	6.540	25.172
Norway	196	1.375	13.386	−57.880	−4.533	9.859	40.532
Spain	196	1.173	11.428	−35.024	−5.374	7.844	46.688
Sweden	196	2.070	11.970	−40.393	−3.929	8.677	41.017
Switzerland	196	0.689	9.068	−42.280	−3.568	5.405	26.070
UK	196	1.386	9.479	−33.888	−2.820	6.463	56.312
Singapore	196	0.910	14.243	−51.799	−4.912	7.496	66.886
USA	196	1.219	8.325	−31.641	−2.678	6.214	19.525

This table presents the summary statistics of the quarterly excess returns (in percentage) on the MSCI country/region indexes. The data span the period from 1970Q1 to 2018Q4. The Pacific index captures large and mid cap representation across 5 developed markets in the Pacific region: Australia, Japan, Hong Kong, New Zealand, Singapore. The EAFE index is for Europe, Australasia and Far East and it includes all developed markets outside of US and Canada.

Table 3: Summary statistics: Consumption growth by country

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
World	196	2.040	1.403	−2.640	1.274	3.093	6.389
Australia	196	1.870	1.704	−2.307	0.883	3.001	6.441
Austria	196	1.917	2.180	−5.789	0.491	3.040	9.286
Belguim	196	1.774	1.871	−1.787	0.426	2.772	8.815
Canada	196	1.859	1.862	−4.559	0.967	2.981	7.304
Finland	196	2.252	2.875	−5.292	0.764	3.893	10.065
France	196	1.671	1.537	−1.868	0.617	2.661	6.015
Germany	196	1.890	1.869	−1.885	0.514	3.244	7.697
Greece	196	1.861	3.562	−12.762	0.759	3.886	9.292
Italy	196	1.667	2.394	−4.819	0.473	3.134	7.831
Japan	196	2.101	2.407	−4.405	0.701	3.285	10.000
Luxembourg	196	1.923	2.272	−5.166	0.304	3.382	7.572
Netherlands	196	1.439	2.273	−5.374	0.133	2.756	7.197
NewZealand	196	4.882	5.912	−3.779	0.349	8.750	18.264
Norway	196	2.259	2.426	−4.707	0.893	3.740	9.611
Portugal	196	2.166	4.029	−6.728	−0.194	3.587	15.338
South.Africa	196	1.196	3.069	−10.454	−0.692	2.931	9.401
South.Korea	196	4.689	4.161	−14.193	2.266	7.502	13.591
Spain	196	1.688	2.714	−5.927	0.061	3.308	7.520
Sweden	196	1.374	2.349	−6.112	0.292	2.631	7.940
Switzerland	196	1.028	1.504	−4.536	0.286	1.637	6.474
UK	196	2.337	2.658	−5.247	0.967	3.861	9.108
US	196	2.057	1.824	−3.168	1.171	3.143	6.882
Average	196	2.086	1.419	−2.487	1.184	3.115	5.734
Median	196	1.978	1.290	−2.493	1.179	2.820	5.139

This table presents the summary statistics on the real per capita growth rate (in percentage) of the quarterly private final consumption expenditure. The data span the period from 1970Q1 to 2018Q4.

Table 4: Correlation matrix of Recession, world excess return and consumption factors

	Recession	$R^{ex}_{w,t}$	$\Delta c_{w,t}$	$d_{w,t}$	$skew_{w,t}$	$kur_{w,t}$	$\Delta c_{w,t-1}$	$d_{w,t-1}$	$skew_{w,t-1}$	$kur_{w,t-1}$
Australia	**-0,176**	**0,657**	-0,009	0,018	-0,066	-0,002	-0,034	-0,062	-0,13	0,014
Austria	**-0,194**	**0,502**	**0,158**	-0,055	-0,129	0,011	0,091	-0,115	-0,127	-0,085
Belgium	**-0,142**	**0,698**	0,128	0,077	**-0,15**	-0,01	0,048	-0,033	**-0,188**	0,008
Canada	**-0,222**	**0,811**	0,109	0,019	0,006	0,019	0,045	-0,128	-0,03	0,002
Denmark	**-0,217**	**0,521**	0,074	-0,03	-0,032	-0,015	-0,021	-0,129	-0,029	-0,051
France	**-0,213**	**0,718**	0,091	0,065	-0,121	-0,04	0,042	-0,075	**-0,155**	-0,044
Germany	**-0,201**	**0,685**	0,002	0,023	-0,118	0,03	-0,081	-0,072	-0,122	-0,008
Hong_Kong	**-0,16**	**0,566**	0,087	0,022	-0,018	0,046	-0,022	0,001	-0,038	-0,008
Italy	**-0,154**	**0,606**	0,082	0,067	-0,115	-0,005	0,035	-0,023	**-0,146**	0,013
Japan	**-0,231**	**0,707**	**0,154**	0	-0,101	0,002	0,045	-0,061	-0,121	0,046
Netherlands	**-0,239**	**0,776**	0,044	0,037	-0,093	-0,041	-0,073	-0,082	-0,111	-0,018
Norway	**-0,248**	**0,533**	**0,201**	-0,018	-0,01	-0,066	**0,163**	-0,111	-0,125	-0,088
Spain	-0,129	**0,631**	0,064	0,014	-0,039	0,004	0,015	-0,137	-0,023	0,084
Sweden	-0,111	**0,657**	0,003	0,037	0,035	0,052	-0,083	-0,056	-0,018	0,079
Switzerland	**-0,144**	**0,728**	0,033	-0,009	-0,133	-0,019	-0,057	**-0,135**	**-0,135**	-0,018
UK	-0,109	**0,733**	0,014	-0,027	-0,082	0,08	-0,1	-0,103	-0,119	0,114
Singapore	**-0,165**	**0,612**	0,087	-0,039	0,04	0,011	-0,028	-0,086	-0,052	0,002
USA	-0,09	**0,924**	0,014	0,03	-0,082	0,106	-0,065	-0,083	-0,117	0,074
Recession	1	**-0,177**	**-0,315**	**0,209**	0,135	0,013	**-0,215**	**0,2**	**0,145**	-0,033
$R^{ex}_{w,t}$	**-0,177**	1	0,078	0,031	-0,102	0,087	-0,018	-0,085	-0,123	0,094
$\Delta c_{w,t}$	**-0,315**	0,078	1	0,074	0,035	0,059	**0,911**	0,066	0,011	0,084
$d_{w,t}$	**0,209**	0,031	0,074	1	-0,097	-0,014	0,103	**0,756**	-0,06	0,001
$skew_{w,t}$	0,135	-0,102	0,035	-0,097	1	**0,144**	0,108	-0,047	**0,805**	0,099
$kur_{w,t}$	0,013	0,087	0,059	-0,014	**0,144**	1	0,075	0,036	0,137	**0,711**
$\Delta c_{w,t-1}$	**-0,215**	-0,018	**0,911**	0,103	0,108	0,075	1	0,082	0,034	0,05
$d_{w,t-1}$	**0,2**	-0,085	0,066	**0,756**	-0,047	0,036	0,082	1	-0,099	-0,029
$skew_{w,t-1}$	**0,145**	-0,123	0,011	-0,06	**0,805**	0,137	0,034	-0,099	1	**0,142**
$kur_{w,t-1}$	-0,033	0,094	0,084	0,001	0,099	**0,711**	0,05	-0,029	**0,142**	1

Recession denotes the OECD and Non OECD recession indicator provided by OECD which tracks the business cycles in 35 OECD and Non-member economies. $R^{ex}_{w,t}$ is the world excess return, $\Delta c_{w,t}$ is the cross-sectional average of the country consumption growth, $d_{w,t}$ is the cross-sectional variance of country consumption growth, $skew_{w,t}$ is the cross-sectional skewness of country consumption growth. In bold font shows the the significance at 5% level.

