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Asset Pricing and Liquidity Risk in the Chilean Stock Market

Lamothe Fernández, Prosper
Vásquez Tejos, Francisco Javier

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Abstract

This paper studies whether or not a premium exists for the risk of liquidity in the Chilean stock market. Using the methodology in Fama and French (1993), liquidity risk factors are constructed on the basis of 4 indexes which evaluate various models. The results show the existence of a premium for liquidity risk, but this is captured by more than a liquidity risk factor.

Keywords:
Liquidity risk, Liquidity, Asset valuation.

JEL classification:
G12.

Lamothe Fernández, P. ✉ *Catedrático de Economía Financiera. Universidad Autónoma de Madrid. C/ Francisco Tomás y Valiente, 5 Carretera de Colmenar Viejo – km. 15,5 28049 Cantoblanco. Madrid.* ✆ *91 497 46 73. E-mail prosper.lamothe@uam.es*

Vásquez Tejos, F. J. Doctor en Ciencias Empresariales, Universidad Autónoma de Madrid. Director de Pugin y Koller Consultores (Chile). ✆ *91 497 46 88. E-mail: fra.vasquez@estudiante.uam.es fvasquez@puginykoller.cl*

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Valoración de activos y riesgo de liquidez **en el mercado de valores chileno**

Lamothe Fernández, Prosper
Vásquez Tejos, Francisco Javier

Resumen

Este artículo analiza la existencia o no de una prima por riesgo de liquidez en el mercado de acciones de Chile. En base a la metodología de Fama y French (1993), se construyen factores de riesgo de liquidez basados en cuatro índices, los cuales se valoran en base a varios modelos. Los resultados muestran la existencia de una prima por riesgo de liquidez, la cual se refleja en más de un factor de riesgo.

Palabras clave:

Riesgo de liquidez, liquidez, valoración de activos.

1. Introduction

Asset Valuation has been an ongoing concern and central to the study of finance for much of the twentieth century and the present. Obtaining the value of an asset is a major challenge, which involves a mixture of science, technology, art and good sense and professional ability.

Liquidity, a different type of (factor) risk has been largely ignored in asset valuation. Despite being first studied in the eighties by Amihud and Mendelson (1986), this topic still has to be assessed more accurately and incorporated into the management and valuation of investment portfolios. The relationship between valuation and liquidity is based on investors seeking higher returns on their investments because the lack of a counterpart is an additional risk they may face when wanting to liquidate their position.

The factor models are equations in which profit yields are divided into two or more components. A factor model specifies that each investment return risk is determined by:

- **i)** A small number of common factors
- **ii)** A risk component that is unique to the investment in question

For example, changes in the price of stock can be partially attributed to a set of macroeconomic variables (exchange rate, interest rate, etc.), which are factors that affect the prices of most shares. Moreover, the stock price changes can be also affected by specific factors (advertising campaign, business strategy, etc.). These components will be known as company-specific, affecting the company and not the profitability of other investments. Some of the factor models we list include: i) the market model; a simple factorial model of a single factor. Usually it's convenient to refer to this factor as the market factor and refer to the model as the market model. ii) The Capital Asset Pricing Model (CAPM) proposed by Sharpe (1964), Lintner (1965) and Black *et al.* (1972), is an equilibrium model that considers a single common risk factor in explaining the average return on assets. This factor is called the market portfolio which allegedly represents the profitability of the market as a whole and, in practice, is approximated by the return of an equity index. More specifically, the model establishes a positive linear relationship between the expected return of any asset and its covariance with the return of the market portfolio. This model is based on the following premises;

a) Investors cannot affect prices with individual negotiations
b) Investors plan a similar time horizon for their investments
c) Investors build portfolios from a universe of financial assets that are publicly traded
d) There are no transaction costs

e) Investors create portfolios intended to attempt to place them on the efficient border, ie they are optimizers (rational investors)
f) Investors have homogeneous expectations with financial assets and the market

iii) Arbitrage Pricing Theory (APT) proposed by Ross (1976) is a model in which an optimal portfolio will consist of those values that provide maximum return for the risk assumed, defined by its sensitivity to unexpected economic changes such as unpredicted changes in industrial production, the inflation rate and the term structure of interest rates. This model starts with the assumption that the profitability of each action depends partly on macroeconomic factors or influences and partly on events that are specific to that company. The APT requires four assumptions:

a) The returns can be described by a factor model
b) There are no arbitrage opportunities
c) There are a significant number of titles, which allows enough diversification to eliminate the specific company risk
d) Financial markets do not have frictions

iv) The model by Fama and French (1993); the expected return of a portfolio in excess of the risk-free rate is explained by the sensitivity of its return to three factors (1) the excess return on a portfolio of a wide market, (2) the difference between the return on a portfolio of stocks with low market capitalization and the return of a portfolio of stocks with high market capitalization (SMB, small minus big) and (3) the difference between the return of a portfolio with high book equity shares and the return of a portfolio of low book equity stocks (HML, high minus low). More specifically, the expected excess return of a portfolio or a stock i is:

$$E(r_i)-r_f = \beta_i^M \cdot E(r_{mt}-r_{ft})+= \beta_i^{SMB} \cdot E(SMB)+ \beta_i^{HML} \cdot E(HML) \quad (1)$$

2. Review of the Literature

Amihud and Mendelson (1986) used the bid-ask spread as a measure of liquidity and contrasted the relationship between stock returns and liquidity finding evidence consistent with the notion of a liquidity premium.

Chordia *et al.* (2000) focused their study on common factors that determine liquidity, rather than individual asset liquidity. They find that the illiquidity of individual assets is correlated with the illiquidity of the market, so the required return for an individual stock or portfolio should be increased with the risk of market liquidity.

Amihud (2002) showed that there is a positive relationship between stock returns and illiquidity and also found the size of the effect.

Pastor and Stambaugh (2003) investigated whether market liquidity had an effect on stock valuations. As the concept of liquidity is elusive and there is no consensus on an indicator, this study focuses on one aspect of liquidity associated with temporary price fluctuations caused by the flow of orders. They concluded that shares with greater sensitivity to the innovations in total cash yield higher expected returns.

