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Do the LCAPM Predictions Hold? Replication and Extension Evidence

Craig W. Holden[1]
Jayoung Nam[2*]

[1]*Indiana University, Bloomington, USA; cholden@indiana.edu*
[2]*Southern Methodist University, USA; jayoungn@smu.edu*

ABSTRACT

First, we replicate the Liquidity-adjusted Capital Asset Pricing Model (LCAPM) tests of Acharya and Pedersen (2005) using their original methodology and covering both their original time period and a more recent period. We successfully qualitatively replicate the descriptive and the first-stage tables and figures, but are *not* successful in replicating the second-stage tables that perform cross-sectional tests. In the large majority of cases, our replication evidence fails to support that the main LCAPM predictions all hold simultaneously. Next, we extend tests of the LCAPM following the Lee (2011) methodology and expanding to: (1) three different time periods spanning 90 years, (2) add NASDAQ stocks, (3) use four alternative liquidity measures, and (4) add risk or characteristic factors. Our extension evidence always fails to support that the main predictions of the Lee two-beta LCAPM and of the four-beta LCAPM hold at the same time. Overall, we fail to support that liquidity risk matters in the specific functional form predicted by the LCAPM. However, we are silent on the more general question of whether liquidity risk matters in some different functional form. We make publicly available our SAS code.

Keywords: Liquidity risk, Liquidity-adjusted CAPM, Liquidity measures

JEL Codes: G0, G1, G12

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1 Introduction

In a pioneering and influential article, Acharya and Pedersen (AP) (2005) develop the Liquidity-adjusted Capital Asset Pricing Model (LCAPM), which extends the standard frictionless asset pricing framework to include a random liquidity cost element. They derive an unconditional version of the LCAPM[1] in which the excess return of a security recovers the expected liquidity cost, includes a market risk premium (i.e., the standard capital asset pricing model (CAPM) risk premium), and provides three new liquidity risk premia. Next, they empirically test the unconditional LCAPM on all New York Stock Exchange (NYSE) and American Stock Exchange (AMEX) stocks with available book-to-market ratios from 1962 to 1999. They find that "net beta", which combines the market risk beta and the three liquidity risk betas, is priced and that the LCAPM has a higher goodness of fit (R^2) than the standard CAPM.

We begin by replicating the LCAPM tests of AP using their original methodology, which is based on GMM and uses portfolios as test assets. We cover their original time period of 1962 to 1999 and a more recent period 2000 to 2015. This section of the paper is part of a broad program by *Critical Finance Review* to replicate the most famous papers in finance. The goal is to build an objective, replicated base of knowledge that the profession can rely upon. In this spirit, we make our SAS code publicly available.

We successfully qualitatively replicate the descriptive and first-stage tables and figures that describe the properties of illiquidity portfolios, the innovations of market illiquidity, and the correlations of the portfolio betas. However, we are *not* successful in replicating the second-stage tables that perform cross-sectional tests under eight different variations of tests assets, portfolio weightings, and added factors. Specifically, when comparing our replicated estimates to the original estimates in these second-stage tables, we find large differences in the number of estimates that are significant, large differences in magnitude of the expected liquidity coefficients, and low similarity in the pattern of which coefficients are significant.

We examine what the replication tests tell us about the LCAPM. We find frequent support for the less-critical predictions that the intercept is zero and mean liquidity cost is priced. However, in the large majority of cases we fail to support that the main LCAPM predictions all hold simultaneously. Throughout this paper, we are *strict* in requiring as our criteria that the main predictions of the LCAPM (i.e., the key predictions that distinguish it from other asset pricing theories) hold true simultaneously.

Our replication tests include four different version of the LCAPM that differ in how aggregated or disaggregated the liquidity premia are. We call these four

[1] Acharya and Pedersen also derive a *conditional* version of the LCAPM in which the lambda coefficients and beta factors can evolve over time, but they do not test this version. Throughout this paper we exclusively test the unconditional version of the LCAPM.

versions the one-beta LCAPM, the AP two-beta LCAPM, the Lee two-beta LCAPM, and the four-beta LCAPM (see formal definitions in the hypothesis section). We find that the AP two-beta LCAPM faces extremely severe multicollinearity with correlations between market beta and net beta always being higher than 97%. Further, we find that the Lee two-beta LCAPM and the four-beta LCAPM face significant multicollinearity when portfolios are used as test assets, but not when individual stocks are used as test assets.

Next, we extend tests of the LCAPM using the innovative Lee (2011) methodology, which is based on a three-stage Fama-MacBeth approach and uses individual stocks as test assets. We expand the range of evidence in four ways. First, we analyze two new time periods, 2000 to 2015 and 1926 to 1961 (in addition to the original, 1962 to 1999 time period). Second, we analyze NASDAQ-listed stocks (in addition to NYSE/AMEX-listed stocks). Third, we analyze four alternative liquidity measures: (1) the Corwin and Schultz proxy, (2) closing percent quoted spread, (3) the Amihud proxy, and (4) zeros. Fourth, we analyze the impact of adding Fama and French/Carhart risk factors or alternatively characteristic factors to the model.

We robustly test the Lee two-beta LCAPM over the following cases: (five different time-period/exchange combinations) multiplied by (four different liquidity measures) multiplied by (three versions of the regression) for a total of $5*4*3 = 60$ cases. Summarizing our Lee two-beta LCAPM main prediction results over these 60 cases, we find that: (1) market risk is priced in 20% of the cases, (2) net liquidity risk is priced in 12%, and (3) the market risk coefficient equals the net liquidity risk coefficient in 0% of the cases. In summary, our extension results *always* fail to support that the main Lee two-beta LCAPM predictions hold at the same time.

We test the four-beta LCAPM predictions over five different time-period/exchange combinations. We find that: (1) market risk is priced in 0% of the cases, (2) the three liquidity risk coefficients are priced with the predicted signs in 7%, and (3) all of the risk coefficients are equal in absolute value and have the predicted signs in 0% of the cases. In summary, our extension results *always* fail to support that the main four-beta LCAPM predictions hold at the same time.

Like AP, we find that the LCAPM has a higher R^2 than the CAPM. We decompose the source of that gain in R^2 into what is attributable to the Amihud and Mendelson-type mean liquidity cost term vs. what is attributable to the LCAPM liquidity risk term. We find that nearly all of the R^2 gain is due to the Amihud and Mendelson-type mean liquidity cost term and very little of the gain is due to the LCAPM liquidity risk term.

Overall, we fail to support that liquidity risk matters in the specific functional form predicted by the LCAPM (i.e., that liquidity betas have the predicted signs; that liquidity betas and the market beta are equal in absolute value with the predicted signs; that liquidity betas have economically significant explanatory power). However, we are silent on the more general question of whether liquidity risk matters in some different functional form (perhaps as an APT or ICAPM rational factor/characteristic and/or as a behavioral factor/characteristic).

In the prior literature, Amihud and Mendelson (1986) and Brennan and Subrahmanyam (1996) provide evidence that the illiquidity characteristic helps to explain stock returns. Pastor and Stambaugh (2003) and Acharya and Pedersen (2005) provide evidence that liquidity risk is priced. Ben-Rephael *et al.* (2015) provide evidence that the illiquidity characteristic is priced, but liquidity risk is *not* priced for a large majority of stocks and time periods. Acharya *et al.* (2013) provide evidence that *conditional* liquidity risk is priced.

Our paper is closely related to Lee (2011), who tests the LCAPM on a global, regional, and US basis. Lee's main US results from his Tables 3 and 5 find that net liquidity risk is *not* significant when evaluated at the 1% level.[2] His appendix results based on portfolio test assets find that net liquidity risk is significant at the 10% level in five out of six cases. However, an important point that Lee does not highlight is that in nearly all US cases the market risk coefficient is significantly different from the net liquidity risk coefficient, which fails to support the LCAPM. Thus, our results are generally consistent with Lee. Our paper is also closely related to Kazumori *et al.* (2018), who replicate AP tests of the LCAPM using US data from 1964 to 1999 and who conduct out-of-sample tests of the LCAPM using US data from 2000 to 2016 and Japanese data from 1978 to 2011. In tests of the AP two-beta LCAPM, they find that the main two LCAPM restrictions (namely, that $\lambda^1 = 0$ and $\lambda^{\text{Net}} > 0$) are true at the same time in only two cases out of 32 cases tested. Thus, their evidence strongly and robustly fails to support the main LCAPM predictions, which is consistent with our results.

The plan of the paper is as follows. Section 2 develops the hypotheses. Section 3 provides our replication tests of the LCAPM following the original AP methodology and covers their original time period as well as a more recent time period. Section 4 provides our extension tests of the LCAPM following the Lee methodology and expanding in four ways. Section 5 concludes.

2 Hypotheses

Let r_t^i, r_t^M, and r_t^f be the returns on date t of individual asset i, the market portfolio, and the riskfree asset, respectively. Let c_t^i and c_t^M be the percentage liquidity cost on date t of individual asset i and of the market portfolio, respectively. The unconditional version of the LCAPM[3] is given by

$$E(r_t^i - r_t^f) = E(c_t^i) + \lambda\beta^{1i} + \lambda\beta^{2i} - \lambda\beta^{3i} - \lambda\beta^{4i} \tag{1}$$

[2]The 1% level of significance is appropriate considering that his cross-sectional regressions are based on thousands of individual stocks.

[3](1) and (2) are based on Lee (2011), Eqs. (2) and (3).

where

$$\beta^{1i} \equiv \frac{\mathrm{Cov}(r_t^i, r_t^M)}{\mathrm{Var}(r_t^M - c_t^M)}, \quad \beta^{2i} \equiv \frac{\mathrm{Cov}(c_t^i, c_t^M)}{\mathrm{Var}(r_t^M - c_t^M)},$$
$$\beta^{3i} \equiv \frac{\mathrm{Cov}(r_t^i, c_t^M)}{\mathrm{Var}(r_t^M - c_t^M)}, \quad \text{and} \quad \beta^{4i} \equiv \frac{\mathrm{Cov}(c_t^i, r_t^M)}{\mathrm{Var}(r_t^M - c_t^M)}, \tag{2}$$

and $\lambda = E(\lambda_t) = E(r_t^M - c_t^M - r_t^f)$. A fundamental property of the LCAPM is that the risk coefficient λ is *identical* across all four risk terms.

AP adapt the theory for empirical testing by adding a coefficient κ times expected liquidity cost term and by defining "net beta" as $\beta^{\text{net},i} \equiv \beta^{1i} + \beta^{2i} - \beta^{3i} - \beta^{4i}$. Thus one of the empirical versions of the unconditional LCAPM that they test[4] is

$$E(r_t^i - r_t^f) = \alpha^i + \kappa E(c_t^i) + \lambda^{\text{net}} \beta^{\text{net},i}, \tag{3}$$

where in order to help keep things straight, we have renamed the coefficient λ^{net}. We refer to (3) as the "one-beta" LCAPM. In this version, α^i is the intercept, which is predicted to equal zero. The LCAPM is derived in a theoretical framework of overlapping generations where one-period lived agents use their entire wealth endowment to buy securities on date t (when they are born) and sell all their securities on date $t+1$ in order to consume (right before they die). Thus, in the theory world $\kappa = 1$. In the real world, long-lived investors can make many small trading adjustments over a lifetime. AP argue that κ should be equal to average monthly turnover.[5] We avoid the difficult question of estimating average monthly turnover and simply test if κ is significantly positive.

There are three LCAPM predictions that can be tested using the one-beta LCAPM.

Hypothesis 1. *The intercept should be equal to zero* ($\alpha^i = 0$).

Hypothesis 2. *The coefficient of expected liquidity cost should be greater than zero* ($\kappa > 0$).

Hypothesis 3. *The coefficient of net beta should be greater than zero* ($\lambda^{net} > 0$).

We call any LCAPM prediction on λ's, the "main" LCAPM predictions. So this case, hypothesis 3 is the main one-beta LCAPM prediction.

Amihud and Mendelson (1986) develop an asset pricing theory in which individual assets that have higher bid-ask spread should have higher expected returns, though the relationship need not be linear. We can capture the spirit of

[4] See Acharya and Pedersen (2005), Eq. (25).

[5] They follow the intuition of Amihud and Mendelson (1986), who show that expected returns need to be higher for more illiquid stocks so that the marginal investor can recover their average trading costs. Further, average trading costs are approximately equal to the product of (average monthly turnover) times (average liquidity cost per trade). Comparing this to (3), they argue that κ should be equal to average monthly turnover.

Amihud and Mendelson by considering a special case of the AP model in which c_t^i and c_t^M are constant (i.e., by zeroing out the liquidity risk). In this case, (3) reduces to

$$E(r_t^i - r_t^f) = \alpha^i + \kappa E(c_t^i) + \lambda^1 \beta^{1,i}. \tag{4}$$

In (4), the second term is a linear, Amihud and Mendelson-type mean liquidity cost term. We refer to (4) as the "mean liquidity cost CAPM." A challenge for empirically testing the one-beta LCAPM is that it doesn't provide a very sharp separation between the LCAPM (3) and the mean liquidity cost CAPM (4). That is, if the empirically-estimated coefficient λ^{net} from Eq. (3) is significantly greater than zero, is that because $\beta^{\text{net},i}$ is truly priced? Or do we obtain that result because the market factor $\beta^{1,i}$ is priced and the liquidity risk factors are irrelevant for pricing? The empirical test of (3) can't easily distinguish between these two cases.

AP also test

$$E(r_t^i - r_t^f) = \alpha^i + \kappa E(c_t^i) + \lambda^1 \beta^{1,i} + \lambda^{\text{net}} \beta^{\text{net},i}, \tag{5}$$

which we refer to as the "AP two-beta" LCAPM. (5) is an odd test in the following sense. Recall that net beta $\beta^{\text{net},i}$ already incorporates all four betas, including the market beta β^{1i}. Thus, the LCAPM predicts that the coefficient of the added term is equal to zero ($\lambda^1 = 0$). Another way to see this is to compare (5) to (3) and it is clear that the LCAPM predicts that the added term will be zero. A related problem with (5) is that, empirically, we find that the correlation between β^{1i} and $\beta^{\text{net},i}$ is greater than 97%. Thus, (5) has an extremely severe degree of multicollinearity.

