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# Consumption, liquidity and the cross-sectional variation of expected returns<sup>\*</sup>

Elena Márquez, Belén Nieto and Gonzalo Rubio<sup>\*\*</sup>

## Abstract

Recent papers in asset pricing have added a market-wide liquidity factor to traditional portfolio-based or factor models. However, none of these papers has reported any evidence on how aggregate liquidity behaves together with consumption growth risk. This paper covers this gap by providing a comprehensive analysis of the cross-sectional variation of average returns under *ultimate consumption risk* and market-wide illiquidity shocks. It derives closed-form expressions for consumption-based stochastic discount factors adjusted by aggregate illiquidity shocks and tests alternative model specifications. We find that market-wide illiquidity risk seems to be especially useful in explaining the size-based cross-sectional differences of average returns. We also find a strongly negative and highly significant illiquidity risk premium under recursive preferences for the first quarter of the year suggesting a time-varying behaviour of the market-wide illiquidity premium.

**Keywords:** stochastic discount factor, ultimate consumption risk, market-wide liquidity, illiquidity premium seasonality.

**JEL Classification:** G10, G12, E44

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## 1. Introduction

Asset pricing literature has been debating between reduced-form portfolio-based models or factor models, where marginal utility of consumption is directly measured by the returns on a few number of large portfolios, and macroeconomic models, where the focus is on understanding the marginal utility that drives asset prices. In other words, these models investigate whether the chosen stochastic discount factor –the chosen proxy for the marginal rate of intertemporal substitution of consumption- reflects macroeconomic conditions properly.<sup>1</sup>

The economic understanding of the stock markets behaviour is based on the fact that investors dislike stocks because they tend to do badly –reducing consumption ultimately- in economic downturns and especially on recessions. Although this idea made consumption-based asset pricing models very popular, their systematic empirical rejection<sup>2</sup> has led to new models in which utility depends not only on consumption but also on other arguments which enter the utility function in a non-separable fashion. Well-known models with habit persistence or recursive utility functions are good examples. Because of the non-separability, marginal utility of consumption responds to changes in state variables making the countercyclical behaviour of the stochastic discount factor (SDF hereafter) more pronounced.

In this framework, different papers have shown the relevance of some state variables that are constrained to a slow adjustment; this is the case of labour income growth, habits, housing collateral or the share of housing consumption in total consumption. This insight, together with the cost of adjusting consumption itself, suggests that the basic consumption-based model may hold at long-horizons. Indeed, a recent line of research explores this field. Jagannatan and Wang (2007) find that the basic consumption-based model can account relatively well for annual frequency data being the relevant data those corresponding to the fourth quarter of each year. And Parker and Julliard (2005) argue that changes in wealth have a delayed effect on consumption patterns. Hence, the covariance between portfolio returns and consumption

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<sup>1</sup> See Cochrane (2008) for a detailed and provocative discussion on these fundamental issues.

<sup>2</sup> Of course, this rejection ignores measurement errors in consumption. For example, institutionally provided data refer to insufficiently representative consumption baskets, aggregation between all the individuals in the economy could compensate for individual consumption risk, available data are updated with some delay, and so on.

growth over the quarter of the return and many following quarters (ultimate consumption) is needed for conciliating expected returns and consumption risk.<sup>3</sup> The dynamics of the long-run consumption growth results in an *ultimate consumption risk* SDF with a counter-cyclical behaviour much more pronounced than the one observed for the contemporaneous consumption growth model. The model has some success in explaining the pricing of size and book-to-market portfolios, although it is unable to fit the extreme Fama-French portfolios (small-value and small-growth stocks).

Given this discussion, we propose a fundamental consumption-based model in the line of the Parker and Julliard (2005) ultimate consumption framework; however, we assume recursive preferences, enabling us to include some additional state variables apart from consumption. The idea is to take advantage of the long-run consumption risk contribution but improving the counter-cyclical pattern of the SDF considering other pertinent state variables. Of course, the identification of the proper state variables is crucial. Our theoretical framework considers two state variables; the market return, as usual when working with recursive preferences, and an aggregate illiquidity factor, due to the consideration of liquidity shocks affecting the investor budget constraint.

The market liquidity role in asset pricing has already been analyzed in the literature. The papers by Chordia, Roll and Subrahmanyam (2000) and Hasbrouck and Seppi (2001) could be considered the starting point on this research line. Their main results show that the time-varying liquidity for individual stocks has common systematic components suggesting the possibility of a market-wide liquidity variable being a priced aggregate factor.<sup>4</sup> Amihud (2002) shows that the level of market-wide liquidity affects expected returns and Pastor and Stambaugh (2003), Acharya and Pedersen (2005), Martínez, Nieto, Rubio and Tapia (2005), Sadka (2006), Liu (2006), and Korajczk and Sadka (2008) find that the covariance between returns and some measure of aggregate liquidity shocks is significantly priced by the market. Lastly, Watanabe and Watanabe (2008) show that the liquidity risk premium is time varying.

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<sup>3</sup> Hansen, Heaton and Li (2008) link the idea of ultimate consumption in Parker and Julliard (2005) to the expectations updating on future consumption growth in the Epstein and Zin (1991) recursive preference framework with a unitary intertemporal elasticity of substitution. See Bansal and Yaron (2004) and Bansal, Dittmar and Lundblad (2005) for additional evidence on the long-run covariances of cash flows with consumption.

<sup>4</sup> More recently, Kamara, Lou and Sadka (2008) have shown that the cross-sectional variation of liquidity commonality has increased over the past three decades. This important result has an unfortunate implication for the investors possibilities to diversify systematic aggregate liquidity shocks.

They report a large liquidity premium for states with particularly large liquidity betas and argue that their result is consistent with investors facing uncertainty about their trading counterparties' preferences.

Rather surprisingly, however, all previous papers include an additional market-wide illiquidity factor to traditional portfolio-based asset pricing models. However, in this paper, we propose a model in which the aggregate liquidity risk factor arises as a result of solving the investor optimization problem, being this our main contribution. We obtain a closed-form expression for a consumption-based SDF adjusted by aggregate liquidity. Moreover, none of the above mentioned empirical asset pricing papers has reported any evidence on how aggregate illiquidity behaves together with consumption growth risk. Another contribution of our paper is to fill this gap. Lastly, our theoretical framework makes it possible to compare the contribution of the *ultimate consumption risk* to the contribution of the liquidity risk when explaining the cross-section of mean returns. Our evidence suggests that aggregate illiquidity is indeed important in pricing risky stocks in models with *ultimate consumption risk*, particularly during the first quarter of the year.

This paper is organized as follows. Section 2 derives our three-factor asset pricing model with market-wide consumption and illiquidity risk under recursive preferences, while Section 3 contains a description of data. Section 4 discusses the estimation strategy, and Section 5 reports the empirical results. Section 6 concludes with a summary of our main findings.

## **2. The Consumption-based Liquidity-adjusted Stochastic Discount Factor**

All the empirical papers concerning the existence of a liquidity market-wide factor are based on the implicit assumption that there exists a SDF that depends on some measure of aggregate liquidity. To be explicit about a SDF with systematic liquidity is not an easy task. He and Modest (1995) argue that a combination of short-selling, borrowing and solvency constraints together with trading costs frictions can generate a wedge between the SDFs and asset prices large enough to make some well-known empirical puzzles compatible with equilibrium in financial markets. More recently, Garleanu, Pedersen and Poteshman (2008) show, inside a multiple assets model, how the SDF depends on the demand. Finally, Lustig and Van Niewerburgh (2005) explore a model

in which shocks in the housing market affecting housing collateral determine the size of the wedge between prices and the marginal rate of intertemporal substitution of consumption.<sup>5</sup>

In this paper, instead of including the market-wide liquidity measure as an argument of the utility function, we follow a different strategy by assuming that shocks to aggregate liquidity directly affect the representative agent intertemporal budget constraint. In that way, future liquidity conditions will affect his future consumption because of their effects on the future investment payoffs.

Assuming recursive preferences as in Epstein and Zin (1991), the representative agent would take his consumption-investment decision by solving the following optimization problem,

$$\begin{aligned}
\max_{\{z_j\}} U_t &= \left[ (1-\beta)C_t^{1-\rho} + \beta \left[ E_t(U_{t+1}^{1-\gamma}) \right]^{\frac{1-\rho}{1-\gamma}} \right]^{\frac{1}{1-\rho}} \\
s. t. \\
C_t &= e_t - z_j p_{jt} \\
C_{t+1} &= e_{t+1} + z_j X_{jt+1} \phi(L_{t+1})
\end{aligned} \tag{1}$$

where  $U_t$  denotes utility at time  $t$ ,  $C_t$  is the aggregate consumption at time  $t$ ,  $\beta$  is the subjective discount factor,  $\gamma$  represents the coefficient of relative risk aversion,  $\rho$  is the inverse of the elasticity of intertemporal substitution,  $e_t$  is the consumption endowment,  $z_j$  is the amount invested today in asset  $j$ ,  $p_{jt}$  is the price today of asset  $j$ , and  $X_{jt+1}$  is the payoff of the asset at  $t+1$ . Finally,  $\phi(L_{t+1})$  represents an aggregate liquidity restriction (or an aggregate illiquidity shock) affecting the investor's budget constraint. It will be higher than one if an adverse aggregate liquidity shock takes place, and lower than one if a positive aggregate liquidity shock occurs. Let's explain the role of this variable in a more detailed way.

When a future adverse illiquidity shock is expected, investors will require a higher asset payoff to buy the asset. This means that the investor will buy an asset if its

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<sup>5</sup> Others papers dealing with similar issues are Piazzesi, Schneider, and Tuzel (2007), and Duarte and Vergara (2008).

illiquidity adjusted payoff, given by the product of  $X_{jt+1}$  and  $\phi(L_{t+1})$ , is high enough in bad states to allow the investor to achieve a determined level of future consumption. In this way, the same asset future payoff will have today a higher value in terms of future consumption when the liquidity of the market is low. Thus, when the market is more illiquid, this is, just before recessions, the SDF will be expected to be higher than the one generated by the standard problem intensifying the desirable countercyclical time series property of this variable.

Solving problem (1),<sup>6</sup> the following Euler equation is obtained,

$$p_{jt} = E_t \left[ M_{LAR,t+1} X_{jt+1} \right], \quad (2)$$

where  $\kappa = \frac{1-\gamma}{1-\rho}$  and  $M_{LAR,t+1}$  denotes the liquidity-adjusted SDF which is given by

$$M_{LAR,t+1} = \beta^\kappa \left( \frac{C_{t+1}}{C_t} \right)^{-\rho\kappa} (R_{Wt+1})^{\kappa-1} \phi(L_{t+1})^\kappa. \quad (3)$$

When there is no illiquidity shocks, i.e.  $\phi(L_t) = 1$ , the SDF in equation (3) is the standard SDF under recursive preferences.

$$M_{R,t+1} = \beta^\kappa \left( \frac{C_{t+1}}{C_t} \right)^{-\rho\kappa} (R_{Wt+1})^{\kappa-1} \quad (4)$$

Therefore, the liquidity adjusted SDF in (3) is just the standard SDF, given by (4), scaled by the function that picks up aggregate illiquidity shocks. Note that  $M_{LAR,t+1}$  will be higher than the correspondent non liquidity-adjusted SDF,  $M_{R,t+1}$ , precisely in those time periods in which recessions are shortly expected. In other words, we obtain a SDF with the same counter-cyclical behaviour that the one generated by the standard recursive preferences problem but with a stronger cycle pattern.

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<sup>6</sup> The details can be found in Appendix A1.