Acharya and Perdersen (2005) developed a valuation model adjusted for liquidity, which is to derive a CAPM which is adjusted for the risk premium on the liquidity of the asset. The study found that the liquidity-adjusted CAPM explains the data better than the standard CAPM, maintaining the same degrees of freedom. Weak evidence was also found that liquidity risk is even more than the important effects of market risk and the level of liquidity. The model displays a reasonably good fit for portfolios, sorted by liquidity and changes in liquidity and size, but fails to explain the effect of book value.

Miralles and Miralles (2005) replicated for the Spanish market the research conducted by Acharya and Pedersen (2005) for the U.S. market. The results obtained largely coincided.

Martínez *et al.* (2005) analyzed empirically whether the average yields of the Spanish market varied with the betas estimated three-factor liquidity risk. The results showed that systematic liquidity risk is significant in obtaining prices on the Spanish stock market only when the betas are obtained from the relation between the response of prices to the volume traded.

Miralles and Miralles (2006) studied the relationship between illiquidity and asset valuation, especially if liquidity affects stock returns. In order to do so, they created a liquidity risk factor using the methodology by Fama and French (1993) and the ratio by Amihud (2002) as an indicator of liquidity. They concluded that liquidity risk is an important factor in explaining the cross-section of asset valuation.

Liu (2006) proposed a new indicator called "Adjusted-Turnover standardized by the number of days without activity", which is written as LMx, x corresponding to the period in months, for example 1 equals one month and 12 twelve months. Using the methodology by Fama and French (1993), Liu creates the risk factors SMB, HML, and LIQ. Finally, the author evaluates a two-factor model that captures liquidity risk better than the CAPM and the three-factor model by Fama and French (1993).

Dong *et al.* (2007) mainly evaluated the effect of an index or measure of resilience in the valuation of shares, in addition to evaluating the effect with other indices such as price range (spread) and depth (depth), which is done by conducting a cross-section in the time series. The results show evidence that resilience is negatively and significantly related to the profitability of the shares held.

Table 1. Summary of Previous Studies on Liquidity Risk and Asset Valuation

(T: transaction-based indicators; O: indicators based on orders and R: Resilience-based indicator).

Paper	Year	Type	Variable	Data	Conclusion
Amihud & Mendelson	1986	O	Orders	1960-1979 monthly	Return is a function of Price spread (Spread)
Chordia. Roll & Subrahmanyam	2000	T	Quantity	1966 - 1995 monthly	Negative relation between return and volatility and i liquidity
Amihud	2002	T	Price impact	1963 - 1997 daily and monthly	Illiquidity has a positive effect on return
Pastor & Stambaugh	2003	T	Price impact. Quantity	1966 - 1999 monthly	Positive premium for liquidity
Acharya & Pedersen	2005	T	Price impact	1962 - 1999 daily	CAPM adjusted for liquidity greater than the C APM
Martínez. Nieto. Rubio & Tapia	2005	T	Quantity	1991 - 2000 daily and monthlyl	The liquidity risk is significant in share valuationn in the Spanish stock market
Liu	2006	T	Quantity	1963 - 2003 daily and monthly	Liquidity risk has a price
Miralles & Miralles	2007	T	Quantity	1994 - 2002 daily and monthlyl	The liquidity risk can be an important element in valuing shares
Dong. Kempf & Yadav	2007	R	Price impact	2000 -2001 minute	Resilence is important valuing shares

SOURCE: AUTHORS

3. Methodology and Data

The objective is to determine the degree of explanation of liquidity risk in the valuation of shares in the Chilean stock market, in other words if the shares or low liquidity portfolios have an extra return for those with greater liquidity. That is, the paper aims to validate the hypothesis that: "There is a relationship between liquidity risk and asset (portfolios) valuation in the Chilean stock market."

In order to select the 36 stocks, we chose the shares that were traded on a continuous basis (at least about 70%) during the period specified above. Stocks and their main statistics are shown in Table 2.

To select the 36 stocks, the criterion used was to choose those shares that were traded on a continuous basis (at least about 70%) during the period specified above. Actions and their principal statistics shown in Table 2.

Table 2. Statistics of Selected Measures for the Formation of Portfolios
The presence is the percentage of days that the stock was traded for a total of 2,240 days of trading activity between 2000 and 2008.

N	Share	Average Monthly Return	Standard Deviation	Presence
1	ANDINA-B	-0.04%	7.56%	96%
2	ANTARCHILE	1.04%	5.66%	99%
3	BESALCO	0.42%	9.27%	94%
4	CALICHERAA	1.94%	10.31%	91%
5	CAP	1.67%	14.99%	98%
6	CEMENTOS	0.53%	8.44%	86%
7	CGE	0.26%	6.14%	95%
8	CMPC	0.48%	6.41%	100%
9	COLBÚN	1.18%	7.73%	100%
10	CONCHATORO	0.74%	7.93%	91%
11	COPEC	0.62%	5.92%	100%
12	CTC-A	-0.87%	8.91%	100%
13	D&S	-0.96%	16.10%	100%
14	EDELNOR	2.30%	14.42%	95%
15	ENDESA	0.89%	7.19%	100%
16	ENERSIS	-0.54%	8.10%	100%
17	ENTEL	0.65%	7.40%	100%
18	FALABELLA	0.88%	7.51%	100%
19	FASA	0.15%	8.36%	81%
20	GENER	0.47%	13.02%	87%
21	IANSA	-1.49%	12.64%	100%
22	INFORSA	0.20%	7.62%	89%
23	MADECO	-2.47%	12.53%	99%
24	ORO BLANCO	1.57%	10.39%	92%
25	PARAUCO	-0.14%	8.25%	89%
26	QUINENCO	0.31%	8.11%	95%
27	SAN PEDRO	-0.16%	8.03%	96%
28	VAPORES	0.53%	9.86%	78%
29	BANMEDICA	0.96%	6.92%	71%
30	CRISTALES	0.68%	7.60%	82%
31	GASCO	-0.18%	7.66%	87%
32	INVERCAP	2.15%	15.95%	83%
33	LAN	1.68%	9.05%	97%
34	MASISA	-1.55%	13.22%	99%
35	SOQUICOM	0.95%	9.43%	83%
36	ZOFRI	0.82%	10.41%	75%

