Liquidity and stock expected returns

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Abstract: This paper constructs an illiquid comprehensive factor by principal component analysis to test the relationship between the liquidity risk of China's A-share market and the expected return of stocks from 2003 to 2018. We employ the procedure proposed by Fama and Macbeth (1973) and make a cross-sectional regression of the portfolio. It is concluded that there is liquidity premium in China's a-share market, and the pricing power of liquidity risk is stronger than that of liquidity level.

1. Introduction

Liquidity is an important indicator to reflect the status of the financial market. Whether it is investors or regulators, liquidity is an important factor that cannot be ignored to affect their decisions. Many studies try to determine the impact of liquidity risk on asset pricing, and they use many different methods to measure liquidity. Most studies have concluded that there is a significant positive correlation between the level of illiquidity and the expected return of stocks. In the stock market, investors holding illiquid stocks will face liquidity risk, and in order to compensate investors for the liquidity risk, the expected return rate of illiquid stocks is higher than that of liquid stocks.

Chinese stock market was set up late, compared with the developed countries it is not mature. Most domestic related research only contains sample data of less than ten years. In order to study the impact of liquidity in a long sample interval as much as possible, this paper selects the stock data of China's A-share market from January 2003 to December 2018, and the principal component analysis is used to reduce the dimension of seven indicators to study the impact of liquidity on stock expected returns.

2. Data Selection

2.1 Liquidity index selection

Harris (1990) defined the concept of market liquidity from four dimensions of "immediacy, market width, market depth and market elasticity" according to the microstructural theory. Considering the four dimensions of liquidity, the applicability of each liquidity index in China's stock market and the availability of data, this paper selects the following seven variables to measure liquidity.

1) Volume (VOL): The number of shares traded during the trading period;

2) Transaction Amount (DVOL): The transaction amount of the stock during the trading period;

3) Turnover rate (TURN): The frequency of stock exchanges: $TURN_{it} = VOL_{it}/LNS_{it}$.

Where LNS_{it} is the number of shares of stock i in the t month.

4) Martin index (Martin): This indicator is constructed based on the theory that the market liquidity ratio is positively correlated with the market price trend and negatively correlated with market price fluctuations : $\text{Martin} = (P_{it} - P_{it-1})^2/VOL_{it}$.

Where P_{it} and P_{it-1} are the closing prices of stock i on t and t-1 day;

5) Amivest Liquidity Ratio (AM): This ratio is volume or turnover to asset price movement ratio: $AM_{it} = DVOL_{it}/|R_{it}|$. Where R_{it} is the return of stock i in period t.

6) The liquidity indicator proposed by Andress and Floriks (2011) uses the ratio of the absolute value of the return to the monthly average turnover rate to indicate the illiquidity of the stock: $AF_{it} = |R_{it}|/TURN_{it}$.

7) Stock illiquidity is defined by Amihud as the average ratio of the daily absolute return to the trading volume on that day: $ILLIQ_{it} = \frac{1}{D_{it}}\sum_{d=1}^{D_{it}}\frac{|R_{it}|}{VOL_{it}}$.

2.2 Control variables

Many empirical studies have proved that the stock market has scale effect and inertia effect. In this paper, the circulation market value and momentum factor are selected as control variables to test the relationship between liquidity and stock expected returns. The specific definition is as follows:

SIZE: The market value of the stock in t-1 month. In order to ensure the stability of the scale time series, the circulation market value is logarithmically processed, SIZE=ln (MV).

MOM: The momentum of stock i in the t month is expressed as the cumulative returns over the first half of the preceding year.

2.3 Data specification

This paper selects stocks that are ordinary shares traded at the beginning and end of the year, and the time interval from January 2000 to December 2018 is taken as the research period. For the validity and comparability of model calculations, stocks with abnormal trading status (ST stocks and *ST stocks) are excluded, stocks with long-term suspension or delisting are excluded, stocks with a book value of less than 0 are excluded, and stocks in the financial industry are excluded. 272 sample stocks are selected as research objects, and monthly data with less than 15 days of trading days are excluded. Both the split share reform and the financial crisis will have an impact on market liquidity. Considering that the completion of the share-trading reform is very similar to the time of the financial crisis, this paper chooses September 2009 as a cut-off point. Before that, the market liquidity was poor, and it fluctuated greatly. After that, the liquidity improved, and the volatility was stable.