It is also possible to get a liquidity-adjusted SDF based on power utility, denoted by  $M_{LAP,t+1}$ , by imposing the equality between the relative risk aversion coefficient and the inverse of the elasticity of intertemporal substitution ( $\gamma = \rho$ ) in equation (3):<sup>7</sup>

$$M_{LAP,t+1} = \beta \left( \frac{C_{t+1}}{C_t} \right)^{-\gamma} \phi(L_{t+1}) \quad (5)$$

Finally, we also consider the specification under *ultimate consumption risk* as in Parker and Julliard (2005). They propose a SDF that relates marginal utility in period  $t$  with marginal utility in period  $t+1+S$ . In that way, investors take the expectation about far away future consumption into account when taking investment decisions today. Applying the same idea, we derive the liquidity-adjusted SDFs for both power and recursive preferences. The resulting expressions, respectively, are given by:<sup>8</sup>

$$M_{LAP,t+1}^S = \beta^{S+1} \left( \frac{C_{t+1+S}}{C_t} \right)^{-\gamma} \phi(L_{t+1,t+1+S}) R_{ft+1,t+1+S} \quad (6)$$

$$M_{LAR,t+1}^S = \left[ \beta^{S+1} \left( \frac{C_{t+1+S}}{C_t} \right)^{-\rho} \phi(L_{t+1,t+1+S}) \right]^\kappa R_{Wt+1,t+1+S}^{\kappa-1} R_{ft+1,t+1+S}, \quad (7)$$

where  $R_{Wt+1,t+1+S}$  and  $R_{ft+1,t+1+S}$  denote the cumulative gross return on wealth and on the risk free asset, respectively, from period  $t+1$  to period  $t+1+S$ . This is our three-factor model in which we simultaneously combine *ultimate consumption risk*, market-wide illiquidity risk and aggregate wealth returns.

It must be noted that equations (6) and (7) nest the correspondent standard (non liquidity-adjusted) SDFs under *ultimate consumption risk* for power and recursive preferences, respectively, when  $\phi(L_{t+1,t+1+S})=1$ . Obviously, equations (6) and (7) also nest equations (5) and (3), respectively, when  $S=0$ . Finally, and as before, equation (6) is a particular case of (7) when  $\gamma = \rho$ .

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<sup>7</sup> As in the case of recursive preferences, the SDF (5) is a function of the standard utility power SDF.

<sup>8</sup> All the details are in Appendix A2

In this paper, the different consumption-based liquidity-adjusted models embodied by equation (7) will be tested. Our conjecture is that this type of specifications should be able to better explain the cross-sectional variation of average returns than other previously analyzed models have done. Note that we are able to perform an empirical comparison among all these models since all of them are nested by equation (7). Ultimately, we want to test whether expression (7) mirror macroeconomic conditions better than non-liquidity adjusted models.

### 3. Data

For the period 1963:I to 2006:IV, we collect quarterly seasonally adjusted aggregate real per capita consumption expenditure of non-durables and services from National Income and Product Accounts (NIPA) given in Table 7.1. Monthly value-weighted stock market return and risk-free rate are taken from Kenneth French's web page, from which we compute quarterly returns. The price deflator from NIPA Table 2.8.4 is used to calculate real rates of returns. We also compute quarterly returns of 25 size/book-to-market value-weighted portfolios, 17 industry portfolio returns, 10 dividend-yield and 10 momentum portfolio returns from the monthly figures available at Kenneth French's web page.

Our liquidity measure is based on Amihud (2002) measure of individual stocks illiquidity, which is calculated as the ratio of the absolute value of daily return over the dollar volume, a measure that is closely related to the notion of price impact. Among others, this ratio has been used by Amihud (2002), Acharya and Pedersen (2005), Korajczyk and Sadka (2008), Kamara, Lou and Sadka (2008), and Watanabe and Watanabe (2008). The main advantage of the Amihud's illiquidity ratio is that it can be computed using daily data enabling us to study a long time period, which is clearly relevant for testing asset pricing models. This illiquidity measure is estimated daily at the individual level as,

$$Illiq_{j,d} = \frac{|R_{j,d}|}{DVol_{j,d}}, \quad (8)$$

where  $|R_{j,d}|$  is the absolute return of asset  $j$  on day  $d$ , and  $DVol_{j,d}$  is the dollar volume of asset  $j$  during day  $d$ .

This measure is aggregated over all days for each month in the sample period to obtain an individual illiquidity measure for each stock at month  $t$ ,

$$Illiq_{j,t} = \frac{1}{D_{j,t}} \sum_{d=1}^{D_{j,t}} \frac{|R_{j,d}|}{DVol_{j,d}}, \quad (9)$$

where  $D_{j,t}$  is the number of days for which data are available for stock  $j$  in month  $t$ .<sup>9</sup>

Finally, using all  $N$  available stocks, we obtain the market-wide illiquidity measure as the cross-sectional average of expression (9) for each month in the sample period as,

$$ILLIQ_{m,t} = \frac{1}{N} \sum_{j=1}^N Illiq_{j,t} \quad (10)$$

Using the value of the aggregate illiquidity ratio given by equation (10) for the last month in each quarter, we compute our function representing market illiquidity shocks as the residual from an  $AR(1)$  process.<sup>10</sup> Finally,  $\phi(L_t)$  is the gross standardized residual from the autoregressive regression.<sup>11</sup> Figure 1 shows how our illiquidity function tends to jump either just before or during recessions suggesting a counter-cyclical time series behaviour. The shaded regions in Figure 1 are U.S. macroeconomic recessions from peak to trough as defined by the National Bureau of Economic Research (NBER). It is also interesting to note the relatively much more stable

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<sup>9</sup> We thank Yakov Amihud for kindly providing his data until December 1996. We update his measure from January 1997 to December 2005 using daily data from CSRP on all individual stocks with enough data within a given month. At least 15 observations of the ratio within the considered month are required for asset  $j$  to be included in the sample. An exception has been made for September 2001 requiring at least 12 observations in this case.

<sup>10</sup> Unlike the  $AR(2)$  model usually employed in literature when using monthly data, we employ the  $AR(1)$  specification with quarterly data. The residuals from the  $AR(1)$  model, our illiquidity-shock measure, have a first-order autocorrelations of only -0.069. It should also be pointed out that the effect of detrending the autoregressive regressions using the ratio of market capitalizations between two adjacent periods is negligible.

<sup>11</sup> In order to have values of our illiquidity measure closely resembling units of rates of returns, the residuals have been standardized dividing by ten times its sample standard deviation. Then, we add up one in order to have the gross standardized residual.

behaviour of the illiquidity function after 1993. It should be recalled that a large number of empirical macroeconomic papers provide evidence of a striking decline in the volatility of U.S. macroeconomic time series since the end of the eighties. Figure 1 also reflects the well-known period of high liquidity, both at the micro and macro levels, that has been experienced during the last years of our sample period.

#### 4. Estimation and Tests

As previously mentioned, we estimate and compare the asset pricing models nested under the SDF specification given by equation (7):

$$M_{LAR,t+1}^S = \left[ \beta^{S+1} \left( \frac{C_{t+1+S}}{C_t} \right)^{-\rho} \phi(L_{t+1,t+1+S}) \right]^\kappa R_{Wt+1,t+1+S}^{\kappa-1} R_{ft+1,t+1+S}$$

They are the following: (i) the standard CCAPM, when  $S=0$ ,  $\gamma = \rho$  and  $\phi(L) = 1$ ; (ii) the *ultimate consumption risk* version of the standard CCAPM, when  $S>0$ ,  $\gamma = \rho$  and  $\phi(L) = 1$ ; (iii) the liquidity-adjusted CCAPM, when  $S=0$  and  $\gamma = \rho$ ; (iv) the *ultimate consumption risk* version of the liquidity-adjusted CCAPM, when  $S>0$  and  $\gamma = \rho$ ; (v) the Epstein-Zin model (recursive), when  $S=0$  and  $\phi(L) = 1$ ; (vi) the *ultimate consumption risk* specification of the Epstein-Zin model, when  $S>0$  and  $\phi(L) = 1$ ; (vii) the liquidity-adjusted Epstein-Zin model, when  $S=0$ ; and (viii) the *ultimate consumption risk* version of the liquidity-adjusted Epstein-Zin model, in which the SDF is given by equation (8) without restrictions.<sup>12</sup>

We employ two different methodologies. The non-linear version of the models is estimated by GMM, while the Fama-MacBeth (1973) procedure is used to estimate the corresponding beta specifications.

For the GMM estimation, we follow Parker and Julliard (2005) and Yogo (2006). The following vector defines the moment restrictions:

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<sup>12</sup> Noted that the general specification given by equation (7) also nests the four corresponding versions of the CAPM when the relative risk aversion equals one.

$$g_T(\theta, \alpha, \mu) = E \left[ \begin{array}{c} R^e - \alpha 1_N + \frac{(M - \mu) R^e}{\mu} \\ M - \mu \end{array} \right], \quad (11)$$

where  $R^e$  is the  $N \times 1$  vector of the excess return of the  $N$  assets,  $1_N$  denotes the  $N \times 1$  vector of ones,  $M(\theta)$  is one of the eight specifications nested in equation (7),  $\theta$  is the vector of the preference parameters for each particular specification and the parameter  $\alpha$  enables us to evaluate separately the ability of the model to explain the equity premium and the cross section of expected returns.<sup>13</sup>

For the GMM estimation we employ a pre-specified weighting matrix that contains the matrix proposed by Hansen and Jagannathan (1997). As usual, it weights the moment conditions for the  $N$  test assets using the (inverse) variance-covariance matrix of excess returns. Following Parker and Julliard (2005), the weight of the last moment condition is chosen large enough to make sure that significant changes in that weight have no effects on the parameter estimates.<sup>14</sup> Given that this weighting matrix is not the optimal one, the distribution of the model performance statistic is unknown. We follow Hansen and Jagannathan (1997) and Parker and Julliard (2005) to infer the  $p$ -value of the test.

The second estimation methodology is based on the linear specification of the model. In Appendix B, the beta version of the model implied by the SDF given by equation (7) is derived. In this case, we estimate the following OLS cross-sectional regression at each moment of time:

$$R_{jt} - R_{ft} = \gamma_0 + \gamma_1 \beta_{jct} + \gamma_2 \beta_{j\phi t} + \gamma_3 \beta_{jWt} + e_{jt}, \quad (12)$$

where the explanatory variables are the sensitivities of the asset returns to changes in non-durable consumption growth, market illiquidity shocks and the return on aggregate wealth. These betas are estimated with a time-series regression using a moving-data set prior to each cross-sectional regression. When the linearized versions of the models are tested, the three factors are always expressed in logarithm terms.

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<sup>13</sup> If  $\alpha$  is zero, we can conclude that the model does not present an equity premium puzzle. Moreover, the last moment condition in (11) forces the SDF to move back to its mean value ( $\mu$ ).

<sup>14</sup> In particular, we choose a weight of 1000 for the restriction on the mean of the SDF.

## 5. Empirical Results

For both estimation methodologies described in Section 4, we employ two sets of test assets: the 25 size/book-to-market Fama-French portfolios and a set of 42 portfolios containing the 25 Fama-French portfolios plus 17 industry portfolios. This second set of portfolios is used in order to mitigate the important concern raised by Lewellen, Nagel and Shanken (2009). In order to test for the robustness of the results, we also extend the 25 Fama-French portfolios with either 10 dividend-yield-sorted portfolios or 10 momentum-sorted portfolios.

The different models have been estimated for different time horizons ( $S=0, 3, 7, 11$  and  $15$  quarters ahead). Consistent with Parker and Julliard (2005), the larger explanatory power for both methodologies is obtained for  $S=11$ . To save space, we just report the results based on  $S=11$ .<sup>15</sup> To make the estimation results for  $S=0$  and  $S=11$  comparable, given that the long-run specifications need growth rates of the risk factors from now to 3 years ahead, the sample period for the estimation ends at the first quarter of 2003.

### 5.1. Portfolio Descriptive Statistics

Panel A of Table 1.a contains the sample mean and standard deviation of excess returns of the 25 Fama-French portfolios showing the well-known empirical facts about these portfolios. Between 1963:II and 2003:I, both small and high book-to-market firms have larger average returns than other portfolios within the same category. The highest average return is obtained for portfolio *15*, where the smallest firms and the highest book-to-market stocks are simultaneously located. However, the highest risk is found in the small but low book-to-market portfolio (portfolio *11*).