There are four LCAPM predictions that can be tested using the AP two-beta LCAPM. It predicts hypotheses 1 to 2, main hypothesis 3, and one more main hypothesis:

Hypothesis 4. *The coefficient of market risk in the AP two-beta LCAPM should be equal to zero* ($\lambda^1 = 0$).[6]

Lee (2011) divides net beta into two terms: (1) the market beta β^{1i} and (2) the net liquidity risk beta β^{5i} as follows

$$\beta^{\text{net},i} = \beta^{1i} + \beta^{5i}, \tag{6}$$

where $\beta^{5i} \equiv \beta^{2i} - \beta^{3i} - \beta^{4i}$. This leads to an alternative empirical specification of the LCAPM

$$E(r_t^i - r_t^f) = \alpha^i + \kappa E(c_t^i) + \lambda^1 \beta^{1i} + \lambda^5 \beta^{5i}, \tag{7}$$

which we refer to as the "Lee two-beta" LCAPM. Substituting (6) into (3) and comparing the result to (7), it is clear that the LCAPM also predicts that the market risk coefficient equals the net liquidity risk coefficient ($\lambda^1 = \lambda^5$). The Lee two-beta LCAPM allows for a clean test of whether market risk is priced vs. whether net

[6] AP do not highlight this test.

liquidity risk is priced and for a direct test of the fundamental LCAPM prediction that both of λ's are equal.

There are five LCAPM predictions that can be tested using the Lee two-beta LCAPM. It predicts Hypotheses 1 and 2 and three more main hypotheses:

Hypothesis 5. *The coefficient of market risk in the Lee two-beta LCAPM should be greater than zero* ($\lambda^1 > 0$).

Hypothesis 6. *The coefficient of net liquidity risk should be greater than zero* ($\lambda^5 > 0$).

Hypothesis 7. *The market risk coefficient in the Lee two-beta LCAPM should be equal to the net liquidity risk coefficient* ($\lambda^1 = \lambda^5$).

AP also test another version of the LCAPM, which we call the "four-beta" LCAPM. It is given by

$$E(r_t^i - r_t^f) = \alpha^i + \kappa E(c_t^i) + \lambda^1 \beta^{1i} + \lambda^2 \beta^{2i} + \lambda^3 \beta^{3i} + \lambda^4 \beta^{4i}, \tag{8}$$

where β^{1i}, β^{2i}, β^{3i}, and β^{4i} are defined in the same way as in (2). This form also allows for a clean test of whether market risk and each of the three liquidity risks are priced and for a direct test of the fundamental LCAPM prediction that all of the λ's are equal in absolute value and have the predicted signs (which follows from comparing [1] to [8]).

There are five LCAPM predictions that can be tested using the four-beta LCAPM. It predicts Hypotheses 1 and 2 and three more main hypotheses:

Hypothesis 8. *The coefficient of market risk in the four-beta LCAPM should be greater than zero* ($\lambda^1 > 0$).

Hypothesis 9. *The liquidity risk coefficients should have predicted signs as follows* $\lambda^2 > 0$, $\lambda^3 < 0$, *and* $\lambda^4 < 0$.

Hypothesis 10. *The risk coefficients should be equal in absolute value and have the predicted signs, such that all of the following relationships should be true simultaneously:* $\lambda^1 = \lambda^2 = -\lambda^3 = -\lambda^4$.

3 Replication Tests of the LCAPM

3.1 Replication Methodology and Data

In this section, we replicate tests of the LCAPM using the original AP methodology and covering their original time period (1962 to 1999), plus an out-of-sample test in a more recent time period (2000 to 2015). We precisely follow the detailed procedures of AP.

Specifically, we analyze all common share stocks listed on NYSE and AMEX[7] that have available book value data in Compustat from July 1, 1962 to December 31, 1999 and from January 1, 2000 to December 31, 2015. The book value for the book-to-market ratios is calculated using the fiscal year-end balance sheet data on COMPUSTAT following Ang and Chen (2002). We apply the same filtering methods on the data to form both value-weighted and equally-weighted market portfolios and test portfolios. We measure liquidity by estimating the Amihud (2002) illiquidity measure, multiplying by a market portfolio capitalization ratio to make it stationary, linearly transforming it to match the approximate scale of the percent effective spreads as reported by Chalmers and Kadlec (1998), and capping it to remove outliers. Then we form portfolios in year y based on their year $y-1$ illiquidity. Specifically, we form 25 "illiquidity portfolios" sorted by average illiquidity and 25 "illiquidity-variation portfolios" sorted by the standard deviation of illiquidity.

We adjust returns for stock delisting following Shumway (1997). We compute innovations in liquidity by truncating the un-normalized illiquidity to remove outliers, forming portfolios, and then collecting the residuals of an AR(2) regression that controls for return, volatility, average illiquidity, log of average dollar volume, log of average turnover, and log of one-month lagged market capitalization. Our AR(2) regression has a R^2 is 80% and a standard error of 0.13%. This is very similar to the AP AR(2) regression, which had a R^2 of 78% and a standard error of 0.17%. We plot the innovations in market liquidity in Figure 1. Panel A shows the AP original figure and Panel B shows our replicated figure. Visual inspection suggests that they look very similar.

We use GMM to estimate the cross-sectional regressions that takes into account the pre-estimation of the betas. Standard errors are computed using the Newey and West (1987) method with two lags. Additionally, the GMM method takes serial correlation into account.

3.2 Quantitative vs. Qualitative Replication

In order to demonstrate our degree of success in replication, we show the original results of AP and our replicated results in the same table. As will be obvious momentarily, our replicated tables do not obtain the *identical* numbers as the original tables. Thus, we have not been able to "quantitatively replicate" AP results in the sense that Ivo Welch describes in his editorial in this issue.

However, no published paper in the literature specifies every single detail. And it is very possible that Center for Research in Security Prices (CRSP) and Compustat may have updated/corrected some of the data. So now we turn to the question of whether we can "qualitatively replicate" AP. Specifically, we compare

[7] In 2008, NYSE Euronext acquired AMEX. In 2012, the Intercontinental Exchange acquired NYSE Euronext. Both the NYSE and AMEX are still operated as separate exchanges, but AMEX has been renamed NYSE American.

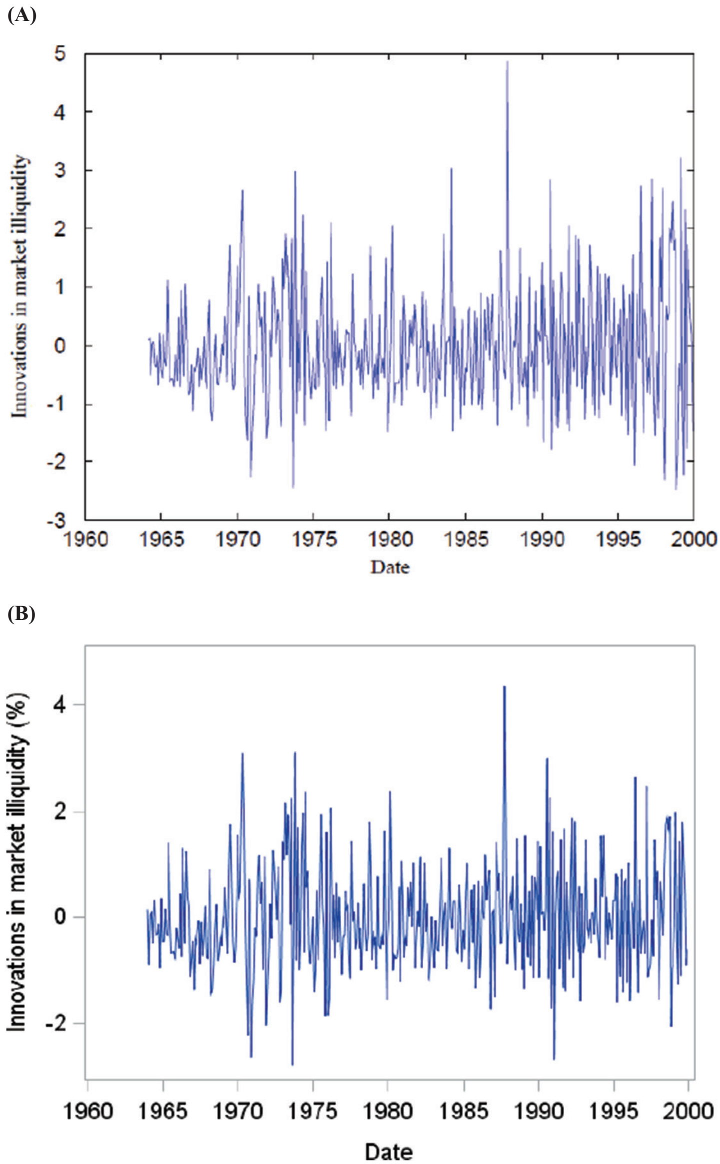

Figure 1: Innovations in Market Illiquidity from 1964 to 1999.

Description: This figure shows the (A) original and (B) replicated version of Acharya and Pedersen (2005).

Interpretation: The replicated innovations in market liquidity in Panel B are very similar to the original innovations in market liquidity in Panel A.

our estimates with the original AP estimates and ask four questions: (1) Do the estimates have the same significant value (e.g., "0") or the same significant sign? (2) Are they of the same order of magnitude? (3) Do they have the same pattern (e.g., monotonically increasing) across portfolios? And (4) do they follow the same pattern of which particular estimates are significant?

3.3 Descriptive and First-Stage Results

Table 1 reports the descriptive properties of the illiquidity portfolios, which corresponds to AP Table 1. Panel A shows the AP original portfolio properties for the odd-numbered portfolios. Panel B shows replicated portfolio properties for the same odd-numbered portfolios from 1962 to 1999. Panel C shows recent portfolio properties for the same odd-numbered portfolios from 2000 to 2015. This table (and the rest of the tables in the replication section) include one, two, or three stars to indicate which variables are significant at the 10%, 5%, and 1% levels, respectively.

Comparing our replicated values of β^{1p}, β^{2p}, β^{3p}, and β^{4p} in the first four columns of Panel B to the original values in Panel A, we find that the portfolio betas have nearly the same statistically significant sign, the same order of magnitude, the same pattern across portfolios (i.e., β^{1p} increases, levels off, and then decreases, β^{2p} monotonically increases, β^{3p} nearly monotonically decreases, and β^{4p} nearly monotonically decreases), and nearly the same pattern of which estimates are significant.[8] Comparing the remaining seven columns of Panel B to Panel A, everything is very similar with roughly the same sign, the same order of magnitude, and the same monotonicity pattern across portfolios. Thus, the portfolio properties are successfully qualitatively replicated for the period 1962 to 1999.

Turning to the recent period of 2000 to 2015, we compare Panel C to Panel A. We find that the portfolio betas have roughly the same signs, same magnitudes, same pattern across portfolios (except for β^{3p} which decreases initially, but then starts increasing), and nearly the same pattern of which estimates are significant. Comparing the remaining seven columns of Panel C to Panel A, everything looks very similar in sign, magnitude, and monotonicity pattern. Thus, the recent period has qualitatively similar properties to the original period.

Table 2 reports the correlations of the four first-stage betas for the illiquidity portfolios, which corresponds to AP Table 2.[9] Panels A, B, and C are the original results, the replicated results for 1962 to 1999, and the recent results for 2000 to 2015, respectively. The replicated beta correlations in Panel B have the same signs and order of magnitudes as the original beta correlations in Panel A. Therefore, the beta correlations are qualitatively replicated for 1962 to 1999.

[8] Following the AP convention, we use a p superscript when the test assets are portfolios and an i superscript when the test assets are individual stocks.

[9] We skip on replicating the beta correlations for *individual stocks* (AP Table 3), since individual stocks are not used in the rest of AP.

	β^{1p} (*100)	β^{2p} (*100)	β^{3p} (*100)	β^{4p} (*100)	$E(c^P)$ (%)	$\sigma(\Delta c^P)$ (%)	$E(r^{e,P})$ (%)	$\sigma(r^P)$ (%)	trn (%)	Size (bl$)	BM
Panel A: Original portfolio properties for 1962 to 1999											
1	55.10***	0.00	−0.80***	−0.00	0.25	0.00	0.48	1.43	3.25	12.50	0.53
3	67.70***	0.00	−1.05***	−0.03	0.26	0.00	0.39	1.64	4.19	2.26	0.72
5	74.67***	0.00	−1.24***	−0.07	0.27	0.01	0.60	1.74	4.17	1.20	0.71
7	76.25***	0.00**	−1.27***	−0.10*	0.29	0.01	0.57	1.83	4.14	0.74	0.73
9	81.93***	0.01***	−1.37***	−0.18***	0.32	0.02	0.71	1.86	3.82	0.48	0.73
11	84.59***	0.01***	−1.41***	−0.33***	0.36	0.04	0.73	1.94	3.87	0.33	0.76
13	85.29***	0.01***	−1.47***	−0.40***	0.43	0.05	0.77	1.99	3.47	0.24	0.77
15	88.99***	0.02***	−1.61***	−0.70***	0.53	0.08	0.85	2.04	3.20	0.17	0.83
17	87.89***	0.04***	−1.59***	−0.98***	0.71	0.13	0.80	2.11	2.96	0.13	0.88
19	87.50***	0.05***	−1.58***	−1.53***	1.01	0.21	0.83	2.13	2.68	0.09	0.92
21	92.73***	0.09***	−1.69***	−2.10***	1.61	0.34	1.13	2.28	2.97	0.06	0.99
23	94.76***	0.19***	−1.71***	−3.35***	3.02	0.62	1.12	2.57	2.75	0.04	1.09
25	84.54***	0.42***	−1.69***	−4.52***	8.83	1.46	1.10	2.87	2.60	0.02	1.15
Panel B: Replicated portfolio properties for 1962 to 1999											
1	62.96***	0.00***	−1.21***	−0.01***	0.25	0.01	0.50	1.67	3.33	13.93	0.61
3	76.35***	0.00***	−1.44***	−0.03***	0.26	0.00	0.44	1.78	4.36	2.42	0.82
5	83.65***	0.00***	−1.72***	−0.08***	0.28	0.01	0.60	1.92	4.43	1.27	0.79
7	84.27***	0.01***	−1.77***	−0.13***	0.31	0.02	0.52	2.00	4.34	0.78	0.79
9	83.50***	0.01***	−1.84***	−0.20***	0.35	0.03	0.58	2.01	3.95	0.49	0.83
11	88.92***	0.01***	−1.85***	−0.34***	0.41	0.05	0.68	2.09	3.93	0.35	0.84
13	90.22***	0.02***	−1.95***	−0.55***	0.50	0.08	0.68	2.14	3.60	0.26	0.87
15	87.86***	0.04***	−1.98***	−0.82***	0.65	0.12	0.73	2.16	3.38	0.20	0.93
17	90.69***	0.07***	−2.13***	−1.24***	0.87	0.18	0.85	2.20	3.27	0.15	0.93
19	87.33***	0.09***	−2.12***	−1.50***	1.22	0.26	1.11	2.23	2.84	0.11	0.91
21	93.76***	0.16***	−2.22***	−2.05***	2.00	0.46	1.05	2.39	2.67	0.09	0.98
23	93.30***	0.25***	−2.40***	−2.50***	3.35	0.79	1.28	2.60	2.92	0.07	0.99
25	87.14***	0.47***	−2.40***	−2.43	6.83	1.46	1.92	3.13	3.31	0.03	1.01

Table 1: Properties of Illiquidity Portfolios.

