XII IBERIAN-ITALIAN CONGRESS OF FINANCIAL AND ACTUARIAL MATHEMATICS

JULY 2011, LISBON

THE ROLE OF AN ILLIQUIDITY FACTOR IN THE PORTUGUESE STOCK MARKET

José Luis Miralles Marcelo
Department of Finance and Accounting, University of Extremadura,
Av. Elvas s/n 06071, Badajoz, Spain
Phone: (+34) 924 28 95 10, Fax: (+34) 924 27 25 09
E-mail: jlmiralles@unex.es

María del Mar Miralles Quirós
Department of Finance and Accounting, University of Extremadura,
Av. Elvas s/n 06071, Badajoz, Spain
Phone: (+34) 924 28 95 10, Fax: (+34) 924 27 25 09
E-mail: marmiralles@unex.es

Célia Oliveira
Polytechnic Institute of Leiria, School of Technology and Management
Morro do Lena - Alto Vieiro, P.O. Box 4163, 2411-901 Leiria, Portugal
Phone: (+351) 244 820 300, Fax: (+351) 244 820 310
E-mail: celia.oliveira@ipleiria.pt

Abstract

This study examines the role of illiquidity (proxied by the proportion of zero returns) as an additional risk factor in asset pricing. We use Portuguese monthly data, covering the period between January 1988 and December 2008. We compute an illiquidity factor using the Fama and French [Fama, E. F., and K. R. French (1993), "Common risk factors in the returns on stocks and bonds", *Journal of Financial Economics*, Vol. 33, Nº. 1, pp. 3-56] procedure and analyze the performance of CAPM, Fama-French three-factor model and illiquidity-augmented versions of these models in explaining both the time-series and the cross-section of returns. Our results reveal that the effect of characteristic liquidity is subsumed by the models considered, but the risk of illiquidity is not priced in the Portuguese stock market.

Keywords: Asset Pricing, Liquidity, Portugal

THE ROLE OF A LIQUIDITY FACTOR IN THE PORTUGUESE STOCK MARKET

1. INTRODUCTION

Is there an illiquidity premium in the Portuguese stock market? Our primary objective is to investigate the role of illiquidity (proxied by the proportion of zero returns) as an additional risk factor in asset pricing. We analyze this issue in the context of the time-series and cross-section versions of CAPM and Fama-French three-factor model (Fama and French, 1993, 1996) using Portuguese data. Motivation for our study is provided by the growing interest in liquidity that has emerged in the asset pricing literature over recent years.

Besides that, the majority of the empirical results reported in the previous literature uses United States data. Gathering evidence from other data sets is also important to check the robustness of the available results and to avoid the problem of data snooping (Lo and MacKinlay, 1990). In the current study, such a goal is best achieved by selecting a market in which illiquidity is likely to be an important factor for many of its listed stocks. It is interesting to study the Portuguese stock market, since it is different in many ways from other developed equity markets: it presents a comparatively small number of listed companies, market capitalization and values traded. Despite its small size, the Portuguese stock market has gained some visibility in the European context, mainly after the merger with Euronext N.V. in 2002.

To our knowledge, Escalda (1993) and Mello and Escalda (1994) are the only researchers who analyze liquidity in the Portuguese stock market. Their results reveal that liquidity affects Portuguese stock returns especially when liquidity is proxied by trading frequency and turnover rate. However, they show that most liquid stocks exhibit larger returns than less liquid stocks.

The main differences between our study and these two concern the liquidity proxies used and the way liquidity affects stock returns. We use the proportion of zero returns (ZR) as a liquidity measure and they use the proportional quoted bid-ask spread, trading frequency and turnover rate. Also, we use an illiquidity risk factor, reflecting market-wide liquidity restrictions, in the context of two asset pricing models and they consider liquidity as a stock characteristic that may affect stock returns. Therefore, this paper extends liquidity-related evidence for the Euronext Lisbon Stock Exchange and thus supports a better understanding of this market. We provide evidence for another liquidity proxy and for the Fama-French model, as well as we extend the sample period studied.

The choice of proportion of zero returns (ZR) as our liquidity measure relates to the fact that there is evidence of commonality in liquidity in the Portuguese stock market with this measure (Miralles and Oliveira, 2009). Therefore, we consider that systematic liquidity shocks should affect the optimal behaviour of agents in financial markets. Accordingly, this paper analyzes empirically the relation between Portuguese stock returns and a market-wide liquidity risk factor constructed with this liquidity proxy.