Panel B reports the return-based illiquidity betas of the 25 Fama-French portfolios. We run time series regressions of the return of each portfolio on our market-wide illiquidity factor. In particular, the estimated regression is given by<sup>16</sup>

$$R_{jt} = \alpha_j + \beta_j \phi(L_t) + u_{jt}. \quad (13)$$

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<sup>15</sup> All results are available from authors upon request.

<sup>16</sup> All regressions in this sub-section are OLS autocorrelation-robust standard-error regressions.

As expected, given the economic implications of the market-wide illiquidity factor, we obtain negative and significant coefficients for all portfolios. All stock returns are negatively affected by adverse illiquidity shocks. By controlling for book-to-market, we report monotonically decreasing return-based illiquidity betas from big to small firms. On the contrary, when we control for size, we do not observe a monotonic pattern when moving from low to high-to-market firms. Interestingly, the illiquidity betas of the low book-to-market portfolios tend to be more negative than those for high-book-to-market ones. The pattern closely resembles the standard deviation of portfolios sorted by book-to-market contained in Panel A. Indeed the highest illiquidity beta is found for portfolio *11*.

Although these previous results are interesting by themselves, we should control for both the market portfolio return and non-durable consumption growth when estimating our illiquidity betas. Panel C of Table 1.a reports the results from the following time-series regressions

$$R_{jt} = \alpha_j + \beta_{j\phi}\phi(L_t) + \beta_{jw}R_{wt} + \beta_{jc}\Delta C_t + u_{jt}. \quad (14)$$

When controlling for book-to-market, we find a monotonically decreasing return-based illiquidity betas from big to small firms for all five book-to-market categories. In particular, small firms are strongly negative and significantly affected by illiquidity shocks. This pattern is shown in Figure 2.a, where the large illiquidity beta dispersion between small and big firms for all book-to-market groups is clearly appreciated. This evidence suggests that illiquidity shocks affects primarily small stocks whatever the value-growth category. In Figure 2.a we also report the average return for all size-sorted portfolios controlling for book-to-market. Although the mean returns tend to increase from big to small stocks for four book-to-market portfolios, we get just the opposite result for growth stocks. Small stocks, within the growth category, have the lowest average return. This already suggests that any model, even when aggregate illiquidity risk is included, will face with serious problems to price growth stocks, particularly small-growth assets (portfolio *11*).

At the same time, and on the contrary to the results in Panel B, once we control for size, Panel C of Table 1.a reports a slightly decreasing return-based illiquidity betas from growth to value firms for all size categories. The stronger declining pattern is

found for small portfolios. However, the dispersion of the illiquidity betas from growth to value assets is quite small in comparison with the dispersion previously reported for size-sorted portfolios. This pattern can be seen in Figure 2.b. This result suggests that our market-wide illiquidity SDF might not be able to account for the value premium. Only when value firms are also relatively small, the liquidity constraints become important.

Summarizing the main findings until now, we conclude that, on the one hand, small rather than value stocks are especially negatively affected by market-wide illiquidity shocks, and, on the other hand, neither big firms nor big stocks with simultaneously low book-to-market are affected by aggregate illiquidity shocks.<sup>17</sup>

Finally, Table 1.b contains the same results for the 17 industry portfolios. As before, all industries are negatively affected by aggregate illiquidity shocks. However, controlling for the market portfolio return and consumption growth, the industries directly affected by market-wide illiquidity shocks are *Durable Goods*, *Construction*, *Clothes*, *Retail Goods* and *Food*.

To further analyze the relationship between aggregate illiquidity and either size or book-to-market, we perform the following regressions,

$$\phi(L_t) = \delta_0 + \delta_W R_{Wt}^e + \delta_{SMB} SMB_t + \delta_{HML} HML_t + u_t, \quad (15)$$

where  $R_{Wt}^e$  is the excess return on aggregate wealth, and  $SMB_t$  and  $HML_t$  are the Fama-French size and book-to-market factors respectively. We now study whether size and book-to-market risk factors explain market-wide illiquidity. The results are reported in Table 2. Regardless of the regression specification, a strongly negative relationship between the market return and the market illiquidity measure is obtained. On the other side, once we control for size, the  $HML$  illiquidity delta coefficient is not longer significantly different from zero. Lastly, the  $SMB$  illiquidity delta coefficients are always strongly negative and significant, no matter the considered specification. As suggested by the analysis of Table 1, these results also indicate that the market-wide

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<sup>17</sup> According to the results reported by Kamara, Lou and Sadka (2008), our overall evidence might have changed in the last years of our sample period. In any case, it should be noted that they report illiquidity betas (from a regression of individual illiquidity changes on market-wide illiquidity changes) and not return-based market-wide illiquidity betas.



liquidity is strongly associated with the size factor but not with the value factor. In other words, aggregate illiquidity shocks particularly affect small stocks rather than value stocks. These results are important to better understand the empirical results on the cross-sectional variation of average returns reported below.

## 5.2. GMM Estimation

We now test the non-linear specification of the consumption-based asset pricing models implied by the eight different SDFs nested by equation (7). The results for the models with and without illiquidity shocks and considering both contemporaneous and *ultimate consumption risk* are reported by Table 3 (panels A and B show the results under power utility, whereas panels C and D show the results under the recursive preferences specification). We employ expression (11) with either 26 or 43 moment conditions depending upon whether we use the 25 Fama-French portfolios or the expanding set including also the 17 industry portfolios.

As we can see in panels A and B of Table 3, the risk aversion coefficient is always estimated with large standard errors due to the flatness of the GMM objective function with respect to  $\gamma$ .<sup>18</sup> As expected, the estimation of risk aversion tends to be smaller for  $S=11$  than for  $S=0$ . For *ultimate consumption risk* and the expanding set of test assets,  $\hat{\gamma}$  is either 2.76 or 2.48 depending upon whether we estimate the model with or without illiquidity shocks. Interestingly, even when we use contemporaneous consumption risk, the estimate of the risk aversion coefficient decreases from 13.93 to 8.76 by recognizing illiquidity shocks.

Secondly, in all cases the average excess returns is too large with respect to the average excess return implied by the model; the estimated intercept is positive and always statistically significant. For the expanded set of assets (Panel B), the average of excess returns exceeds that implied by consumption and/or illiquidity risk by 4.6 to 5.2 percent per year.<sup>19</sup> In Panel B, the lowest pricing error is obtained for contemporaneous consumption risk with illiquidity shocks. This specification also presents the lowest H-J

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<sup>18</sup> The same result is found in Parker and Julliard (2005),

<sup>19</sup> It should be noted that the pricing error for contemporaneous consumption risk without illiquidity shocks and for the 25 Fama-French portfolios is 8.6 percent per year.

distance and the estimate of the risk aversion parameter is 8.76.<sup>20</sup> In fact, it is also true that, within each panel, the distance is always reduced when illiquidity shocks are included in the asset pricing model specification. However, the null hypothesis  $T(Dist)^2 = 0$ , is always rejected.

The results showed in panels C and D of Table 3.b tend to be slightly more encouraging than those for the power utility case. As before, Panel C refers to the 25 Fama-French portfolios, while Panel D reports results for the expanded set including the 17 industry portfolios. Once again, both the risk aversion and the elasticity of intertemporal substitution estimates contain large standard errors. Their values also become economically more sensible when we use  $S=11$  rather than  $S=0$ . They are, respectively, 2.57 and 0.40 for the *ultimate consumption risk* with illiquidity shocks model considering the expanded set of portfolios. The estimated pricing errors are systematically lower in Panel D than in Panel C, although they all are statistically different from zero suggesting that the model is not well-specified. The pricing error for the expanded set of test assets is approximately 5.2 percent per year for all pricing models. However, it must be pointed out the systematic reduction of the H-J distance when illiquidity shocks are included, regardless of the considered time horizon. So, generally speaking, we conclude that the recursive specification does present slightly better pricing results than the power utility case.

Figure 3 shows the contemporaneous SDF under recursive preferences with and without illiquidity shocks. As expected, the SDF path is clearly counter-cyclical, being especially accentuated when the market-wide illiquidity shocks are considered. This is precisely the time-varying behaviour we would like to find in any SDF potentially capable of explaining the cross-section and time-varying behaviour of stock returns.

### **5.3. Fama-MacBeth Estimation**

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<sup>20</sup> Since we include a moment for the mean of the SDFs, the statistic is not just the squared root of the variance-covariance matrix of excess returns and, therefore, it is not strictly speaking the H-J distance. So, the distribution of the correct p-value based on this adjusted distance needs to be simulated. Our conclusions are based on the simulation of the p-values for 1000 replications, although we have also estimated the distribution for both a lower and a higher number of replications in order to test for the robustness of our results and the conclusions do not change. All the results are available from authors upon request.

The non-linear pricing models tested above are linearized in Appendix B to obtain the general linear three-factor model given by equation (12)

$$R_{jt} - R_{ft} = \gamma_0 + \gamma_1\beta_{jct} + \gamma_2\beta_{j\phi t} + \gamma_3\beta_{jWt} + e_{jt},$$

where the betas are the sensitivities to consumption growth, illiquidity shocks and the market portfolio returns respectively, and the gammas are the risk premia associated to these aggregate risk factors.

The empirical results are reported in Tables 4.a, 4.b and 4.c in which we respectively analyze the Consumption CAPM under power utility, the traditional (Wealth) CAPM under logarithmic utility, and the Consumption CAPM under recursive preferences. In all cases, we compare the results using either ultimate or contemporaneous consumption risk specifications, with or without illiquidity shocks. The most general linear three-factor model of equation (12) is a model under recursive preferences with illiquidity shocks. All other specifications are just special cases of that expression. For the three above mentioned tables, Panel A shows the results when we use the 25 Fama-French portfolios, while the expanded set of 42 test assets (including the 17 industry portfolios) is employed for the estimates reported in Panel B.

Table 4.a shows that the results for  $S=0$  are very disappointing regardless of whether illiquidity shocks are or not included. As expected, *ultimate consumption risk* produces lower pricing errors than the traditional consumption pricing model and the inclusion of illiquidity shocks improves the model performance in comparison with the specification without market-wide illiquidity. However, once we include illiquidity, *ultimate consumption risk* does not improve the overall fit of the model. Both adjusted *R-square* and mean-squared errors tend to be very similar, although it must be pointed out that the risk premium of market-wide illiquidity is negative and significantly different from zero when the model is estimated under *ultimate consumption risk*, which is not the case for contemporaneous consumption risk. This suggests that both illiquidity shocks and *ultimate consumption risk* are important to price risky stocks. However, the intercept of the second-pass cross-sectional regressions is always statistically different from zero indicating the overall rejection of the model. The pricing improvements can be observed in Figure 4. It is clear that a better fit is obtained when we use  $S=11$  and aggregate illiquidity shocks. As usual, portfolios 15 and, especially, 11 remain very

problematic. It should be noted that portfolio 15 has a large and negative return-based illiquidity beta as shown in Table 1.a, while portfolio 11 has an illiquidity beta much lower and even non-significant at the 5% level. In other words, it seems that the inclusion of a market-wide illiquidity factor improves the pricing of portfolio 15, but the average return of portfolio 11 is too low even for its relatively low sensitivity to illiquidity shocks.

Table 4.b indicates that adding illiquidity risk to a standard CAPM does not improve the results: none of the risk premia are significantly different from zero no matter if  $S=0$  or  $S=11$  and, as before, the intercept is always positive and statistically different from zero.