	β^{1p} (*100)	β^{2p} (*100)	β^{3p} (*100)	β^{4p} (*100)	$E(c^P)$ (%)	$\sigma(\Delta c^P)$ (%)	$E(r^{e,P})$ (%)	$\sigma(r^P)$ (%)	trn (%)	Size (bl$)	BM
Panel C: Recent portfolio properties for 2000 to 2015											
1	55.1***	0.00***	−0.49***	0.00***	0.25	0.00	0.33	1.56	11.10	100.6	0.42
3	70.86***	0.00***	−0.79***	0.00***	0.25	0.00	0.54	1.79	16.94	18.69	0.59
5	81.68***	0.00***	−0.87***	0.00***	0.25	0.00	0.66	1.93	19.27	10.18	0.55
7	88.72***	0.00***	−1.03***	−0.01***	0.25	0.00	0.71	2.03	22.21	5.95	0.56
9	91.9***	0.00***	−1.11***	−0.01***	0.26	0.00	0.82	2.01	21.32	3.88	0.59
11	91.03***	0.00***	−0.90***	−0.02***	0.26	0.00	0.79	2.05	19.89	2.78	0.63
13	89.78***	0.00***	−0.89***	−0.03***	0.26	0.00	0.60	2.14	18.56	2.19	0.60
15	89.36***	0.00***	−0.79***	−0.04***	0.27	0.01	1.14	2.20	17.73	1.63	0.67
17	102.27***	0.00***	−0.97***	−0.08***	0.29	0.01	0.83	2.38	16.33	1.22	0.66
19	109.97***	0.00***	−0.93***	−0.16***	0.33	0.02	0.87	2.47	14.50	0.87	0.69
21	104.33***	0.01***	−0.81***	−0.45***	0.44	0.06	0.92	2.59	11.37	0.54	0.68
23	87.18***	0.02**	−0.79***	−1.02**	1.22	0.30	0.86	2.57	7.18	0.35	0.70
25	70.46***	0.58***	−0.60***	−8.60**	10.68	2.28	1.50	2.41	2.49	0.12	0.88

Table 1: *Continued.*

Description: This table reports the original, replicated, and recent results that correspond to Acharya and Pedersen (2005), Table 1. It reports the properties of the odd-numbered portfolios of 25 value-weighted illiquidity portfolios formed each year during 1964 to 1999. The market beta (β^{1p}) and the liquidity betas (β^{2p}; β^{3p}; and β^{4p}) are computed using all monthly return and illiquidity observations for each portfolio p and for an equal-weighted market portfolio. The standard deviation of a portfolio's illiquidity innovations is reported under the column of $\sigma(\Delta c^P)$. The average illiquidity, $E(c^P)$; the average excess return, $E(r^{e,P})$; the turnover (trn), the market capitalization (size), and book-to-market (BM) are computed for each portfolio as time-series averages of the respective monthly characteristics. Finally, $\sigma(r^P)$ is the average of the standard deviation of daily returns for the portfolio's constituent stocks computed each month. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Interpretation: The replicated illiquidity portfolio betas in Panel B have nearly the same statistically significant sign, the same order of magnitude, the same pattern across portfolios, and nearly the same pattern of which estimates are significant as the original illiquidity portfolio betas in Panel A and the remaining seven columns are also very similar. Thus, the portfolio properties are successfully qualitatively replicated for the period 1962–1999.

	β^{1p}	β^{2p}	β^{3p}	β^{4p}	β^{5p}	$\beta^{Net,p}$
Panel A: Original beta correlations for 1962 to 1999						
β^{1p}	1.000	0.441	−0.972	−0.628		
β^{2p}		1.000	−0.573	−0.941		
β^{3p}			1.000	0.726		
β^{4p}				1.000		
Panel B: Replicated beta correlations for 1962 to 1999						
β^{1p}	1.000	0.417	−0.865	−0.642	0.699	0.994
β^{2p}		1.000	−0.772	−0.840	0.868	0.504
β^{3p}			1.000	0.885	−0.934	−0.91
β^{4p}				1.000	−0.991	−0.722
β^{5p}					1.000	0.773
$\beta^{Net,p}$						1.000
Panel C: Recent beta correlations for 2000 to 2015						
β^{1p}	1.000	−0.330	−0.667	0.340	−0.304	0.990
β^{2p}		1.000	0.464	−0.975	0.975	−0.201
β^{3p}			1.000	−0.462	0.407	−0.631
β^{4p}				1.000	−0.998	0.207
β^{5p}					1.000	−0.170
$\beta^{Net,p}$						1.000

Table 2: Beta Correlations.

Description: This table reports the original, replicated, and recent results that correspond to Acharya and Pedersen (2005), Table 2. It reports the correlations of β^{1p}, β^{2p}, β^{3p}, β^{4p}, β^{5p}, and $\beta^{Net,p}$ for the 25 value-weighted illiquidity portfolios p formed for each year.

Interpretation: The replicated beta correlations in panel B have the same signs and order of magnitudes as the original beta correlations in panel A. Therefore the beta correlations are qualitatively replicated for 1962–1999.

The recent beta correlations in Panel C for 2000 to 2015 have *different* signs and magnitudes compared to the original beta correlations in Panel A for 1962 to 1999. The only explanation that we can find for this is the difference in time period.

In both Panels B and C, we add the correlations of the four portfolio betas with β^{5p} and $\beta^{\text{Net},p}$. In the two panels, we find that the correlations between β^{1p} and $\beta^{\text{Net},p}$ are 0.994 and 0.990. Intuitively, this very high correlation happens, because β^{1p} is so much larger in magnitude than β^{2p}, β^{3p}, and β^{4p}. Hence, β^{1p} very strongly influences the value of $\beta^{\text{Net},p}$. Thus, the correlation between β^{1p} and $\beta^{\text{Net},p}$ is very close to a perfect correlation of 1.00. Importantly, this implies that the AP two-beta LCAPM, which includes both β^{1p} and $\beta^{\text{Net},p}$ as independent variables, faces an *extremely severe* degree of multicollinearity. In the two panels, we find that the correlations between β^{1p} and β^{5p} are 0.699 and −0.304. The first correlation raises concern about multicollinearity, but the second correlation is much less concerning. This suggests that the Lee two-beta LCAPM, which includes both β^{1p} and β^{5p} as independent variables, sometimes faces significant multicollinearity. Taking the absolute value of the six correlations between different pairs of β^{1p}, β^{2p}, β^{3p}, and β^{4p}, we find that average absolute value of these six correlations are 0.737 and 0.540, which are also pretty high. This suggests that the four-beta LCAPM faces significant multicollinearity.

3.4 Common Format of the Second-Stage Tests

Next, we provide eight tables (Tables 3 and A1 to A7) that report second-stage tests. These eight tables follow the same variations of tests assets, portfolio weightings, and added factors as AP. All eight tables have a common format and are presented in the same order as AP.[10] In each table, Panel A provides the original AP results for 1962 to 1999, Panel B provides our replicated results for 1962 to 1999, and Panel C provides our recent results (still following the AP methodology) for the period 2000 to 2015. Each panel contains at least eight cross-sectional regressions labeled as lines 1 to 8 in the left-most column. In order they are:

(1) One-beta LCAPM with a *calibrated* expected cost term (in gray shading),[11]

(2) One-beta LCAPM with an *estimated* expected cost term,

(3) CAPM,

(4) AP two-beta LCAPM with a *calibrated* expected cost term (in gray shading),

(5) AP two-beta LCAPM with an *estimated* expected cost term,

(6) AP two-beta LCAPM with *no* expected cost term,

(7) Four-beta LCAPM with a *calibrated* expected cost term (in gray shading), and

(8) Four-beta LCAPM with an *estimated* expected cost term.

[10] Specifically, Table 3 is based on illiquidity portfolios (AP Table 4A). Table A1 is based on portfolios sorted by the standard deviation of liquidity (AP Table 4B). Table A2 is based on equally-weighted illiquidity portfolios and an equally-weighted market portfolio (AP Table 5A). Table A3 is based on value-weighted illiquidity portfolios and a value-weighted market portfolio (AP Table 5B). Table A4 is based on size portfolios (AP Table 6A). Table A5 is based on portfolios sorted first by book/market and then sorted by size (AP Table 6B). Table A6 is the same as Table 3, except that it adds size and book-to-market factors (AP Table 7A). Table A7 is the same as Table A5, except that it adds size and book-to-market factors (AP Table 7B).

[11] For the three cross-sectional regressions with a *calibrated* expected cost term, there is no analog of the Chalmers and Kadlec (1998) study for the 2000 to 2015 period. In the absence of a straight-forward way to apply the AP methodology to recalibrate the expected cost value for the 2000 to 2015 period, we simply reuse the 1962 to 1999 expected cost value. Although we include the three regressions with a *calibrated* expected cost for completeness, we ignore them in interpreting the LCAPM results. That is, we only interpret the regressions with *estimated* expected cost terms in analyzing the degree of success of the LCAPM.

We have added two more regressions to Panels B and C. They are:

(9) Mean liquidity cost CAPM with an *estimated* expected liquidity cost term and

(10) Lee two-beta LCAPM with an *estimated* expected cost term.

Panel D decomposes the source of the R^2 gain in going from the CAPM to the LCAPM. Specifically, it divides the R^2 gain into what is attributable to the Amihud and Mendelson-type mean liquidity cost term vs. what is attributable to the LCAPM liquidity risk term.

All of the cross-sectional regressions in this section are based on 25 portfolios. Since the sample size is 25 in each case, we focus our analysis on the 10% level of significance for all tables. Specifically, the two-tailed (one-tailed) t-test with 25 observations has a critical value of 1.708 (1.316).

3.5 Second-Stage Tests Based On Illiquidity Portfolios

Table 3 reports second-stage tests based on 25 illiquidity portfolios. Panels A, B, and C are the original results, the replicated results for 1962 to 1999, and the recent results for 2000 to 2015, respectively. Nearly all of the R^2 in the three panels range from 0.65 to 0.95, which is what we would expect with *portfolios* where most of the idiosyncratic variation has been diversified away.

We start with the question of how well Panel B replicates Panel A. Examining the intercept (α) column for lines 1 to 8, four are significantly different from zero in Panel B vs. one in Panel A. Considering all of the rest of *estimated* coefficients (i.e., excluding the *calibrated* coefficients with gray shading) in lines 1 to 8, 16 are significant in Panels B vs. five in Panel A. Considering the magnitude of the estimated coefficients for expected liquidity ($E(c^P)$), the absolute value of Panel B coefficients average 6.7 times larger than the absolute value of Panel A coefficients. Next, consider *which* of the non-intercept coefficients are significant at the 10% level. 50% of these coefficients have the same significance pattern in both Panels A and B (i.e., both are significant or both are not), but 50% are different. In summary, we find major differences in *how many* estimates are significant, large differences in magnitude of the expected liquidity coefficients, and a low similarity in *which* estimates are significant. We conclude that the second-state tests are *not* qualitatively replicated.

Next, we turn to the key question of whether the main predictions of four different versions of the LCAPM are true and apply our strict criteria that *all* of the main predictions need to be true simultaneously.[12] First consider the one-beta LCAPM on line 2. In both Panels B and C, $\beta^{\mathrm{net},p}$ is priced (i.e., significant in the

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[12] More specifically, in the replication section we test all of the main predictions excluding hypotheses 7 ($\lambda^1 = \lambda^5$) and hypothesis 10 ($\lambda^1 = \lambda^2 = -\lambda^3 = -\lambda^4$). In the extension section, we test all of the main predictions including hypotheses 7 and 10.

	α	$E(c^p)$	β^{1p}	β^{2p}	β^{3p}	β^{4p}	$\beta^{Net,p}$	β^{5p}	R^2
Panel A: Original illiquidity portfolio results for 1962 to 1999									
1	−0.556	0.034					1.512**		0.732
2	−0.512	0.042**					1.449***		0.825
3	−0.788*		1.891***						0.653
4	−0.333	0.034	−3.181				4.334		0.843
5	0.005	−0.032	−13.223*				13.767**		0.878
6	−0.160		−8.322**				9.164***		0.870
7	−0.089	0.034	0.992	−153.369	7.112	−17.583*			0.881
8	−0.089	0.033	0.992	−151.152	7.087	−17.542			0.881
Panel B: Replicated illiquidity portfolio results for 1962 to 1999									
1	−1.207**	0.034					2.217***		0.347
2	−0.124	0.194***					0.776***		0.928
3	−1.308**		2.457***						0.245
4	0.758*	0.034	−25.443***				24.613***		0.786
5	0.108	0.170***	−5.084				5.465		0.932
6	0.921**		−30.524***				29.393***		0.793
7	0.232	0.034	−0.153	184.933***	−26.346	−0.540			0.897
8	0.143	0.683***	−0.759	−801.838	−50.842*	−16.122**			0.949
9	−0.141	0.198***	0.816***						0.927
10	0.108	0.170***	0.381					5.465	0.932
Panel C: Recent illiquidity portfolio results for 2000 to 2015									
1	−0.317	0.034					1.104***		0.357
2	−0.038	0.084***					0.865***		0.705
3	0.477		0.385						0.053
4	−0.034	0.034	7.480***				−6.560		0.692
5	−0.074	−0.003	−9.785				10.606***		0.730
6	−0.073		−9.456				10.278***		0.730
7	−0.078	0.034	0.891***	−258.414	0.769	−9.051***			0.767
8	−0.039	0.046	0.898***	−86.783	2.554	−10.954***			0.734
9	−0.026	0.092***	0.860***						0.700
10	−0.074	−0.003	0.821***					10.606***	0.730

Panel D: R^2 decomposition

	One-Beta LCAPM		*Lee 2-Beta LCAPM*		*Four-Beta LCAPM*	
	$E(c^p)$	$\beta^{Net,p}$	$E(c^p)$	$\beta^{5,p}$	$E(c^p)$	$Liq.\beta$'s
1962 to 1999	0.682	0.001	0.682	0.005	0.682	0.022
2000 to 2015	0.646	0.005	0.646	0.030	0.646	0.034

Table 3: Tests for Illiquidity Portfolios.