SOURCE: AUTHORS

In order to evaluate the models outlined below, various risk factors are constructed using the methodology by Fama and French (1993) and subsequently the participation of liquidity risk in the valuation of shares is measured. Next, we describe the estimated factors:

i) *SMB* is the difference between the profitability of a portfolio comprised of small capitalization companies (*S* = Small) with a portfolio consisting of large capitalization companies (*B* = Big), i.e. a difference between the returns of small capitalization with large companies of large capitalization (Small Minus Big, SMB).

ii) *HML* is the difference between the return on a portfolio consisting of companies with high book value ratio on market value (*H* = High) with a portfolio consisting of companies with low book value ratio on market value (*L* = Low) i.e., a difference in profitability between companies and small cap high book (High Minus Low, *HML*).

iii) *IML* is the difference between the return on a portfolio consisting of companies with a high level of illiquidity (*I* = Iliquidity) with a portfolio composed of companies with high liquidity index (*L* = Liquidity), i.e. a profitability difference between illiquid companies (shares) minus liquid shares (Illiquidity Minus Liquidity, *IML*). This factor is calculated on the basis of four levels of liquidity

The factors were constructed as follows: the shares of the sample were sorted each year by market size from the smallest (Small) to the largest (Big), this according to the values of the last business day of December last year (t_{-1}). Subsequently, the two previous groups of shares (Big and Small) are ranked according to the size of book value over market value ratio at three levels: high (High), medium (Medium) and low (Low). Finally, according to the ratio of liquidity or illiquidity stocks are ordered from the most illiquid (*I*) to the most liquid (*L*). Each of the 36, shares will be classified in one of the following categories: *SHI* (Small, High and Illiquid), *SHL* (Small, High and Liquid), *SMI* (Small, Medium and Illiquid), *SML* (Small , Medium and Liquid), *SLI* (Small, Low and Illiquid), *SLL* (Small, Low and Liquid), *BHI* (Big, High and Illiquid), *BHL* (Big, High, and Liquid), *BMI* (Big, Medium and Illiquid), *BML* (Big, Medium and Liquid), *BLI* (Big, Low and Illiquid), *BLL* (Big, Low and Liquid).

Subsequently, portfolios were grouped according to the following characteristics: shares of companies with high market capitalization (*B*), shares of companies with small market capitalization (*S*), shares of companies with high book value ratio on market value (*H*) shares of companies with low book value ratio on market value (*L*), illiquid stocks (*I*) and liquid shares (*L*). For each portfolio simple monthly averages of yields were obtained and their risk factors estimated, the characteristics of which are shown in Tables 3 and 4.

Table 3. Statistics of risk factors, the monthly average daily return and standard deviations

	R_f	*SMB*	*HML*	*IML* (*LM*1)	*IML* (*ILLQ*)	*IML* (*IL*6)	*IML* (*IL*9)
Average	0.26%	-0.40%	-1.68%	0.68%	-0.35%	0.52%	0.77%
Desviation	4.74%	3.37%	4.10%	3.57%	3.32%	3.73%	3.51%

SOURCE: OWN CALCULATIONS

Table 4. Correlations between risk factors

	R_f	*SMB*	*HML*	*IML* (*LM*1)	*IML* (*ILLQ*)	*IML* (*IL*6)	*IML* (*IL*9)
R_f	1.00						
SMB	0.05	1.00					
HML	0.07	0.12	1.00				
IML (*LM*1)	-0.31	0.03	0.29	1.00			
IML (*ILLQ*)	-0.09	0.18	-0.25	-0.10	1.00		
IML (*IL*6)	-0.45	0.02	0.13	0.70	0.13	1.00	
IML (*IL*9)	-0.15	0.25	0.36	0.65	-0.13	0.63	1.00

SOURCE: OWN CALCULATIONS

As can be seen in Table 3, in addition to the factors Rim - R_f, *SMB* and *HML*, 4 liquidity risk factors are obtained, which were estimated using the methodology by Fama and French and the ratio (indicator) of liquidity risk, Amihud (2002), Liu (2006) and two indices proposed by Lamothe and Vásquez 2011 (*IL*6 and *IL*9). The market risk premium (*rmt*), the *HML* factor and Factor *IML* (*ILLQ*) have the expected sign, but the risk factors *SMB*, *IML* (*LM*1), *IML* (*IL*6) and *IML* (*IL*9) do not. Furthermore, we expected companies with small market capitalization to deliver better returns than those which are larger and in turn those with less liquid share holdings to deliver higher returns than those with greater liquidity.

Table 4 shows the correlations between risk factors. As we can see, correlations between risk factors are generally low and the correlations of risk factors of liquidity to the market risk factor are also low and negative. As for the correlation between risk factors for liquidity there is more diversity of high correlations and/or negative.

As mentioned, the objective is to determine whether the liquidity risk explains the profitability of stock returns (portfolios). In order to do so, monthly returns are used to ascertain whether the returns of 6 portfolios sorted by liquidity are explained by liquidity risk or whether the only relevant factor is the market risk.

Portfolios are ranked from the most liquid to the most illiquid, with portfolio 1 ($Rc1$) including the most liquid shares and so on until Portfolio 6 ($Rc6$) which gathers the most illiquid or least liquid shares. Market presence was used as the criterion to create a ranking, with portfolios $Rc1$, $Rc2$ and $Rc3$ actions, having more presence and $Rc4$, $Rc5$ and $Rc6$ those with less presence. Table No. 5 shows the average returns of portfolios sorted by presence.