The proportion of zero returns is obtained as the number of zero daily returns in each month divided by the total number of transactions days on that month and it measures stock illiquidity. This measure presents two main advantages. First, it has a strong theoretical appeal. As argued by Lesmond, Ogden and Trzcinka (1999), a security with high transaction costs will have less frequent price movements and more zero returns than a security with low transaction costs. So, the occurrence of zero returns can be considered a measure of illiquidity and it is used with success by Bekaert *et al.* (2007) and Lee (2011). Second, to compute this measure it only requires a time series of daily equity returns, which is available for a large number of socks and over a long period of time.

Therefore, we seek to address the role of illiquidity in asset pricing with Portuguese stock market data. We use monthly data for the period between January 1988 and December 2008 and we generate a mimicking portfolio for illiquidity, following the procedure of Fama and French (1993), and use the corresponding returns as an augmenting variable in their three-factor model and in CAPM.

Our results reveal that time varying expected excess portfolio returns can be explained by the asset pricing models considered and these models can subsume the effect of characteristic liquidity. We also find that the risk of illiquidity is not priced in the Portuguese stock market, although we cannot exclude the potential benefit of an illiquidity risk factor in asset pricing.

The remainder of the paper is organized as follows. Section 2 presents related literature review. Section 3 describes the data and presents some methodological issues. Sections 4 and 5 report time-series and cross-sectional evidence, respectively. Section 6 concludes.

2. LITERATURE REVIEW

2.1. Asset pricing models

The Capital Asset Pricing Model (CAPM) of Sharpe (1964), Lintner (1965) and Mossin (1966) is, for its simplicity, a very attractive model for investigation. This model states that the expected excess return of an asset is proportional to its covariance with market returns and, thus, the only risk factor that matters is the market beta:

$$E(R_i) - R_F = \beta_i \left[E(R_M) - R_F \right] \tag{1}$$

where $E(R_i)$ is the expected return on asset *i*, R_F is the free-risk rate of return, $E(R_M)$ is the expected market return and β_i is the sensitivity of asset *i* expected returns to variations of expected market returns.

Nevertheless, it seems to have limited empirical ability to explain asset returns in recent times. In fact, some studies reveal that CAPM cannot explain the expected returns from some investment strategies based on firm characteristics. It is shown that, on average, assets with low betas present a better expected excess return and assets with high betas present a worst expected excess return (Black, 1972; Fama and Macbeth, 1973); there seem to exist the so called size effect, that is, small firms stocks tend to have higher average returns and big firms stocks tend to have lower average returns (Blume and Friend, 1973; Banz, 1981; Reinganum, 1981); high earnings-to-price ratio (E/P) stocks tend to exhibit higher average returns (Basu, 1977, 1983); high book-to-market ratio (B/M) stocks (value stocks) present average higher returns (Ball, 1978; Rosenberg *et al.*, 1985; Fama and French, 1992).

Based on this empirical evidence, Fama and French (1993, 1996) propose a three-factor model to explain expected returns:

$$E(R_i) - R_F = \beta_{iM}\left[E(R_M) - R_F\right] + \beta_{iSMB}E(SMB) + \beta_{iHML}E(HML) \tag{2}$$

The model states that the expected return on a portfolio in excess of the risk-free rate $\left[E(R_i) - R_F\right]$ is explained by the sensitivity of its return to three factors: the expected excess market return $\left[E(R_M) - R_F\right]$; the difference between the return on a portfolio of small stocks and the return on a portfolio of big stocks, $E(SMB)$; and the difference between the return on a portfolio of high B/M stocks and the return on a portfolio of low B/M stocks, $E(HML)$.

Empirical evidence on this three-factor model can be found, among others, in Fama and French (1996), Bartholdy and Peare (2005) for the US market; Fletcher and Kihanda (2005) for United Kingdom; Nieto (2001), Nieto and Rodríguez (2005) for Spain.