Description: This table reports the original, replicated, and recent results that correspond to Acharya and Pedersen (2005), Table 4, Panel A. It reports the estimated coefficients from cross-sectional regressions of the liquidity-adjusted CAPM for 25 value-weighted illiquidity portfolios p using monthly data with an equal-weighted market portfolio. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Interpretation: In eight cases (four LCAPM versions X 2 panels), the main LCAPM predictions all hold true in four cases and two of these four cases are based on the one-beta LCAPM, which is difficult to empirically distinguish from the mean liquidity cost CAPM. Further, nearly all of R^2 gain is due to the Amihud and Mendelson-type mean liquidity cost term and very little is due to LCAPM liquidity risk.

direction of the predicted sign). Next consider the AP two-beta LCAPM on line 5. In Panel B, β^{1p} is insignificantly different from zero (as the LCAPM predicts), but $\beta^{\text{net},p}$ is not priced. In Panel C, β^{1p} is insignificantly different from zero and $\beta^{\text{net},p}$ is priced. Now turn to the Lee two-beta LCAPM on line 10. In Panel B, β^{1p} is not priced and β^{5p} is not priced. In Panel C, β^{1p} is priced and β^{5p} is priced. Finally, consider the four-beta LCAPM on line 8. In Panel B, β^{1p} and β^{2p} are not priced, but β^{3p} and β^{4p} are priced. In Panel C, β^{2p} and β^{3p} are not priced, but β^{1p} and β^{4p} are priced. In summary, out of eight cases (four LCAPM versions X 2 panels), the main LCAPM predictions all hold true in four cases and two of these four cases are based on the one-beta LCAPM, which is difficult to empirically distinguish from the mean liquidity cost CAPM.

Like AP, we find that the LCAPM has a higher R^2 than the CAPM. For example, if you take the one-beta LCAPM R^2 in line 2 and subtract the CAPM R^2 in line 3, you get an R^2 gain of 0.683 in Panel B and of 0.651 in Panel C. Panel D decomposes the source of that R^2 gain into what is attributable to the expected liquidity cost term vs. what is attributable to the net liquidity risk term. This is done by comparing to line 9, which estimates the mean liquidity cost CAPM with an *estimated* mean liquidity cost term. Taking the mean liquidity cost CAPM R^2 in line 9 and subtracting the CAPM R^2 in line 3, we find that adding an expected liquidity cost $(E(c_t^i))$ term yields a large R^2 gain of 0.682 in 1962 to 1999 and 0.646 in 2000 to 2015. Taking LCAPM R^2 in line 2 and subtracting the mean liquidity cost CAPM R^2 in line 9, we find that switching from the CAPM market beta (β^{1i}) to the LCAPM net beta $(\beta^{\text{net},i})$, yields a tiny R^2 gain of just 0.001 in 1962 to 1999 and just 0.005 in 2000 to 2015. Similarly, the R^2 gain from adding β^{5p} to obtain the Lee two-beta LCAPM is small (0.005 and 0.030) and the R^2 gain from adding β^{2p}, β^{3p}, and β^{4p} to obtain the four-beta LCAPM is small (0.022 and 0.034). Thus, we conclude that nearly all of R^2 gain is due to the Amihud and Mendelson-type mean liquidity cost term and very little is due to LCAPM liquidity risk.

In summary, we are not able to qualitatively replicate the second-stage results, in half of the cases the main LCAPM predictions are not true at the same time, and nearly all of R^2 gain is due to the Amihud and Mendelson-type mean liquidity cost term and very little is due to LCAPM liquidity risk.

3.6 Summary of All Second-Stage Tests

Table 4 summarizes the LCAPM prediction success across the eight second-stage tables (i.e., Tables 3 and A1 to A7). Panels A, B, C, and D summarize how frequently the LCAPM predictions (hypotheses) are true[13] for the one-beta, AP two-beta, Lee two-beta, and four-beta LCAPM, respectively.

[13] For any hypothesis that predicts that a coefficient is greater than zero or less than zero, we consider it to be true only when the estimated coefficient has the predicted sign and is significant in a one-tail test at the 10% level. For a hypothesis that predicts a coefficient is equal to zero, we consider it to be true only when the estimated coefficient is insignificantly different from zero in a two-tail test at the 10% level.

		Frequency that the hypotheses are true			R^2 Gain	
		$\alpha = 0$	$\kappa > 0$	$\lambda^{Net} > 0$	$E(c^p)$	$\beta^{Net,p}$
Panel A: Summary of Second-Stage Tests of the One-Beta Version of the LCAPM						
All 24 Cases	#	17	18	20		
	%	70.8%	75.0%	83.3%		
Original 62-99	#	7	6	6		
Replication 62-99	#	3	6	7	0.348	0.007
Recent 00-15	#	7	6	7	0.263	0.003

		Frequency that the hypotheses are true				
		$\alpha = 0$	$\kappa > 0$	$\lambda^1 = 0$	$\lambda^{Net} > 0$	*Both*
Panel B: Summary of Second-Stage Tests of the A.P. Two-Beta Version of the LCAPM						
All 24 Cases	#	21	10	14	9	4
	%	87.5%	41.7%	58.3%	37.5%	16.7%
Original 62-99	#	8	1	3	5	1
Replication 62-99	#	6	7	4	2	1
Recent 00-15	#	7	2	7	2	2

		Frequency that the hypotheses are true					R^2 Gain	
		$\alpha = 0$	$\kappa > 0$	$\lambda^1 > 0$	$\lambda^5 > 0$	*Both*	$E(c^p)$	$\beta^{5,p}$
Panel C: Summary of Second-Stage Tests of the Lee Two-Beta Version of the LCAPM								
All 16 Cases	#	13	8	11	5	4		
	%	81.3%	50.0%	68.8%	31.3%	25.0%		
Replication 62-99	#	6	6	4	2	1	0.348	0.046
Recent 00-15	#	7	2	7	3	3	0.263	0.022

		Frequency that the hypotheses are true							R^2 Gain	
		$\alpha = 0$	$\kappa > 0$	$\lambda^1 > 0$	$\lambda^2 > 0$	$\lambda^3 < 0$	$\lambda^4 < 0$	*All Four*	$E(c^p)$	*Liq.* $\beta's$
Panel D: Summary of Second-Stage Tests of the Four-Beta Version of the LCAPM										
All 24 Cases	#	19	8	10	0	5	8	0		
	%	79.2%	33.3%	41.7%	0.0%	20.8%	33.3%	0.0%		
Original 62-99	#	8	0	2	0	1	0	0		
Replication 62-99	#	4	5	2	0	4	4	0	0.348	0.055
Recent 00-15	#	7	3	6	0	0	4	0	0.263	0.076

Table 4: Summary of LCAPM Prediction Success.

Description: This table summarizes the frequency that LCAPM hypotheses are true and the decomposition of the R-squared for different versions of the second-stage tests of the LCAPM. The replication and recent tests follow the original Acharya and Pedersen (2005) methodology, which uses 25 portfolios as test assets. All hypotheses are tested at the 10% level of significance based on 25 observations. The results summarized here are based on eight different sets of test assets, portfolio weightings, and added factors. The table-by-tables results are reported in Tables 3 and A1–A7.

Interpretation: For the AP two-beta, Lee two-beta, and four-beta LCAPMs, we do not support that the main LCAPM predictions are true at the same time in the large majority of cases. Further, nearly all of R^2 gain is due to the Amihud and Mendelson mean-type liquidity cost term and very little is due to LCAPM liquidity risk.

Panel A summarizes the frequency that three hypotheses of the one-beta LCAPM are true. It is based on line 2 in (eight tables) times (three panels each) for a total of 24 cases. The first row summarizes our findings that the hypothesis $\alpha = 0$ is true in 70.8% of the cases (i.e., in 17 times out of 24 cases), $\kappa > 0$ is true in 75.0%, and $\lambda^{\text{Net}} > 0$ in 83.3%. On the surface, these results appear to be supportive of the LCAPM. However, recall that the one-beta LCAPM doesn't provide a very sharp separation between the LCAPM and the mean liquidity cost CAPM.

Panel B summarizes the frequency that four hypotheses of the AP two-beta LCAPM are true. It is based on line 5 in (eight tables) times (three panels each) for a total of 24 cases. Focusing on the main hypotheses, we find that $\lambda^1 = 0$ is true in 58.3% of the cases and $\lambda^{\text{Net}} > 0$ in 31.3%. Given the extremely severe multicollinearity between β^{1p} and $\beta^{\text{Net}.p}$, it is not surprising that λ^1 and λ^{Net} frequently have opposite signs. So importantly we consider how often *both* of the main hypotheses, $\lambda^1 = 0$ and $\lambda^{\text{Net}} > 0$, are true at the same time. This happens in only 16.7% of cases. Thus, the AP two-beta CAPM is not supported 83.3% of the time.

Panel C summarizes the frequency that four hypotheses of the Lee two-beta LCAPM are true. It is based on line 10 in (eight tables) times (two panels each) for a total of 16 cases. We find that $\lambda^1 > 0$ is true in 68.8% of the cases and $\lambda^5 > 0$ in 31.3%. Given that sometimes there is significant multicollinearity between β^{1p} and β^{5p}, it is important to consider how often *both* of the main hypotheses, $\lambda^1 > 0$ and $\lambda^5 > 0$, are true at the same time. This happens in only 25.0% of cases. Thus, the Lee two-beta CAPM is not supported 75.0% of the time.

Panel D summarizes the frequency that six hypotheses of the four-beta LCAPM are true. It is based on line 8 in (eight tables) times (three panels each) for a total of 24 cases. We find that $\lambda^1 > 0$ is true in 41.7% of the cases and the three liquidity betas are priced in 0.0%, 20.8%, and 33.3%, respectively. Given significant multicollinearity between the four portfolio betas, it is important to consider how often all four lambda predictions are true at the same time. This happens 0.0% of cases. Thus, the four-beta LCAPM is not supported 100% of the time.

Finally, we turn to the R^2 decomposition. In Panel A, we find that adding an expected liquidity cost term yields a large R^2 gain (0.348 and 0.263), whereas switching from the CAPM β^{1p} to the LCAPM $\beta^{\text{Net},p}$ yields a tiny R^2 gain (0.007 and 0.003). Similarly in Panel C, the R^2 gain from adding β^{5p} to obtain the Lee two-beta LCAPM is small (0.046 and 0.022) and in Panel D, the R^2 gain from adding three separate liquidity betas to obtain the four-beta LCAPM is small (0.055 and 0.076). Thus, we conclude that nearly all of R^2 gain is due to the Amihud and Mendelson-type mean liquidity cost term and very little is due to LCAPM liquidity risk.

In summary, we obtain frequent support for the LCAPM predictions that $\alpha = 0$ and for $\kappa > 0$. However, for AP two-beta, Lee two-beta, and four-beta LCAPMs, we do not support that the main LCAPM predictions are true at the same time in the large majority of cases. Further, nearly all of R^2 gain is due to the Amihud and Mendelson mean-type liquidity cost term and very little is due to LCAPM liquidity risk.

4 Extension Tests of the LCAPM

4.1 Extension Methodology and Data

In this section, we extend tests of the unconditional LCAPM using the Lee (2011) methodology and expand to: (1) cover 90 years, (2) add NASDAQ stocks, (3) use four alternative liquidity measures, and (4) add risk or characteristic factors. Lee's methodology is founded on the Fama-MacBeth (1973) approach. Fama-MacBeth allows the beta parameters to evolve over rolling estimation windows and avoids errors-in-variables problems in estimating the betas. Lee's methodology also uses individual stocks as the test assets (as opposed to portfolios), which provides greater statistical power due to a larger number of observations in each cross-sectional regression. Lee's innovative methodology has three-stages. In the first-stage, it involves computing pre-ranking betas from monthly returns in years $t-5$ to $t-1$. Then individual stocks are one-dimensionally sorted in 10 portfolios based on pre-ranking beta. Next in the second-stage, post-ranking betas are computed for the 10 portfolios in year t. In order to minimize noise in beta estimation, the portfolio betas are assigned to the individual stocks. Then in the third-stage, cross-sectional regressions are run for each month across the individual stocks in the year $t+1$. Finally, the whole process is rolled forward by a year and this continues throughout the time period. We report the average results of the cross-sectional regressions over a given time period.

Stock return data covering 1926 to 2015 comes from the CRSP. The book equity value data for the periods 1961 to 2015 comes from Compustat. For the pre-Compustat period 1926 to 1961, we use the book equity value data reported in Moody's Industrial, Public Utility, Transportation, and Bank and Finance Manuals, which is available on Ken French's web site. The Fama and French risk factors are also obtained from Ken French's web site.

We divide the 90-year period from 1926 to 2015 into three periods: 1926 to 1961, 1962 to 1999, and 2000 to 2015. These three time periods correspond to before, during, and after the time period studied by AP. We also study NASDAQ-listed as a separate sample from the NYSE- and AMEX-listed stocks that Acharya and Pedersen studied. Since NASDAQ didn't exist in the before period, we have five combinations of time period and exchange. The data for the NASDAQ-listed stocks begins in 1971.

Table 5 provides descriptive statistics and first-stage beta correlations for the extension sample. Panel A provides the descriptive statistics for five period-exchange combinations. The average number of stocks in the cross-section ranges from 644 to 2,180. Based on this large sample size, all statistical tests in the extension section are based on the 1% level of significance. Monthly turnover for

	NYSE-AMEX 1926 to 1961	**NYSE-AMEX 1962 to 1999**	**NYSE-AMEX 2000 to 2015**	**NASDAQ 1973 to 1999**	**NASDAQ 2000 to 2015**
Panel A: Descriptive statistics					
Average Number of Stocks	644	1,800	1,454	2,180	1,864
Std Dev of Ret (%)	8.65	5.45	5.15	5.50	5.94
Size (in $million)	114.51	1209.16	7855.53	374.78	2076.74
Volume (in $million)	24.69	659.80	11954.45	377.79	4823.51
Average Monthly Turnover	2.58%	3.72%	14.43%	11.31%	25.97%

	$\boldsymbol{\beta^{1i}}$	$\boldsymbol{\beta^{2i}}$	$\boldsymbol{\beta^{3i}}$	$\boldsymbol{\beta^{4i}}$	$\boldsymbol{\beta^{5i}}$	$\boldsymbol{\beta^{Net,i}}$
Panel B: Beta correlations for NYSE-AMEX in 1925 to 1961						
β^{1i}	1.000	0.203	−0.601	−0.308	0.400	0.998
β^{2i}		1.000	−0.190	−0.293	0.358	0.220
β^{3i}			1.000	0.242	−0.408	−0.610
β^{4i}				1.000	−0.983	−0.364
β^{5i}					1.000	0.455
$\beta^{Net,i}$						1.000
Panel C: Beta correlations for NYSE-AMEX in 1962 to 1999						
β^{1i}	1.000	0.203	−0.715	−0.308	0.424	0.999
β^{2i}		1.000	−0.253	−0.284	0.339	0.213
β^{3i}			1.000	0.280	−0.454	−0.721
β^{4i}				1.000	−0.982	−0.344
β^{5i}					1.000	0.459
$\beta^{Net,i}$						1.000
Panel D: Beta correlations for NYSE-AMEX in 2000 to 2015						
β^{1i}	1.000	−0.038	−0.355	−0.192	0.226	1.000
β^{2i}		1.000	0.013	0.188	−0.186	−0.038
β^{3i}			1.000	0.071	−0.178	−0.355
β^{4i}				1.000	−0.994	−0.193
β^{5i}					1.000	0.228
$\beta^{Net,i}$						1.000
Panel E: Beta correlations for NASDAQ in 1973 to 1999						
β^{1i}	1.000	0.108	−0.624	−0.283	0.492	0.976
β^{2i}		1.000	−0.034	−0.182	0.388	0.181
β^{3i}			1.000	0.133	−0.468	−0.660
β^{4i}				1.000	−0.906	−0.462
β^{5i}					1.000	0.663
$\beta^{Net,i}$						1.000

Table 5: Extension Descriptive Statistics and Beta Correlations for Five Period-Exchange Combinations.