Table 5. Performance is Average monthly sorted by Presence Stock Portfolios

	Rc1	Rc2	Rc3	Rc4	Rc5	Rc6
Presence	-0.03%	-0.13%	-0.79%	0.52%	0.60%	0.32%

SOURCE: OWN CALCULATIONS

With these portfolios the detailed models listed below are evaluated with a total of n = 108 monthly returns:

I) Market Model (CAPM);

$$r_{Ci,t} = \alpha_{Ci} + \beta_{rm} \times r_{m,t} + \varepsilon_t \quad (2)$$

II) Fama and French Model;

$$r_{Ci,t} = \alpha_{Ci} + \beta_{rm} \times r_{m,t} + \beta_{SMB} \times SMB_t + \beta_{HML} \times HML_t + \varepsilon_t \quad (3)$$

III) Model + 1 Market Liquidity Risk Factor (four models)

$$r_{Ci,t} = \alpha_{Ci} + \beta_{rm} \times r_{m,t} + \beta_{IML_{ILQ}} \times IML_{ILQ} + \varepsilon_t \quad (4)$$

$$r_{Ci,t} = \alpha_{Ci} + \beta_{rm} \times r_{m,t} + \beta_{IML_{LM1}} \times IML_{LM1} + \varepsilon_t \quad (5)$$

$$r_{Ci,t} = \alpha_{Ci} + \beta_{rm} \times r_{m,t} + \beta_{IML_{IL6}} \times IML_{IL6} + \varepsilon_t \quad (6)$$

$$r_{Ci,t} = \alpha_{Ci} + \beta_{rm} \times r_{m,t} + \beta_{IML_{IL9}} \times IML_{IL9} + \varepsilon_t \quad (7)$$

IV) Model + 4 Market Liquidity Risk Factors

$$r_{Ci,t} = \alpha_{Ci} + \beta_{rm} \times r_{m,t} + \beta_{IML_{ILQ}} \times IML_{ILQ} + \beta_{IML_{LM1}} \times IML_{LM1} \beta_{IML_{IL6}} \times IML_{IL6} \beta_{IML_{IL9}} \times IML_{IL9} + \varepsilon_t \quad (8)$$

V) Model of Fama and French + 1 Liquidity Risk Factor (four models);

$$r_{Ci,t} = \alpha_{Ci} + \beta_{rm} \times r_{m,t} + \beta_{SMB} \times SMB_{t-1} + \beta_{HML} \times HML_t + \beta_{IML_{ILQ}} \times IML_{ILQ} + \varepsilon_t \quad (9)$$

$$r_{Ci,t} = \alpha_{Ci} + \beta_{rm} \times r_{m,t} + \beta_{SMB} \times SMB_{t-1} + \beta_{HML} \times HML_t + \beta_{IML_{LM1}} \times IML_{LM1} + \varepsilon_t \quad (10)$$

$$r_{Ci,t} = \alpha_{Ci} + \beta_{rm} \times r_{m,t} + \beta_{SMB} \times SMB_{t-1} + \beta_{HML} \times HML_t + \beta_{IML_{IL6}} \times IML_{IL6} + \varepsilon_t \quad (11)$$

$$r_{Ci,t} = \alpha_{Ci} + \beta_{rm} \times r_{m,t} + \beta_{SMB} \times SMB_{t-1} + \beta_{HML} \times HML_t + \beta_{IML_{IL9}} \times IML_{IL9} + \varepsilon_t \quad (12)$$

VI) Model of Fama and French + 4 Liquidity Risk Factor

$$r_{Ci,t} = \alpha_{Ci} + \beta_{rm} \times r_{m,t} + \beta_{SMB} \times SMB_{t-1} + \beta_{HML} \times HML_t + \beta_{IML_{ILQ}} \\ \times IML_{ILQ} + \beta_{IML_{LM1}} \times IML_{LM1}\, \beta_{IML_{IL6}} \times IML_{IL6}\, \beta_{IML_{IL9}} \times IML_{IL9} + \varepsilon_t \qquad (13)$$

Where:

$r_{Ci,t}$, is the portfolio's return minus the risk free return (Rc - Rf).

α_{Ci} , is the intercept.

$r_{m,t}$, is the market return less risk free return (Rm - Rf). *SMB, HML, IML*, are the risk factors outlined above.

β , is the beta factor.

ε_t , is the error.

As a risk-free rate, the average IRR of the risk-free instruments traded on the Santiago Stock Exchange is used. The market return used corresponds to the profitability of the targeted price index of shares (IPSA).

4. Results

In order to perform the linear regressions of the 12 models, SPSS software was used and the results obtained by the models are as follows

The alpha (constant) models are mostly statistically equal to zero. Table 6 shows the results of the alpha models for the portfolios.

In general, the Durbin-Watson statistic was close to two (2) in all models, indicating no problems of serial correlation of the residues of the models. High values were also obtained in the F test, indicating that there is joint significance of the coefficients of the models and there were no problems of multicollinearity indicators according to IVF and Tolerance. The result of the betas for the different models were diverse. Only in model 1 are all the betas statistically significant, while the results of models 2 to 6 are varied, see Tables 7 to 12.

Table 6. Alpha (by model and portfolio)

Portfolio	Model 1		Model 2		Model 4		Model 6	
	alpha	t-statistic	alpha	t-statistic	alpha	t-statistic	alpha	t-statistic
1	-0.003	-1.144	-0.005	-1.684	-0.001	-0.434	-0.002	-0.589
2	-0.004	-1.138	-0.006	-1.642	-0.003	-0.864	-0.006	-1.508
3	-0.011	-2.974	-0.006	-1.576	-0.012	-3.20	-0.005	-1.343
4	0.003	0.683	0.006	1.546	-0.001	-0.221	0.001	0.216
5	0.003	0.774	0.003	0.815	0.000	-0.031	-0.004	-1.115
6	0.001	0.216	0.008	1.985	-0.006	-1.486	-0.002	-0.64

Portfolio	Model 3 ($LM1$)		Model 3 ($IL6$)		Model 3 ($IL9$)		Model 3 ($ILLQ$)	
	alpha	t-statistic	alpha	t-statistic	alpha	t-statistic	alpha	t-statistic
1	-0.002	-0.864	-0.002	-0.826	-0.001	-0.562	-0.002	-0.899
2	-0.004	-1.006	-0.002	-0.568	-0.002	-0.552	-0.005	-1.441
3	-0.012	-3.337	-0.011	-2.945	-0.012	-3.136	-0.011	-2.915
4	0.000	0.938	0.001	0.169	-0.001	-0.158	0.003	0.718
5	0.001	0.144	0.002	0.393	-0.001	-0.173	0.004	0.893
6	-0.005	-1.142	-0.002	-0.506	-0.005	-1.282	0.001	0.203