Asset pricing literature concerning Portuguese stock market is recent and it can be grouped into four categories: efficiency analysis (Afonso, 1997; Afonso and Teixeira, 1999; Areal and Armada, 2002; Curto *et al.*, 2003; Duque and Madeira, 2004; Duque and Pinto, 2004; Machado-Santos and Fernandes, 2005; Borges, 2007), empirical anomalies (Miralles and Miralles, 2000; Balbina and Martins, 2002; Miralles and Miralles, 2003), equity fund performance (Vieira and Armada, 1998; Cortez *et al.*, 1999) and asset pricing models (Mello and Escalda, 1994; Miranda, 1995; Pascoal, 1996; Tomé, 2000; Pinto and Armada, 2002; Alpalhão and Alves, 2005). These studies show that Portuguese stock market reveals some inefficiencies, market returns don’t follow a Normal distribution and the empirically tested asset pricing models (conditional and unconditional CAPM as well as APT) seem to have only a limited ability to explain the risk-return relationship.

2.2. Liquidity and asset pricing

In recent years a large part of financial research has been devoted to the study of equity market liquidity. Currently, there are two main strands of liquidity research: the first concentrates on idiosyncratic characteristics of individual assets liquidity and on their impact on returns (Amihud and Mendelson, 1986; Eleswarapu and Reinganum, 1993; Brennan and Subrahmanyam, 1996; Datar *et al.*, 1998, among others), and the other one, more recent, focuses on the identification of the common determinants of liquidity, or commonality in liquidity (Chordia *et al.*, 2000, 2001a; Huberman and Halka, 2001; Hasbrouck and Seppi, 2001, among others).

Amihud and Mendelson (1986) was one of the first to examine the role of liquidity in asset pricing using the bid-ask spread as a proxy for illiquidity. They document a positive relation between expected return and illiquidity. However, Eleswarapu and Reinganum (1993), who extended the sample period by 10 years, find that the existence of a positive liquidity premium is limited only to January. Brennan and Subrahmanyam (1996) examine the liquidity premium and find a positive return-illiquidity relation even after taking price, size and B/M factors into account in a Fama-French framework.

Petersen and Fialkowski (1994) and Brennan and Subrahmanyam (1996) raise concerns about the bid-ask spread being a poor proxy for liquidity. This leads to the use of alternative measures of liquidity, such as trading volume (Brennan *et al.*, 1998), turnover ratio (Datar *et al.*, 1998; Chordia *et al.*, 2001b; Chan and Faff, 2003), illiquidity ratio (Amihud, 2002), Gibbs measure (Hasbrouck, 2009). Most of these studies support the liquidity premium notion, but it is important to note that they consider liquidity as a stock characteristic rather than an aggregate risk factor of concern to investors.

The recent relative consensus about the existence of commonality in liquidity raises a new question about the role of liquidity in asset pricing. In fact, many studies have documented that financial assets liquidity changes over time and these time variations are ruled by a significant common component in the liquidity across assets or market liquidity (Chordia *et al.*, 2000; Huberman and Halka, 2001; Hasbrouck and Seppi, 2001; Brockman and Chung, 2002, 2006, 2008; Galariotis and Giouvris, 2007; Kamara *et al.*, 2008; Sujoto *et al.*, 2008; Brockman *et al.*, 2009). Therefore, commonality in liquidity could represent a source of non-diversifiable risk and, in that case, the sensitivity of an individual stock to liquidity shocks could induce the market to require a higher average return. This extends research which documents a positive cross-sectional relationship between the level of illiquidity and expected returns.

Consistent with this proposition, several authors provide evidence that expected returns are positively related to market-wide illiquidity, such as Pástor and Stambaugh (2003), Acharya and Pedersen (2005), Chan and Faff (2005), Martínez *et al.* (2005), Miralles and Miralles (2006), Sadka (2006), Liu (2006), among others.

For the US market, Pástor and Stambaugh (2003) develops a measure of aggregate liquidity, based on daily price reversal, and shows that stocks whose returns are more sensitive to market liquidity factor command a higher rate of return than stocks whose returns are less sensitive to market liquidity factor. Acharya and Pedersen (2005) and Sadka (2006) also provide evidence of a premium of systematic liquidity risk (measured as return covariation with particular measures of aggregate liquidity shocks). Liu (2006) constructs a new liquidity measure that captures multiple dimensions of liquidity such as trading quantity, speed and cost, with particular emphasis on trading speed. He documents a significant and robust liquidity premium that is distinct from systematic market risk and the Fama-French three-factor risks.