		NYSE-AMEX 1926 to 1961	NYSE-AMEX 1962 to 1999	NYSE-AMEX 2000 to 2015	NASDAQ 1973 to 1999	NASDAQ 2000 to 2015
Panel F: Beta correlations for NASDAQ in 2000 to 2015						
β^{1i}	1.000	−0.324	−0.075	−0.388	0.372	1.000
β^{2i}		1.000	0.031	0.658	−0.515	−0.330
β^{3i}			1.000	0.044	−0.249	−0.078
β^{4i}				1.000	−0.965	−0.400
β^{5i}					1.000	0.385
$\beta^{Net,i}$						1.000

Table 5: *Continued*.

Description: Descriptive Statistics and Beta Correlation by three time periods (25-61, 62-99, 00-15) and two exchanges (NYSE-AMEX and NASDAQ).

Interpretation: Low average absolute value of the correlations between the four betas (Lee two betas) suggests that there is no multicollinearity issue for the four-beta (Lee two-beta) LCAPM in the extended sample based on individual stocks. However, extremely high average absolute value of the correlations between AP two betas suggests extremely high multicollinearity for the AP two-beta LCAPM in the extended sample.

a given stock in a given month is computed as the dollar trading volume of that month divided by the dollar value of shares outstanding at the beginning of the month. Average monthly turnover for a period-exchange is the equally-weighted average of monthly turnover across all stocks on an exchange and all months in the period. Average monthly turnover has increased over time for the three periods examined.

Panels B to F provide first-stage, individual stock beta correlations for five period-exchange combinations. Generally speaking the correlations between the four betas are relatively modest. Taking the absolute value of the six correlations between different pairs of β^{1i}, β^{2i}, β^{3i}, and β^{4i} and averaging the absolute value of these six correlations over all five panels, we find an average absolute value of 0.254 for the extended sample.[14] This suggests that there is no multicollinearity issue for the four-beta LCAPM in the extended sample, which is likely due to the fact that the extension sample uses individual stocks as test assets.

Next, we average the correlations between β^{1i} and $\beta^{\mathrm{Net},i}$ across all five panels and find an average correlation of 0.995. Again, intuitively this is because that β^{1i} strongly dominates the three other betas in determining the value of $\beta^{\mathrm{Net},i}$ and so the correlation is close to 1.00. As before with the replication sample, we conclude that the AP two-beta LCAPM, which includes both β^{1i} and $\beta^{\mathrm{Net},i}$ as independent variables, faces an *extremely severe* degree of multicollinearity.

Finally, we average the correlations between β^{1i} and β^{5i} across all five panels and find an average correlation of 0.383. This suggests that the Lee two-beta

[14]Throughout the extension section, the i superscript indicates that individual stocks are the test assets.

LCAPM, which includes both β^{1p} and β^{5p} as independent variables, faces minimal multicollinearity.

We test four alternative liquidity proxies based on the results of Fong *et al.* (2017). They study both percent-cost liquidity measures, which measure small trade transaction costs as a percentage of the price, and cost-per-dollar-volume liquidity measures, which capture the marginal transaction costs per dollar of volume. Specifically, they test all low-frequency liquidity proxies that had been developed to see how well they capture high-frequency liquidity benchmarks on a global basis. They find that Closing Percent Quoted Spread is the best monthly percent-cost proxy when available. Unfortunately, the daily bid and ask prices needed to compute it are only available for NYSE/AMEX stocks from 1926 to 1941 and 1993-present and for NASDAQ stocks over the life of the exchange. They find that the next best monthly percent-cost proxy is the High–Low proxy. Fortunately, the daily high and low prices needed to compute it are available from 1926-present. They also find that the Amihud proxy is tied as one of the best monthly cost-per-dollar-volume proxies. We test these three liquidity proxies plus the zeros proxy. They find that the zeros proxy does not perform as well as others, but we include it here in order to facilitate comparisons with Lee (2011) that uses zeros.

The first liquidity proxy that we test the High–Low measure developed by Corwin and Schultz (2012) as a proxy for the percent effective spread. It is computed as follows

$$\text{High} - \text{Low} = \text{Average}\left(\frac{2(e^{\alpha_t} - 1)}{1 + e^{\alpha_t}}\right), \tag{9}$$

where $\alpha_t = \frac{\sqrt{2\beta_t} - \sqrt{\beta_t}}{3 - 2\sqrt{2}} - \sqrt{\frac{\gamma_t}{3 - 2\sqrt{2}}}$, β_t is the sum over 2 days of the squared daily log(high price/low price), and γ_t is the squared log(high price/low price) where the high (low) price is over 2 days.

The second liquidity proxy we test is the Closing Percent Quoted Spread developed by Chung and Zhang (2014). It is computed as follows

$$\begin{aligned}&\text{Closing Percent Quoted Spread}\\ &\quad = \text{Average}\left(\frac{\text{Closing Ask}_t - \text{Closing Bid}_t}{(\text{Closing Ask}_t + \text{Closing Bid}_t)/2}\right).\end{aligned} \tag{10}$$

The third liquidity proxy we test is the Amihud proxy developed by Amihud (2002). It is computed as follows

$$\text{Amihud} = \text{Average}\left(\frac{|r_t|}{\text{Dollar Volume}_t}\right), \tag{11}$$

where the average is computed over positive volume days only and where r_t is the stock return on day t and Dollar Volume$_t$ is the US dollar value, in millions, of volume on day t.

The fourth liquidity proxy we test is the Zeros proxy developed by Lesmond *et al.* (1999). It is computed as follows

$$\text{Zeros} = \frac{\text{ZRD}}{\text{TD} + \text{NTD}}, \tag{12}$$

where ZRD is the number of zero returns days, TD is the number of trading days, and NTD is the number of no-trade days in a given stock-month.

4.2 Extension Tests by Five Period-Exchange Combinations

Table 6, Panels A to E report the base case cross-sectional regression results for five period-exchange combinations. Each panel contains five cross-sectional regressions labeled 1 to 5 in the left-most column. In order they are: (1) CAPM, (2) mean liquidity cost CAPM, (3) one-beta LCAPM, (4) Lee two-beta LCAPM, and (5) four-beta LCAPM. The liquidity measure is the High–Low proxy of Corwin and Schultz (2012). Stars are added to indicate significance at the 1% level.

Starting with the R^2 columns in Panels A to E, we see values ranging from 0.02 to 0.08. This lower range is what we would expect for regressions based on *individual stock* returns, where idiosyncratic shocks cause much of the variation.

Next, we examine line 4, which is the Lee two-beta LCAPM that will allow us to test several hypotheses. First, we look at the α estimate on line 4 of Panels A to E. We see that this coefficient is significantly different from zero in zero times out of five regressions, which supports the prediction that the intercept is zero. Second, we look the $E(c^i)$ coefficient in line 4 and see that it is significantly greater than zero in one time out of five cases, which largely fails to support the prediction that it is priced. Third, we look at β^{1i} coefficient in line 4 and observe that it is significantly greater than zero in zero times out of five, which fails to support the prediction that it is priced. Fourth, we look at the β^{5i} coefficient in line 4 and see that it is significantly greater than zero in zero times out of five, which fails to support the prediction that it is priced.

Next, we examine line 5, which is the four-beta LCAPM that will allow us to test several hypotheses. The intercept coefficient in line 5 of Panels A to E is never significantly from zero, which supports the prediction that the intercept is zero. The expected liquidity cost coefficient is significant one time out of five, which mostly fails to support the prediction that it is priced. The market beta coefficient is never significant, which fails to support the prediction that it is priced. The β^{2i} and β^{4i} coefficients are never significant and the β^{3i} coefficient is significant one time out of five, which mostly fails to support the prediction that they are priced.

Panel F reports likelihood ratio tests (LRT) for the Lee two-beta or four-beta LCAPM with the restriction(s) that lambda coefficients are equal in absolute value and have the predicted signs against the analogous unrestricted LCAPM. For the Lee two-beta LCAPM, the first column reports the p-value of the Chi-squared statistic that the restriction $\lambda^1 = \lambda^5$ is true. We find that this restriction is always not supported. Thus, the Lee two-beta LCAPM is not supported 100% of the time. For the four-beta LCAPM, the second column reports the p-value of the Chi-squared statistic that all of the restrictions $\lambda^1 = \lambda^2 = -\lambda^3 = -\lambda^4$ are true. We find that this restriction is always not supported. Thus, the four-beta LCAPM is not supported 100% of the time.

In summary, our base case extension results always fails to support the main Lee two-beta and four-beta LCAPM predictions in each of the five period-exchange combinations.

	α	$E(c^i)$	β^{1i}	β^{2i}	β^{3i}	β^{4i}	$\beta^{Net,i}$	β^{5i}	R^2
Panel A: 1926 to 1961 NYSE-AMEX									
1	0.311		0.865						0.056
2	0.304	0.012	0.836						0.069
3	0.305	0.012					0.825		0.069
4	0.305	0.011	0.864					−1.554	0.073
5	0.412	0.012	0.798	−2.654	−28.546*	14.779			0.080
Panel B: 1962 to 1999 NYSE-AMEX									
1	0.477		0.268						0.030
2	0.465	0.014	0.182						0.036
3	0.474	0.014					0.171		0.035
4	0.428	0.015	0.206					−7.174	0.038
5	0.196	0.011	0.135	38.679	1.681	10.993			0.042
Panel C: 2000 to 2015 NYSE-AMEX									
1	0.615		0.558						0.032
2	0.604	−0.001	0.546						0.043
3	0.684	−0.001					0.511		0.043
4	0.462	−0.001	0.666					−0.419	0.046
5	0.691	0.001	0.659	−4.988	−0.725	1.503			0.051
Panel D: 1973 to 1999 NASDAQ									
1	−36.550		40.754						0.050
2	−1.317	0.011	1.773						0.023
3	−1.101	−0.108					2.460		0.020
4	−0.333	0.045*	0.685					0.462	0.025
5	−0.303	0.044*	0.679	0.211	−15.239	−0.403			0.029
Panel E: 2000 to 2015 NASDAQ									
1	1.048*		0.084						0.034
2	0.848	0.029	−0.061						0.041
3	0.838	0.028					−0.044		0.041
4	1.162	0.029	−0.171					3.121	0.043
5	1.094	0.030	−0.248	3.034	−4.503	0.201			0.048

Table 6: Extension Tests by Five Period-Exchange Combinations.

	Lee Two-beta LCAPM: $\lambda^1 = \lambda^5$	Four-beta LCAPM: $\lambda^1 = \lambda^2 = -\lambda^3 = -\lambda^4$
Panel F: Likelihood Ratio Tests for Equal Absolute Value and Predicted Sign of Lambdas		
1926 to 1961 NYSE-AMEX	0.418*	0.326*
1962 to 1999 NYSE-AMEX	0.361*	0.204*
2000 to 2015 NYSE-AMEX	0.333*	0.179*
1973 to 1999 NASDAQ	0.303*	0.064*
2000 to 2015 NASDAQ	0.401*	0.157*

Table 6: *Continued.*

Description: This table reports five cross-sectional regressions in each panel: (1) CAPM, (2) adding an expected liquidity cost ($E(c^i)$), (3) one-beta LCAPM, (4) two-beta LCAPM, and (5) four-beta LCAPM. Each panel is based on a different combination of time periods and exchanges. In all cases, the liquidity measure is High-Low. Following Lee (2011) and Fama-MacBeth (1973), the pre-ranking betas are computed from monthly returns in years $t-5$ to $t-1$, then individual stocks are sorted in 10 portfolios based on pre-ranking betas, then in the second stage post-ranking betas are computed for the 10 portfolios in year t, then these betas are assigned to the individual stocks, then in the third stage the seven cross-sectional regressions are run across each individual stock i, and the whole process is rolled forward each year during the time period. * means significant at the 1% level.

Interpretation: The base case extension tests always fail to support the main Lee two-beta and four-beta LCAPM predictions in each of the five period-exchange combinations.

4.3 Extension Tests Using Alternative Liquidity Measures

Table 7 reports extension tests of the Lee two-beta LCAPM using alternative liquidity measures. For convenience in comparison, Panel A repeats the line 4 results from Table 6 based on the High–Low liquidity measure. Panels B, C, and D report analogous Lee two-beta LCAPM results based on three other liquidity measures: closing percent quoted spread, Amihud, and zeros, respectively.

