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AN EMPIRICAL ANALYSIS OF THE SYSTEMATIC LIQUIDITY RISK IN THE SPANISH STOCK MARKET*

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Abstract

The main object of this study is to construct a liquidity risk factor and analyze its impact on asset pricing for the Spanish stock market over the 1994-2002 period. We generated this factor using the Fama and French (1993) orthogonal approach and analyzed if it must be included as an augmented variable on the stochastic discount factor. Moreover, and because of the absence of consensus in empirical research about the most appropriate liquidity measure, we applied the illiquidity ratio, proposed by Amihud (2002) for the American stock market that computes the price response associated with one currency of trading volume.

KEYWORDS: asset pricing, systematic liquidity, illiquidity ratio.

1. INTRODUCTION

Liquidity is an important attribute of assets which influences investors' portfolio decisions caused by its close relation to transactions costs. It's reasonable to think that investors who buy illiquid assets require higher expected returns for their inversions. Then, the lack of liquidity can be interpreted as an additional risk.

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However, the question whether liquidity affects or not asset returns remain unresolved thus far. Amihud and Mendelson (1986) were one of the first to examine the role of liquidity in asset pricing. They analyzed the relationship between stock returns and the bid-ask spread and found empirical evidence related to the existence of liquidity premium. However, Eleswarapu and Reinganum (1993), extending the sample period ten years, examined the effect of seasonality on the bid-ask spread and returns. They found that the relationship between the bid-ask spread and asset returns are mainly limited to the month of January. Brennan and Subrahmanyam (1996) carried out later a new analysis. Separating the cost of transacting into a variable and fixed cost, they did not find empirical evidence of seasonality in liquidity premium but weak evidence of the Amihud and Mendelson (1986) model.

Previous research for the Spanish stock market tends to show quite similar results to those traditionally reported for the US market. Tapia (1997) analyzes the seasonality of liquidity premium on 1990-1994 period considering the influence of trading by fiscal reasons. The main results of this work indicate the existence of a differential behavior of the liquidity premium, but not for asset with more probability of trading by fiscal reasons. Moreover, when he includes the size variable, his results are weaker. Rubio and Tapia (1998), employing a similar methodology from Brennan and Subrahmanyam (1996), provide additional evidence on the relationship between the bid-ask spread and stock returns, analyzing the effect of seasonality. The results provide a positive liquidity premium in January, although non-significant statistically. Nevertheless, the most complete study for the Spanish stock market about the bid-ask spread is due to Blanco (1999). This work is based on the influence of minimum variation in prices on the bid-ask spread. He argues that the bid-ask spread underestimates the temporal and cross-sectional movements in liquidity.

Given the lack of robustness of empirical results several investigators have re-examined the relationship between liquidity and asset returns using alternative measures of liquidity that allow us to approach the concept of liquidity employed by investors in their financial decisions[1]. In this sense, an amount number of papers has focused on the use of liquidity measures based on trading activity, such as the trading volume (Brennan, Chordia, and Subrahmanyam, 1998), turnover (Datar, Naik, and Radcliffe, 1998) or illiquidity ratio (Amihud, 2002), that allow to obtain longer time series of observations and to check the robustness of the empirical results.

In this sense, we have to point out the studies of Chan and Faff (2002), Martínez, Nieto, Rubio, and Tapia (2002), and Pastor and Stambaugh (2003), that analyze the asset pricing implications of a systematic liquidity risk factor.

[1] See Aitken and Comerton-Forde (2003), who focus the analysis on different measures of liquidity.

Those studies are based on contributions of Chordia, Roll, and Subrahmanyam (2000) of fluctuations in various measures of liquidity are significantly correlated across common stocks. Related to this study, the works of Lo and Wang (2000), Hasbrouck and Seppi (2001), and Gibson and Mougeot (2003) also analyze the systematic nature of market liquidity.

Following these two current ways of research, the main object of this study is to construct a risk factor based on liquidity and to analyze pricing implications for the Spanish stock market over the 1994-2002 period. We generate a liquidity factor employing the orthogonal approach procedure of Fama and French (1993) and analyze whether it must be included as an augmented variable on the stochastic discount factor. Another main contribution of this study is the use of an alternative measure of liquidity based on trading activity of common stocks, the illiquidity ratio suggested by Amihud (2002), that can be interpreted as the daily price response associated with one euro of trading volume.