Summarizing, the average returns of alternative combinations of portfolios are too far to be explained by either *ultimate consumption risk* and illiquidity shocks or by market returns and market-wide illiquidity innovations. Table 4.c contains further and more complete information by reporting the results from the model under recursive preferences with illiquidity shocks. It is our three-factor linear model in which we simultaneously take into account *ultimate consumption risk*, market risk and market-wide illiquidity risk. A relevant contribution of the illiquidity risk factor when  $S=11$  is found. In this case, for both Panel A and Panel B, and consistent with the evidence shown in Table 4.a,<sup>21</sup> the risk premium for ultimate consumption growth becomes positive relative to contemporaneous consumption, the risk premium of aggregate illiquidity shocks is negative and significantly different from zero, and the market risk premium has the expected sign.<sup>22</sup> Additionally, mean-squared errors are also lower relative to Table 4.a. However, the intercept remains positive and highly significant pointing out the overall model misspecification. Figure 5 shows the improvements in the results. Although, under recursive preferences, portfolio 11 remains far from the 45 degrees line, the inclusion of both illiquidity risk and *ultimate consumption risk* improve the adjustment of the portfolio 15. In any case, it should be noted that both portfolios have negative illiquidity betas and lie on the opposite side of the 45° degree line. This reflects how difficult is to price these two portfolios by the same set of risk factors. As

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<sup>21</sup> And also consistent with the results for the recursive preferences specifications of Table 3.

<sup>22</sup> The negative sign of the illiquidity premium makes sense since the derivative of marginal utility of wealth with respect to illiquidity is positive. When the market experiences a negative illiquidity shock, marginal utility of wealth increases because one additional unit of wealth is highly valued by investors.

we pointed out at the beginning of this section, there are large differences between the liquidity betas for the size-sorted portfolios, while these differences are lower for book-to-market sorted portfolios. So, our market-wide illiquidity factor seems to do a good job in pricing risky assets because its ability to account for size risk, although it seems to be unable to price cross-sectional variation between value and growth stocks.

#### 5.4 Robustness

To check for the results of Table 4.c, we repeat the Fama-MacBeth estimation using two different expanded sets of portfolios. The results are reported in Table 5; in Panel A we consider the 25 Fama-French portfolios plus 10 dividend yield portfolios, and in Panel B, 10 momentum portfolios are added to the 25 Fama-French portfolios. The robustness of the results with respect to different test portfolio sets is confirmed. The intercepts are always positive and highly significant, and the illiquidity risk premium, when we employ *ultimate consumption risk*, is negative and significantly different from zero for both sets of portfolios.

#### 5.5 Risk Premia Seasonality

Given the well-known January seasonality of stock returns, we run the following OLS regressions, for both the contemporaneous and *ultimate consumption risk* specifications.

$$\hat{\gamma}_{it} = a + bD_{RYt} + u_{it} \quad ; \quad i = 1, 2, 3 \text{ and } 4 \quad (16)$$

The dependent variable in (16) is one out of the four coefficients from the estimation of equation (12) with the 25 Fama-French portfolios and the 17 industry portfolios.  $D_{RYt}$  is a dummy variable which is equal to one if the observation belongs to either the second, third or fourth quarter of the year, and equals zero otherwise. The estimated intercept is therefore the average risk premia during the first quarter, while the slope coefficients represent the difference between the average risk premia during the rest of the year and the average risk premia during the first quarter.

The results, reported in Table 6, show a strong first quarter seasonality of the illiquidity risk premium for both the contemporaneous and ultimate risk consumption specifications. In particular, the negative and statistically significant risk premium,

reported in Table 4.c, for recursive preferences with long run consumption and illiquidity risk, is completely due to the first quarter of the year. The same result is obtained for the contemporaneous case; the negative but insignificant risk premium becomes strongly negative and highly significant. We can therefore conclude that the illiquidity risk premium seems to be negative and significant only during the first quarter of the year. In fact, the illiquidity premium for the rest of the year is positive and statistically different from the illiquidity risk premium during the first quarter. These results suggest a strong time-varying behaviour of the illiquidity risk premium. Indeed, the time-varying behaviour reported by Watanabe and Watanabe (2008) might be just a consequence of the striking seasonality found for the illiquidity risk premium during the first quarter of the year.

There is also some marginally significant evidence of the consumption growth risk premium seasonality for the ultimate consumption risk specification. However, we find no evidence of market risk premium seasonality once we control for both consumption risk and illiquidity risk.

## **6. Conclusions**

This paper proposes a fundamental consumption asset pricing model by assuming recursive preferences and considering that market liquidity shocks affect the investors budget constraint. In this context, the model is a consumption-based model in which, apart from the market return, a new state variable related to aggregate illiquidity shocks arises. Differently to other asset pricing papers that consider aggregate liquidity risk, our model is derived by solving the representative consumer-investor optimization problem under the *ultimate consumption risk* idea as in Parker and Julliard (2005). Our conjecture is that this model will price risky assets better than others do because the resulting SDF shows a stronger counter-cyclical pattern.

Our model nests both standard and new model specifications which have been tested for different sets of portfolios. The non-linear version of the models have been tested by GMM and the Fama and MacBeth (1973) procedure has been used to test the beta version models.

The best overall results have been got for our three factor model under the *ultimate risk* specification. For the GMM estimation, we get preferences parameters estimates economically sensible and systematically lower pricing errors than those estimated under other model specifications. However, the overall model is rejected. The results of the beta models corroborate this evidence in the sense that, once again, the best overall results are for the three factor model proposed in this paper. In this case, all the risk premia have the expected signs and the illiquidity risk factor is significantly priced. However, and as before, the intercept is significantly different from zero indicating the model misspecification.

We have also found a strong and highly significance evidence of a negative market-wide illiquidity premium during the first quarter of the year. Interestingly, the behaviour of the illiquidity premium seems to change dramatically from a significant negative premium during the first quarter of the year to a positive risk premium for the rest of the year.

Summarizing, we find that the market-wide illiquidity factor contributes to the improvement of consumption-based SDFs, but the average excess returns of our test assets remain too far of the estimated mean returns. Although our model is able to account for the size premium reasonably, it seems that additional aggregate risk factors are needed in order to fully explain the value premium. The analysis of our illiquidity risk factor shows that the differences of the illiquidity betas for value and growth portfolios are not large enough to generate the necessary cross-sectional variation between average returns of value and growth stocks. This could help to understand our results that also show how difficult it would be to price the extreme portfolios by the same set of risk factors.

## Appendix A: Derivation of the Model

### 1. Recursive Utility with Aggregate Liquidity Constraints

Assuming recursive preferences as in Epstein and Zin (1991), and considering that the aggregate illiquidity shocks affect future consumption throughout the budget constrain, the representative agent would solve the following problem,

$$\begin{aligned} \max_{\{z_j\}} U_t &= \left[ (1-\beta)C_t^{1-\rho} + \beta \left[ E_t \left( U_{t+1}^{1-\gamma} \right) \right]^{\frac{1-\rho}{1-\gamma}} \right]^{\frac{1}{1-\rho}} \\ \text{s. t.} \\ C_t &= e_t - z_j p_{jt} \end{aligned} \quad (\text{A1})$$

$$C_{t+1} = e_{t+1} + z_j X_{jt+1} \phi(L_{t+1})$$

Introducing the budget restrictions on the objective function and taking the derivative with respect to the amount invested in asset  $j$ , and solving for the asset price, we get the following first order condition:

$$p_{jt} = E_t \left[ \beta \left( \frac{U_{t+1}}{\left[ E_t \left( U_{t+1}^{1-\gamma} \right) \right]^{\frac{1}{1-\gamma}}} \right)^{\rho-\gamma} \left( \frac{C_{t+1}}{C_t} \right)^{-\rho} \phi(L_{t+1}) X_{jt+1} \right] \quad (\text{A2})$$

By using the definition of the utility function in (A1), we can solve for

$$\left[ E_t \left( U_{t+1}^{1-\gamma} \right) \right]^{\frac{1}{1-\gamma}}.$$

$$\left[ E_t \left( U_{t+1}^{1-\gamma} \right) \right]^{\frac{1}{1-\gamma}} = \left( \frac{1}{\beta} \right)^{\frac{1}{1-\rho}} \left[ U_t^{1-\rho} - (1-\beta)C_t^{1-\rho} \right]^{\frac{1}{1-\rho}} \quad (\text{A3})$$

On the other hand, the utility function in (A1) is linearly homogeneous. Thus,<sup>23</sup>

$$U_t = E_t \sum_{j=0}^{\infty} \frac{\partial U_t}{\partial C_{t+j}} C_{t+j} \Rightarrow \frac{U_t}{\partial U_t / \partial C_t} = W_t \quad (\text{A4})$$

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<sup>23</sup> See Cochrane (2008).



Finally, the marginal utility with respect to consumption is

$$\frac{\partial U_t}{\partial C_t} = (1-\beta)U_t^\rho C_t^{-\rho} \quad (\text{A5})$$

Combining (A5) and (A4),

$$U_t = \left[ (1-\beta)W_t C_t^{-\rho} \right]^{\frac{1}{1-\rho}} \quad (\text{A6})$$

Using the equations (A3) and (A6), the following equivalence holds.

$$\frac{U_{t+1}}{\left[ E_t(U_{t+1}^{1-\gamma}) \right]^{\frac{1}{1-\rho}}} = \beta^{\frac{1}{1-\rho}} \left( \frac{W_{t+1}}{W_t - C_t} \right)^{\frac{1}{1-\rho}} \left( \frac{C_{t+1}}{C_t} \right)^{\frac{-\rho}{1-\rho}} \quad (\text{A7})$$

The intertemporal budget constraint for the representative agent is now given by<sup>24</sup>

$$W_{t+1} = (W_t - C_t)R_{W_{t+1}}\phi(L_{t+1}), \quad (\text{A8})$$

which implies that (A7) is

$$\frac{U_{t+1}}{\left[ E_t(U_{t+1}^{1-\gamma}) \right]^{\frac{1}{1-\rho}}} = \beta^{\frac{1}{1-\rho}} \left( R_{W_{t+1}}\phi(L_{t+1}) \right)^{\frac{1}{1-\rho}} \left( \frac{C_{t+1}}{C_t} \right)^{\frac{-\rho}{1-\rho}}. \quad (\text{A9})$$

The final expression for the SDF is obtained by introducing (A9) in (A2)

$$p_{jt} = E_t \left[ \beta^\kappa \left( \frac{C_{t+1}}{C_t} \right)^{-\rho\kappa} \left( R_{W_{t+1}} \right)^{\kappa-1} \phi(L_{t+1})^\kappa X_{jt+1} \right], \quad (\text{A10})$$

with  $\kappa = \frac{1-\gamma}{1-\rho}$ .

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<sup>24</sup> This is of course equivalent to the budget constraint in (A4).

## 2. Recursive Utility with Aggregate Liquidity Constraints under Ultimate Consumption Risk

The first order condition in equation (A2) can be written in terms of the gross return on asset  $j$  as follows.

$$C_t^{-\rho} = E_t \left[ \beta \left( \frac{U_{t+1}}{\left[ E_t (U_{t+1}^{1-\gamma}) \right]^{\frac{1}{1-\gamma}}} \right)^{\rho-\gamma} C_{t+1}^{-\rho} \phi(L_{t+1}) R_{jt+1} \right] \quad (\text{A11})$$

Applying equation (A11) to the risk free rate ( $R_f$ ) and expanding forward by substituting  $C_{t+1}$  on the right hand side successively,

$$C_t^{-\rho} = E_t \left[ \beta^S \prod_{\tau=1}^S \left( \frac{U_{t+\tau}}{\left[ E_{t+\tau-1} (U_{t+\tau}^{1-\gamma}) \right]^{\frac{1}{1-\gamma}}} \right)^{\rho-\gamma} \phi(L_{t+1,t+S}) C_{t+S}^{-\rho} R_{ft,t+S} \right] \quad (\text{A12})$$

where  $\phi(L_{t+1,t+S}) = \prod_{\tau=1}^S \phi(L_{t+\tau})$  represents the cumulative illiquidity shocks between periods  $t+1$  and  $t+S$  and  $R_{ft,t+S}$  is the cumulative gross risk free rate also between periods  $t$  and  $t+S$ .