Portfolio	Model 5 ($LM1$)		Model 5 ($IL6$)		Model 5 ($IL9$)		Model 5 ($ILLQ$)	
	alpha	t-statistic	alpha	t-statistic	alpha	t-statistic	alpha	t-statistic
1	-0.004	-1.366	-0.004	-1.300	-0.002	-0.696	-0.004	-1.293
2	-0.006	-1.529	-0.003	-0.921	-0.003	-0.773	-0.008	-2.204
3	-0.007	-1.823	-0.005	-1.415	-0.005	-1.151	-0.005	-1.467
4	-0.001	0.385	0.003	0.898	0.002	0.417	0.006	1.514
5	-0.002	-0.526	0.001	0.215	-0.004	-0.914	0.003	0.769
6	-0.001	-0.173	0.004	1.052	0.000	0.001	0.007	1.782

SOURCE: OWN CALCULATIONS

Table 7. Beta for model 1 (by portfolio)

Portfolio	alpha	t-statistic
1	1.006	18.573
2	1.01	13.884
3	1.125	14.622
4	1.013	12.768
5	1.029	11.403
6	0.843	8.697

SOURCE: OWN CALCULATIONS

Table 8. **Beta for model 2 (by portfolio)**

Portfolio	Factor	Beta	t-statistic	Portfolio	Factor	Beta	t-statistic
1	$r_{m,t}$	1.01	18.742	4	$r_{m,t}$	0.992	13.321
	SMB	0.061	0.799		SMB	0.403	3.831
	HML	-0.116	-1.845		HML	0.099	1.145
2	$r_{m,t}$	1.021	14.077	5	$r_{m,t}$	1.013	12.862
	SMB	-0.134	-1.31		SMB	0.658	5.921
	HML	0.096	-1.139		HML	-0.16	-1.745
3	$r_{m,t}$	1.1	15.36	6	$r_{m,t}$	0.8	10.309
	SMB	0.319	3.16		SMB	0.79	7.215
	HML	0.221	2.649		HML	0.216	2.392

SOURCE: OWN CALCULATIONS

Table 9. **Beta for model 3 (by portfolio)**

Portfolio	Factor	Beta	t-statistic	Factor	Beta	t-statistic	Factor	Beta	t-statistic	Factor	Beta	t-statistic
1	$r_{m,t}$	0.985	17.296	$r_{m,t}$	0.96	15.952	$r_{m,t}$	0.986	18.47	$r_{m,t}$	1.02	19.278
	IML $(LM1)$	-0.091	-1.202	IML $(IL6)$	-0.13	-1.697	IML $(IL9)$	-0.186	-2.586	IML $(ILLQ)$	0.203	2.685
2	$r_{m,t}$	0.999	12.987	$r_{m,t}$	0.894	11.464	$r_{m,t}$	0.982	13.715	$r_{m,t}$	0.992	13.973
	IML $(LM1)$	-0.049	-0.477	IML $(IL6)$	-0.327	-3.301	IML $(IL9)$	-0.252	-2.61	IML $(ILLQ)$	-0.275	-2.714
3	$r_{m,t}$	1.172	14.63	$r_{m,t}$	1.132	13.071	$r_{m,t}$	1.137	14.623	$r_{m,t}$	1.127	14.524
	IML $(LM1)$	0.198	1.863	IML $(IL6)$	0.02	0.184	IML $(IL9)$	0.11	1.05	IML $(ILLQ)$	0.035	0.312
4	$r_{m,t}$	1.104	13.968	$r_{m,t}$	1.125	13.08	$r_{m,t}$	1.056	13.994	$r_{m,t}$	1.016	12.698
	IML $(LM1)$	0.386	3.67	IML $(IL6)$	0.315	2.882	IML $(IL9)$	0.392	3.846	IML $(ILLQ)$	0.046	0.401
5	$r_{m,t}$	1.116	12.169	$r_{m,t}$	1.123	11.275	$r_{m,t}$	1.084	12.866	$r_{m,t}$	1.04	11.49
	IML $(LM1)$	0.365	2.997	IML $(IL6)$	0.264	2.084	IML $(IL9)$	0.5	4.397	IML $(ILLQ)$	0.156	1.203
6	$r_{m,t}$	1.019	11.787	$r_{m,t}$	1.027	10.112	$r_{m,t}$	0.925	11.292	$r_{m,t}$	0.842	8.607
	IML $(LM1)$	0.75	6.521	IML $(IL6)$	0.519	4.02	IML $(IL9)$	0.754	6.816	IML $(ILLQ)$	-0.016	-0.112

SOURCE: OWN CALCULATIONS

Table 10. **Beta 4 for Model Portfolio**

Portfolio	Factor	Beta	t-statistic
1	$r_{m,t}$	0.987	16.643
	$IML\ (LM1)$	0.12	1.136
	$IML\ (ILLQ)$	0.208	2.648
	$IML\ (IL6)$	0.005	-1.133
	$IML\ (IL9)$	0.005	-1.55
2	$r_{m,t}$	0.922	12.158
	$IML\ (LM1)$	0.315	2.339
	$IML\ (ILLQ)$	-0.243	-2.416
	$IML\ (IL6)$	-0.325	-2.308
	$IML\ (IL9)$	-0.283	-2.19
3	$r_{m,t}$	1.125	12.903
	$IML\ (LM1)$	0.331	2.136
	$IML\ (ILLQ)$	0.118	1.022
	$IML\ (IL6)$	-0.266	-1.645
	$IML\ (IL9)$	0.082	0.552
4	$r_{m,t}$	1.093	12.813
	$IML\ (LM1)$	0.248	1.637
	$IML\ (ILLQ)$	0.128	1.131
	$IML\ (IL6)$	-0.054	-0.339
	$IML\ (IL9)$	0.287	1.97
5	$r_{m,t}$	1.057	11.272
	$IML\ (LM1)$	0.205	1.228
	$IML\ (ILLQ)$	0.301	2.425
	$IML\ (IL6)$	-0.299	-1.715
	$IML\ (IL9)$	0.596	3.725
6	$r_{m,t}$	0.957	10.763
	$IML\ (LM1)$	0.549	3.47
	$IML\ (ILLQ)$	0.173	1.468
	$IML\ (IL6)$	-0.258	-1.564
	$IML\ (IL9)$	0.592	3.905