The rest of the paper is organized as follows. Section 2 describes the measure selected to capture the illiquidity of common stocks. Section 3 describes the data base employed. Section 4 reports the empirical analysis and results. Finally, section 5 concludes.

2. THE ILLIQUIDITY MEASURE

Liquidity is a broad and elusive concept that generally denotes the ability to trade large quantities quickly, at low cost, and without moving the price (Pastor and Stambaugh, 2003), but liquidity is not an observable variable. Exist many proxies for liquidity, such as the bid-ask spread, are based on market microstructure data, which are not available for a time series as long as is usually desirable for studying the effect on expected returns. In contrast, the illiquidity measure used in this study is calculated from daily data on returns and volume that are readily available over long periods of time for most markets.

Following previous studies for the US market reported by Amihud (2002) and Acharya and Pedersen (2003), we apply for our empirical analysis the "illiquidity ratio" as the best proxy measure of illiquidity that computes the price response associated with one euro of trading volume.

The illiquidity ratio of stock *i* in month *t* is calculated as (1),

$$IL_{it} = \frac{1}{D_{it}} \cdot \sum_{d=1}^{D_{it}} \frac{|R_{itd}|}{V_{itd}} \tag{1}$$

where R_{itd} and V_{itd} are, respectively, the return and dollar volume on day *d* in month *t*, and D_{it} is the number of valid observation days in month *t* for stock *i*.

The intuition behind this illiquidity measure is as follows. A stock is illiquid, that is, has a high value of IL_{it}, if the stock's price moves a lot in response to little volume.

This measure is interpreted as the daily stock price reaction to one euro of trading volume. Following Amihud (2002), IL_{it} can also be interpreted as a measure of consensus belief among investors about new information. Thus, when investors agree about the implication of news, the stock price changes without trading while disagreement induces increase in trading volume.

Finally, it should be pointed out that this measure can be easily obtained from databases that contain daily data on stock return and volume. This makes it available for most stock markets and enables to construct a time series of illiquidity over a long period of time, which is necessary for the study of the effects of illiquidity over time. Moreover it allows checking the robustness of the available results.

3. DATA

Data employed in this study are daily prices and trading volume of all stocks traded on the Spanish stock market from January 1994 through December 2002. These daily data are employed for the monthly calculation of firms' illiquidity ratios.

Once estimated individual illiquidity ratios, the following step consists in the construction of 10 illiquidity-based sorted portfolios according to the average illiquidity value of each security at the previous year. C1 includes the stocks with the smallest illiquidity ratio within the sample and C10 contains the stocks with the largest illiquidity ratio within the sample. Afterwards, are calculated portfolio returns giving equal weight to each asset within the portfolio. These are the portfolio returns which will be employed in testing the illiquidity-based asset pricing models in the next sections.

Asset return in month *t* is calculated as the relative spread between its price in month *t* and in month *t*-1, adjusted by dividends and IPOs. The return of the market is an equally-weighted portfolio comprised of all stocks available either in a given month of the sample while the monthly Treasury Bill rate observed in the secondary market is used as the risk-free rate.

In order to construct the Fama-French risk factors, we also used the number of shares traded at the end of each sample year and the accounting information from the balance sheets of each firm at the end of each sample year. The book value for any firm in month *t* is given by its value at the end of the previous year, and it remains constant from January to December. The market value is given by total capitalization of each company in the previous month. Then, the book-to-market ratio in all months of year *t* is calculated by dividing the book value at the end of December in previous year by the market value at that date.

4. SYSTEMATIC ILLIQUIDITY VERSUS STOCK RETURNS

The absence of concluding results in previous empirical research suggests that asset pricing and liquidity have not been properly addressed in the standard literature. We should not regress common stock returns on individual characteristics of liquidity but rather on a proxy for a liquidity factor reflecting aggregate (market-wide) liquidity restrictions. In this paper, we examine the role of illiquidity, proxied by Amihud's ratio, as an additional factor in asset pricing. This analysis is carried out within the context of the time-series version of the Fama and French three-factor model.

4.1. Commonality in illiquidity

Following Chordia, Roll and Subrahmanyam (2000), and as a natural and simple first step on our empirical expedition, we calculate simple "market model" time series regressions. Monthly percentage changes in illiquidity variables for portfolio regressed on market measures of illiquidity, i.e.,

$$DIL_{jt} = a_j + b_j DIL_{mt} + e_{jt} \tag{2}$$

where DIL_{jt} is, for portfolio j, the percentage change from trading month t-1 to t in illiquidity variable, and DIL_{mt} is the concurrent change in a cross-sectional average of the same variable.