3. Methodology

3.1 Build liquidity factor

This paper selects 7 indicators including turnover rate, volume, turnover, AF illiquidity index, Amivest liquidity index, Martin index and Amihud illiquidity index to measure liquidity.

Principal component analysis is conducted with SPSS. The KMO sample test and Bartlett spheroid test showed that the selected liquidity factors were suitable for factor analysis, and then the result table of the total variance explained was obtained, which showed that three of the obtained factors had eigenvalues greater than 1. The initial eigenvalues and cumulative variance contribution rates of each factor are shown in Table 1. The cumulative variance contribution rate of these three factors reached 89.522%, which satisfies the requirements.

Table 1. Total Variance Explained

Component	Total	% of Variance	Cumulative%
1	3.900	55.714	55.714
2	1.345	19.216	74.930
3	1.021	14.592	89.522
4	0.370	5.281	94.803
5	0.243	3.473	98.276
6	0.091	1.294	99.570
7	0.030	0.430	100.000

In order to make economic interpretation of the three principal component factors, it is necessary to obtain the factor loads of the seven original liquidity indicators on the three principal component factors (correlation coefficients of the original indicators and principal component factors). From Table 2 we can conclude:

Z1=0.817VOL+0.933DVOL+0.811AM+0.887ILLIQ

Z2=0.937AF+0.962TR

Z3=0.978Martin+0.25ILLIQ

According to the contribution rate of each principal component in Table 1, the principal component prediction function can be obtained as follows:

G=0.55714Z1+0.19216Z2+0.14592Z3

Table 2. Component Matrix

	1	2	3
Martin	0.093	0.098	0.978
AF	0.215	0.937	0.201
TURN	0.213	0.962	-0.035
VOL	0.817	0.403	-0.021
DVOL	0.933	0.215	-0.097
AM	0.811	0.266	0.139
ILLIQ	0.887	-0.021	0.250

This function is the liquidity synthesis factor, and this indicator is negatively correlated with liquidity. This indicator reflects all the information of the primary liquidity index, which reflects the multi-dimensional nature of liquidity, and records this comprehensive liquidity factor as G.

3.2 Model design

This paper uses the method proposed by Fama and Macbeth (1973) to construct a portfolio to test whether the illiquidity factor G can explain the expected returns of stocks.

Portfolios are formed annually based on the information available at the start of the year: G and beta estimated over the prior period. At the end of a year, the sample stocks are ranked in five equal groups by the pre-ranking beta estimates. Each of these five beta groups is then divided into another five equal subgroups by ranking stocks based on their G. This results in 25 portfolios, as asset representatives, with almost equal numbers of stocks which are rebalanced every year.

To study the relationship between stock expected returns and illiquidity factor G, based on the Fama-Macbeth approach, cross-sectional model estimates are made for all portfolios for each month:

$$r_{it} - r_{ft} = \alpha_0 + \sum_{k=j}^{K} \beta_{ki} f_{kt} + e_{it} \tag{1}$$

$$r_{it} - r_{ft} = \delta_0 + \sum_{k=1}^{K} \lambda_{kt}\beta_{ki} + \sum_{j=i}^{J} \delta_{jt} Z_{ji,t-1} + \varepsilon_{it} \tag{2}$$

Where $r_{it} - r_{ft}$ is the excess return of stock i in t month, f_{kt} is the risk factor of t month, $Z_{ji,t-1}$ is the characteristic variable of stock i in the t-1 month.

4. Empirical analysis

4.1 Summary statistics

According to the time series diagram of illiquidity factor G, before the completion of the reform of non-tradable shares in 2006, the value of illiquidity indicator G was very large, indicating that the liquidity of China's a-share market was relatively poor at that time. With the implementation of the reform of non-tradable shares, the liquidity was significantly improved.

During the financial crisis, the liquidity of the stock market was impacted, and the illiquidity G increased significantly in 2008. By the end of 2008, the impact of the financial crisis gradually subsided. Until 2018, the value of illiquidity factor G was at a low level below 2.5, and the fluctuation was relatively smooth.