Table 5: Summary statistics: Cross-sectional Mean, Dispersion, Skewness and Kurtosis

Panel A: Equally weighted moments.

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Cross_Mean	196	2.086	1.419	−2.487	1.184	3.115	5.734
Cross_Var	196	6.955	4.759	0.516	2.893	10.579	20.147
Cross_Skew	196	0.456	1.147	−3.136	−0.105	1.161	2.730
Cross_Kurt	196	4.811	2.712	1.696	2.796	6.275	13.359

Panel B: Consumption per capita weighted moments.

W_Cross_Mean	196	2.040	1.403	−2.640	1.274	3.093	6.389
W_Cross_Var	196	3.092	2.048	0.183	1.522	3.994	11.156
W_Cross_Skew	196	0.365	1.629	−5.130	−0.664	1.445	4.730
W_Cross_Kurt	196	5.454	7.159	−1.587	0.430	7.534	41.949

This table presents the summary statistics of the cross sectional moments of the real per capita growth rate (in percentage) of the quarterly private final consumption expenditure. Panel A presents the equally weighted cross-sectional moment and Panel B presents the same moments where the weights are the proportion of the country consumption to world consumption. The data span the period from 1970Q1 to 2018Q4.

Table 6: Expected returns by periods (Skewness and Mean)

	Skew>0	Skew<0	Diff.	t-stat (diff.)	Mean>0	Mean<0	Diff.	t-stat (diff.)
Australia	0.02	0.02	0.00	0.11	0.02	0.02	0.00	0.07
Austria	0.01	0.03	-0.02	-0.90	0.02	-0.03	0.05	0.83
Belguim	0.01	0.05	-0.03	-2.26	0.02	0.01	0.01	0.29
Canada	0.02	0.02	0.01	0.60	0.02	0.00	0.03	0.78
Denmark	0.03	0.03	0.00	-0.15	0.03	0.02	0.01	0.25
France	0.02	0.04	-0.02	-1.24	0.02	0.02	0.01	0.26
Germany	0.01	0.03	-0.01	-0.81	0.02	0.01	0.01	0.19
Hong_Kong	0.04	0.03	0.01	0.57	0.04	0.03	0.01	0.11
Italy	0.02	0.02	0.00	-0.25	0.02	0.01	0.01	0.22
Japan	0.01	0.02	0.00	-0.25	0.02	0.01	0.01	0.22
Netherlands	0.02	0.04	-0.02	-1.10	0.02	0.03	0.00	-0.08
Norway	0.03	0.02	0.00	0.08	0.03	-0.01	0.03	0.69
Spain	0.02	0.03	0.00	-0.25	0.02	0.03	0.00	-0.13
Sweden	0.03	0.03	0.00	0.15	0.03	0.04	-0.01	-0.19
Switzerland	0.01	0.03	-0.02	-1.36	0.02	0.03	-0.01	-0.51
UK	0.02	0.03	-0.01	-0.86	0.03	0.02	0.01	0.28
Singapore	0.02	0.02	0.00	-0.16	0.02	0.01	0.01	0.35
USA	0.02	0.03	-0.01	-1.16	0.02	0.01	0.01	0.40
R.FF_US	0.01	0.01	0.01	5.76	0.01	0.00	0.01	11.21
factor.Mrkt	0.02	0.03	-0.01	-0.46	0.02	0.01	0.01	0.29
factor.Cross_mean	0.02	0.01	0.01	4.24	0.02	-0.01	0.03	14.06
factor.Cross_var	0.00	0.00	0.00	2.88	0.00	0.00	0.00	3.19
factor.Cross_skew	0.99	-0.81	1.80	13.40	0.52	-0.50	1.03	4.82
factor.Cross_kurt	5.00	4.37	0.63	1.35	4.92	3.21	1.71	5.94

This table summarizes the change in expected returns by periods of positive or negative cross-sectional average (or skewness) of countries consumption growth. It also shows the correlation between episodes of positive or negative cross-sectional average (or skewness) of countries consumption growth and the U.S risk free rate (R.FF_US) and the cross-sectional moment of countries consumption growth.

Table 7: Beta with countries market portfolios excess returns

	CCAPM		Skewness		DLP				HWCCAPM							
	$\beta_{\Delta c}$	t-stat	β_{Skew}	t-stat	$\beta_{\Delta c}$	t-stat	β_{Var}	t-stat	$\beta_{\Delta c}$	t-stat	β_{Var}	t-stat	β_{Skew}	t-stat	β_{Kurt}	t-stat
Australia	-0.09	-0.15	-0.40	-1.00	-0.10	-0.16	0.06	0.17	-0.09	-0.14	0.03	0.08	-0.40	-1.01	0.02	0.14
Austria	1.30	1.30	-0.93	-1.58	1.35	1.35	-0.41	-0.92	1.39	1.69	-0.49	-1.14	-1.06	-1.74	0.04	0.28
Belgium	0.92	1.04	-0.93	-2.70	0.88	1.10	0.32	0.91	0.92	1.08	0.25	0.77	-0.94	-2.66	0.01	0.10
Canada	0.68	1.11	0.03	0.08	0.67	1.11	0.06	0.17	0.66	1.09	0.06	0.18	0.01	0.03	0.01	0.12
Denmark	0.49	0.61	-0.19	-0.47	0.51	0.65	-0.20	-0.51	0.53	0.65	-0.22	-0.54	-0.23	-0.54	-0.02	-0.16
France	0.69	1.10	-0.81	-2.05	0.66	1.04	0.29	0.67	0.71	1.08	0.23	0.55	-0.77	-1.86	-0.04	-0.40
Germany	-0.02	-0.03	-0.80	-1.84	-0.03	-0.05	0.08	0.21	-0.01	-0.02	0.02	0.06	-0.85	-1.86	0.08	0.83
Hong_Kong	1.11	0.88	-0.19	-0.31	1.09	0.81	0.18	0.26	1.08	0.81	0.17	0.24	-0.27	-0.42	0.10	0.75
Italy	0.73	0.94	-0.87	-1.69	0.68	0.86	0.37	0.75	0.72	0.85	0.31	0.65	-0.86	-1.63	0.01	0.12
Japan	1.16	1.72	-0.65	-1.31	1.17	1.73	-0.06	-0.18	1.20	1.80	-0.11	-0.34	-0.71	-1.47	0.01	0.11
Netherlands	0.27	0.45	-0.54	-1.37	0.25	0.44	0.13	0.34	0.29	0.47	0.08	0.22	-0.52	-1.25	-0.03	-0.40
Norway	1.93	2.16	-0.08	-0.15	1.96	2.19	-0.21	-0.37	2.00	2.29	-0.23	-0.41	-0.08	-0.13	-0.14	-0.86
Spain	0.53	0.79	-0.27	-0.64	0.52	0.77	0.06	0.13	0.54	0.79	0.04	0.08	-0.29	-0.63	0.01	0.08
Sweden	-0.02	-0.03	0.26	0.53	-0.04	-0.07	0.16	0.36	-0.08	-0.13	0.19	0.42	0.23	0.42	0.09	0.83
Switzerland	0.19	0.34	-0.74	-1.78	0.20	0.36	-0.08	-0.22	0.23	0.45	-0.14	-0.37	-0.76	-1.80	0.00	0.02
UK	0.06	0.12	-0.48	-1.37	0.08	0.14	-0.16	-0.37	0.08	0.13	-0.19	-0.45	-0.58	-1.63	0.13	1.41
Singapore	0.86	0.77	0.35	0.63	0.90	0.80	-0.35	-0.60	0.89	0.78	-0.32	-0.57	0.28	0.50	0.00	0.02
USA	0.07	0.12	-0.42	-1.21	0.05	0.08	0.10	0.32	0.04	0.06	0.07	0.23	-0.50	-1.57	0.14	1.84
Pseudo R^2	0.42		0.27		0.07				0.65							
P-value. B=0	0.04		0.15		0.28				0.61							

This table shows the estimated β's from the first step Fama-MacBeth regressions. The test assets are the 18 country market portfolios plus the US risk free asset, over 1970Q1 to 2018Q4 (quarterly data). The pseudo-R^2 is a goodness of fit measure that captures the percentage of the variation of asset excess returns that is explained by the risk factor. The p-value is based on the F-test of $H_0 : rank\left(\iota_N \vdots \beta\right) = 1$ (or equivalently $\mathbf{B} = 0$); see Kleibergen and Zhan, 2019. In each case, we subtract the risk free rate from the asset return such that we can directly test for $\mathbf{B} = 0$. The results are reported for the single factor models (CCAPM, CAPM and Skewness) and the consumption multi-factor models (DLP and HCCAPM).