The main results from these regressions are reported in Table 1. The estimated coefficient $\hat{b}_j$ measures the assets illiquidity–sorted in portfolios- sensibility to the market shocks in illiquidity. The sensitivity of changes in the illiquidity ratio to changes in the aggregate illiquidity measure is positive and significantly different from zero for all portfolios. This indicates the existence of commonality in illiquidity for the Spanish stock market. Portfolios illiquidity move with market illiquidity, mainly portfolios constituted by assets with the highest illiquidity ratio. Based on these results, we may expect a higher return on stocks highly and positively sensitive to systematic adverse liquidity shocks.

4.2. Illiquidity-based risk factor construction

Based on previous results, fluctuations in illiquidity are significantly correlated across common stocks. It may be the explanation for the absence of consensus in previous empirical evidence, characterized by the analysis of cross-sectional liquidity variable effects on asset expected returns. In this sense, we propose the construction of an illiquid-based risk factor in a Fama and French (1993) framework through the formation of mimicking portfolios. This illiquidity mimicking factor is created by obtaining the mean return on a set of illiquid stock portfolios (*I*) minus (*M*) the mean return on a set of very liquid (*V*) stock portfolios, named *IMV* (illiquid minus very liquid)[2].

For the size and book-to-market portfolio formation procedure, we follow Fama and French (1993). At the end of December in year *t*-1, the companies are ranked on size and partitioned into small (*S*) and big (*B*) companies. Then, the sample companies are ranked on book-to-market and partitioned into three groups, high (*H*), medium (*M*) and low (*L*). Finally, the illiquidity ratio is used to rank companies into very liquid (*V*), moderately liquid (*N*) and illiquid (*I*) companies. We take the average of twelve monthly illiquidity ratios as our measure of the company's illiquidity throughout the year *t*-1 to avoid the possible effect of seasonality.

Based upon the independent sorts and ranking procedure in year *t*-1, we construct eighteen portfolios from the intersection of the two size, three book-to-market and three illiquidity groups (*S/L/V, S/L/N, S/L/I, S/M/V, S/M/N, S/M/I, S/H/V, S/H/N, S/H/I, B/L/V, B/L/N, B/L/I, B/M/V, B/M/N, B/M/I, B/H/V, B/H/N, B/H/I*).

Following the procedure developed by Fama and French (1993), the size factor *SMB* (small minus big) is created as the difference each month between the simple averaged of the returns on the nine small company portfolios (*S/L/V, S/L/N, S/L/I, S/M/V, S/M/N, S/M/I, S/H/V, S/H/N, S/H/I*) and the simple averaged of the returns on the nine big company portfolios (*B/L/V, B/L/N, B/L/I, B/M/V, B/M/N, B/M/I, B/H/V, B/H/N, B/H/I*).

The book-to-market factor *HML* (high minus low) is generated as the difference each month between the simple averaged of the returns on the six high book-to-market company portfolios (*S/H/V, S/H/N, S/H/I, B/H/V, B/H/N, B/H/I*) and the simple averaged of the returns on the six low book-to-market company portfolios (*S/L/V, S/L/N, S/L/I, B/L/V, B/L/N, B/L/I*).

Then, the illiquidity factor *IMV* (illiquid minus very liquid) is created as the difference each month between the simple averaged of the returns on the six illiquid company portfolios (*S/L/I, S/M/I, S/H/I, B/L/I, B/M/I, B/H/I*) and the simple averaged of the returns on the six very liquid company portfolios (*S/L/V, S/M/V, S/H/V, B/L/V, B/H/V*). The advantage of this construction is that each factor is formed while controlling for the effect of the others.

We first calculate the usual descriptive statistics of the factors employed in this research. Table 2 reports the average characteristics of the distribution of the market return factor, the Fama-French factors, and the illiquidity-based systematic factor. The correlation coefficients between them are presented in Panel B. As we can prove, the correlations between three last factors are low and correlation with the market factor is quite similar to previous results shown for the Spanish market

[2] As suggested by Chan and Faff (2002).