Chan and Faff (2005) examine the asset pricing role of liquidity (as proxied by share turnover) in the context of the Fama and French (1993) three-factor model with Australian data. Their results support the overall favourability of the liquidity-augmented Fama-French model.

Martínez *et al.* (2005), Miralles and Miralles (2006) also document that systematic liquidity risk is significantly priced in the Spanish stock market when betas are measured relative to the illiquidity risk factor based on the illiquidity ratio of Amihud (2002) on either unconditional or conditional versions of liquidity-augmented asset pricing models.

Regarding the Portuguese stock market, Escalda (1993) and Mello and Escalda (1994) investigate if liquidity affects asset returns. They use monthly data over the December 1987 to December 1993 period to compute different proxies for liquidity, as the proportional quoted bid-ask spread, trading frequency and turnover rate. The results reveal that liquidity (as an individual stock characteristic) affects Portuguese stock returns and it seems that the liquidity feature that is more important to investors is the time of waiting for the transaction, since the trading frequency and the turnover rate are the most significant liquidity proxies. However, in contrast to previous evidence for other markets, they show that most traded stocks (hence most liquid stocks) exhibit larger returns.

2.3. The proportion of zero returns

Liquidity is a slippery and elusive concept, in part because it encompasses a number of transactional properties of markets. These include tightness (the cost of turning around a position over a short period of time), depth (the size of an order flow innovation required to change prices a given amount), and resiliency (the speed with which process recover from a random, uninformative shock) (Kyle, 1985). Therefore, it is difficult to fully measure liquidity in all of its dimensions.

Previous literature has adopted a broad range of measures to proxy for market liquidity, suggesting that there is no consensus about the most appropriate measure. The various measures used fall into two broad categories: trade-based measures and order-based measures (Aitken and Comerton-Forde, 2003).

Order-based measures require intraday data of the order book and include, among others, the bid-ask spreads, depth, Brennan and Subrahmanyam (1996) and Sadka (2006) measures of transaction costs, and the measures of Aitken and Comerton-Forde (2003) and of Martínez *et al.*(2005).

Trade-based measures commonly used in previous literature include trading value, trading volume, the number of trades (frequency), the turnover ratio, the illiquidity ratio of Amihud (2002), Pástor and Stambaugh (2003) measure, and some other liquidity measures used on small and emergent markets as the LOT measure of Lesmond *et al.* (1999) and the proportion of zero returns. These measures are attractive, as they are simple to calculate using readily available data on price and volume.

In this work, we will focus solely on the proportion of zero returns illiquidity measure. It is calculated as (3),

$$ZR_{it} = \frac{\# ZR_{it}}{T_{it}} \tag{3}$$

where $\# ZR_{it}$ is the number of daily zero returns for stock *i* on month *t* and T_{it} is the total number of transactions days on month *t* for asset *i*.

We select the proportion of zero returns as the best proxy for illiquidity based on four main criteria. First, it is ease to interpret. As argued by Lesmond, Ogden and Trzcinka (1999), a security with high transaction costs will have less frequent price movements and more zero returns than a security with low transaction costs. So, the occurrence of zero returns can be considered a measure of liquidity and it reflects the time of waiting for a transaction. Second, it has been used with some success in some previous studies for a wide range of countries (Lesmond, 2005; Bekaert *et al.*, 2007; Lee, 2011). Third, in our previous work (Miralles and Oliveira, 2009), we demonstrate that there are common factors that drive time variation of liquidity of individual stocks in the Portuguese market when liquidity (or illiquidity) is proxied by proportion of zero returns. And finally, since it only requires a time series of daily equity returns, data required to compute it is readily available for the Portuguese stock market over a long period of time.

3. DATA AND METHODOLOGY

3.1. Data

In this study, we use monthly and daily data for the period from January 2, 1988 to December 31, 2008, retrieved from Thomson Datastream. The data obtained includes the following variables: closing price, book-to-market (B/M) ratio, and market value.

We select all stocks traded in the Euronext Lisbon Stock Exchange with available data for at least 24 months. The final sample is composed of 219 different stocks, which were traded during some period of time between 1988 and 2008. The number of stocks in our sample ranges between a minimum of 69 in 2008 and a maximum of 168 in 1994.

The return of the market portfolio is proxied by the equally-weighted return of all stocks available in each month of the sample[1].