Table 8: Estimation results: Fama-MacBeth regressions (with-out intercept in the second pass)

	Consumption-based Models					CAPM and 3 factors Models	
	CCAPM	Skewness	DLP	HWCCAPM		CAPM	3 Global FF
λ_{CCAPM}	1.01		1.06	1.18	λ_{CAPM}	1.32	1.33
	(1.56)		(1.60)	(1.89)		(1.76)	(1.49)
	[1.40]		[1.22]	[1.16]		[1.92]	[1.52]
	(-2.14, 0.47)		(-3.2, 1.5)	(-3.6, 1.8)		(0.65, 1.64)	(0.3, 1.4)
$\lambda_{CrossVar}$			1.57	1.30	λ_{HML}		-1.59
			(1.64)	(1.79)			(-1.56)
			[1.23]	[1.04]			[-1.94]
			(-7.2, 3.7)	(-7, 3.5)			(-3.2, -0.4)
$\lambda_{CrossSkew}$		-1.13		0.09	λ_{SMB}		-0.53
		(-1.33)		(0.15)			(-0.71)
		[-1.28]		[0.10]			[-0.74]
		(-0.84, 1.73)		(-3.4, 3.2)			(-1.6, 0.5)
$\lambda_{CrossKurt}$				8.08			-
				(2.13)			
				[1.18]			
				(-19, 15)			
R^2	1.31%	32.28%	4.89%	49.65%		9.19%	36.32%
MAE	118.27	115.86	113.39	96.78		95.90	67.37
Rank test	1.89	1.38	0.79	0.86		143.40	2.26
p-value	(0.02)	(0.15)	(0.70)	(0.61)		(0.00)	(0.01)
Alpha test	24.46	15.06	23.34	16.33		19.82	27.74
p-value	(0.11)	(0.59)	(0.10)	(0.57)		(0.34)	(0.02)

Panel C: Test of difference in MAE between models	
The MAE difference between CCAPM and Skewness (only)	-2.42
	(0.10)
The MAE difference between Skewness (only) and DLP	-2.47
	(0.07)
The MAE difference between DLP and HWCCAPM	-16.61
	(0.00)

This table shows the results of the Fama-MacBeth regressions. In the first step. we regress for each country the excess return on the factors to obtained the risk exposures (betas). In the second step. we run a cross-sectional regression of the country excess returns at each time period on the betas (without intercept) to obtain the risk price λs. The 3 Fama-French global factor model (Global FF-3factors) uses the data from 1990M1 to 2018M12. The Excess return in the CAPM is the MSCI World return minus the US 3-month Tbill rate. The Newey-West t-statistics (in (blue)) are given in brackets just below the estimates and the Shanken t-statistics (in [red]). which adjust for the fact that the betas are estimated. are given below the Newey-West t-statistics. The 95% confidence set for the price of risk is given in brackets below the Shanken t-statistics. Alpha test is computed using equation (26) and the p-value is given below in brackets. R^2 is the r-squared

from the cross-sectional regression (with intercept) of average excess return on the betas.

Figure 1: Betas and predicted returns in Consumption-based factors models

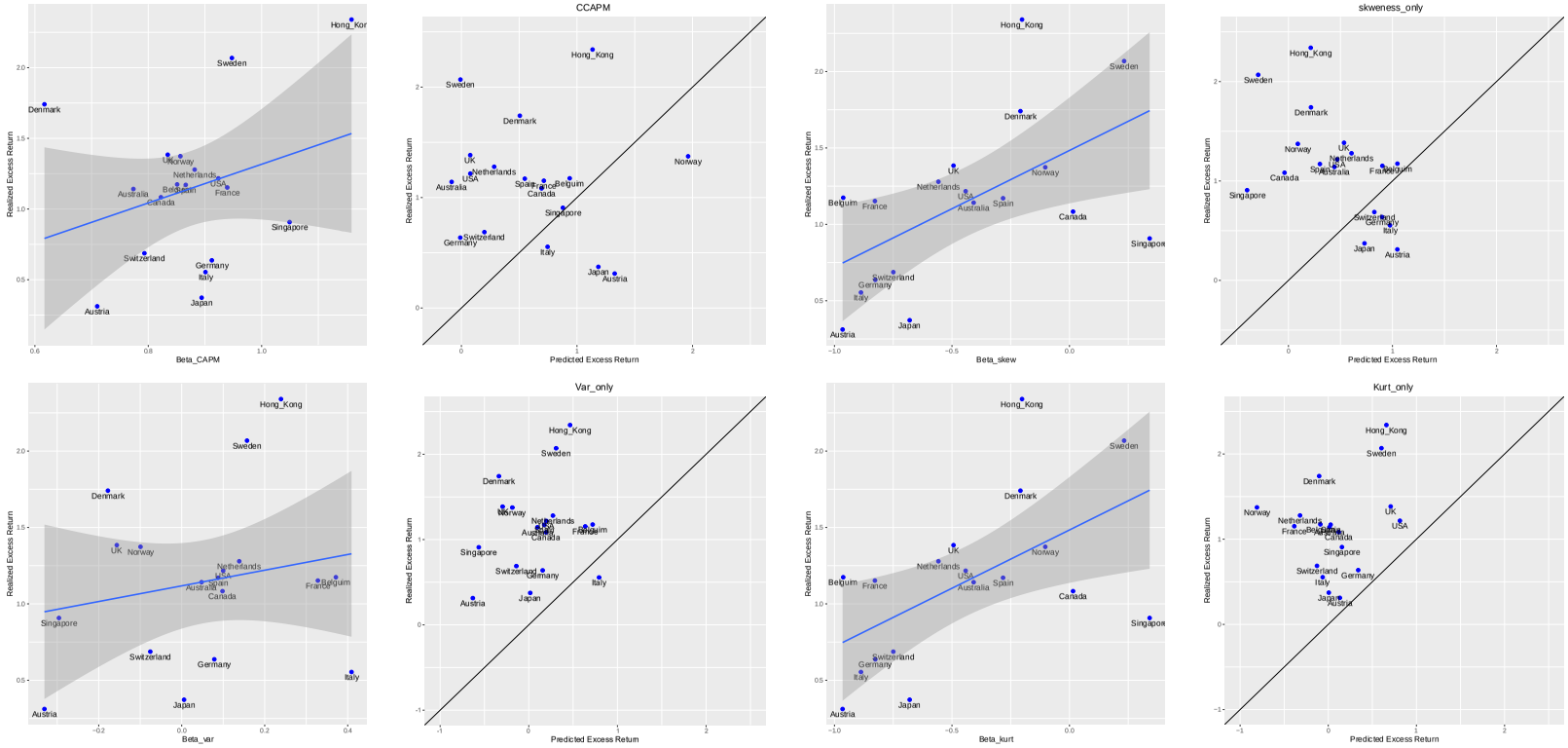
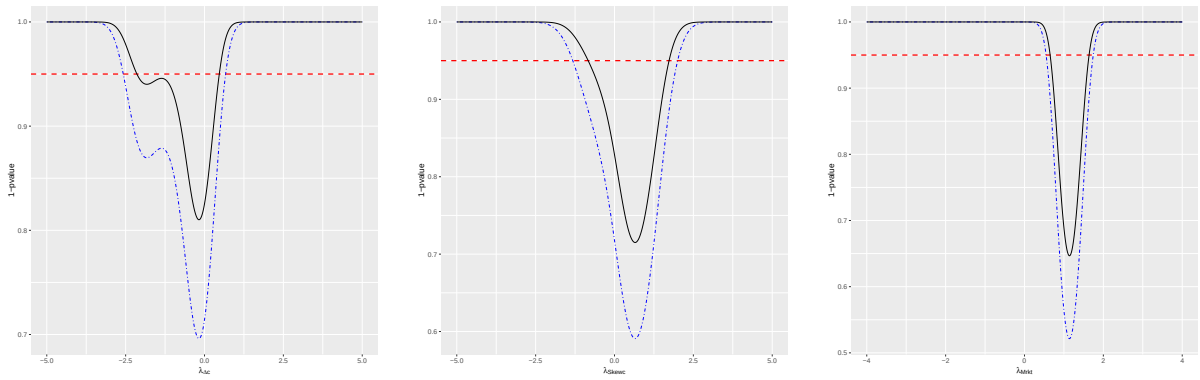