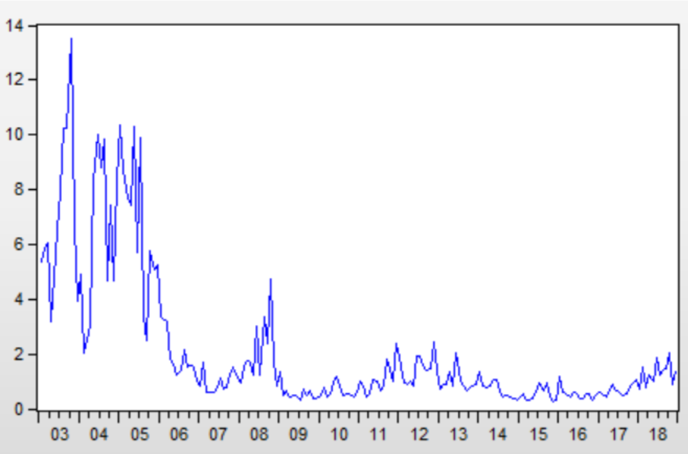

Fig 1. Time series of G

After grouping the sample stocks, summary statistics are carried out for 25 beta-G portfolios, and equalized weighted average values of illiquidity factor G, CAPM risk factor, expected return rate and size of each group were calculated.

Table 3. Summary Statistics for 25 Portfolios

G group	G, [Beta], <Returns>, (Size)					
	Beta group					
	Lowest	2	3	4	Highest	Mean
Lowest	0.474	0.563	0.561	0.615	0.514	0.545
	[0.659]	[0.909]	[1.051]	[1.196]	[1.476]	[1.058]
	<-0.011>	<-0.013>	<-0.009>	<-0.011>	<-0.007>	<-0.010>
	(3.777)	(3.673)	(3.550)	(3.498)	(3.586)	(3.617)
2	0.894	1.083	1.172	1.245	1.010	1.081
	[0.660]	[0.911]	[1.049]	[1.195]	[1.457]	[1.054]
	<-0.002 >	<-0.006 >	<-0.003>	<-0.003>	<-0.002>	<-0.003>
	(3.713)	(3.553)	(3.490)	(3.556)	(3.436)	(3.549)
3	1.4114	1.6599	1.804	1.883	1.585	1.669
	[0.658]	[0.909]	[1.051]	[1.197]	[1.446]	[1.052]
	<-0.001>	<-0.001>	<-0.002>	<0.002>	<0.000>	<-0.001>
	(3.693)	(3.470)	(3.446)	(3.509)	(3.437)	(3.511)
4	2.351	2.523	2.780	2.768	2.394	2.563
	[0.664]	[0.908]	[1.050]	[1.194]	[1.438]	[1.051]
	<-0.001>	<0.002>	<0.008>	<0.007>	<0.008>	<0.005>
	(3.593)	(3.405)	(3.417)	(3.520)	(3.447)	(3.477)
Highest	5.771	5.122	5.665	4.994	5.872	5.485
	[0.645]	[0.912]	[1.049]	[1.190]	[1.428]	[1.045]
	<-0.001>	<0.003>	<0.006>	<0.008>	<0.010>	<0.005>
	(3.599)	(3.392)	(3.213)	(3.487)	(3.512)	(3.441)
Mean	2.180	2.190	2.396	2.301	2.275	2.269
	[0.657]	[0.910]	[1.050]	[1.194]	[1.449]	[1.052]
	<-0.003>	<-0.003>	<0.000>	<0.000>	<0.002>	<-0.001>
	(3.675)	(3.499)	(3.423)	(3.514)	(3.484)	(3.519)

The lowest expected return belongs to the group with the lowest beta and lowest illiquidity, whereas the highest expected return belongs to the group with the highest beta and highest illiquidity, they are -1.06% and 1.01% respectively. As β increases, the risk increases, the expected return shows an incremental change, and the size does not have a significant change trend. As the illiquidity factor

G increases, the liquidity becomes worse and the liquidity risk increases, expected returns also show an increasing trend. At the same time, the company's scale is gradually decreasing, indicating that the liquidity of small companies is poor, and the expected returns are high.