Now, equation (A12) is introduced into (A11). The idea is, as in Parker and Julliard (2005), to relate marginal utility in period  $t+1+S$  with marginal utility in period  $t$ .

$$C_t^{-\rho} = E_t \left[ \beta^{S+1} \prod_{\tau=0}^S \left( \frac{U_{t+1+\tau}}{\left[ E_{t+\tau} (U_{t+1+\tau}^{1-\gamma}) \right]^{\frac{1}{1-\gamma}}} \right)^{\rho-\gamma} \phi(L_{t+1,t+1+S}) C_{t+1+S}^{-\rho} R_{ft+1,t+1+S} R_{jt+1} \right] \quad (\text{A13})$$

Finally, we incorporate equation (A9) into equation (A13) to get the expression for the SDF.

$$1 = E_t \left[ \beta^{(S+1)\kappa} \left( \frac{C_{t+1+S}}{C_t} \right)^{-\rho\kappa} (R_{Wt+1,t+1+S})^{\kappa-1} \phi(L_{t+1,t+1+S})^\kappa R_{ft+1,t+1+S} R_{jt+1} \right], \quad (\text{A14})$$

where  $R_{Wt+1,t+1+S}$  denotes the cumulative gross return on wealth from period  $t+1$  to period  $t+1+S$ .

Therefore, the liquidity-adjusted SDF with recursive preferences under *ultimate consumption risk* is

$$M_{LAR,t+1}^S = \left[ \beta^{S+1} \left( \frac{C_{t+1+S}}{C_t} \right)^{-\rho} \phi(L_{t+1,t+1+S}) \right]^\kappa R_{Wt+1,t+1+S}^{\kappa-1} R_{ft+1,t+1+S} \quad (\text{A15})$$

When  $\gamma = \rho$ , equation (A15) corresponds to the liquidity-adjusted SDF with power utility function under *ultimate consumption risk* which is given by:

$$M_{LAP,t+1}^S = \beta^{S+1} \left( \frac{C_{t+1+S}}{C_t} \right)^{-\gamma} \phi(L_{t+1,t+1+S}) R_{ft+1,t+1+S} \quad (\text{A16})$$

## APPENDIX B: The linear factor model approximation

Now we obtain the beta (linear) version of the models analyzed in the paper. We do it for the most general case; this is, the recursive preferences with illiquidity shocks and *ultimate consumption risk*. The rest of the models are just special cases of our general specification.

The non-linear asset pricing model is given by

$$E_t \left[ M_{LAR,t+1}^S R_{jt+1} \right] = 1 \quad (\text{B1})$$

Using the definition of the covariance, equation (B1) can be written as

$$E_t \left( R_{jt+1} - R_{ft+1} \right) = - \frac{\text{Cov}_t \left( M_{LAR,t+1}^S, R_{jt+1} \right)}{E_t \left( M_{LAR,t+1}^S \right)} \quad (\text{B2})$$

The SDF based on recursive preferences with illiquidity shocks in the intertemporal budget constrain and ultimate risk is given by:

$$M_{LAR,t+1}^S = \left[ \beta^{S+1} \left( \frac{C_{t+1+S}}{C_t} \right)^{-\rho} \phi(L_{t+1,t+1+S}) \right]^\kappa R_{Wt+1,t+1+S}^{\kappa-1} R_{ft+1,t+1+S} \quad (\text{B3})$$

Taking logs in the SDF, we get

$$m_{LAR,t+1}^S = \kappa(S+1)\log(\beta) - \kappa\rho\Delta c_{t,t+1+S} + \kappa\log(\phi(L_{t+1,t+1+S})) + (\kappa-1)r_{Wt+1,t+1+S} + r_{ft+1,t+1+S} \quad (\text{B4})$$

where lowercase letters denote the logs of uppercase letters.

Assuming that the risk free rate is approximately constant over time, the covariance between the linear SDF in (B4) and the return on asset  $j$  is given by

$$\begin{aligned} \text{Cov}_t(m_{LAR,t+1}^S, R_{jt+1}) = \\ -\kappa\rho\text{Cov}_t(\Delta c_{t,t+1+S}, R_{jt+1}) + \kappa\text{Cov}_t(\log(\phi(L_{t+1,t+1+S})), R_{jt+1}) + (\kappa-1)\text{Cov}_t(r_{Wt+1,t+1+S}, R_{jt+1}) \end{aligned} \quad (\text{B5})$$

Introducing (B5) in (B2) and operating, the beta version of the model is

$$E_t(R_{jt+1} - R_{ft+1}) \cong \gamma_1\beta_{jct} + \gamma_2\beta_{j\phi t} + \gamma_3\beta_{jWt} \quad (\text{B6})$$

where the risk premium associated to each beta is given by  $\gamma_1 = \frac{\kappa\rho\text{Var}_t(\Delta c_{t,t+1+S})}{E_t(M_{LAR,t+1}^S)}$ ,

$\gamma_2 = \frac{-\kappa\text{Var}_t(\log(\phi(L_{t+1,t+1+S})))}{E_t(M_{LAR,t+1}^S)}$ , and  $\gamma_3 = \frac{(1-\kappa)\text{Var}_t(r_{Wt+1,t+1+S})}{E_t(M_{LAR,t+1}^S)}$ , respectively, and the

three risk factors are determined as  $\beta_{jct} = \frac{\text{Cov}_t(\Delta c_{t,t+1+S}, R_{jt+1})}{\text{Var}_t(\Delta c_{t,t+1+S})}$ ,

$\beta_{j\phi t} = \frac{\text{Cov}_t(\log(\phi(L_{t+1,t+1+S})), R_{jt+1})}{\text{Var}_t(\log(\phi(L_{t+1,t+1+S})))}$ , and  $\beta_{jWt} = \frac{\text{Cov}_t(r_{Wt+1,t+1+S}, R_{jt+1})}{\text{Var}_t(r_{Wt+1,t+1+S})}$ .

## APPENDIX C: Tables and Figures

**Table 1.a. Descriptive Statistics: 25 Fama and French Portfolios**

PANEL A: Mean return and Standard deviation						
	Low	2	3	4	High	Mean
Small	2.114 (17.30)	3.831 (14.62)	4.042 (12.98)	4.768 (12.29)	4.845 (13.27)	4.013 (13.40)
2	2.605 (15.45)	3.455 (12.88)	4.105 (11.38)	4.297 (11.05)	4.368 (11.84)	3.861 (11.75)
3	2.685 (14.01)	3.539 (11.35)	3.462 (10.08)	3.914 (9.94)	4.390 (11.04)	3.712 (10.44)
4	3.013 (12.64)	2.836 (10.50)	3.489 (9.51)	3.758 (9.39)	3.847 (10.53)	3.518 (9.68)
Big	2.643 (9.73)	2.826 (8.71)	2.710 (7.65)	3.057 (7.85)	2.985 (8.82)	2.915 (7.62)
Mean	2.699 (12.90)	3.353 (10.77)	3.650 (9.52)	4.062 (9.41)	4.256 (10.28)	
PANEL B: Return-based illiquidity betas from the time series regression: $R_{jt} = \alpha_j + \beta_j \phi(L_t) + u_{jt}$						
	Low	2	3	4	High	Mean
Small	-0.762 (-6.38)	-0.678 (-6.77)	-0.627 (-7.20)	-0.633 (-7.82)	-0.660 (-7.41)	-0.672 (-7.28)
2	-0.678 (-6.35)	-0.598 (-6.83)	-0.538 (-6.98)	-0.517 (-6.88)	-0.544 (-6.69)	-0.575 (-7.05)
3	-0.619 (-6.43)	-0.533 (-6.92)	-0.447 (-6.40)	-0.447 (-6.51)	-0.469 (-6.05)	-0.503 (-6.91)
4	-0.533 (-6.08)	-0.476 (-6.64)	-0.398 (-5.97)	-0.378 (-5.64)	-0.443 (-5.91)	-0.445 (-6.52)
Big	-0.399 (-5.87)	-0.323 (-5.22)	-0.245 (-4.37)	-0.293 (-5.23)	-0.309 (-4.82)	-0.314 (-5.68)
Mean	-0.598 (-6.58)	-0.522 (-6.95)	-0.451 (-6.75)	-0.454 (-6.92)	-0.485 (-6.73)	
PANEL C: Return-based illiquidity betas from the time series regression: $R_{jt} = \alpha_j + \beta_{j\phi} \phi(L_t) + \beta_{jW} R_{Wt} + \beta_{jc} \Delta C_t + u_{jt}$						
	Low	2	3	4	High	Mean
Small	-0.153 (-1.84)	-0.166 (-2.36)	-0.204 (-3.17)	-0.250 (-4.03)	-0.259 (-3.57)	-0.206 (-3.16)
2	-0.099 (-1.61)	-0.140 (-2.56)	-0.129 (-2.68)	-0.143 (-2.71)	-0.153 (-2.47)	-0.133 (-2.78)
3	-0.087 (-1.74)	-0.104 (-2.58)	-0.075 (-1.74)	-0.102 (-2.16)	-0.107 (-1.77)	-0.095 (-2.52)
4	-0.034 (-0.83)	-0.077 (-2.05)	-0.038 (-1.00)	-0.020 (-0.48)	-0.072 (-1.32)	-0.048 (-1.62)
Big	0.001 (0.02)	0.028 (1.03)	0.067 (2.08)	-0.006 (-0.16)	0.001 (0.03)	0.018 (0.95)
Mean	-0.075 (-1.76)	-0.092 (-2.57)	-0.076 (-2.14)	-0.104 (-2.60)	-0.118 (-2.35)	

The sample period covers from 1963:II to 2003:I. Mean returns and standard deviations (in parenthesis) are in Panel A. In Panels B and C, numbers in parenthesis are  $t$ -statistics. In the three panels, last column refers to the average portfolio of the five book-to-market groups for each size portfolio and the last row refers to the average portfolio of the five size groups for each book-to-market portfolio.  $R_{jt}$  denotes the gross return on portfolio  $j$  at time  $t$ ,  $\phi(L_t)$  is the illiquidity function that depends on the Amihud ratio,  $R_{Wt}$  is the gross return on aggregate wealth, and  $\Delta C_t$  is the non durable consumption growth rate. All  $t$ -statistics in parentheses are obtained from OLS autocorrelation-robust standard-error regressions.