Since Portugal did not have short-term government securities during most of the period covered by this study, we proxy the risk-free rate of return by the equivalent monthly Interbank Money Market (IMM) Overnight (O/N) interest rate as suggested by Costa *et al.* (2009). Data on IMM O/N interest rate is taken from Banco de Portugal (www.bportugal.pt).

Our liquidity measure is the monthly proportion of zero returns (ZR_{it}), computed as (3) for each stock *i* and month *t* in the sample.

3.2. Illiquidity-sorted portfolios

The testing assets are ten portfolios sorted by illiquidity. Based on the average illiquidity value (measured by ZR) in the previous year, all sample stocks are ranked and divided into ten groups with approximately the same number of stocks. L1 includes the stocks with the smallest ZR, that is, the most liquid stocks, and L10 includes the stocks with the largest ZR, that is, the least liquid stocks. The portfolio composition is revised every December and it is maintained throughout the following year. To be included in a portfolio the stock must have been traded from January to December of

[1] We also use the value-weighted average return of all stocks available in each month of the sample as the return of the market portfolio to check the robustness of some of the empirical results. The full set of results may be supplied upon request to the authors.

year *t*. For each month, we calculate the equally-weighted returns of these 10 portfolios[2].

In Table 1, we summarize the principal descriptive statistics of the illiquidity portfolios used in the tests. On average the portfolios are composed of 10 or 11 stocks. The mean returns of the portfolios are negative except for the least liquid decile portfolio (L10), which presents an average monthly return of 0,294%. On average, illiquid stocks earn 0,6% per month more than very liquid stocks. In terms of volatility, there are not substantial differences among the portfolios, although portfolio L9 is the most volatile. As expected, market value decreases with ZR, since the most liquid stocks are also the stocks of firms with the largest capitalization. B/M ratio increases with ZR, suggesting that least liquid stocks are also the ones less profitable or relatively distressed (Fama and French, 1995).

Table 1

Summary statistics for portfolios

	Returns		**Market value**	**B/M**	**ZR**	**Nº of stocks**
	Mean	**Standard deviation**				
L1	-0,262	7,018	4 886,620	0,684	0,196	10,7
L2	-0,248	6,217	1 072,783	0,757	0,249	10,1
L3	-0,251	6,062	988,087	0,941	0,309	10,3
L4	-0,083	6,120	452,481	0,952	0,368	10,2
L5	-0,382	6,115	339,110	0,914	0,432	10,1
L6	-0,637	5,755	172,385	1,009	0,529	10,3
L7	-0,391	5,807	85,906	1,549	0,660	10,2
L8	-0,106	7,434	99,274	2,188	0,792	10,2
L9	-0,630	10,440	154,028	2,616	0,874	10,1
L10	0,294	7,333	17,417	2,806	0,889	10,9

At December of each year, from 1988 to 2007, stocks are sorted in ascending order based on their average illiquidity value, measured by ZR, and divided into equally-weighted decile portfolios. The portfolio composition is held constant throughout the following year. L1 denotes the lowest ZR decile portfolio (the most liquid decile) and L10 is the highest ZR decile (the least liquid decile). This table reports summary statistics for these portfolios: mean and standard deviation of the returns, monthly averages of market value, B/M ratio, ZR and number of constituent stocks. Market value is expressed in million of Euros.

3.3. Illiquidity factor

[2] We also compute the value-weighted returns of the 10 illiquidity-sorted portfolios to check the robustness of the empirical results. The full set of results may be supplied upon request to the authors.

As suggested by Chan and Faff (2005), Miralles and Miralles (2006), we compute an illiquidity-based risk factor in the context of Fama and French (1993) framework through the formation of mimicking portfolios. This illiquidity-mimicking factor, called IMV (illiquid minus very liquid) corresponds to the difference between the mean return on a set of illiquid stock portfolios (I) and the mean return on a set of very liquid stock portfolios (V). The advantage of this procedure is that each factor is formed while controlling for the effect of the other Fama-French factors.