In the asset pricing analysis below, liquidity risk factor LIQ is added into the Fama-French three-factor model to form the Fama-French model of liquidity adjustment. The construction of LIQ is similar to the construction of SMB in Fama and French (1993). At the start of each year, all common stocks are ranked based on their CAPM beta computed using the previous three to five years. Three portfolios based on the breakpoints for the bottom 30%, middle 40%, and top 30% of the values of beta. Then, within each beta portfolio, stocks are sorted based on their G at the start of the year and three additional portfolios are constructed: high liquid, medium liquid and low liquid. The breakpoints are the bottom 30%, middle 40%, and top 30% of the values of G for the stocks in the sample. The 9 portfolios are rebalanced at the start of each year based on the prior year's information. The mimicking liquidity factor, LIQ, is the monthly average return on the three (equally weighted) low-liquid portfolios minus the monthly average return on the three (equally weighted) high-liquid portfolios:

$$\mathrm{LIQ} = \frac{\frac{\mathrm{L\beta}}{\mathrm{iLiq}}+\frac{\mathrm{M\beta}}{\mathrm{iLiq}}+\frac{\mathrm{H\beta}}{\mathrm{iLiq}}}{3} - \frac{\frac{\mathrm{L\beta}}{\mathrm{Liq}}+\frac{\mathrm{M\beta}}{\mathrm{Liq}}+\frac{\mathrm{H\beta}}{\mathrm{Liq}}}{3} \tag{3}$$

4.2 Asset pricing tests

Cross-sectional regression analysis was performed on 25 portfolios over 3 sample periods. The liquidity risk factor LIQ was added to the Fama-French regression for asset pricing estimation.

$$r_{it} - r_{ft} = \alpha_0 + \beta_i^m(\mathrm{RM}-\mathrm{RF})_t + \beta_i^{smb}\mathrm{smb}_t + \beta_i^{hml}\mathrm{hml}_t + \beta_i^{liq}\mathrm{LIQ}_t + e_{it} \tag{4}$$

$$r_{it} - r_{ft} = \delta_0 + \lambda_m\beta_i^m + \lambda_{smb}\beta_i^{smb} + \lambda_{hml}\beta_i^{hml} + \lambda_{liq}\beta_i^{liq} + \delta_g G_{it-1} + \delta_s SIZE_{it-1} + \delta_{7-12}Ret7-12_{it-1} + \mu_{it} \tag{5}$$

Table 4. Liquidity Pricing Estimates

Specification								
Variable	1	2	3	4	5	6	7	8
Panel A: 2003/01—2018/12								
Intercept	-0.014 (-2.477)	-0.013 (2.352)	-0.007 (-0.971)	-0.012 (-2.211)	-0.009 (-1.160)	-0.009 (-1.119)	-0.018 (-3.701)	-0.0202 (-3.737)
β_i^m	0.002 (0.316)	0.002 (0.296)	0.003 (0.407)	0.002 (0.278)	0.003 (0.406)	0.003 (0.358)	0.008 (1.139)	0.000 (0.026)
β_i^{smb}	0.015 (2.602)	0.016 (2.643)	0.013 (2.171)	0.013 (2.118)	0.014 (2.333)	0.011 (1.868)		0.026 (4.518)
β_i^{hml}	-0.001 (-0.229)	-0.004 (-0.593)	-0.001 (-0.090)	0.001 (0.198)	-0.003 (-0.566)	-0.001 (-0.112)		-0.007 (-1.256)
β_i^{liq}	0.013 (5.583)	0.014 (4.667)	0.013 (5.381)	0.013 (5.472)	0.013 (4.587)	0.013 (4.461)		
G		-0.001 (-0.433)			-0.001 (-0.312)	0.000 (0.077)	0.006 (4.388)	0.002 (1.646)
Size			-0.002 (-1.325)		-0.0012 (-0.953)	-0.001 (-0.557)		
Ret7_12				-0.005 (-0.879)		-0.004 (-0.704)		
Panel B: 2003/01—2009/09								
Intercept	-0.029 (-3.264)	-0.030 (-3.399)	-0.020 (-1.872)	-0.028 (-3.211)	-0.021 (-1.878)	-0.024 (-2.030)	-0.028 (-3.332)	-0.034 (-3.943)
β_i^m	0.021	0.023	0.022	0.021	0.023	0.023	0.022	0.020