**Table 1.b. Descriptive Statistics: 17 Industry Portfolios**

	Mean Return	Standard Deviation	Illiquidity beta Simple regression		Illiquidity beta Multiple regression	
Steel	1.933	11.43	-0.341	(-3.93)	0.075	(1.12)
Utilities	2.362	7.59	-0.182	(-3.10)	0.037	(0.70)
Durables	2.597	10.52	-0.508	(-6.93)	-0.148	(-2.93)
Chemicals	2.608	9.36	-0.343	(-4.95)	0.007	(0.14)
Other	2.688	9.62	-0.400	(-5.76)	0.014	(0.54)
Cars	2.767	11.56	-0.373	(-4.28)	0.038	(0.55)
Fab. Products	2.821	9.91	-0.404	(-5.61)	-0.050	(-0.98)
Mines	2.941	11.77	-0.292	(-3.22)	0.049	(0.57)
Transport	3.032	11.05	-0.465	(-5.82)	-0.053	(-0.97)
Machinery	3.038	12.25	-0.475	(-5.28)	0.028	(0.53)
Construction	3.105	11.82	-0.535	(-6.38)	-0.081	(-1.73)
Oil	3.117	8.60	-0.173	(-2.58)	0.103	(1.71)
Cloths	3.271	12.98	-0.631	(-6.99)	-0.215	(-3.08)
Finance	3.342	10.23	-0.441	(-6.00)	-0.054	(-1.28)
Retail	3.377	11.50	-0.517	(-6.33)	-0.099	(-1.85)
Food	3.506	9.04	-0.389	(-6.00)	-0.108	(-2.14)
Drugs	3.573	9.21	-0.342	(-5.03)	-0.060	(-1.07)

The sample period covers from 1963:II to 2003:I. Mean returns and standard deviations are in percentages. Numbers in parenthesis are  $t$ -statistics. Simple regression refers to equation in the top of Panel B of Table 1, and multiple regressions refer to equation in the top of Panel C of Table 1. All  $t$ -statistics in parentheses are obtained from OLS autocorrelation-robust standard-error regressions

**Table 2. Market-Wide Illiquidity and the Fama-French Factors. 1963:II-2003:I**

$\phi(L_t) = \delta_0 + \delta_W R_{Wt}^e + \delta_{SMB} SMB_t + \delta_{HML} HML_t + u_t$			
$\delta_W$	$\delta_{SMB}$	$\delta_{HML}$	$R_{adj}^2$
-0.414 (-4.23)	-0.385 (-3.00)	-0.085 (-0.67)	23.15
-0.514 (-6.52)	-	-	19.65
-	-0.661 (-5.60)	-	15.15
-	-	0.257 (2.05)	1.84
-	-0.635 (-5.30)	0.146 (1.24)	15.41

Table 2 provides estimates of the market-wide illiquidity betas with respect to the three Fama-French factors.  $\phi(L_t)$  is an illiquidity function that depends on the Amihud ratio,  $R_{Wt}^e$  is the excess return on aggregate wealth,  $SMB_t$  is the Fama-French size factor, and  $HML_t$  is the Fama-French book-to-market factor. The results are reported for different versions of the time-series regression of the market-wide illiquidity shocks on the Fama-French factors from 1971:I to 2003:I. All  $t$ -statistics in parentheses are obtained from OLS autocorrelation-robust standard-error regressions

**Table 3. GMM Estimation**

PANEL A: Power Utility, 25 Fama and French Portfolios								
	S=0			S=11				
	$\gamma$	$\alpha$	$T(Dist)^2$	$\gamma$	$\alpha$	$T(Dist)^2$		
$M_P$	-21.21 (40.73)	0.0214 (0.0049)	50.922 (0.0006)	8.658 (8.50)	0.0208 (0.0047)	50.660 (0.001)		
$M_{LAP}$	-33.82 (40.96)	0.0206 (0.0050)	49.030 (0.0013)	9.68 (8.73)	0.0208 (0.0047)	50.219 (0.0019)		
PANEL B: Power Utility, 25 Fama and French Portfolios and 17 Industry Portfolios								
	S=0			S=11				
	$\gamma$	$\alpha$	$T(Dist)^2$	$\gamma$	$\alpha$	$T(Dist)^2$		
$M_P$	13.93 (34.31)	0.0123 (0.0041)	86.898 (0)	2.48 (6.26)	0.0129 (0.0039)	87.185 (0)		
$M_{LAP}$	8.76 (35.07)	0.0116 (0.0042)	85.672 (0)	2.76 (6.30)	0.0130 (0.0040)	86.391 (0)		
PANEL C: Recursive Utility, 25 Fama and French Portfolios								
	S=0				S=11			
	$\gamma$	$\rho$	$\alpha$	$T(Dist)^2$	$\gamma$	$\rho$	$\alpha$	$T(Dist)^2$
$M_R$	-11.53 (41.50)	-5.36 (22.54)	0.0245 (0.0066)	50.415 (0.0007)	12.42 (9.07)	9.05 (7.68)	0.0229 (0.0050)	50.211 (0.0011)
$M_{LAR}$	-37.25 (42.34)	-11.08 (14.37)	0.0254 (0.0062)	45.722 (0.0044)	10.81 (9.21)	6.89 (6.47)	0.0230 (0.0052)	49.259 (0.0011)
PANEL D: Recursive Utility, 25 Fama and French Portfolios and 17 Industry Portfolios								
	S=0				S=11			
	$\gamma$	$\rho$	$\alpha$	$T(Dist)^2$	$\gamma$	$\rho$	$\alpha$	$T(Dist)^2$
$M_R$	15.70 (34.84)	13.10 (28.69)	0.0128 (0.0048)	86.859 (0)	2.57 (6.26)	2.53 (6.20)	0.013 (0.0041)	87.182 (0)
$M_{LAR}$	13.13 (35.29)	6.99 (17.48)	0.0131 (0.0047)	84.778 (0.0001)	2.57 (5.97)	2.48 (5.73)	0.0131 (0.0040)	86.388 (0)

The sample period covers from 1963:II to 2003:I.  $M_P$  (panels A and B) and  $M_R$  (panels C and D) are the SDFs based on power and recursive preferences, respectively. We report the results for both the non-liquidity adjusted and the liquidity adjusted stochastic discount factors (the latter is denoted by  $M_{LAP}$  and  $M_{LAR}$  for power and recursive preferences, respectively).

When  $S=0$ , the marginal rate of substitution relates periods  $t+1$  and  $t$ , whereas  $S=11$  means that the marginal rate of substitution relates periods  $t+12$  and  $t$ .  $\gamma$  is the relative risk aversion coefficient,  $\rho$  is the inverse of the elasticity of substitution and  $\alpha$  is the mean error of the model in explaining the returns on the considered set of portfolios. The numbers in parenthesis below the estimated parameters are standard errors. Finally,  $T(Dist)^2$  is the measure for the model performance; in this case, the number in parenthesis is the  $p$ -value for the null  $T(Dist)^2=0$ .

**Table 4.a. Fama-MacBeth Estimation. CCAPM and Illiquidity Shocks**

PANEL A: 25 Fama and French Portfolios									
S=0					S=11				
$\gamma_0$	$\gamma_1$	$\gamma_2$	$R_{adj}^2$	$MSE^{1/2}$	$\gamma_0$	$\gamma_1$	$\gamma_2$	$R_{adj}^2$	$MSE^{1/2}$
0.0378 (5.12)	-0.0011 (-1.01)		32.99	0.605	0.0301 (3.50)	0.0043 (0.69)		31.11	0.473
0.0299 (4.19)	-0.0033 (-2.97)	-0.0011 (-0.07)	57.13	0.459	0.0296 (3.81)	0.0061 (0.93)	-0.0493 (-2.05)	52.42	0.458
PANEL B: 25 Fama and French Portfolios and 17 Industry Portfolios									
S=0					S=11				
$\gamma_0$	$\gamma_1$	$\gamma_2$	$R_{adj}^2$	$MSE^{1/2}$	$\gamma_0$	$\gamma_1$	$\gamma_2$	$R_{adj}^2$	$MSE^{1/2}$
0.0354 (5.21)	-0.0015 (-1.65)		22.06	0.696	0.0311 (4.06)	0.0003 (0.07)		22.68	0.610
0.0247 (4.01)	-0.0021 (-2.65)	-0.0070 (-0.49)	39.43	0.614	0.0310 (4.41)	0.0033 (0.67)	-0.0455 (-2.68)	36.79	0.615

Tables 4a, 4b and 4c provide estimates of the risk premia from different versions of the following cross-sectional regression from 1971:I to 2003:I.

$$R_{jt} - R_{ft} = \gamma_0 + \gamma_1 \beta_{jct} + \gamma_2 \beta_{j\phi t} + \gamma_3 \beta_{jw t} + e_{jt}$$

Results shown in Table 4a correspond to the power utility function estimation (in this case,  $\gamma_3$  is zero as shown in Appendixes A and C). Table 4b reports the results from CAPM (in this case,  $\gamma_1$  is zero as shown in Appendixes A and C). Finally, Table 4c shows results from the full regression.

$\beta_{jc}$ ,  $\beta_{j\phi}$  and  $\beta_{jw}$  are the sensitivities of the return on asset  $j$  to changes into the three risk factors: non-durable consumption growth rate, unexpected aggregate illiquidity and the return on the aggregate wealth, respectively. They are estimated with a rolling window of data previous to each cross-sectional regression.

S=0 means that the risk factors are computed by relating periods  $t$  and  $t+1$ . S=11 means that the risk factors are computed by relating periods  $t$  and  $t+12$ .

$R_{adj}^2$  is the adjusted determination coefficient, computed using the sum of the total sums and the sum of the residual sums from each cross-sectional regression and  $MSE^{1/2}$  is square root of the mean square errors for the portfolios. Both are reported as percentages.  $t$ -statistics are in parenthesis.



**Table 4.b. Fama-MacBeth Estimation. CAPM and Illiquidity Shocks**

PANEL A: 25 Fama and French Portfolios									
S=0					S=11				
$\gamma_0$	$\gamma_2$	$\gamma_3$	$R_{adj}^2$	$MSE^{1/2}$	$\gamma_0$	$\gamma_2$	$\gamma_3$	$R_{adj}^2$	$MSE^{1/2}$
0.0391 (4.02)		-0.0064 (-0.54)	49.20	0.634	0.0334 (4.01)		-0.0652 (-0.95)	33.86	0.799
0.0451 (4.37)	-0.0356 (-1.79)	-0.0172 (-1.36)	61.95	0.377	0.0384 (4.67)	-0.0139 (-0.55)	-0.0690 (-0.95)	50.87	0.578
PANEL B: 25 Fama and French Portfolios and 17 Industry Portfolios									
S=0					S=11				
$\gamma_0$	$\gamma_2$	$\gamma_3$	$R_{adj}^2$	$MSE^{1/2}$	$\gamma_0$	$\gamma_2$	$\gamma_3$	$R_{adj}^2$	$MSE^{1/2}$
0.0283 (3.80)		0.0008 (0.08)	32.73	0.629	0.0211 (3.01)		0.0052 (0.10)	23.32	0.790
0.0313 (3.92)	-0.0179 (-0.97)	-0.0045 (-0.41)	42.11	0.518	0.0261 (3.71)	-0.0280 (-1.57)	0.0165 (0.33)	35.71	0.656

See notes in Table 4.a.

**Table 4.c. Fama-MacBeth Estimation. Recursive Preferences and Illiquidity Shocks**

PANEL A: 25 Fama and French Portfolios											
S=0						S=11					
$\gamma_0$	$\gamma_1$	$\gamma_2$	$\gamma_3$	$R_{adj}^2$	$MSE^{1/2}$	$\gamma_0$	$\gamma_1$	$\gamma_2$	$\gamma_3$	$R_{adj}^2$	$MSE^{1/2}$
0.0421 (4.42)	-0.0026 (-2.64)		-0.0149 (-1.29)	57.38	0.562	0.0251 (3.30)	0.0036 (0.64)		0.0812 (1.32)	51.03	0.453
0.0437 (4.58)	-0.0021 (-2.16)	-0.0190 (-1.05)	-0.0184 (-1.57)	69.73	0.385	0.0314 (4.40)	0.0066 (1.20)	-0.0450 (-2.01)	0.0441 (0.85)	65.82	0.423
PANEL B: 25 Fama and French Portfolios and 17 Industry Portfolios											
S=0						S=11					
$\gamma_0$	$\gamma_1$	$\gamma_2$	$\gamma_3$	$R_{adj}^2$	$MSE^{1/2}$	$\gamma_0$	$\gamma_1$	$\gamma_2$	$\gamma_3$	$R_{adj}^2$	$MSE^{1/2}$
0.0305 (4.31)	-0.0018 (-2.46)		-0.0042 (-0.41)	40.11	0.644	0.0241 (3.54)	-0.002 (-0.34)		0.0773 (1.61)	38.01	0.573
0.0323 (4.45)	-0.0014 (-2.03)	-0.0082 (-0.48)	-0.0070 (-0.69)	50.47	0.560	0.0302 (4.32)	0.0031 (0.65)	-0.0409 (-2.47)	0.0595 (1.35)	48.46	0.559

See notes in Table 4.a.