SOURCE: OWN CALCULATIONS

Table 11. **Beta for model 5 (by portfolio)**

Portfolio	Factor	Beta	t-statistic	Factor	Beta	t-statistic	Factor	Beta	t-statistic	Factor	Beta	t-statistic
1	$r_{m,t}$	0.997	17.288	$r_{m,t}$	0.97	15.999	$r_{m,t}$	0.985	18.278	$r_{m,t}$	1.021	19.199
	SMB	0.061	0.803	*SMB*	0.064	0.846	*SMB*	0.104	1.358	*SMB*	0.024	0.312
	HML	-0.101	-1.52	*HML*	-0.1	-1.569	*HML*	-0.06	-0.916	*HML*	-0.078	-1.212
	IML (*LM*1)	-0.054	-0.672	*IML* (*IL*6)	-0.111	-1.429	*IML*) (*IL*9	-0.186	-2.337	*IML* (*ILLQ*)	0.175	2.183
2	$r_{m,t}$	1.019	13.115	$r_{m,t}$	0.908	11.518	$r_{m,t}$	0.991	13.584	$r_{m,t}$	1.001	14.247
	SMB	-0.134	-1.303	*SMB*	-0.125	-1.269	*SMB*	-0.084	-0.803	*SMB*	-0.068	-0.675
	HML	-0.095	-1.056	*HML*	-0.051	-0.618	*HML*	-0.032	-0.355	*HML*	-0.164-1939	
	IML (*LM*1)	-0.005	-0.047	*IML* (*IL*6)	-0.309	-3.07	*IML* (*IL*9	-0.217	-2.005	*IML* (*ILLQ*)	-0.312	-2.949
3	$r_{m,t}$	1.127	14.757	$r_{m,t}$	1.083	13.327	$r_{m,t}$	1.088	14.86	$r_{m,t}$	1.103	15.272
	SMB	0.319	3.151	*SMB*	0.321	3.16	*SMB*	0.34	3.252	*SMB*	0.31	2.976
	HML	0.191	2.173	*HML*	0.228	2.677	*HML*	0.246	2.752	*HML*	0.231	2.655
	IML (*LM*1)	0.108	1.02	*IML* (*IL*6)	-0.047	-0.453	*IML* (*IL*9	-0.086	-0.792	*IML* (*ILLQ*)	0.046	0.426
4	$r_{m,t}$	1.085	14.38	$r_{m,t}$	1.095	13.397	$r_{m,t}$	1.033	14.017	$r_{m,t}$	0.992	13.199
	SMB	0.399	4.002	*SMB*	0.394	3.862	*SMB*	0.332	3.163	*SMB*	0.403	3.718
	HML	-0.001	-0.007	*HML*	0.058	0.679	*HML*	0.009	0.105	*HML*	0.099	1.097
	IML (*LM*1)	0.368	3.521	*IML* (*IL*6)	0.282	2.701	*IML* (*IL*9	0.302	2.767	*IML* (*ILLQ*)	0	0.001
5	$r_{m,t}$	1.125	14.39	$r_{m,t}$	1.113	12.816	$r_{m,t}$	1.08	14.649	$r_{m,t}$	1.012	12.73
	SMB	0.654	6.323	*SMB*	0.65	5.989	*SMB*	0.542	5.162	*SMB*	0.662	5.783
	HML	-0.281	-3.117	*HML*	-0.2	-2.202	*HML*	-0.307	-0.191	*HML*	-0.164	-1.714
	IML (*LM*1)	0.447	4.128	*IML* (*IL*6)	0.276	2.484	*IML* (*IL*9	0.496	0.265	*IML* (*ILLQ*)	-0.019	-0.157
6	$r_{m,t}$	0.977	14.719	$r_{m,t}$	0.962	11.862	$r_{m,t}$	0.876	12.476	$r_{m,t}$	0.793	10.17
	SMB	0.784	8.926	*SMB*	0.777	7.665	*SMB*	0.659	6.582	*SMB*	0.813	7.242
	HML	0.025	0.324	*HML*	0.151	1.778	*HML*	0.049	0.568	*HML*	0.192	2.044
	IML (*LM*1)	0.704	7.662	*IML* (*IL*6)	0.445	4.3	*IML* (*IL*9	0.562	5.409	*IML* (*ILLQ*)	-0.111	-0.942

SOURCE: OWN CALCULATIONS

Table 12. **Beta for model 6 (by portfolio)**

Portfolio	Factor	Beta	t-statistic	Portfolio	Factor	Beta	t-statistic
1	$r_{m,t}$	0.99	16.552	4	$r_{m,t}$	1.093	13.324
	SMB	0.065	0.811		*SMB*	0.37	3.352
	HML	-0.045	-0.666		*HML*	-0.008	-0.091
	IML (*LM*1)	0.136	1.264		*IML* (*LM*1)	0.283	1.92
	IML (*ILLQ*)	0.181	2.168		*IML* (*ILLQ*)	0.024	0.209
	IML (*IL*6)	-0.115	-1.018		*IML* (*IL*6)	0.039	0.254
	IML (*IL*9)	-0.173	-1.555		*IML* (*IL*9)	0.103	0.671
2	$r_{m,t}$	0.932	12.264	5	$r_{m,t}$	1.083	13.209
	SMB	-0.018	-0.178		*SMB*	0.54	4.894
	HML	-0.128	-1.497		*HML*	-0.331	-3.584
	IML (*LM*1)	0.343	2.514		*IML* (*LM*1)	0.327	2.223
	IML (*ILLQ*)	-0.264	-2.488		*IML* (*ILLQ*)	0.085	0.742
	IML (*IL*6)	-0.349	-2.433		*IML* (*IL*6)	-0.211	-1.364
	IML (*IL*9)	-0.227	-1.604		*IML* (*IL*9)	0.443	2.897
3	$r_{m,t}$	1.106	13.531	6	$r_{m,t}$	0.957	13.418
	SMB	0.348	3.159		*SMB*	0.742	7.735
	HML	0.224	2.438		*HML*	-0.015	-0.183
	IML (*LM*1)	0.311	2.118		*IML* (*LM*1)	0.617	4.821
	IML (*ILLQ*)	0.068	0.594		*IML* (*ILLQ*)	-0.035	-0.353
	IML (*IL*6)	-0.144	0.353		*IML* (*IL*6)	-0.071	-0.529
	IML (*IL*9)	-0.175	0.252		*IML* (*IL*9)	0.222	1.671

SOURCE: OWN CALCULATIONS

5. Factor Analysis for Portfolios

The beta coefficients of the market risk premium were highly significant for all models and portfolios (99%) and the value of the coefficient always bordered 1. Out of a total of 36 factors, 100% proved to be significant.