	(1.547)	(1.637)	(1.582)	(1.531)	(1.626)	(1.640)	(1.693)	(1.526)
β_i^{smb}	0.0156 (1.602)	0.016 (1.635)	0.014 (1.383)	0.014 (1.437)	0.015 (1.547)	0.015 (1.494)		0.022 (2.312)
β_i^{hml}	-0.005 (-0.531)	-0.010 (-0.940)	-0.005 (-0.492)	-0.002 (-0.240)	-0.011 (-1.056)	-0.009 (-0.847)		-0.011 (-1.081)
β_i^{liq}	0.008 (1.965)	0.008 (1.667)	0.008 (1.984)	0.008 (2.046)	0.009 (1.905)	0.011 (2.317)		
G		-0.001 (-0.697)			-0.001 (-0.966)	-0.002 (-1.333)	0.002 (1.433)	0.0003 (0.149)
Size			-0.002 (-1.103)		-0.002 (-1.102)	-0.001 (-0.480)		
Ret7_12				0.002 (0.256)		0.000 (0.015)		
Panel C: 2009/10—2018/12								
Intercept	-0.003 (-0.385)	-0.001 (-0.159)	0.003 (0.278)	-0.001 (-0.076)	0.000 (0.016)	0.002 (0.202)	-0.011 (-1.904)	-0.010 (-1.506)
β_i^{m}	-0.011 (-1.436)	-0.013 (-1.562)	-0.011 (-1.285)	-0.012 (-1.454)	-0.011 (-1.330)	-0.012 (-1.412)	-0.002 (-0.297)	-0.015 (-1.819)
β_i^{smb}	0.015 (2.057)	0.015 (2.090)	0.013 (1.673)	0.012 (1.548)	0.013 (1.741)	0.009 (1.158)		0.028 (4.082)
β_i^{hml}	0.002 (0.216)	0.001 (0.124)	0.003 (0.390)	0.004 (0.565)	0.002 (0.297)	0.006 (0.773)		-0.005 (-0.678)
β_i^{liq}	0.017 (6.253)	0.017 (5.032)	0.016 (5.897)	0.016 (5.933)	0.016 (4.650)	0.014 (3.974)		
G		-0.0003 (-0.137)			0.0002 (0.096)	0.002 (0.670)	0.0080 (4.3032)	0.003 (1.828)
Size			-0.001 (-0.785)		-0.001 (-0.312)	-0.001 (-0.322)		
Ret7_12				-0.010 (-1.476)		-0.007 (-1.026)		

During the whole sample period and the period after October 2009, the coefficient of illiquidity factor G is significantly positive, and the expected return of stocks is in direct proportion to the illiquidity level, and the more illiquidity is poor, the more excess returns will be obtained. Before the completion of the reform and during the financial crisis, liquidity was not good at explaining the expected earnings of stocks.

After the addition of scale risk factor, the coefficient and t statistic of illiquidity factor G decrease significantly, and the explanatory power of G is weakened, while the coefficient of scale risk factor is very significant. When the liquidity risk factor LIQ is added, the regression coefficient of G and t statistics significantly decrease, and the coefficient becomes negative, while the coefficient of liquidity risk factor LIQ is significantly positive, even in the period before September 2009. It indicates that liquidity risk has stronger explanatory ability than liquidity level. The addition of momentum hardly changes the regression results of illiquidity factor G or liquidity risk factor.

5. Conclusion

In this paper, 7 liquidity indicators were dimensionalized by principal component analysis, and the illiquidity factor G was constructed. The cross-sectional relationship between expected stock returns and liquidity in China's a-share market from 2003 to 2018 was analyzed by regression method of Fama and Macbeth. The whole sample period was divided into 2 subsamples with September 2009, and two control variables were added for comparative analysis. The results show:

Liquidity premium exists in China's a-share market. However, before the reform of non-tradable shares and the occurrence of financial crisis, the liquidity level of China's a-share market is low and fluctuates greatly, so the liquidity has a weak ability to explain the expected returns of stocks. Between October 2009 and December 2018, liquidity levels and liquidity risks have pricing power, and liquidity risks are more explanatory than liquidity levels. Size factor will affect the pricing power of liquidity level to some extent, the effects usually attributed to size are more accurately ascribed to liquidity costs. The addition of momentum hardly changes the regression results of illiquidity factor G or liquidity risk factor.

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