**Table 5. Fama-MacBeth Estimation. Recursive Preferences and Illiquidity Shocks**

PANEL A: 25 Fama and French Portfolios and 10 Dividend Yield Portfolios											
S=0						S=11					
$\gamma_0$	$\gamma_1$	$\gamma_2$	$\gamma_3$	$R_{adj}^2$	$MSE^{1/2}$	$\gamma_0$	$\gamma_1$	$\gamma_2$	$\gamma_3$	$R_{adj}^2$	$MSE^{1/2}$
0.0377 (4.51)	-0.0024 (-2.52)		-0.0113 (-1.03)	54.85	0.554	0.0252 (3.50)	0.0004 (0.07)		0.0837 (1.42)	48.82	0.494
0.0378 (4.61)	-0.0020 (-2.26)	-0.0113 (-0.67)	-0.0123 (-1.15)	65.21	0.413	0.0309 (4.50)	0.0039 (0.83)	-0.0416 (-2.00)	0.0499 (0.99)	61.73	0.451
PANEL B: 25 Fama and French Portfolios and 10 Momentum Portfolios											
S=0						S=11					
$\gamma_0$	$\gamma_1$	$\gamma_2$	$\gamma_3$	$R_{adj}^2$	$MSE^{1/2}$	$\gamma_0$	$\gamma_1$	$\gamma_2$	$\gamma_3$	$R_{adj}^2$	$MSE^{1/2}$
0.0297 (4.51)	-0.0031 (-2.83)		-0.0003 (-0.02)	59.95	0.594	0.0265 (3.63)	-0.0032 (-0.59)		0.0224 (0.43)	42.83	0.832
0.0432 (4.91)	-0.0003 (-0.33)	-0.0159 (-0.86)	-0.0161 (-1.376)	60.89	0.660	0.0379 (5.50)	0.0012 (0.23)	-0.0560 (-2.77)	0.0028 (0.06)	59.31	0.622

See notes in Table 4.a.

**Table 6. Fama-MacBeth Estimation: Risk Premia Seasonality. Recursive Preference and Illiquidity Shocks. 25 Fama and French Portfolios and 17 Industry Portfolios**

Risk premia first quarter: S = 0				Risk premia first quarter: S = 11			
$\hat{a}$ for $\gamma_0$	$\hat{a}$ for $\gamma_1$	$\hat{a}$ for $\gamma_2$	$\hat{a}$ for $\gamma_3$	$\hat{a}$ for $\gamma_0$	$\hat{a}$ for $\gamma_1$	$\hat{a}$ for $\gamma_2$	$\hat{a}$ for $\gamma_3$
0.0329 (2.28)	-0.0012 (-0.81)	-0.0809 (-2.42)	0.0105 (0.52)	0.0544 (3.99)	0.0156 (1.65)	-0.1168 (-3.66)	0.0472 (0.54)
Difference between risk premia during the rest of the year and the first quarter: S = 0				Difference between risk premia during the rest of the year and the first quarter: S = 11			
$\hat{b}$ for $\gamma_0$	$\hat{b}$ for $\gamma_1$	$\hat{b}$ for $\gamma_2$	$\hat{b}$ for $\gamma_3$	$\hat{b}$ for $\gamma_0$	$\hat{b}$ for $\gamma_1$	$\hat{b}$ for $\gamma_2$	$\hat{b}$ for $\gamma_3$
-0.0006 (-0.04)	-0.0004 (-0.25)	0.0976 (2.52)	-0.0236 (-1.01)	-0.0326 (-2.06)	-0.0167 (-1.53)	0.1019 (2.76)	0.0166 (0.16)

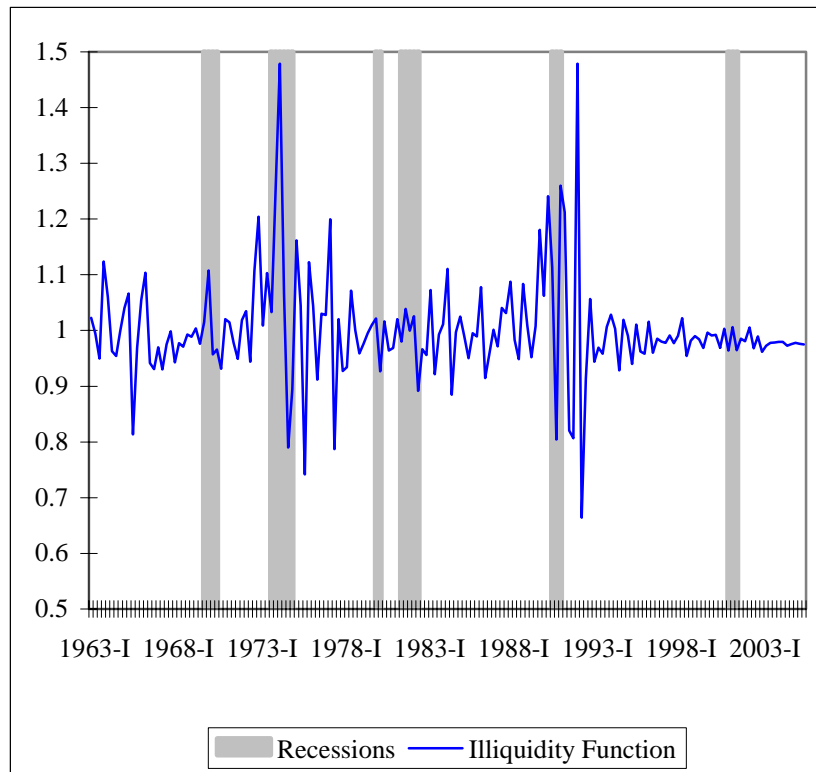
This table shows the risk premia estimates from the first quarter of the full sample period, and for the difference between the rest of the year and the first quarter from 1971:I to 2003:I. In particular, we run the following regression under recursive preferences with illiquidity shocks:

$$\hat{\gamma}_{it} = a + bD_{RYt} + u_{it}, \quad i = 1, 2, 3, \text{ and } 4$$

where  $\hat{\gamma}_{it}$  are the time-series of the estimated risk premia corresponding to the second row of the Panel B of Table 4.a, and  $D_{RYt}$  is a dummy variable which is equal to one for quarters 2, 3 and 4, and zero otherwise. Then, the estimated intercept is the average risk premia for the first quarter, while the estimated slopes represent the difference between the risk premia during the rest of the year and the first quarter. We report the results for both the contemporaneous (S=0) and ultimate risk specifications (S=11) of the SDFs. *t*-statistic in parentheses.

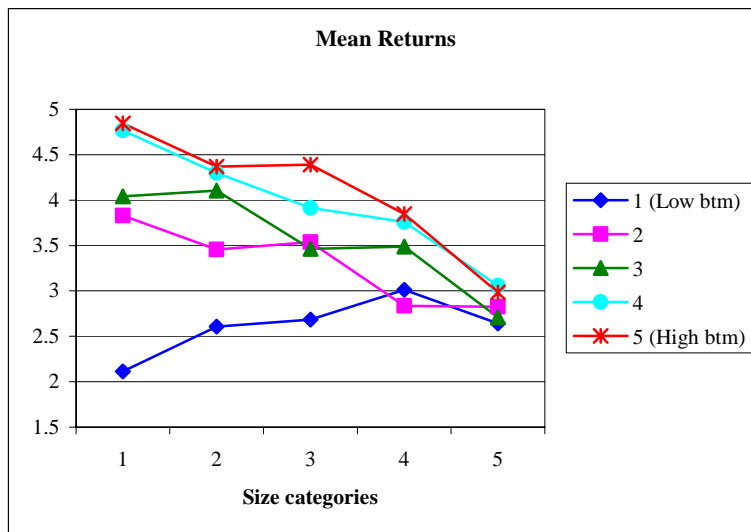
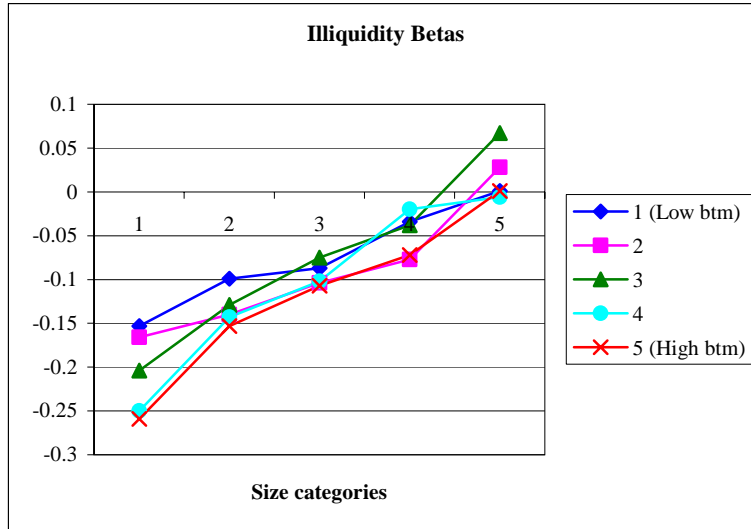
**Figure 1**

*Aggregate Illiquidity Shocks and Recessions*



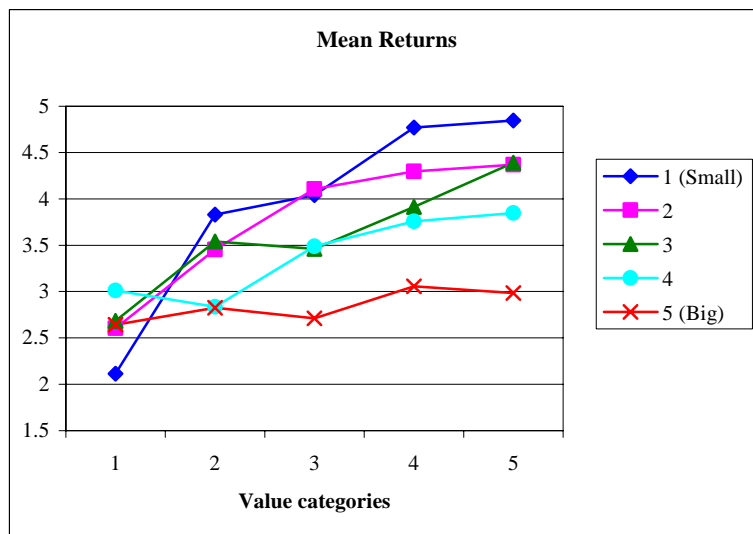
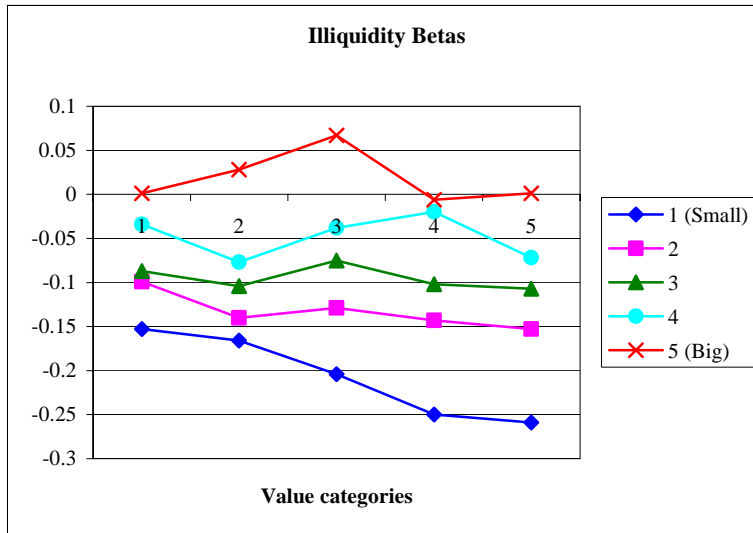
**Figure 2.a**

*Illiquidity Betas and Mean Returns Controlling for Value  
25 Fama and French Portfolios*