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 (t = 1989, …, 2008), all sample stocks are ranked according to their market value and divided into small (S) and big (B) based on a 50:50 split. Then, sample stocks are ranked based on book-to-market ratio at the end of December in year *t*-1 and partitioned into three groups based on a 30:40:30 split: low (L), medium (M) and high (H). Finally, the monthly average of proportion of zero returns in year *t*-1 is used to rank stocks into very liquid (V), moderately liquid (N) and illiquid (I) based on a 30:40:30 split. The portfolio composition is revised every December and it is maintained throughout the following year. To be included in a portfolio the stock must have been traded from January to December of year *t*.

Based upon the independent sorts and ranking procedure in year *t*-1, we construct 18 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, 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) from the intersection of the two size, three book-to-market and three illiquidity groups.

The size factor SMB (small minus big) is calculated each month as the difference between the simple average of the returns on the nine small stock 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 average of the returns on nine big stock 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 defined similarly. HML is the difference, each month, between the simple average of the returns on the six high book-to-market stock portfolios (S/H/V, S/H/N, S/H/I, B/H/V, B/H/N, B/H/I) and the simple average of the returns on the six low book-to-market stock portfolios (S/L/V, S/L/N, S/L/I, B/L/V, B/L/N, B/L/I).

Likewise, the illiquidity factor IMV (illiquid minus very liquid) is the difference, each month, between the simple average of the returns on the six illiquid stock portfolios (S/L/I, S/M/I, S/H/I, B/L/I, B/M/I, B/H/I) and the simple average of the returns on the six very liquid stock portfolios (S/L/V, S/M/V, S/H/V, B/L/V, B/M/V, B/H/V).

The mean return and volatility of the market portfolio and of the mimicking portfolios of size, B/M and illiquidity factors are reported in Panel A of Table 2. Panel B presents the correlation coefficients between these factors. The average excess market return and the average return on SMB are negative. In this latter case, there is evidence that the small firm effect may not be stable over time and also that the size premium may have disappeared or become reversed (Dimson and Marsh, 1999; Horowitz *et al.*, 2000). The average returns on HML and IMV factors are positive, as expected. The correlations between market factor and SMB and IMV factors are negative, suggesting that the gap between the returns on small and big stocks portfolios and the difference between the returns on illiquid and very liquid stocks portfolios become wide (narrow) when the market is down (up).

Table 2

Summary statistics for mimicking portfolios

Panel A: Descriptive statistics		
	Mean	**Standard deviation**
MKT	-0,704	3,980
SMB	-0,200	5,614
HML	0,267	6,372
IMV	0,306	9,522

Panel B: Correlation coefficients				
	MKT	**SMB**	**HML**	**IMV**
MKT	1,000			
SMB	-0,091	1,000		
HML	0,208	0,228	1,000	
IMV	-0,217	0,406	0,027	1,000

Panel A reports mean and standard deviation for the excess market return (MKT) and for the mimicking portfolio factor returns of size (SMB), B/M (HML) and illiquidity (IMV). Panel B reports the correlation coefficients.

4. TIME SERIES EVIDENCE

First, we analyze CAPM and Fama-French three-factor model as well as both of these models augmented with the illiquidity-risk factor IMV within a time series context.

While controlling characteristic liquidity by sorting stocks into illiquidity groups based on their proportion of zero returns (ZR), we perform time series regressions for these liquidity portfolios using CAPM (4), Fama-French three-factor model (5) and these two models augmented by the illiquidity risk factor IMV, as stated in equations (6) and (7), respectively:

$$r_{jt} = \alpha_j + \beta_{jM} r_{Mt} + \varepsilon_{jt} \tag{4}$$

$$r_{jt} = \alpha_j + \beta_{jM} r_{Mt} + \beta_{jSMB} SMB_t + \beta_{jHML} HML_t + \eta_{jt} \tag{5}$$

$$r_{jt} = \alpha_j + \beta_{jM} r_{Mt} + \beta_{jIMV} IMV_t + \mu_{jt} \tag{6}$$

$$r_{jt} = \alpha_j + \beta_{jM} r_{Mt} + \beta_{jSMB} SMB_t + \beta_{jHML} HML_t + \beta_{jIMV} IMV_t + \upsilon_{jt} \tag{7}$$

where r_{it} is the excess return on portfolio *j*, r_{Mt} is the excess return on market portfolio, SMB_t is the mimicking portfolio for the size factor, HML_t is the mimicking portfolio for the B/M factor, IMV_t is the mimicking portfolio for the illiquidity factor, α_j is the intercept of portfolio *j*, β_{jM}, β_{jSMB}, β_{jHML} and β_{jIMV} are the sensitivities to the risk factors.