The first five columns of Table 7 allow us to test five hypotheses. First, looking down the α column of Panels A to D, we see that this coefficient is significantly different from zero in one time out of twenty cases, which supports the prediction that the intercept is zero. Second, the $E(c^i)$ coefficient is significant four times out of twenty (20%), which largely fails to support the prediction that it is priced. Third, the β^{1i} coefficient is significant zero times out of twenty, which fails to support the prediction that it is priced. Fourth, the net liquidity beta β^{5i} coefficient is significant one time out of twenty (5%), which largely fails to support the prediction that it is priced. Fifth, the p-value of the Chi-squared statistic that the LRT that $\lambda^1 = \lambda^5$ is always not supported. Thus, the Lee two-beta LCAPM is not supported 100% of the time. The last two columns report the R^2 gain decomposition of what is attributable to the $E(c^i)$ term vs. what is attributable to β^{5i}. The R^2 gain from the $E(c^i)$ term is positive in nearly all cases and averages 0.004 over all twenty cases. The β^{5i} term yields a R^2 gain of zero in nearly all cases and averages 0.000 over all twenty cases. Thus, all of R^2 gain is due to the

Period-Exchange	α	$E(c^i)$	β^{1i}	β^{5i}	$\lambda^1 = \lambda^5$	R^2 Gain $E(c^i)$	R^2 Gain $\beta^{5,i}$
Panel A: High-Low							
26-61 NY-AM	0.305	0.011	0.864	−1.554	20.4%*	0.013	0.000
62-99 NY-AM	0.428	0.015	0.206	−7.174	11.6%*	0.006	−0.001
00-15 NY-AM	0.462	−0.001	0.666	−0.419	7.2%*	0.011	0.000
73-99 NASDAQ	−0.333	0.045*	0.685	0.462	6.0%*	−0.027	−0.003
00-15 NASDAQ	1.162	0.029	−0.171	3.121	13.4%*	0.007	0.000
Panel B: Closing Percent Quoted Spread							
26-61 NY-AM	0.193	−0.086	1.017	−5.687	25.4%*	0.017	0.000
62-99 NY-AM	0.341	−0.076	0.332	−12.068	6.1%*	0.010	0.000
00-15 NY-AM	−0.130	0.069	0.543	−5.445	9.4%*	0.020	0.000
73-99 NASDAQ	−0.088	0.071	0.635	0.710	22.3%*	−0.023	0.000
00-15 NASDAQ	0.962	0.127	−0.245	1.976	13.9%*	0.012	0.000
Panel C: Amihud							
26-61 NY-AM	0.509	0.002	0.779	2.799	17.5%*	0.012	0.001
62-99 NY-AM	0.667*	0.183*	0.119	7.191*	6.1%*	0.006	0.000
00-15 NY-AM	0.421	5.601	0.412	−699.333	11.9%*	0.006	0.000
73-99 NASDAQ	−0.004	−0.009	1.335	−0.934	21.5%*	−0.027	0.000
00-15 NASDAQ	0.754	0.278	0.171	−102.367	23.1%*	0.002	0.000
Panel D: Zeros							
26-61 NY-AM	0.146	0.009	0.982	−2.552	23.2%*	0.009	0.000
62-99 NY-AM	0.014	0.013*	0.509	2.926	16.7%*	0.005	0.000
00-15 NY-AM	0.434	0.027*	0.459	1.005	27.4%*	0.002	0.000
73-99 NASDAQ	−0.506	0.005	0.940	0.842	16.3%*	0.023	−0.004
00-15 NASDAQ	0.470	0.021	0.253	3.144	23.9%*	0.003	0.000

Table 7: Extension Tests using Alternative Liquidity Measures.

Description: This table reports the cross-sectional regression of excess return on the expected liquidity cost ($E(c^i)$), market beta (β^{1i}), and net liquidity risk beta (β^{5i}). The panels are based on alternative liquidity measures. Following Lee (2011) and Fama-MacBeth (1973), the pre-ranking betas are computed from monthly returns in years $t-5$ to $t-1$, then individual stocks are sorted in 10 portfolios based on pre-ranking betas, then in the second stage post-ranking betas are computed for the 10 portfolios in year t, then these betas are assigned to the individual stocks, then in the third stage the four cross-sectional regressions are run across each individual stock i, and the whole process is rolled forward each year during the time period. * means significant at the 1% level.

Interpretation: The extension tests robustly fail to support the main Lee two-beta LCAPM predictions under each of the alternative liquidity measures. Further under each of the alternative liquidity measures, the LCAPM R^2 gain is not due to incorporating liquidity risk.

Amihud and Mendelson-type mean liquidity cost term and none is due to LCAPM liquidity risk term.

In summary, our extension tests robustly fail to support the main Lee two-beta LCAPM predictions under each of the alternative liquidity measures. Further under each of the alternative liquidity measures, the LCAPM R^2 gain is not due to incorporating liquidity risk.

4.4 Extension Tests Adding Characteristic Factors or Risk Factors

Table 8 reports extension tests of the Lee two-beta LCAPM when adding either characteristic factors or risk factors. Panel A adds the following characteristic variables: (1) the log of market value (LnMV), (2) the log of book/market when available or zero otherwise (LnBMmod), and (3) a dummy that equals 1 when book value is available and zero otherwise (BMdum). Panel B adds the following risk factors based on Fama and French (1993) and Carhart (1997): (1) Small-Minus-Big size risk factor, (2) High-Minus-Low (HML) book/market risk factor, and (3) Up-Minus-Down (UMD) momentum risk factor.

Panel A reports that LnMV and LnBMmod are significant in all five period-exchange cases and BMdum is significant in two out of five cases. So the added characteristic factors are priced most of the time. Regarding the five hypotheses: $\alpha = 0$ is not supported all five times, $E(c^i)$ is priced two times out of five, β^{1i} is priced two times out of five, β^{5i} is priced one time out of five, and $\lambda^1 = \lambda^5$ is not supported all five times. The average R^2 gain from the $E(c^i)$ term is 0.035, whereas the average R^2 gain due to the β^{5i} term is 0.002. Thus, nearly all of R^2 gain is due to the Amihud and Mendelson-type mean liquidity cost term and very little is due to LCAPM liquidity risk term.

Panel B reports that SML and HML are not significant in all five period-exchange cases and UMD is significant in two out of five cases. Regarding the five hypotheses: $\alpha = 0$ is not supported two times out of five, $E(c^i)$ is priced two times out of five, β^{1i} is priced one time out of five, β^{5i} is priced one times out of five, and $\lambda^1 = \lambda^5$ is not supported all five times.

In summary, our extension tests robustly fail to support the main Lee two-beta LCAPM are true at the same time after adding characteristics or risk factors. Further after adding characteristics or risk factors, the LCAPM R^2 gain is not due to incorporating liquidity risk.

4.5 Summary of Extension Tests

Table 9 summarizes extension tests of the Lee two-beta LCAPM for 60 different cases and by various breakouts. Specifically, it includes: (five different period-exchange combinations) times (four different liquidity measures) times (three different versions of the regression) for a total of $5 * 4 * 3 = 60$ cases. The three

	α	$E(c^i)$	β^{1i}	β^{5i}	LnMV	LnBMmod	BMdum	$\lambda^1 = \lambda^5$	R^2 Gain $E(c^i)$	R^2 Gain $\beta^{5,i}$
Panel A: Characteristic Factors										
26-61 NY-AM	−5.794*	−0.043	1.190*	7.836	0.325*	0.351*	0.105	25.5%*	0.019	0.001
62-99 NY-AM	−5.610*	0.006	0.810*	−15.768	0.281*	0.352*	0.149*	15.8%*	−0.003	−0.001
00-15 NY-AM	−3.966*	0.012	0.899	−1.462	0.181*	0.353*	0.342*	7.5%*	−0.006	−0.002
73-99 NASDAQ	−20.245*	0.083*	0.562	0.872*	1.032*	0.354*	0.157	7.8%*	0.142	0.011
00-15 NASDAQ	−8.901*	0.052*	−0.307	1.710	0.503*	0.355*	0.113	14.9%*	0.024	−0.001

	α	$E(c^i)$	β^{1i}	β^{5i}	β^{SML}	β^{HML}	β^{UMD}	$\lambda^1 = \lambda^5$	R^2 Gain $E(c^i)$	R^2 Gain $\beta^{5,i}$
Panel B: Risk Factors										
26-61 NY-AM	0.123	0.017	1.092*	−0.766	−0.069	−0.024	0.452	24.7%*	0.022	−0.002
62-99 NY-AM	0.496*	0.025	0.119	−6.695	0.138	−0.076	0.579*	18.6%*	0.001	0.002
00-15 NY-AM	0.495	0.015	0.510	0.012	0.084	−0.044	0.015	6.2%*	0.015	0.003
73-99 NASDAQ	−0.665	0.086*	0.542	0.101	0.018	−0.034	0.523*	8.8%*	−0.059	0.007
00-15 NASDAQ	1.077*	0.056*	−0.425	3.412*	0.053	−0.133	0.097	16.0%*	−0.036	−0.003

Table 8: Extension Tests Adding Characteristic Factors Or Risk Factors.

Description: This table reports the cross-sectional regression of excess return on the expected liquidity cost ($E(c^i)$), market beta (β^{1i}), and net liquidity risk beta (β^{5i}). Panel A includes three characteristic variables and panel B includes three Fama and French risk factor variables. In all cases, the liquidity measure is High-Low. Following Lee (2011) and Fama-MacBeth (1973), the pre-ranking betas are computed from monthly returns in years $t-5$ to $t-1$, then individual stocks are sorted in 10 portfolios based on pre-ranking betas, then in the second stage post-ranking betas are computed for the 10 portfolios in year t, then these betas are assigned to the individual stocks, then in the third stage the four cross-sectional regressions are run across each individual stock i, and the whole process is rolled forward each year during the time period. * means significant at the 1% level.

Interpretation: The extension tests robustly fail to support the main Lee two-beta LCAPM are true at the same time after adding characteristics or risk factors. Further after adding characteristics or risk factors, the LCAPM R^2 gain is not due to incorporating liquidity risk.

		Frequency that the hypotheses are true					R^2 Gain	
		$\alpha = 0$	$\kappa > 0$	$\lambda^1 > 0$	$\lambda^5 > 0$	$\lambda^1 = \lambda^5$	$E(c^i)$	$\beta^{5,i}$
Panel A: Summary of Extension Tests								
All 60 Cases	#	34	26	12	7	0	0.029	0.000
	%	56.7%	43.3%	20.0%	11.7%	0.0%		
Panel B: Summary of Extension Tests by Period-Exchange								
26-61 NY-AM	#	8	3	6	1	0	0.014	0.000
	%	66.7%	25.0%	50.0%	8.3%	0.0%		
62-99 NY-AM	#	4	6	3	3	0	0.015	0.000
	%	33.3%	50.0%	25.0%	25.0%	0.0%		
00-15 NY-AM	#	8	3	0	0	0	0.006	0.000
	%	66.7%	25.0%	0.0%	0.0%	0.0%		
73-99 NASDAQ	#	8	7	3	2	0	0.086	0.002
	%	66.7%	58.3%	25.0%	16.7%	0.0%		
00-15 NASDAQ	#	6	7	0	1	0	0.024	0.000
	%	50.0%	58.3%	0.0%	8.3%	0.0%		
Panel C: Summary of Extension Tests by Alternative Liquidity Measures								
High-Low	#	8	5	3	2	0	0.009	0.001
	%	53.3%	33.3%	20.0%	13.3%	0.0%		
% Quoted Sprd	#	9	3	3	0	0	0.004	0.000
	%	60.0%	20.0%	20.0%	0.0%	0.0%		
Amihud	#	7	6	2	5	0	0.086	0.003
	%	46.7%	40.0%	13.3%	33.3%	0.0%		
Zeros	#	10	12	4	0	0	0.018	−0.002
	%	66.7%	80.0%	26.7%	0.0%	0.0%		

Table 9: Summary of Extension Tests.

Description: This table summarizes all the extension results by reporting the number and percentage of cases where the hypotheses are true. Specifically, it reports the results of excess return on the expected liquidity cost ($E(c^i)$), market beta (β^{1i}), and net liquidity risk beta (β^{5i}). This table summarizes the extension results for five combinations of time period and exchange, four liquidity measures, and three versions of the regression for a total of $5^*4^*3 = 60$ cases. The extension results follow the Lee (2011) methodology, which uses individual stocks as test assets. Specifically, the pre-ranking betas are computed from monthly returns in years $t-5$ to $t-1$, then individual stocks are sorted in 10 portfolios based on pre-ranking betas, then in the second stage post-ranking betas are computed for the 10 portfolios in year t, then these betas are assigned to the individual stocks, then in the third stage the cross-sectional regressions are run across each individual stock i, and the whole process is rolled forward each year during the time period. Given the relatively large number of individual stocks, all hypotheses are tested at the 1% level of significance.

Interpretation: Extension tests over 60 different cases always fail to support the main Lee two-beta LCAPM predictions and find that incorporating liquidity risk robustly adds nothing to the LCAPM R^2 gain.

regression versions are: (1) no added variables, (2) added characteristic factors, and (3) added risk factors.

Panel A summarizes the extension tests overall all 60 cases. Specifically, it reports the frequency that the five hypotheses are true.[15] We find that $\alpha = 0$ is true in 56.7% of the cases (34 out of 60), $\kappa > 0$ in 43.3%, $\lambda^1 > 0$ in 20.0%, $\lambda^5 > 0$ in 11.7%, and $\lambda^1 = \lambda^5$ in 0.0%. Thus, our extension results always fail to support the main Lee two-beta LCAPM predictions are true at the same time. Across all 60 cases, the $E(c^i)$ term contributes 0.029 to the R^2 gain, whereas the β^{5i} term contributes exactly 0.000 overall.

Panel B summarizes the extension tests by period-exchange. Each row of Panel B represents (four different liquidity measures) times (three different versions of the regression) for a total of $4 * 3 = 12$ cases. We see a consistent pattern in each period-exchange that most of the LCAPM predictions are not supported and that incorporating liquidity risk robustly adds nothing to the LCAPM R^2 gain.

Panel C summarizes the extension tests by alternative liquidity measures. Each row of Panel C represents (five different period-exchange combinations) times (three different versions of the regression) for a total of $5 * 3 = 15$ cases. We see a consistent pattern for each liquidity measure that most of the LCAPM predictions are not supported and that incorporating liquidity risk robustly adds nothing to the LCAPM R^2 gain.

In summary, our extension results always fail to support the main Lee two-beta LCAPM predictions and that incorporating liquidity risk robustly adds nothing to the LCAPM R^2 gain.

5 Conclusion

We replicate the LCAPM tests of Acharya and Pedersen using their original methodology and covering both their original time period and a more recent period. We successfully qualitatively replicate the descriptive and first-stage tables and figure, but are *not* successful in replicating the second-stage tables that perform cross-sectional tests. In the large majority of cases, our replication evidence fails to support that the main LCAPM predictions all hold simultaneously. Next, we extend tests of the LCAPM following the Lee (2011) methodology and expanding to: (1) three different time periods spanning 90 years, (2) add NASDAQ stocks, (3) use four alternative liquidity measures, and (4) add risk or characteristic factors. Our extension evidence always fails to support that the main predictions of the Lee two-beta LCAPM and of the four-beta LCAPM hold at the same time. Overall, we

[15] For any hypothesis that predicts that a coefficient is greater than zero or less than zero, we consider it to be true only when the estimated coefficient has the predicted sign and is significant in a one-tail test at the 1% level. For a hypothesis that predicts a coefficient is equal to zero, we consider it to be true only when the estimated coefficient is insignificantly different from zero in a two-tail test at the 1% level.

fail to support that liquidity risk matters in the specific functional form predicted by the LCAPM. However, we are silent on the more general question of whether liquidity risk matters in some different functional form. We make our SAS code publicly available.