In the case of factor *SMB* (small minus big), the situation was different. This factor is only present in models 2 - 5 and 6 and was found to be highly significant (99%) in all the cases in portfolios 3, 4, 5 and 6. However, this factor was not significant for portfolios 1 and 2. Out of the 36 factors, 12 were not significant while 24 were.

The situation of the factor *HML* (High minus Low) is less favorable than for the *SMB* factor. It (*HML*) is present in models 2, 5 and 6 and proved to be always significant in only two portfolios, namely 3 and 5, while in portfolio 4 this factor was never significant. Out of the 36 factors, 19 were not significant while 17 of them were.

As regards the *LM*1 factor, which is present in models 3, 4, 5 and 6, it is only significant in all cases in portfolio 6 and is not significant for any cases in portfolio 1. Out of the 24 factors, 9 were not significant while 15 of them were.

The *IL*6 factor which is present in models 3, 4, 5 and 6, is only significant for all models in portfolio 2. Out of the 24 factors, 12 were not significant while 12 were.

The *IL*9 factor, which is present in models 3, 4, 5 and 6, is only significant for all models in portfolios 5 and 6, but in the case of portfolio 3 it was not significant. Out of the 24 factors, 8 were not significant while 16 were.

The *ILLQ* factor, which is present in models 3, 4, 5 and 6, is only significant for all models in portfolios 1 and 2, but in the case of portfolios 3, 4 and 6 it was not significant. Out of the 24 factors, 15 were not significant while 9 were. This can be seen in Table 13.

Table 13. **Significance of the liquidity risk factor for Portfolio Models**

Model	Factor	*Rc*1	*Rc*2	*Rc*3	*Rc*4	*Rc*5	*Rc*6
1	R_m	99%	99%	99%	99%	99%	99%
2	R_m	99%	99%	99%	99%	99%	99%
3	R_m	99%	99%	99%	99%	99%	99%
4	R_m	99%	99%	99%	99%	99%	99%
5	R_m	99%	99%	99%	99%	99%	99%
6	R_m	99%	99%	99%	99%	99%	99%
2	*SMB*	No	No	99%	99%	99%	99%
5 + *LM*1	*SMB*	No	No	99%	99%	99%	99%
5 + *IL*6	*SMB*	No	No	99%	99%	99%	99%
5 + *IL*9	*SMB*	No	No	99%	99%	99%	99%
5 + *ILLQ*	*SMB*	No	No	99%	99%	99%	99%
6	*SMB*	No	No	99%	99%	99%	99%
2	*HML*	90%	No	99%	No	90%	95%
5 + *LM*1	*HML*	No	No	95%	No	99%	No
5 + *IL*6	*HML*	No	No	99%	No	95%	90%

5 + *IL9*	*HML*	No	No	99%	No	99%	No
5 + *ILLQ*	*HML*	No	90%	99%	No	90%	95%
6	*HML*	No	No	95%	No	99%	No
3	*LM1*	No	No	90%	99%	99%	99%
4	*LM1*	No	95%	95%	No	No	99%
5	*LM1*	No	No	No	99%	99%	99%
6	*LM1*	No	95%	95%	90%	95%	99%
3	*IL6*	90%	99%	No	99%	95%	99%
4	*IL6*	No	95%	No	No	90%	No
5	*IL6*	No	99%	No	99%	95%	99%
6	*IL6*	No	95%	No	No	No	No
3	*IL9*	95%	99%	No	99%	99%	99%
4	*IL9*	No	96%	No	90%	99%	99%
5	*IL9*	95%	95%	No	99%	99%	99%
6	*IL9*	No	No	No	No	99%	90%
3	*ILLQ*	99%	99%	No	No	No	No
4	*ILLQ*	99%	95%	No	No	95%	No
5	*ILLQ*	95%	99%	No	No	No	No
6	*ILLQ*	95%	95%	No	No	No	No

SOURCE: OWN CALCULATIONS

6. In search of a Model

If we chose a model from those studied so far without making any modifications, the analysis would not be complete. Therefore, making use of SPSS software features new tests were performed, where together with the factor of market risk premium ($r_{m,t}$) and the four risk factors ($LM1$, $IL6$, $IL9$ and $ILLQ$) the model was sought by the portfolio that best explains the relationship between the profitability of the portfolio risk factors. This analysis excluded *SMB* and *HML* factors because in previous models the results were not entirely satisfactory, as was the case with the factor of market risk premium ($r_{m,t}$). The results obtained are shown in Table 14.