We estimate equations (4) to (7) by generalized method of moments (GMM) and the intercepts are shown in Table 3.

If the intercept of regression is significant, it indicates the presence of a premium associated with the characteristic liquidity. If market liquidity and/or Fama-French factors subsume the effect of characteristic liquidity, a systematic increase in the intercepts (or the liquidity premium on portfolios arranged in order of decreasing liquidity) will not be observed. The results show that almost all intercepts are insignificant, independently of the model tested. The only intercepts statistically significant at 10% level are the ones of portfolio L6 for Fama-French model, CAPM and Fama-French illiquidity-augmented models. In addition, the risk-adjusted average return (alpha) of the least liquid portfolio (L10) is lower than the alpha of the most liquid portfolio, except for the CAPM illiquidity-augmented model. This findings are consistent with evidence reported by Escalda (1993) and Mello and Escalda (1994) for the Portuguese market.

Table 3

Intercepts from time-series regressions of the 10 illiquidity-sorted portfolios

	CAPM			**Fama-French**			**CAPM+IMV**			**Fama-French+IMV**		
	Alphas		$\bar{R}^2$	**Alphas**		$\bar{R}^2$	**Alphas**		$\bar{R}^2$	**Alphas**		$\bar{R}^2$
L1	0,245	(0,82)	0,61	0,254	(0,92)	0,65	0,234	(0,86)	0,65	0,221	(0,83)	0,67
L2	0,174	(0,80)	0,66	0,184	(0,87)	0,69	0,083	(0,42)	0,71	0,087	(0,45)	0,72
L3	0,131	(0,57)	0,63	0,146	(0,62)	0,64	0,074	(0,32)	0,64	0,093	(0,40)	0,64
L4	0,261	(1,02)	0,57	0,284	(1,15)	0,62	0,299	(1,20)	0,61	0,306	(1,23)	0,64
L5	0,001	(0,00)	0,62	-0,008	(-0,04)	0,62	0,064	(0,25)	0,60	0,059	(0,23)	0,60
L6	-0,448	(-1,55)	0,45	-0,475	(-1,66)*	0,45	-0,514	(-1,67)*	0,42	-0,547	(-1,79)*	0,42
L7	-0,274	(-0,85)	0,36	-0,212	(-0,65)	0,39	-0,294	(-0,92)	0,30	-0,197	(-0,59)	0,33
L8	0,027	(0,08)	0,23	0,008	(0,02)	0,24	0,078	(0,22)	0,26	0,055	(0,16)	0,26
L9	-0,460	(-0,85)	0,13	-0,408	(-0,77)	0,14	-0,526	(-0,95)	0,17	-0,44	(-0,80)	0,17
L10	0,210	(0,44)	0,11	0,089	(0,20)	0,16	0,369	(0,81)	0,17	0,220	(0,50)	0,21
Wald	7,716	[0,66]		7,812	[0,65]		9,243	[0,51]		8,608	[0,57]	

This table reports the value of the intercepts obtained for four asset pricing models: the standard CAPM (4), the Fama-French three factor model (5), and both of them augmented by the illiquidity risk factor IMV, (6) and (7). The associated t-statistics are in parentheses to the right of the coefficient estimates. The adjusted R^2 are also reported. The last row shows the Wald test statistics that analyzes whether intercepts are jointly equal to zero with the corresponding p-values in brackets. *, **, *** denotes significance at 10%, 5% and 1% levels, respectively.

Moreover, if the intercepts are jointly equal to zero after controlling for characteristic liquidity, then the asset pricing model as specified is able to explain stock returns after controlling for liquidity. The asset pricing model, therefore, captures the liquidity effect. On the contrary, if the time series intercepts are not jointly equal to zero, the model does not capture liquidity. To test whether the intercepts are jointly equal to zero, we use the Wald test. For all asset pricing models we are not able to reject the null hypothesis.

The explanatory power of the regressions ranges between 11% and 72% and is very similar amongst all models. Nevertheless, Fama-French illiquidity-augmented model presents slightly higher adjusted R^2.

We may conclude that, within a time series context, there is evidence that all of the asset pricing models can explain the effect of characteristic liquidity and the time-variation of stock returns.