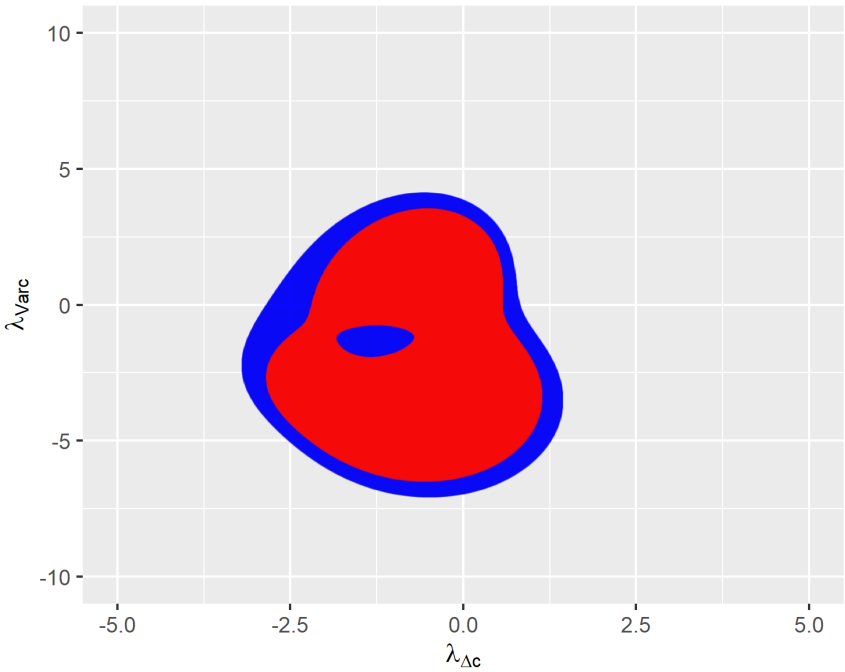
Figure 2: 95% Confidence Sets for the risk prices

CCAPM ($\lambda_{\Delta c}$) Skewness (λ_{Skew}) CAPM (λ_{Mrkt})



This figure represents one minus p-value plot for the GRS_FAR (black line) and for the F_GRS_FAR (dash-dotted line) - see section 4.3. The dashed horizontal line is the 95% rejection threshold. Each column corresponds to a single factor model; from left to right we have respectively the standard CCAPM with the cross-sectional mean of consumption growth as factor, the skewness only model with the cross-sectional skewness of consumption growth as factor and the CAPM model with the world market excess return as factor.

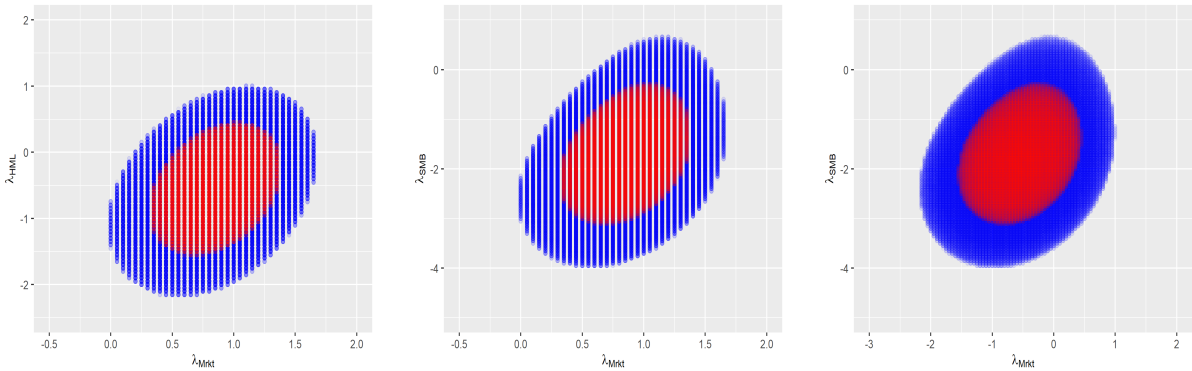
Figure 3: 95% joint confidence sets for the risk prices in the DLP model



This figure represents the 95% joint confidence set for the cross-sectional mean and variance risk prices. The red dots correspond to the confidence set obtained by using the chi-squared asymptotic distribution and the blue dots correspond to the confidence set obtained by using the finite sample Fischer distribution (see section 4.3).

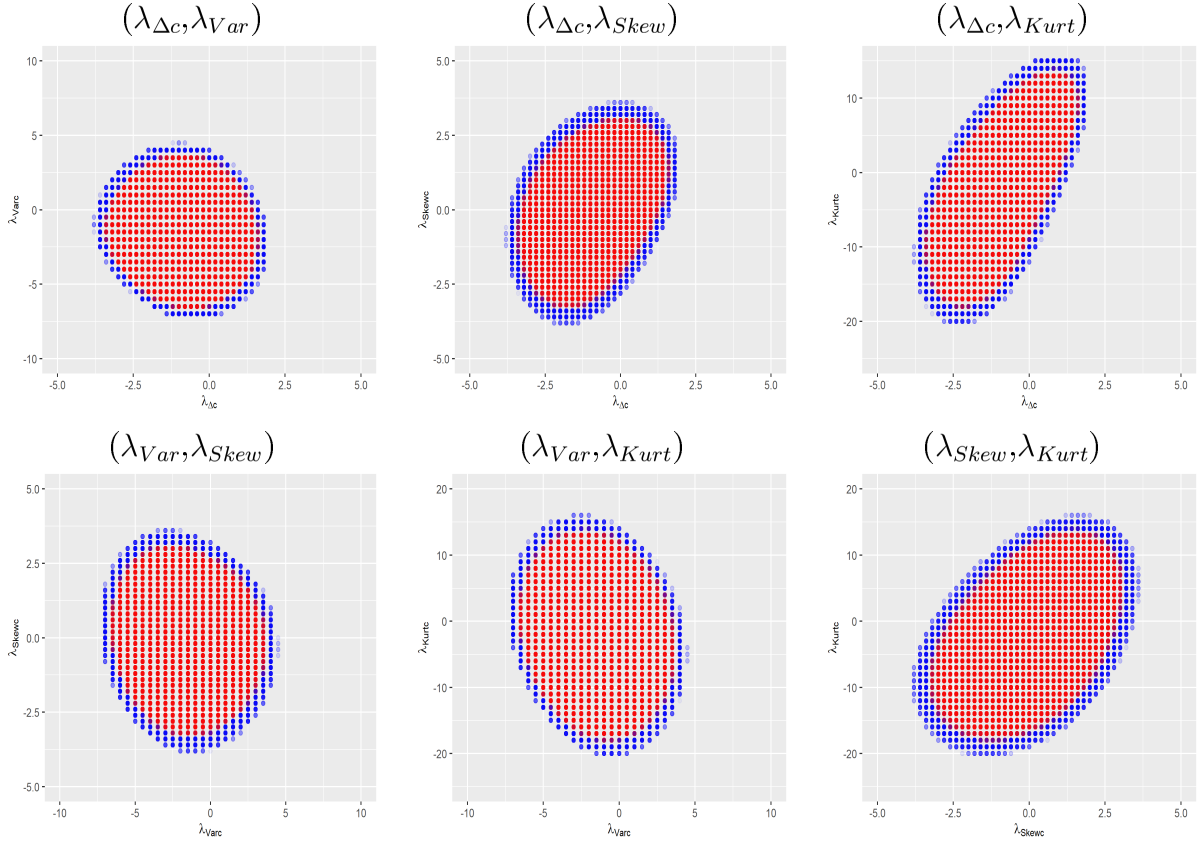
Figure 4: 95% joint confidence Sets for the risk prices in the 3 Fama-French factors model