(Menéndez, 2000; Nieto, 2001; Martínez, Nieto, Rubio and Tapia, 2002; and López and Marhuenda, 2003).

4.3. Comparison of alternative risk specifications

The approach employed to investigate the role of an illiquidity factor in asset pricing is as follows. First of all, we analyze the standard CAPM model for the 10 illiquid-based portfolios. However, we also analyze the available results proportionate by the Fama and French three-factor model[3]. Finally, we test the standard CAPM and Fama and French three-factor asset pricing model augmented by the illiquidity factor.

$$r_{jt} = \alpha_j + \beta_{jm} \cdot r_{mt} + \varepsilon_{jt} \tag{3}$$

$$r_{jt} = \alpha_j + \beta_{jm} \cdot r_{mt} + \beta_{jsmb} \cdot SMB_t + \beta_{jhml} \cdot HML_t + \eta_{jt} \tag{4}$$

$$r_{jt} = \alpha_j + \beta_{jm} \cdot r_{mt} + \beta_{jimv} \cdot IMV_t + u_{jt} \tag{5}$$

$$r_{jt} = \alpha_j + \beta_{jm} \cdot r_{mt} + \beta_{jsmb} \cdot SMB_t + \beta_{jhml} \cdot HML_t + \beta_{jimv} \cdot IMV_t + v_{jt} \tag{6}$$

where r_{jt} is the excess return on portfolio *j*, r_{mt} is the excess return on the market portfolio, SMB_t is the mimicking portfolio for the size factor, HML_t is the mimicking portfolio for the book-to-market factor, and IMV_t is a mimicking portfolio for the illiquidity factor, α_j is the intercept of portfolio *j*, and β_{jm}, β_{jsmb}, β_{jhml} and β_{jimv} are the sensitivities to the risk factors.

In order to mitigate the errors-in-variable problem, we chose the generalized method of moments (GMM) approach of MacKinlay and Richardson (1991). Our estimation technique employs heteroskedasticity and autocorrelation consistent covariance matrices and following Ferson and Foerster (1994) uses an iterated procedure[4]. Moreover, we analyze whether intercepts in the regressions above are jointly equal to zero using Wald test. This parametric statistic has an asymptotic $\chi^2(q)$ distribution, where *q* is the number of restrictions under the null hypothesis.

As reported in Table 3, we employ four alternative pricing models. The standard CAPM, the three-factor Fama and French model, and two illiquidity-based models in which we add the illiquidity factor to the CAPM and the Fama-French models. We report the alphas for each illiquidity portfolio. Moreover, in the last row, we

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[3] There are several reasons to considerate this model in the empirical analysis. Firstly, the previous evidence for the Spanish market has found that the coefficient on beta is non-significant and, in some cases, negative. These are the works of Rubio (1988, 1991), Gallego, Gómez and Marhuenda (1992), and Sentana (1995, 1997). Secondly, the evidence shows that companies with higher book-to-market and smaller size earn large risk-adjusted returns (Gómez and Marhuenda, 1998; Menéndez, 2000; and Miralles and Miralles, 2003).

[4] More exhaustive description for this approach system may be found in Marin and Rubio (2001).

show the available results of the Wald test that analyze the null hypotesis of absence of abnormal jointly return. This test also indicates the risk specification more adequate for the Spanish market.

The results indicate that, for all asset pricing models considered, except the Fama and French three-factor model, the risk-adjusted average return (alpha) of the C10 portfolio is significantly higher than the alpha for the C1 portfolio. Average risk-adjusted returns of stocks with high liquidity exceed those for stocks with low liquidity. Pastor and Stambaugh (2003) interpret the result as the average liquidity premium existing in the US market.

The Wald test is rejected with a significant level of 5% for all asset models considered except the third, the illiquidity-based CAPM. It is relevant to point out that, using these portfolios, and adding the illiquidity factor to the CAPM we obtain the best risk specification.

We may conclude that, within a time-series context, this paper presents evidence showing that an illiquidity risk factor plays a relevant role in explaining the average returns in the Spanish market.

5. CONCLUSIONS

In this paper, we examine the asset pricing role of liquidity, proxied by Amihud's ratio, in the context of the standard CAPM and the Fama and French three-factor models. The motivation for our study is provided by the growing interest in liquidity that has emerged in the asset pricing literature over recent years.