Table 14. Best Models by Portfolio

Portfolio	Beta	Coefficient	t	sig	Low Limit	Upper Limit	R^2 Corrected	Durbin - Watson	F	Sig
1	Constant	-0.001	-0.412	0.681	-0.006	0.004	0.784	1.903	130.808	0.000
	$r_{m,t}$	1.000	19.028	0.000						
	$ILLQ$	0.179	2.387	0.019						
	$IL9$	-0.162	-2.278	0.025						
2	Constant	-0.003	0.873	0.384	-0.009	0.004	0.688	1.881	79.732	0.000
	$r_{m,t}$	0.886	11.634	0.000						
	$IL6$	-0.304	-3.127	0.002						
	$ILLQ$	-0.246	-2.513	0.014						
3	Constant	-0.011	-2.974	0.004	-0.018	-0.004	0.665	2.004	213.816	0.000
	$r_{m,t}$	1.125	14.622	0.000						
4	Constant	-0.001	-0.158	0.875	-0.008	0.007	0.648	2.241	163.021	0.000
	$r_{m,t}$	1.056	13.994	0.000						
	$IL9$	0.392	3.846	0.000						
5	Constant	-0.001	-0.173	0.863	-0.009	0.007	0.614	1.959	130.039	0.000
	$r_{m,t}$	1.084	12.866	0.000						
	$IL9$	0.500	4.397	0.000						
6	Constant	-0.006	-1.593	0.114	-0.014	0.001	0.617	2.163	58.537	0.000
	$r_{m,t}$	0.997	12.094	0.000						
	$IL9$	0.585	3.484	0.001						
	$LM1$	0.431	3.021	0.003						

SOURCE: AUTHORS

As shown in Table 14, the models are different, except for portfolios 4 and 5, in which the same factors coincide. All the beta coefficients of the models are significant; in the case of the factor for market risk premium the level of significance is 99% and for the liquidity risk factor it is between 95% and 99%. The market risk premium factor is the only one present in all models. The liquidity risk factor is altered; the $IL9$ factor is present in the models for portfolios 1, 4, 5 and 6, the $IL6$ factor is present in the model for portfolio 2, the $LM1$ factor is present in the model for Portfolio 6 and $ILLQ$ factor is present in the model for portfolios 1 and 2.

The models for portfolios 2 and 6 are the only ones that consider two liquidity risk factors each, the $IL6$ and $ILLQ$ factors in the case of portfolio 2 and the $IL9$ and LM1 factors in the case of portfolio 6.

The risk factors $LM1$ and $IL6$ are present in only one model, whereas the $IL9$ factor is present in 4 of the 6 models. Only the model for portfolio 3 sees no liquidity risk factor.

The combination of the above results are: the alphas (α) are not significant, the beta (β) are significant, high $R2$ corrected, there are no problems of collinearity or multicollinearity etc. which allows us to validate the hypothesis that there is a relationship between liquidity risk and valuation of assets (portfolios) in the Chilean stock market.

7. Conclusion

Two of the proposed liquidity ratios were selected for use in models to evaluate the principal hypothesis of this thesis in terms of both liquidity, trading activity and price impact. The selected indices were: the $IL6$ and the $IL9$. Additionally, we can add that both indices include a component of trading activity, the continuity of this transaction is by way of the presence of a parameter. This concept is incorporated by Liu (2006) in his index (LMx), but as days of no activity, while Amihud (2002) omits this parameter in his ratio of liquidity.

In general, the 6 models with their versions obtained high F test scores which is an indicator that there is a high level of joint significance of the coefficients of the model. The Durbin-Watson test on all models was close to 2, which is an indicator that there are no problems of serial correlation of the residues of the models. Nor would there be problems of multicollinearity indicators according to IVF and Tolerance. In addition, the adjusted $R2$ scores were all high, generally greater than 50%. This supports the validation of our hypothesis that there is a relationship between liquidity risk and valuation of assets (portfolios) in the Chilean stock market.

Model 1, which corresponds to the market model ($CAPM$), obtained highly significant beta coefficients for all portfolios (6 in total), whereas in Model 2 by Fama and French this does not happen for the beta coefficients of the SML and HML factors. This is an indication that the market model can be validated in the Chilean stock market in the period under study, but not the model by Fama and French (1993).

For all models studied, gross residues as typified have resulted in an established average value equal to zero. The normal probability graph (Annexes 1 to 6) indicates that the assumption of normality in the residuals is not a problem. Moreover, the graph of residuals against the predicted values indicates that we can accept the assumption of linearity of the model and equal variances (homoskedasticity).

The beta coefficients of the market risk factor (rmt) were significant in all models and for all portfolios, at 99%.

The beta coefficients of the size risk factor (*SMB*) were significant in all models but only in the most illiquid portfolios (3, 4, 5 and 6), all at confidence levels of 99%.

The beta coefficients of the size risk factor (*HML*) were significant in all models but only in portfolios 3 and 5 and at different levels of certainty (90%, 95% and 99%).

The beta coefficients of the liquidity risk factor (*LM*1) were significant in all models only in portfolios 6, at a confidence level of 99%.

The beta coefficients of the liquidity risk factor (*IL*6) were significant in all models only in portfolios 2, but at different levels of certainty (95% and 99%).

The beta coefficients of the liquidity risk factor (*IL*9) were significant in all models, but only in portfolios 5 and 6 (the most illiquid), almost all displaying 99% confidence levels (except one at 90%).

The beta coefficients of the liquidity risk factor (*ILLQ*) were significant in all models, but only in portfolios 1 and 2 (the most liquid) and at different levels of certainty (95% and 99%).

When looking for the best portfolio model, all considered the market risk factor (rmt) plus one or two liquidity risk factors, with the exception of portfolio 3, which only considered the market risk factor. For most liquid portfolios, the liquidity risk factors that best explained the performance of the portfolio were: *ILLQ*, *IL*6 and *IL*9. For the most illiquid portfolios the liquidity risk factors that best explained the performance of the portfolio were: *IL*9 and *LM*1.

The liquidity risk factor that best explains the stock returns in conjunction with the market risk factor is the risk factor *IL*9, as it is present in 4 of the 6 models obtained by portfolio. This factor (*IL*9) performs even better when it comes to illiquid portfolios (4, 5 and 6). In contrast, the factor index developed by Amihud (*ILLQ*) is present in 2 of the 6 models while the factor index developed by Liu (LM1) is present in only 1 of the 6 models.

The liquidity index (*IL*9) probably performs better because of the incorporation of price impact by means of the index of price spread, which is ignored in the ratios by Amihud (*ILLQ*) and Liu (*LM*1).

Therefore, we conclude that there is a value for liquidity risk in the Chilean stock market, but this is not captured by a single factor (created by an index of liquidity risk), but by a set of factors, such as the *ILLQ* of Amihud, *LM*1 of Liu and the proposed *IL6* and *IL9* indices. That is, we can validate the hypothesis that there is a relationship between liquidity risk and asset valuation in the Chilean stock market.

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