$(\lambda_{Mrkt}, \lambda_{HML})$ $(\lambda_{Mrkt}, \lambda_{SMB})$ $(\lambda_{HML}, \lambda_{SMB})$



This figure represents from left to right the 95% joint confidence sets of the risk prices for respectively the market vs. High minus Low factors, the market vs. Small minus Big factors and the High minus Low vs. Small minus Big factors. The red dots correspond to the confidence set obtained by using the chi-squared asymptotic distribution and the blue dots correspond to the confidence set obtained by using the finite sample Fischer distribution (see section 4.3).

Figure 5: 95% joint confidence Sets for two risk prices in the HWCCAPM model



This figure represents on the top panel from left to right the 95% joint confidence sets of the risk prices for respectively the cross-sectional mean vs. variance factors,the cross-sectional mean vs. skewness factors, and the cross-sectional mean vs. kurtosis factors. On the bottom panel, from left to right, there are respectively the cross-sectional variance vs. skewness factors, the cross-sectional variance vs. kurtosis factors and the cross-sectional skewness vs. kurtosis factors. The red dots correspond to the confidence set obtained by using the chi-squared asymptotic distribution and the blue dots correspond to the confidence set obtained by using the finite sample Fischer distribution (see section 4.3).

Table 9: Estimation results: Fama-MacBeth regressions (with intercept)

Panel A: Consumption-based Model								
	$Cste$	λ_{CCAPM}	$\lambda_{CrossVar}$	$\lambda_{CrossSkew}$	$\lambda_{CrossKurt}$	MAE	$\bar{R}^2$	J-test
CCAPM	1.28	-0.101				145.29	-4.9%	32.3
	(1.99)	(-0.28)						(0.01)
Cross Skewness (Only)	1.68			0.81		93.13	27.8%	18.63
	(2.47)			(1.60)				(0.29)
Heterogeneous World CCAPM (DLP)	1.17	-0.06	0.47			89.30	-1.1%	21.6
	(1.84)	(-0.16)	(0.70)					(0.16)
Heterogeneous World CCAPM	1.43	0.12	0.90	0.85	1.95	81.71	49.65%	9.97
	(2.08)	(0.28)	(1.40)	(1.55)	(0.65)			(0.70)
Panel B: CAPM and Fama-French 3 factors Model								
		λ_{CAPM}	λ_{HML}	λ_{SMB}		MAE	$\bar{R}^2$	
CAPM	-0.05	1.37				91.63	9.2%	20.5
	(-0.03)	(0.77)						(0.20)
Global FF-3factors	2.04	-0.81	-1.25	-0.39		64.39	16.4%	18.7
	(3.65)	(-0.75)	(-1.23)	(-0.51)				(0.28)
Panel C: Test of difference in MAE between models								
The MAE difference between CCAPM and Skewness (only)						52.16		
						(0.00)		
The MAE difference between Skewness (only) and DLP						3.83		
						(0.34)		
The MAE difference between DLP and HWCCAPM						7.59		
						(0.05)		

This table shows the results of the Fama-MacBeth regressions. In the first step we regress for each country the excess return on the factors to obtained the risk exposures (betas). In the second step we cross-sectionally regress the country excess returns at each time period on the betas to obtain the risk price λs. The 3 Fama-French global factor model (Global FF-3factors) uses the data from 1990M1 to 2018M12. The Excess return in the CAPM is the MSCI World return minus the US 3-month Tbill rate. The Newey-West t-statistics are given in brackets below the estimates. J-test is computed using equation (26) and the p-value is given below in brackets.

Table 10: Results of the GMM estimation

Panel A: Consumption-based Model										
	b_{CMean}	b_{CVar}	b_{CSkew}	b_{CKurt}	μ_{CMean}	μ_{CVar}	μ_{CSkew}	μ_{CKurt}	MAE	$\bar{R}^2$
CCAPM	57.39				0.02				154.12	-6%
	(21.89)				(28.41)					
Skewness			31.70				-0.01		98.24	65%
			(18.45)				(-9.77)			
DLP	27.86	51.67			0.02	0.02			146.44	37%
	(11.55)	(23.77)			(48.37)	(27.86)				
HWCCAPM	32.76	-0.64	45.43	-2.62	0.02	0.04	-0.01	0.08	114.01	39%
	(44.51)	(-0.73)	(49.33)	(-9.37)	(79.60)	(88.34)	(-15.33)	(74.06)		
Panel B: CAPM and Fama-French 3 factors Model										
	b_{Mrkt}	b_{HML}	b_{SMB}	μ_{Mrkt}	μ_{HML}	μ_{SMB}				
CAPM	1.48			0.005					149.58	5%
	(4.93)			(2.76)						
3FF	0.46	0.09	-11.33	-0.03	0.01	0.06			59.04	11%
	(1.76)	(0.03)	(-6.14)	(-9.69)	(21.08)	(58.70)				

This table shows the results of the 2 steps GMM estimation. For the first step the identity matrix is used as the weighting matrix and in the second step the optimal weighting matrix is used. The adjusted R-squared is obtained by cross-sectionally regressing the realized average excess returns on the predicted average excess return from the estimation. MAE is the mean absolute error.

Table 11: Predictability of the ex-post sdf by the cross-sectional moments of consumption growth

	Dependent variable:Ex-post sdf
	Ex-post sdf
W_Cross_mean	−0.060
	(0.049)
W_Cross_var	0.007
	(0.034)
W_Cross_skew	0.062
	(0.043)
W_Cross_kurt	−0.013
	(0.010)
Constant	−0.017
	(0.162)
Observations	196
R^2	0.025
Adjusted R^2	0.005
Residual Std. Error	0.956 (df = 191)
F Statistic	1.227 (df = 4; 191)
Note:	*p<0.1; **p<0.05; ***p<0.01

Figure 6: Betas and predicted returns in CAPM and global Fama-French 3 factors model