6 Appendix

The appendix provides seven of the eight tables that report the replication second-stage tests. The eight tables (Tables 3 and A1 to A7) follow the same variations of tests assets, portfolio weights, and added factors in the same order as Acharya and Pedersen. Specifically, Table 3 is based on illiquidity portfolios. Table A1 is based on portfolios sorted by the standard deviation of liquidity. Table A2 is based on equally-weighted illiquidity portfolios and an equally-weighted market portfolio. Table A3 is based on value-weighted illiquidity portfolios and a value-weighted market portfolio. Table A4 is based on size portfolios. Table A5 is based on portfolios sorted first by book/market and then sorted by size. Table A6 is the same as Table 8, except that it adds size and book-to-market variables. Table A7 is the same as Table A5, except that it adds size and book-to-market variables.

	α	$E(c^p)$	β^{1p}	β^{2p}	β^{3p}	β^{4p}	$\beta^{Net,p}$	β^{5p}	R^2
Panel A: Original σ (illiquidity) portfolio results for 1962 to 1999									
1	−0.528	0.035					1.471***		0.865
2	−0.363	0.062**					1.243**		0.886
3	−0.827*		1.923***						0.726
4	−0.014	0.035	−7.113*				7.772***		0.917
5	0.094	0.007	−11.013**				11.476**		0.924
6	0.119		−11.914**				12.320***		0.924
7	0.464	0.035	−1.105	−83.690	−74.538	−14.560*			0.940
8	0.459	0.148	−1.125	−390.588	−73.552**	−21.688			0.942
Panel B: Replicated σ (illiquidity) portfolio results for 1962 to 1999									
1	−1.461**	0.035					2.486***		0.524
2	−0.031	0.259***					0.635***		0.935
3	−1.750**		2.944***						0.451
4	0.517*	0.035	−24.276***				23.757***		0.802
5	0.177	0.230***	−4.810				5.088*		0.938
6	0.578**		−27.765***				27.103***		0.806
7	0.822**	0.035	−2.588	108.563**	−108.416**	0.336			0.908
8	0.505*	0.470***	−1.479	−344.170	−66.776**	−8.842***			0.964
9	−0.040	0.264***	0.661***						0.934
10	0.177	0.230***	0.278					5.088*	0.938
Panel C: Recent σ (illiquidity) portfolio results for 2000 to 2015									
1	−0.195	0.035					1.007***		0.578
2	−0.108	0.123***					0.938***		0.746
3	0.360		0.524						0.119
4	−0.114	0.035	2.357***				−1.398		0.641
5	−0.100	0.043	−5.372				6.268		0.747
6	−0.095		−8.232				9.106***		0.747
7	−0.182	0.035	0.876***	−215.518	−12.971	−11.321***			0.681
8	−0.192	0.181*	0.878***	−220.527	−13.282	−10.042			0.772
9	−0.109	0.136***	0.944***						0.745
10	−0.100	0.043	0.896***					6.268	0.747

Panel D: R^2 decomposition

	One-Beta LCAPM		*Lee 2-Beta LCAPM*		*Four-Beta LCAPM*	
	$E(c^p)$	$\beta^{Net,p}$	$E(c^p)$	$\beta^{5,p}$	$E(c^p)$	*Liq.* $\beta's$
1962 to 1999	0.483	0.001	0.483	0.004	0.483	0.03
2000 to 2015	0.626	0.001	0.626	0.003	0.626	0.027

Table A1: Tests for σ (Illiquidity) Portfolios.

Description: This table reports the original, replicated, and recent results that correspond to Acharya and Pedersen (2005), Table 4, Panel B. It reports the estimated coefficients from cross-sectional regressions of the liquidity-adjusted CAPM for 25 value-weighted σ (illiquidity) portfolios p with an equal-weighted market portfolio. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Interpretation: In eight cases (four LCAPM versions X 2 panels), the main LCAPM predictions all hold true in three cases and two of these cases are based on the one-beta LCAPM, which is difficult to empirically distinguish from the mean liquidity cost CAPM. Further, nearly all of R^2 gain is due to the Amihud and Mendelson-type mean liquidity cost term and very little is due to LCAPM liquidity risk.

	α	$E(c^p)$	β^{1p}	β^{2p}	β^{3p}	β^{4p}	$\beta^{Net,p}$	β^{5p}	R^2
Panel A: Original equal-weighted port., equal-weighted market results for 1962 to 1999									
1	−0.391	0.046					1.115^{**}		0.825
2	−0.299	0.062^{***}					0.996^{***}		0.846
3	−0.530		1.374^{**}						0.350
4	−0.088	0.046	−2.699				3.395^{**}		0.879
5	0.105	0.008	-6.392^{**}				6.800^{**}		0.901
6	0.143		-7.115^{***}				7.467^{***}		0.900
7	−0.132	0.046	1.568	−141.416	47.823	-12.784^{*}			0.911
8	−0.053	0.117	1.207	−346.547	33.043	−17.356			0.913
Panel B: Replicated equal-weighted port., equal-weighted market results for 1962 to 1999									
1	−0.327	0.046					0.916^{***}		0.274
2	-0.383^{**}	0.007					1.022^{***}		0.412
3	-0.322^{*}		1.004^{***}						0.307
4	−0.430	0.046	1.352				−0.282		0.295
5	0.125	−0.052	-7.761^{***}				8.054^{***}		0.637
6	−0.169		-2.930^{**}				3.635^{***}		0.513
7	0.116	0.046	0.310	−116.936	−6.214	-11.034^{***}			0.683
8	0.116	0.052	0.309	−124.388	−6.167	-11.204^{***}			0.640
9	-0.354^{**}	0.015	1.019^{***}						0.345
10	0.125	−0.052	0.293^{*}					8.054^{***}	0.637
Panel C: Recent equal-weighted port., equal-weighted market results for 2000 to 2015									
1	−0.827	0.046					1.524^{**}		0.405
2	0.100	0.011^{**}					0.705^{***}		0.369
3	0.219		0.604^{***}						0.338
4	0.020	0.046	17.368^{***}				−16.421		0.797
5	0.090	−0.013	−3.421				4.102		0.378
6	0.085		−1.804				2.506^{***}		0.376
7	0.093	0.046	0.776^{***}	−176.766	9.657	0.207			0.875
8	0.176	−0.044	0.749^{***}	27.384	10.468	−5.412			0.385
9	0.107	0.016^{***}	0.706^{***}						0.365
10	0.090	−0.013	0.681^{***}					4.102	0.378

Panel D: R^2 decomposition

	One-Beta LCAPM		*Lee 2-Beta LCAPM*		*Four-Beta LCAPM*	
	$E(c^p)$	$\beta^{Net,p}$	$E(c^p)$	$\beta^{5,p}$	$E(c^p)$	*Liq.* β'*s*
1962 to 1999	0.038	0.067	0.038	0.292	0.038	0.295
2000 to 2015	0.027	0.004	0.027	0.013	0.027	0.021

Table A2: Tests of Equally-Weighted Portfolios with Equally-Weighted Market.

Description: This table reports the original, replicated, and recent results that correspond to Acharya and Pedersen (2005), Table 5, Panel A. It reports the estimated coefficients from cross-sectional regressions of the liquidity-adjusted CAPM for 25 equally-weighted illiquidity portfolios p using monthly data with an equal-weighted market portfolio. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Interpretation: In eight cases (four LCAPM versions X 2 panels), the main LCAPM predictions all hold true in three cases and two of these cases are based on the one-beta LCAPM, which is difficult to empirically distinguish from the mean liquidity cost CAPM. Further, in the recent period, nearly all of R^2 gain is due to the Amihud and Mendelson-type mean liquidity cost term and very little is due to LCAPM liquidity risk.

	α	$E(c^p)$	β^{1p}	β^{2p}	β^{3p}	β^{4p}	$\beta^{Net,p}$	β^{5p}	R^2
Panel A: Original value-weighted port., value-weighted market results for 1962 to 1999									
1	−1.938	0.034					2.495*		0.486
2	−2.059*	0.081***					2.556**		0.642
3	0.700		0.062						0.000
4	−1.536*	0.034	−6.070				8.099**		0.754
5	−0.583	−0.076	−16.226***				17.333***		0.841
6	−1.241		−9.210**				10.954***		0.800
7	−0.301	0.034	0.363	−4494.924	−370.840	−26.044*			0.850
8	0.039	−0.056	0.015	−116.450	−405.451	−13.135			0.865
Panel B: Replicated value-weighted port., value-weighted market results for 1962 to 1999									
1	−1.035*	0.034					1.875***		0.140
2	−0.202	0.251***					0.770***		0.921
3	−0.417		1.284*						0.044
4	0.773*	0.034	−26.182***				25.836***		0.834
5	0.130	0.194***	−7.975				8.359		0.930
6	0.909*		−30.046***				29.545***		0.842
7	0.532	0.034	−0.687	1961.820**	−395.764	−2.075			0.877
8	0.186	0.256***	−0.113	−1774.294	−248.425	−12.236*			0.938
9	−0.190	0.257***	0.761***						0.931
10	0.130	0.194***	0.384					8.359	0.936
Panel C: Recent value-weighted port., value-weighted market results for 2000 to 2015									
1	−0.360	0.034					0.937***		0.441
2	−0.286	0.144***					0.880***		0.670
3	0.864		−0.038						0.001
4	−0.288	0.034	0.658				0.221		0.451
5	−0.335	0.236***	4.334*				−3.431		0.673
6	−0.194		−6.706				7.538***		0.653
7	−0.139	0.034	0.250	6,259.338**	2225.890	−2.492			0.512
8	−0.288	0.533**	0.330	30,120.643***	2352.627	−12.077*			0.713
9	−0.298	0.163***	0.887***						0.671
10	−0.335	0.236***	0.903***					−3.431	0.673

Panel D: R^2 decomposition

	One-Beta LCAPM		*Lee 2-Beta LCAPM*		*Four-Beta LCAPM*	
	$E(c^p)$	$\beta^{Net,p}$	$E(c^p)$	$\beta^{5,p}$	$E(c^p)$	*Liq.* $\beta's$
1962 to 1999	0.887	−0.010	0.887	0.005	0.887	0.007
2000 to 2015	0.670	−0.001	0.670	0.002	0.670	0.042

Table A3: Tests of Value-Weighted Portfolios with Value-Weighted Market.

Description: This table reports the original, replicated, and recent results that correspond to Acharya and Pedersen (2005), Table 5, Panel B. It reports the estimated coefficients from cross-sectional regressions of the liquidity-adjusted CAPM for 25 value-weighted illiquidity portfolios p using monthly data with an value-weighted market portfolio. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Interpretation: In eight cases (four LCAPM versions X 2 panels), the main LCAPM predictions all hold true in two cases and both of these cases are based on the one-beta LCAPM, which is difficult to empirically distinguish from the mean liquidity cost CAPM. Further, nearly all of R^2 gain is due to the Amihud and Mendelson-type mean liquidity cost term and very little is due to LCAPM liquidity risk.

	α	$E(c^p)$	β^{1p}	β^{2p}	β^{3p}	β^{4p}	$\beta^{Net,p}$	β^{5p}	R^2
Panel A: Original size portfolio results for 1962 to 1999									
1	−0.087	0.047					0.865**		0.910
2	−0.059	0.056**					0.823**		0.912
3	−0.265		1.144**						0.757
4	−0.043	0.047	−0.770				1.562		0.912
5	−0.055	0.054	−0.168				0.984		0.912
6	0.032		−4.633*				5.278**		0.902
7	−0.073	0.047	0.887	27.387	1.741	0.038			0.913
8	0.224	−0.408	−0.079	742.841	−42.800	7.933			0.929
Panel B: Replicated size portfolio results for 1962 to 1999									
1	−0.540*	0.047					1.329***		0.502
2	0.165*	0.185***					0.449***		0.959
3	−0.788*		1.696***						0.418
4	0.410***	0.047	−14.660***				14.545***		0.756
5	−0.099	0.235***	8.037***				−7.117		0.971
6	0.538***		−20.343***				19.969***		0.778
7	0.345**	0.047	−0.894	195.501***	−57.331***	12.510			0.968
8	0.304*	0.090	−0.797	141.237	−54.385***	11.562			0.980
9	0.137*	0.187***	0.490***						0.961
10	−0.099	0.235***	0.920***					−7.117	0.971
Panel C: Recent size portfolio results for 2000 to 2015									
1	−0.773	0.047					1.532***		0.408
2	−0.156	0.032***					1.040***		0.694
3	0.021		0.903***						0.557
4	−0.529**	0.047	21.694**				−20.118		0.644
5	−0.115	−0.004	−10.107				11.004***		0.768
6	−0.124		−9.409				10.321***		0.768
7	−0.111	0.047	0.990***	−303.999	6.986	−16.117***			0.937
8	−0.088	−0.097	1.008***	177.649	2.551	−9.590**			0.775
9	−0.147	0.035***	1.042***						0.677
10	−0.115	−0.004	0.897***					11.004***	0.768

Panel D: R^2 decomposition

	One-Beta LCAPM		*Lee 2-Beta LCAPM*		*Four-Beta LCAPM*	
	$E(c^p)$	$\beta^{Net,p}$	$E(c^p)$	$\beta^{5,p}$	$E(c^p)$	*Liq.* β*'s*
1962 to 1999	0.543	−0.002	0.543	0.010	0.543	0.019
2000 to 2015	0.120	0.016	0.120	0.091	0.120	0.097

Table A4: Tests for Size Portfolios.

Description: This table reports the original, replicated, and recent results that correspond to Acharya and Pedersen (2005), Table 6, Panel A. It reports the estimated coefficients from cross-sectional regressions of the liquidity-adjusted CAPM for 25 value-weighted size portfolios p using monthly data with an equal-weighted market portfolio. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Interpretation: In eight cases (four LCAPM versions X 2 panels), the main LCAPM predictions all hold true in four cases and two of these cases are based on the one-beta LCAPM, which is difficult to empirically distinguish from the mean liquidity cost CAPM. Further, in the original period, nearly all of R^2 gain is due to the Amihud and Mendelson-type mean liquidity cost term and very little is due to LCAPM liquidity risk.