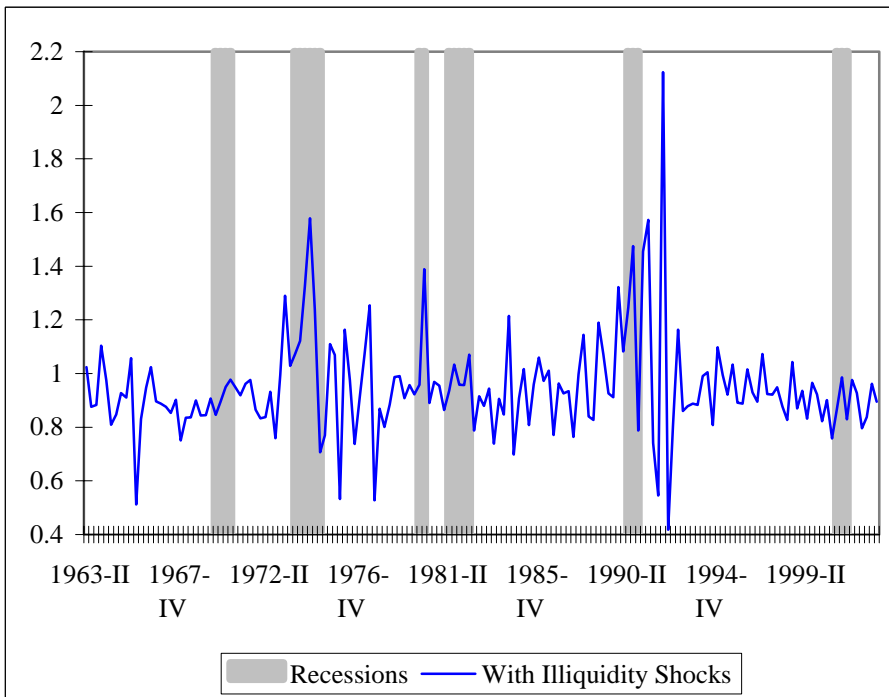
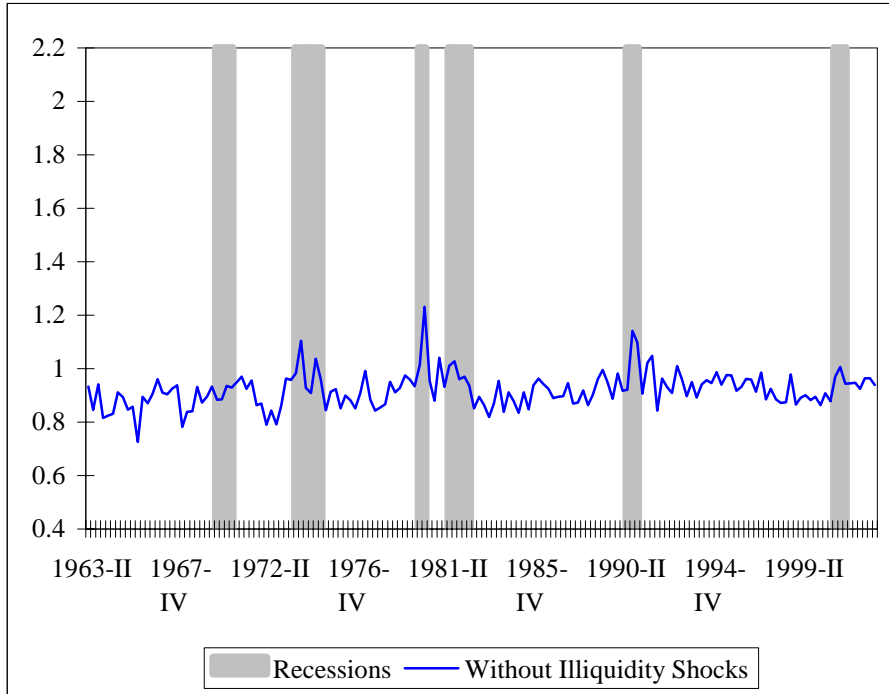
**Figure 2.b**

*Illiquidity Betas and Mean Returns Controlling for Size*  
*25 Fama and French Portfolios*



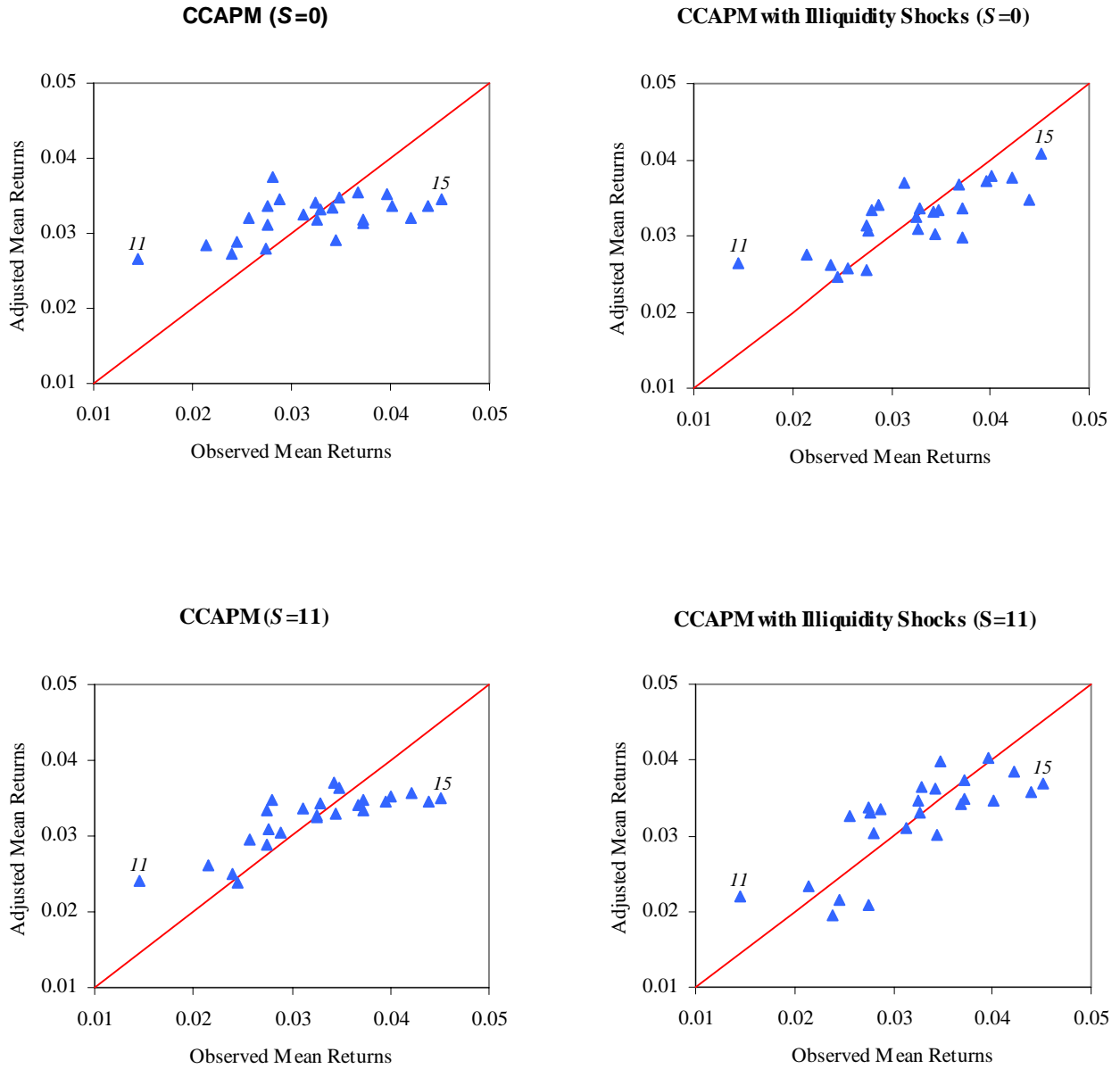
**Figure 3**

*Stochastic Discount Factor based on Recursive Preferences  
Without and With Illiquidity Shocks*



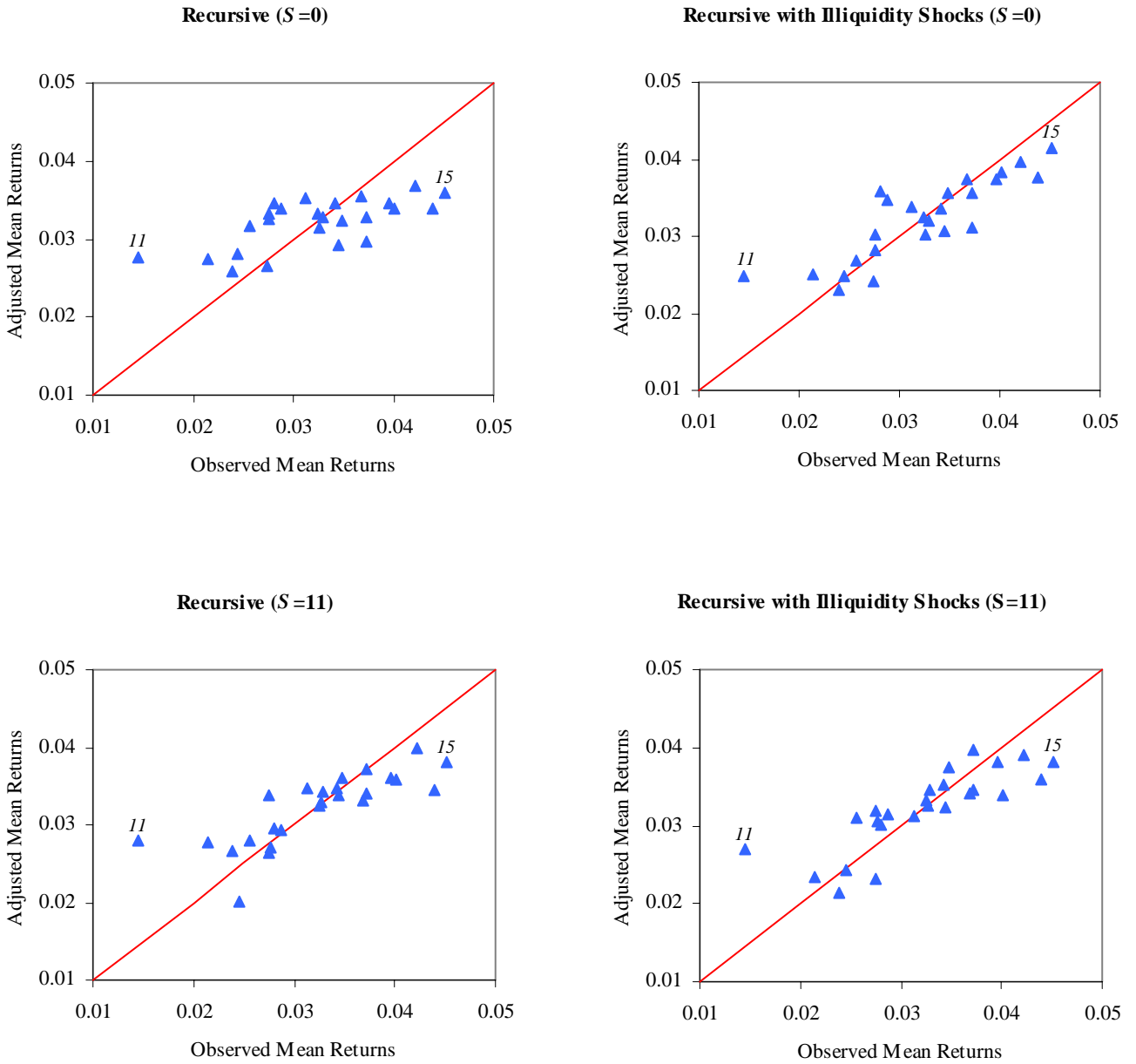
**Figure 4**

*Mean Adjusted Returns versus Mean Observed Returns. Power Utility  
Results from Fama-MacBeth Estimation with 25 Fama and French Portfolios*



**Figure 5**

*Mean Adjusted Returns versus Mean Observed Returns. Recursive Preferences  
Results from Fama-MacBeth Estimation with 25 Fama and French Portfolios*





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