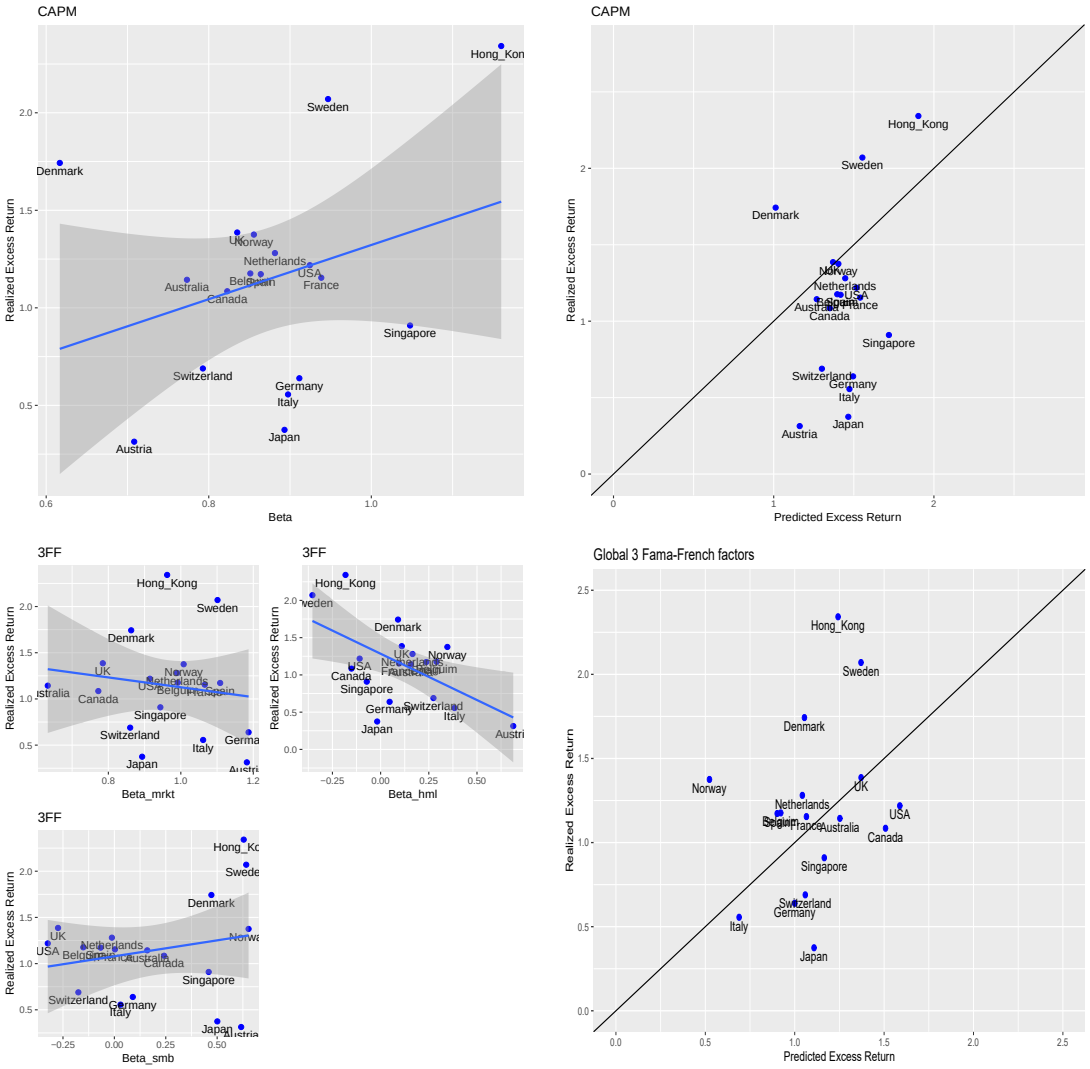


Figure 7: Evolution of the cross-sectional moments of consumption growth

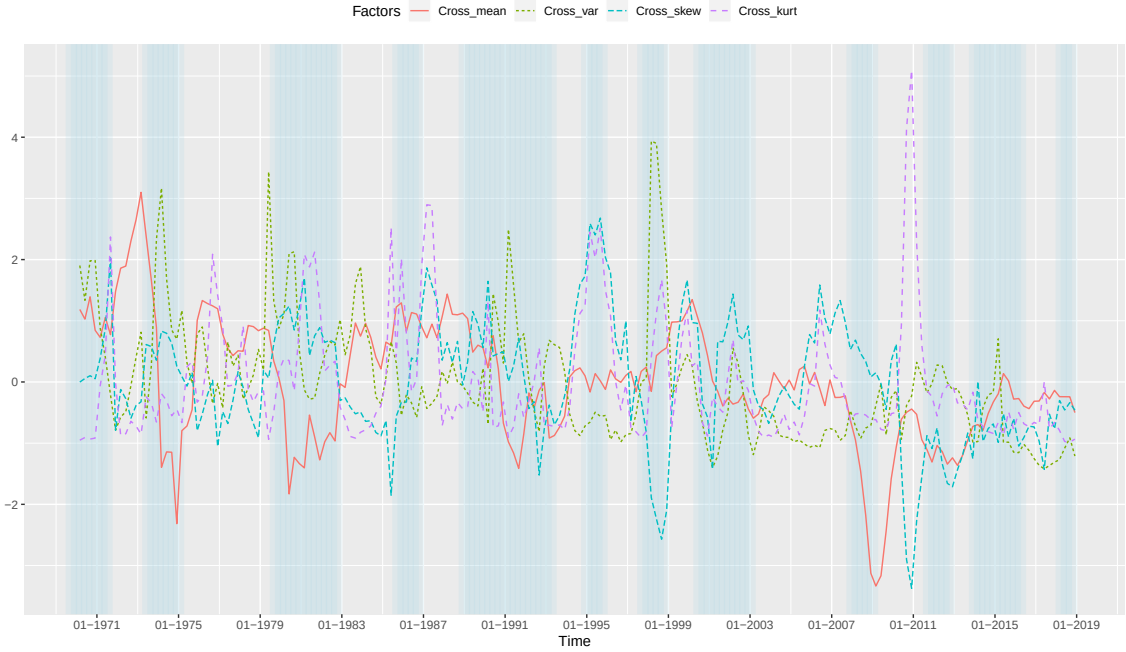


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Figure 8: Predicted returns vs. Realized returns (Fama-MacBeth regressions)