In this context, we have employed a simple but intuitive measure of stock illiquidity defined as the ratio of absolute return to one euro trading volume. Moreover, we have analyzed the role of illiquidity as an additional factor in asset pricing. Then, we generated a mimicking portfolio for illiquidity by extending the approximately orthogonalizing procedure of Fama and French (1993). So each factor was formed while controlling for the effect of the others. Finally, we used a generalized method of moments (GMM) system approach to overcome the errors-in-variables problem.

Our results support the recent evidence found with US market data and allow us to affirm that aggregate illiquidity should be a key ingredient of asset pricing models. These results indicate that time varying expected excess asset returns can be explained by an illiquidity-based CAPM model.

However, it must be recognized that our sample period is short in comparison to the available evidence on asset pricing. The results should be taken as valid just for the period being studied, and more general conclusions should be left for future research when longer series of data will be readily available.

Finally, the observed results are suggestive of further empirical work. In particular, it would be of interest to explain the cross-sectional variation in illiquidity.

TABLE 1

Commonality in illiquidity

	Beta slope	t-statistic	R^2 Adjusted
C1	0.253	2.410	0.036
C2	0.296	6.595	0.216
C3	0.273	4.537	0.112
C4	0.485	5.046	0.137
C5	0.274	4.011	0.089
C6	0.217	3.202	0.056
C7	0.249	3.269	0.059
C8	0.460	5.288	0.149
C9	0.404	6.114	0.191
C10	1.195	21.53	0.751

This table reports the slope of equation (2) that represents. for each illiquidity-based portfolio. the sensibility of changes in the illiquidity ratio to changes in the aggregate illiquidity measure. The third column reports the t-statistic of individual significance. Finally. we reports the adjusted R^2 for each regression.

TABLE 2

Descriptive statistics and correlation across risk factors

	Panel A: Descriptive statistics			
	Mean	Volatility	Skewness	Kurtosis
MKT	0.8762	6.2296	-0.0023	3.9763
SML	-0.1982	3.5307	0.7985	3.7127
HML	0.2866	3.2991	0.6307	3.4945
IMV	0.2118	11.043	0.9130	6.0562
	Panel B: Correlation coefficients			
	MKT	SML	HML	IMV
MKT	1.000	0.304	0.287	0.122
SML		1.000	0.077	0.219
HML			1.000	0.155
IMV				1.000

Panel A reports the mean. volatility. skewness. and kurtosis for the excess market return (MKT) and for the mimicking portfolio factor returns of size (SMB). book-to-market (HML) and illiquidity (IMV). Panel B reports correlation coefficients between them.

TABLE 3

Comparison of alternative risk specifications

	CAPM alphas	Fama-French alphas	CAPM+IMV alphas	FF+IMV alphas
C1	0.382 (1.08)	0.602 (1.94)	0.296 (1.00)	0.249 (0.88)
C2	0.840 (2.79)	1.064 (4.49)	0.769 (2.74)	0.873 (3.22)
C3	-0.717 (-2.08)	0.454 (1.22)	-0.657 (-2.29)	-0.557 (-1.96)
C4	-0.299 (-0.86)	0.355 (0.84)	-0.265 (-0.73)	-0.155 (-0.36)
C5	-0.532 (-1.56)	-0.599 (-1.75)	-0.393 (-1.25)	-0.423 (-1.14)
C6	-0.195 (-0.63)	-0.475 (-1.43)	-0.087 (-0.30)	-0.299 (-0.99)
C7	0.011 (0.02)	0.223 (0.61)	-0.038 (-0.08)	-0.205 (-0.43)
C8	-0.072 (-0.25)	-1.049 (-3.48)	-0.067 (-0.29)	-0.383 (-1.54)
C9	-0.164 (-0.40)	-0.205 (-0.53)	-0.144 (-0.45)	0.123 (0.33)
C10	0.774 (1.72)	-0.329 (-0.66)	0.610 (1.68)	0.803 (1.85)
χ^2 p-value	22.673 0.012	36.765 0.000	15.276 0.122	18.581 0.045

This table reports the available results employing four asset pricing models: the standard CAPM model. the Fama-French three factors models. and both of them augmented by an illiquidity risk factor. named IMV. The result reported is the average risk-adjusted return. estimated by the alpha coefficient. In parentheses we report the *t*-statistic of individual significance. The last row reports the Wald test that analyzes whether alpha coefficients are jointly equal to zero.

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