	α	$E(c^p)$	β^{1p}	β^{2p}	β^{3p}	β^{4p}	$\beta^{Net,p}$	β^{5p}	R^2
Panel A: Original book/market-by-size portfolio results for 1962 to 1999									
1	0.200	0.045					0.582		0.406
2	0.453	0.167***					0.182		0.541
3	0.109		0.748*						0.262
4	0.529	0.045	−8.289*				8.275**		0.502
5	0.187	0.387***	18.229**				−17.458		0.571
6	0.574*		−11.787***				11.671***		0.483
7	−0.425	0.045	4.606	203.397	198.027	−3.330			0.788
8	−0.395	−0.031	4.545**	397.770	195.128	0.380			0.789
Panel B: Replicated book/market-by-size portfolio results for 1962 to 1999									
1	−2.485**	0.045					3.346***		0.498
2	−2.801***	−0.218					3.909***		0.566
3	−2.687**		3.707***						0.539
4	−3.238***	0.045	28.755***				−23.759		0.583
5	−3.913***	0.647*	82.000**				−75.233		0.608
6	−3.188***		24.773**				−19.910		0.584
7	−3.584***	0.045	6.413**	381.346	69.964	61.847			0.592
8	−4.099**	1.060	7.075**	−623.725	85.760	59.063			0.612
9	−2.870***	−0.177	4.066***						0.567
10	−3.913***	0.647	6.767***					−75.233	0.608
Panel C: Recent book/market-by-size portfolio results for 2000 to 2015									
1	−0.480	0.045					1.351**		0.073
2	−0.507	−0.084					1.506**		0.089
3	−0.520		1.492**						0.088
4	−0.847	0.045	62.411*				−60.063		0.131
5	−1.021	0.409	96.238				−93.497		0.128
6	−0.726		38.788				−36.714		0.108
7	−0.601	0.045	4.866***	−1160.693	157.572	−204.096**			0.454
8	−0.942	2.010	4.664***	−2921.537	152.017	−167.643*			0.458
9	−0.524	−0.076	1.536**						0.090
10	−1.021	0.409	2.740**					−93.497	0.128

Panel D: R^2 decomposition

	One-Beta LCAPM		*Lee 2-Beta LCAPM*		*Four-Beta LCAPM*	
	$E(c^p)$	$\beta^{Net,p}$	$E(c^p)$	$\beta^{5,p}$	$E(c^p)$	*Liq.* β*'s*
1962 to 1999	0.028	−0.001	0.028	0.041	0.028	0.045
2000 to 2015	0.002	−0.001	0.002	0.037	0.002	0.367

Table A5: Tests for Book/Market-By-Size Portfolios.

Description: This table reports the original, replicated, and recent results that correspond to Acharya and Pedersen (2005), Table 6, Panel B. It reports the estimated coefficients from cross-sectional regressions of the liquidity-adjusted CAPM for 25 B/M-by-size portfolios p using monthly data with an equal-weighted market portfolio. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Interpretation: In eight cases (four LCAPM versions X 2 panels), the main LCAPM predictions all hold true in two cases and both of these cases are based on the one-beta LCAPM, which is difficult to empirically distinguish from the mean liquidity cost CAPM.

	α	$E(c^p)$	β^{1p}	β^{2p}	β^{3p}	β^{4p}	$\beta^{Net,p}$	β^{5p}	$\ln(\text{size}^p)$	B/M	R^2
Panel A: Original liquidity portfolios controlling for size and book-to-market results for 1962 to 1999											
1	−1.358**	0.034					2.158**		0.142	1.076*	0.865
2	−1.286	0.028					1.970**		0.129	1.120**	0.865
3	−0.818		0.798						0.043	1.350*	0.850
4	−1.273	0.034	−3.740				6.145		0.155	0.679	0.869
5	−0.441	−0.018	−12.278				13.565*		0.068	0.159	0.882
6	−0.730		−9.313*				10.988**		0.098	0.339	0.880
7	−0.491	0.034	1.253	−124.221	−18.359	−16.421			0.078	0.205	0.884
8	−0.557	0.059	1.300**	−183.466	−19.865	−17.238			0.087	0.253	0.884
Panel B: Replicated liquidity portfolios controlling for size and book-to-market results for 1962 to 1999											
1	3.385***	0.034					−2.391		0.363***	−0.955*	0.893
2	0.749*	0.196***					0.493		0.043	−0.826**	0.963
3	3.900***		−3.009						0.415***	−0.991	0.907
4	3.560***	0.034	2.639				−5.197		0.396***	−0.927	0.896
5	0.730	0.227***	7.792***				−7.205		0.075	−0.718*	0.974
6	4.261***		1.362				−4.699		0.476***	−0.979	0.911
7	−0.474	0.034	−0.778	220.439***	−82.238***	12.257			−0.105	0.368	0.97
8	−0.626	0.140*	−0.452	109.780	−78.900***	9.825			−0.120**	0.250	0.982
9	0.351	0.216***	0.897*						0.002	−0.748**	0.965
10	0.730	0.227***	0.587					−7.205	0.075	−0.718*	0.974

Table A6: Tests for Liquidity Portfolios Controlling for Size and Book-To-Market.

	α	$E(c^p)$	β^{1p}	β^{2p}	β^{3p}	β^{4p}	$\beta^{Net,p}$	β^{5p}	$\ln(\text{size}^p)$	B/M	R^2
Panel C: Recent liquidity portfolios controlling for size and book-to-market results for 2000 to 2015											
1	1.525	0.034					1.763***		0.110*	−1.215	0.777
2	1.236**	−0.023					0.306**		0.079	−0.090	0.825
3	1.287**		0.465***						0.094	−0.473	0.815
4	0.959	0.034	−17.643				19.839		0.010	−0.400	0.793
5	1.275**	−0.025	1.287				−1.023		0.008	−0.104	0.825
6	1.236**		−1.058				1.561		0.006	0.297	0.815
7	1.413**	0.034	0.341	−358.676	27.399	−4.074			0.061	−0.970	0.954
8	1.354**	−0.046	0.392	34.937	22.682	0.547			0.065	0.106	0.833
9	1.243**	−0.023	0.298**						0.084	−0.124	0.825
10	1.275**	−0.025	0.264					−1.023	0.008	−0.104	0.825

Panel D: R^2 decomposition

	One-Beta LCAPM		*Lee 2-Beta LCAPM*		*Four-Beta LCAPM*	
	$E(c^p)$	$\beta^{Net,p}$	$E(c^p)$	$\beta^{5,p}$	$E(c^p)$	*Liq.* $\beta's$
1962 to 1999	0.058	−0.002	0.058	0.009	0.058	0.017
2000 to 2015	0.010	0.000	0.010	0.000	0.010	0.008

Table A6: *Continued*.

Description: This table reports the original, replicated, and recent results that correspond to Acharya and Pedersen (2005), Table 7, Panel A. It reports the estimated coefficients from cross-sectional regressions of the liquidity-adjusted CAPM for 25 illiquidity portfolios p using monthly data with an equal-weighted market portfolio. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Interpretation: In eight cases (four LCAPM versions X 2 panels), the main LCAPM predictions all hold true in one case and that case is based on the one-beta LCAPM, which is difficult to empirically distinguish from the mean liquidity cost CAPM. Further, nearly all of R^2 gain is due to the Amihud and Mendelson-type mean liquidity cost term and very little is due to LCAPM liquidity risk.

	α	$E(c^p)$	β^{1p}	β^{2p}	β^{3p}	β^{4p}	$\beta^{Net,p}$	β^{5p}	ln(size^p)	B/M	R^2
Panel A: Original book/market-by-size portfolios controlling for size and book-to-market results for 1962 to 1999											
1	0.310	0.045					−0.199		−0.084	0.251***	0.924
2	0.317	0.035					−0.236		−0.091	0.250***	0.925
3	0.365		−0.403						−0.119**	0.246**	0.920
4	0.311	0.045	0.484				−0.696		−0.089	0.249***	0.924
5	0.340	−0.003	−3.145				2.850		−0.087	0.259***	0.925
6	0.338		−2.930				2.639		−0.087	0.259***	0.925
7	0.237	0.045	0.490	−286.927	38.480	−14.711			−0.095	0.226***	0.932
8	0.171	0.284	0.529	−916.982	42.353	−26.730			−0.100	0.233	0.937
Panel B: Replicated book/market-by-size portfolios controlling for size and book-to-market results for 1962 to 1999											
1	−0.993	0.045					2.868***		0.019	−1.176***	0.909
2	−3.310***	0.525***					5.347***		0.450***	−0.875***	0.959
3	−0.528		2.420**						−0.061	−1.250***	0.897
4	−2.854***	0.045	−43.363***				47.370***		0.465***	−0.860***	0.943
5	−3.288***	0.560***	4.486				0.925		0.436***	−0.885***	0.959
6	−2.817***		−47.541***				51.426***		0.468***	−0.858***	0.941
7	−2.901***	0.045	4.202***	468.495**	−43.916	−2.231			0.449***	−0.881***	0.952
8	−3.379***	0.738***	4.625***	−221.247	−40.410	−5.216			0.472***	−0.841***	0.960
9	−3.282***	0.568***	5.423***						0.432***	−0.888***	0.959
10	−3.288***	0.560***	5.411***					0.925	0.436***	−0.885***	0.959

Table A7: Tests for Book/Market-By-Size Portfolios Controlling for Size and Book-To-Market.

	α	$E(c^p)$	β^{1p}	β^{2p}	β^{3p}	β^{4p}	$\beta^{Net,p}$	β^{5p}	ln(size^p)	B/M	R^2
Panel C: Recent book/market-by-size portfolios controlling for size and book-to-market results for 2000 to 2015											
1	0.488**	0.045					1.502***		−0.245***	−2.355***	0.960
2	0.183	0.276***					1.867***		−0.063	−2.539***	0.961
3	0.979***		0.919***						−0.268***	−2.333***	0.955
4	0.340	0.045	−16.922				18.503**		−0.153***	−2.516***	0.962
5	0.228	0.217**	−13.981				15.713*		−0.061	−2.590***	0.962
6	0.726***		−27.056				28.117***		−0.168***	−2.504***	0.959
7	0.375	0.045	1.601**	−45.161	−7.659	−25.709**			−0.070	−2.555***	0.962
8	−0.481	2.274***	2.036***	−2448	−4.173	−33.044***			−0.040	−2.586***	0.973
9	0.189	0.281***	1.871***						−0.068	−2.532***	0.961
10	0.228	0.217**	1.733***					15.713*	−0.061	−2.590***	0.962

Panel D: R^2 decomposition

	One-Beta LCAPM		*Lee 2-Beta LCAPM*		*Four-Beta LCAPM*	
	$E(c^p)$	$\beta^{Net,p}$	$E(c^p)$	$\beta^{5,p}$	$E(c^p)$	*Liq.* $\beta's$
1962 to 1999	0.062	0.000	0.062	0.000	0.062	0.001
2000 to 2015	0.006	0.000	0.006	0.001	0.006	0.012

Table A7: *Continued.*

Description: This table reports the original, replicated, and recent results that correspond to Acharya and Pedersen (2005), Table 7, Panel B. It reports the estimated coefficients from cross-sectional regressions of the liquidity-adjusted CAPM for 25 value-weighted B/M-by-size portfolios p using monthly data with an equal-weighted market portfolio. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Interpretation: In eight cases (four LCAPM versions X 2 panels), the main LCAPM predictions all hold true in four cases and two of these cases are based on the one-beta LCAPM, which is difficult to empirically distinguish from the mean liquidity cost CAPM. Further, in the original period, nearly all of R^2 gain is due to the Amihud and Mendelson-type mean liquidity cost term and very little is due to LCAPM liquidity risk.

References

Acharya, V., Y. Amihud, and S. Bharath. 2013. “Liquidity Risk of Corporate Bond Returns: Conditional Approach.” *Journal of Financial Economics*. 110: 358–386.

Acharya, V. and L. Pedersen. 2005. “Asset Pricing with Liquidity Risk.” *Journal of Financial Economics*. 77: 375–410.

Amihud, Y. 2002. “Illiquidity and Stock Returns: Cross Section and Time-Series Effects.” *Journal of Financial Markets*. 5: 31–56.

Amihud, Y. and H. Mendelson. 1986. “Asset Pricing and the Bid–Ask Spread.” *Journal of Financial Economics*. 17: 223–279.

Amihud, Y. and J. Noh. 2016. “The Pricing of the Illiquity Factor’s Systematic Risk.” *Working Paper*. New York University.

Ang, A. and J. Chen. 2002. “Asymmetric Correlations of Equity Portfolios.” *Journal of Financial Economics*. 63: 443–494.

Ben-Rephael, A., O. Kadan, and A. Wohl. 2015. “The Diminishing Liquidity Premium.” *Journal of Financial and Quantitative Analysis*. 50: 197–229.

Brennan, M. and A. Subrahmanyam. 1996. “Market Microstructure and Asset Pricing: On the Compensation for Illiquidity in Stock Returns.” *Journal of Financial Economics*. 41: 441–464.

Carhart, M. 1997. “On Persistence in Mutual Fund Performance.” *Journal of Finance*. 52: 57–82.

Chalmers, J. and G. Kadlec. 1998. “An Empirical Examination of the Amortized Spread.” *Journal of Financial Economics*. 48: 159–188.

Chung, K. and H. Zhang. 2014. “A Simple Approximation of Intraday Spreads Using Daily Data.” *Journal of Financial Markets*. 17: 94–120.

Corwin, S. and P. Schultz. 2012. “A Simple Way to Estimate Bid-Ask Spreads from Daily High and Low Prices.” *Journal of Finance*. 67: 719–759.

Fama, E. and K. French. 1993. “Common Risk Factors in the Returns on Stocks and Bonds.” *Journal of Financial Economics*. 33: 3–56.

Fama, E. and J. MacBeth. 1973. “Risk, Return, and Equilibrium: Empirical Tests.” *Journal of Political Economy*. 81: 607–636.

Fong, K., C. Holden, and C. Trzcinka. 2017. “What are the Best Liquidity Proxies for Global Research?” *Review of Finance*. 21: 1355–1401.

Kazumori, E., F. Fang, R. Sharman, and F. Takeda. 2018. “Asset Pricing with Liquidity Risk: A Replication and Out-of-Sample Tests with the Recent US and the Japanese Market Data.” *Working Paper*. State University of New York.

Lee, K. 2011. “The World Price of Liquidity Risk.” *Journal of Financial Economics*. 99: 136–161.

Lesmond, D., J. Ogden, and C. Trzcinka. 1999. “A New Estimate of Transaction Costs.” *Review of Financial Studies*. 12: 1113–1141.

Newey, W. and K. West. 1987. “A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix.” *Econometrica*. 55: 703–708.

Pastor, L. and R. Stambaugh. 2003. "Liquidity Risk and Expected Stock Returns." *Journal of Political Economy*. 111: 642–685.

Shumway, T. 1997. "The Delisting Bias in CRSP Data." *Journal of Finance*. 52: 327–340.