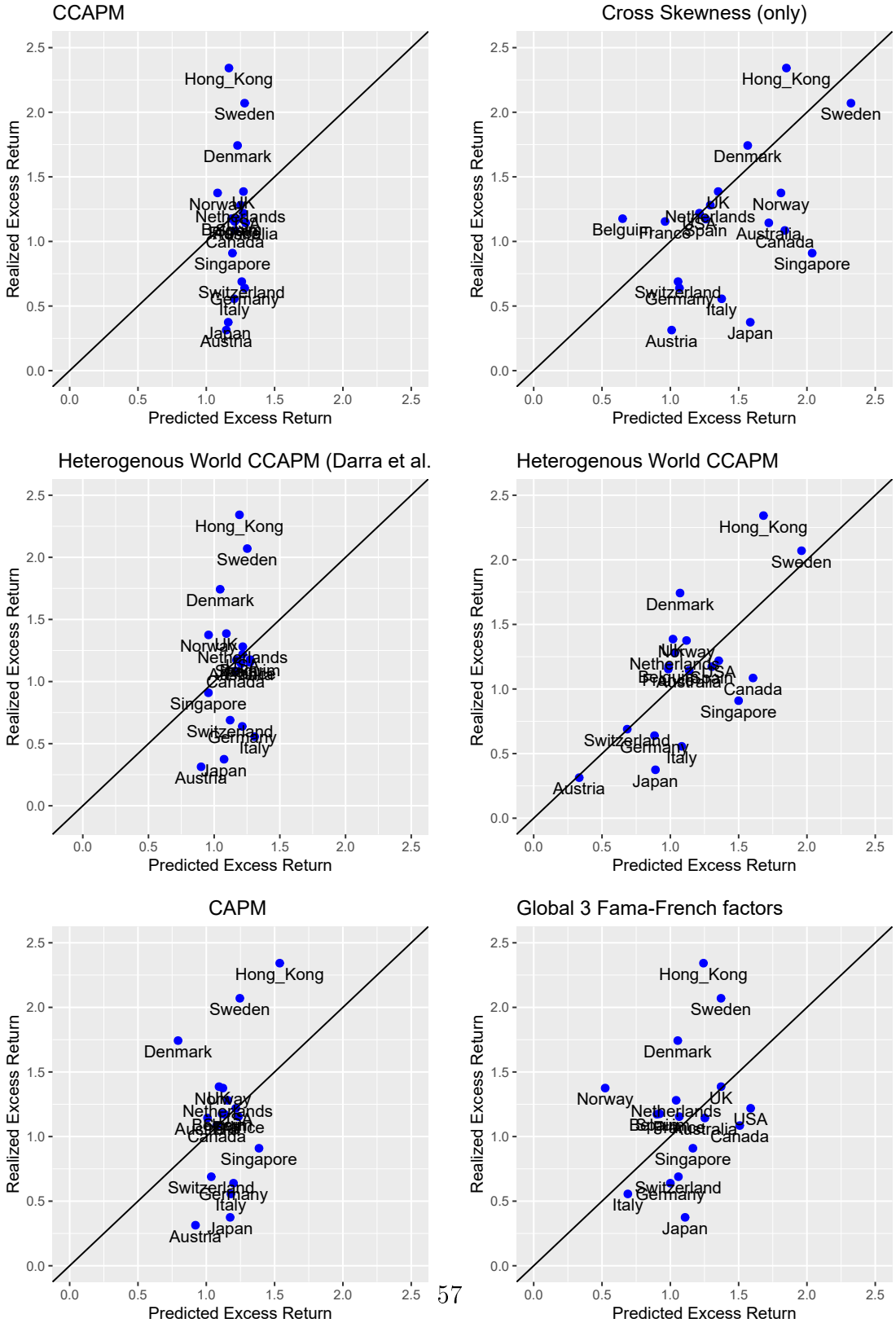


Figure 9: Implied Beta vs. Realized returns (GMM estimation)

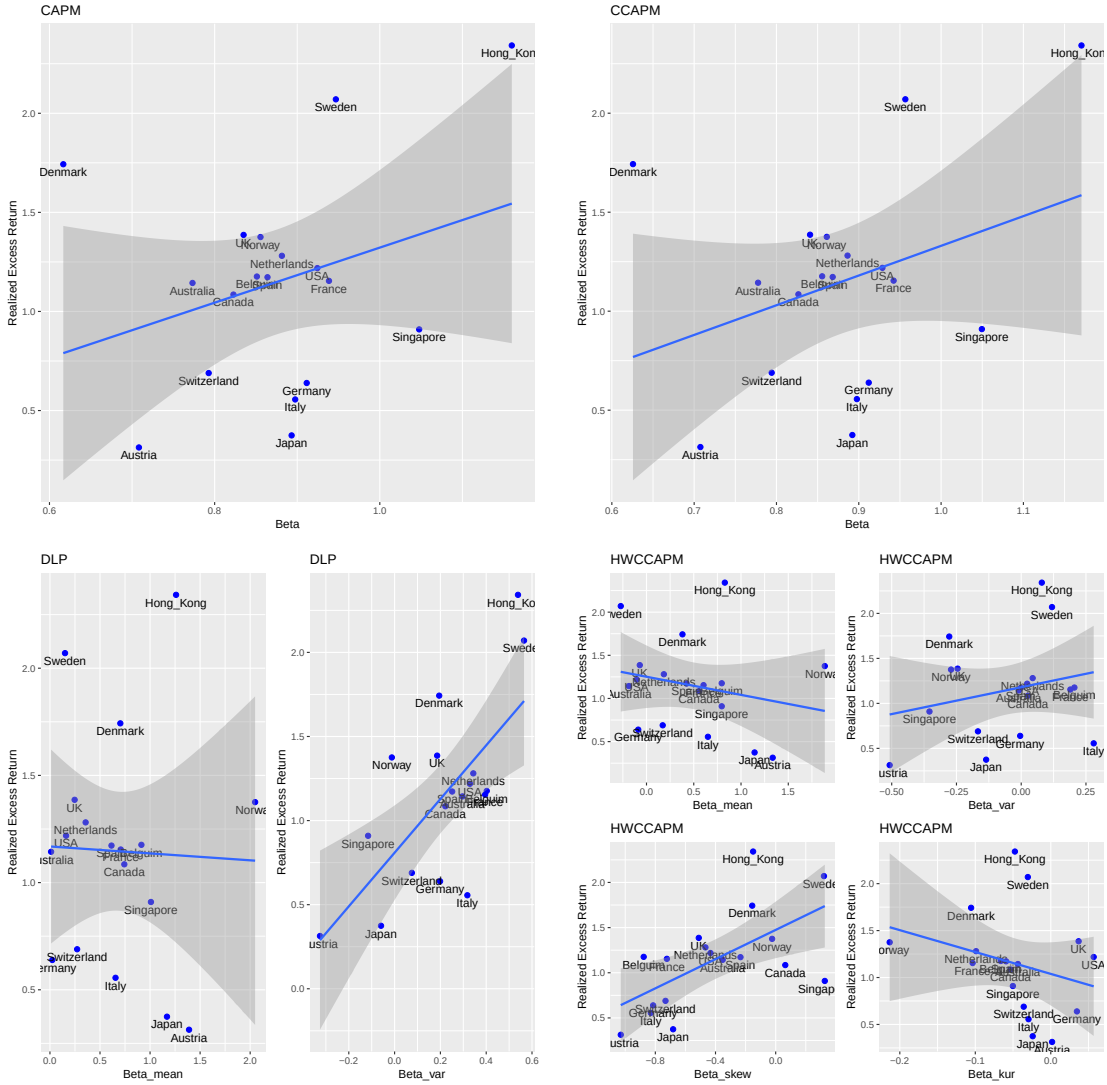


Figure 10: Predicted returns vs. Realized returns (GMM estimation)

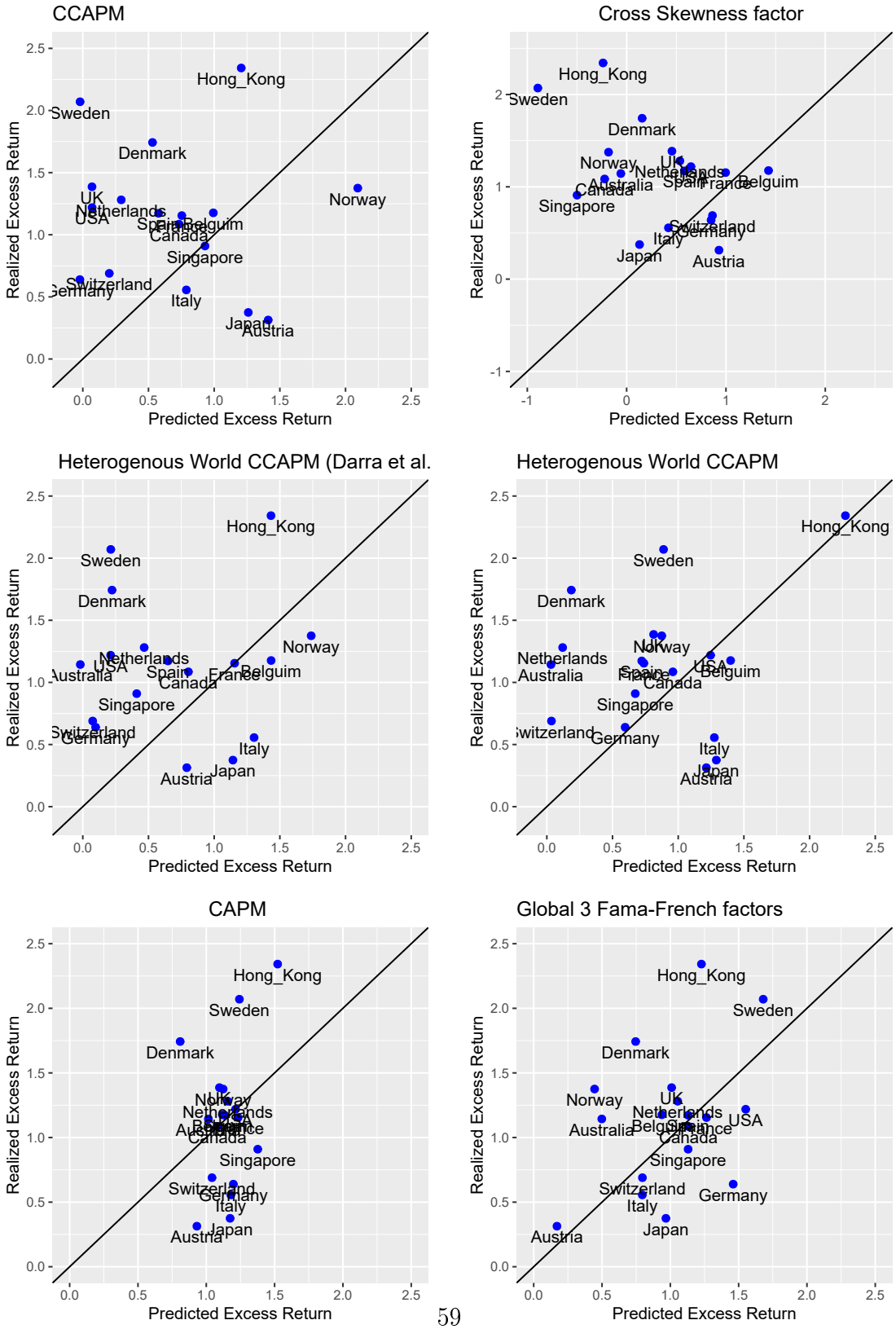
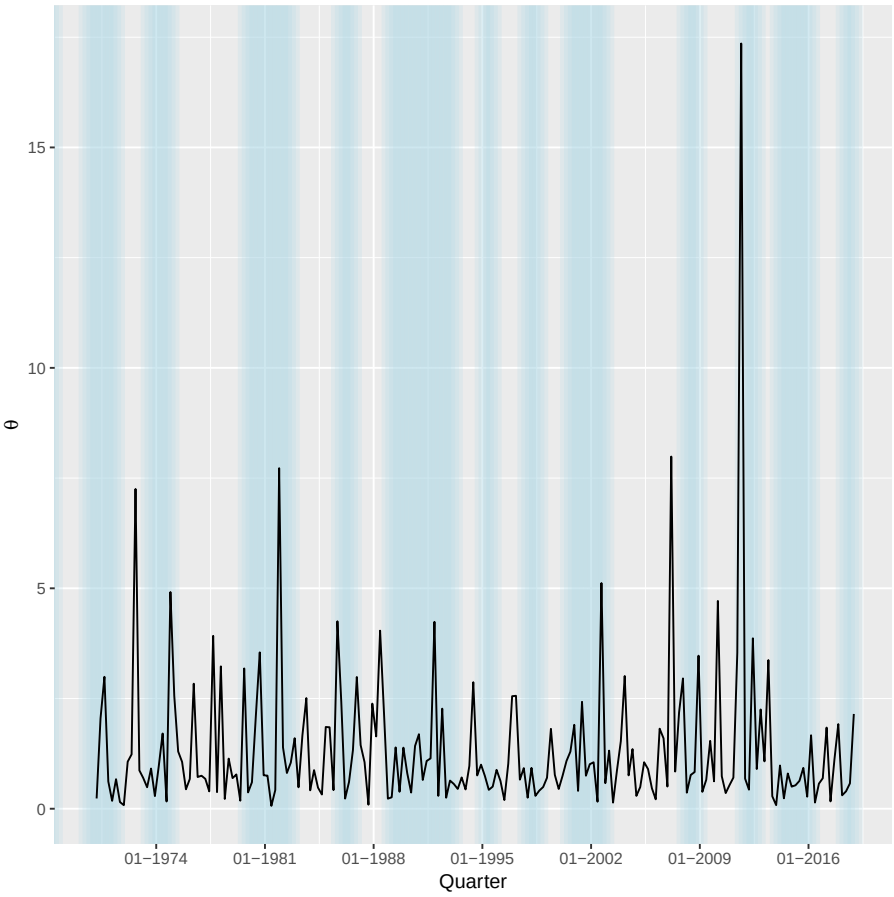
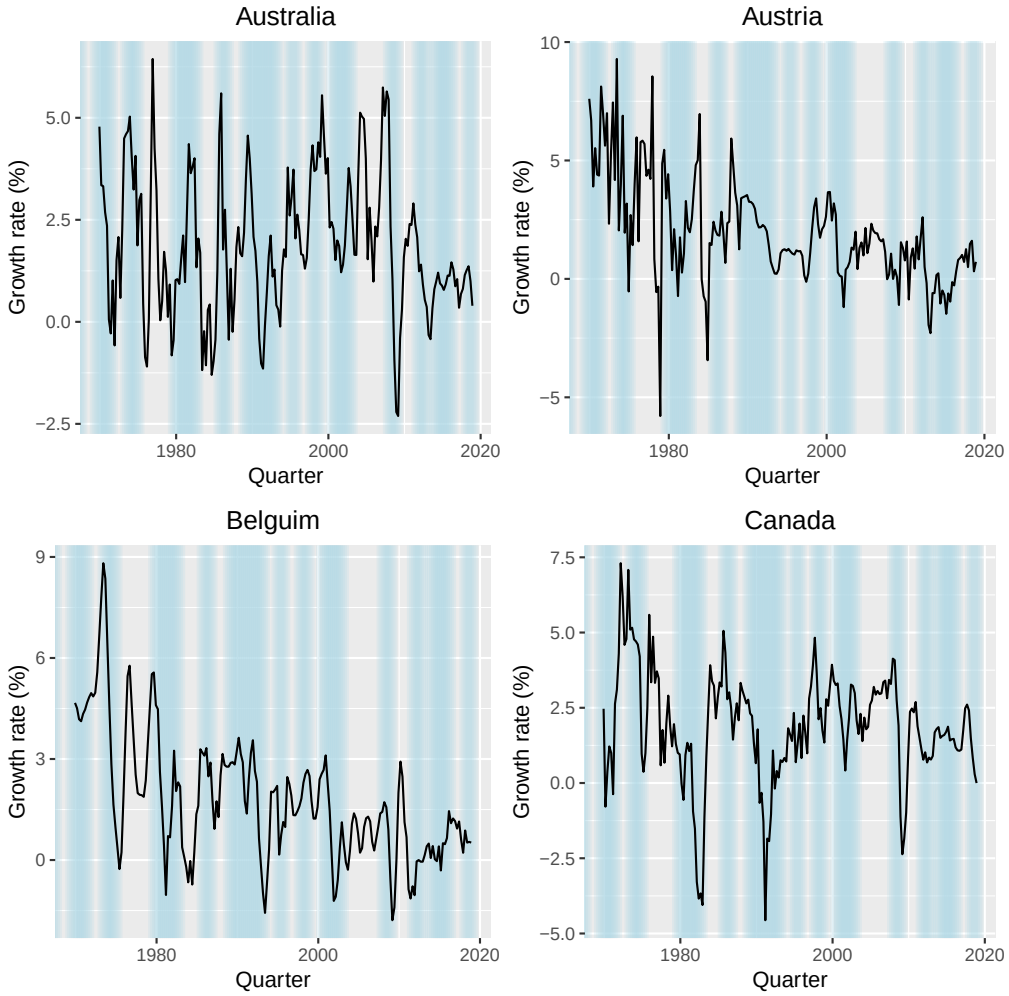


Figure 11: Model free ex-post stochastic discount factor



This figure shows the ex-post model-free sdf extracted from the panel of country market portfolio returns. The blue vertical bars represent the OECD and Non OECD countries recession indicator.

Figure 12: Time series evolution of (selected) countries consumption growth



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