5. CROSS-SECTIONAL EVIDENCE

In this section, we describe the cross-sectional evidence of the four asset pricing models. The objective is to test whether the illiquidity factor is statistically priced, that is, the illiquidity risk premium is positive and statistically significant.

The cross-sectional specifications of the models are tested using Fama and Macbeth (1973) three-step procedure. In the first step, we compute each factor betas for each of the 10 illiquidity-sorted portfolios with a two-year rolling regression. In the second step, we estimate by GMM the following regressions, where the betas are the ones estimated in the first step:

$$r_{jt} = \gamma_{0t} + \gamma_{1t}\hat{\beta}_{jMt} + \gamma_{2t}\hat{\beta}_{jSMBt} + \gamma_{3t}\hat{\beta}_{jHMLt} + \gamma_{4t}\hat{\beta}_{jIMVt} + \omega_{jt} \tag{8}$$

where r_{it} is the excess return on portfolio j, $\hat{\beta}$ are the pre-estimated factor loadings or betas and γ are the corresponding risk factors premiums.

Finally, in the third step, based on the mean and variance of the risk factors premiums (γ), we compute the *t*-statistics corrected by the adjustment proposed by Shanken (1992), in order to correct the error-in-variables problem.

The results are presented in Table 4. All asset pricing risk premiums are statistically insignificant. The illiquidity premiums, although insignificant, are negative, which is consistent with the findings that most liquid stocks exhibit larger returns than least liquid stocks (Escalda, 1993; Mello and Escalda, 1994). Nevertheless, adding the IMV factor to CAPM and to Fama-French model improves the ability of the models to price equities, as reported by the adjusted R^2. The best adjustment is obtained for the Fama-French IMV-augmented model.

Table 4

Cross-sectional asset pricing tests

	CAPM	**Fama-French**	**CAPM+IMV**	**Fama-French+IMV**
γ_0	-0,615 (-0,85)	-0,449 (-0,76)	-0,562 (-0,82)	-0,678 (-0,87)
γ_1	0,214 (0,39)	0,117 (0,18)	0,246 (0,37)	0,678 (0,70)
γ_2		-0,343 (-0,29)		-0,346 (-0,24)
γ_3		-0,033 (-0,03)		1,025 (0,61)
γ_4			-0,334 (-0,20)	-1,099 (-0,39)
$\bar{R}^2$	0,15	0,37	0,27	0,43

This table contains the time series average of the monthly coefficients in cross-sectional asset pricing tests using Fama-Macbeth methodology. The cross-sectional regressions for each month are $r_{jt} = \gamma_{0t} + \gamma_{1t}\hat{\beta}_{jMt} + \gamma_{2t}\hat{\beta}_{jSMBt} + \gamma_{3t}\hat{\beta}_{jHMLt} + \gamma_{4t}\hat{\beta}_{jIMVt} + \omega_{jt}$. The dependent variable is the monthly return on illiquidity-sorted portfolios. The explanatory variables are the betas of the different factors estimated with 23 previous monthly returns and the corresponding month return. Each γ coefficient represents the risk premium associated with each risk factor. In total, the results are based on 193 monthly observations. In parentheses we report the Fama-Macbeth *t*-statistic. *, **, *** denotes significance at 10%, 5% and 1% levels, respectively.

We also check for seasonality in risk premiums, given previous empirical evidence (Eleswarapu and Reinganum, 1993; Rubio and Tapia, 1998; Liu, 2006). Accordingly, we repeat our analysis using data for January and non-January months. The results are summarized in Table 5. As before, all risk premiums are insignificant. However, the explanatory power of the regressions is higher when only January months are considered.

We conclude that, in a cross-sectional framework, the risk of illiquidity is not priced in the Portuguese stock market.

Table 5

Cross-sectional asset pricing tests: seasonal evidence

	CAPM	Fama-French	CAPM+IMV	Fama-French+IMV
Panel A: January months				
γ_0	-2,805 (-0,90)	-0,474 (-0,34)	-0,432 (-0,27)	-0,641 (-0,45)
γ_1	2,737 (0,85)	-0,524 (-0,20)	-0,766 (-0,25)	-0,146 (-0,05)
γ_2		-2,901 (-0,57)		-4,553 (-0,71)
γ_3		-2,962 (-0,56)		-4,507 (-0,73)
γ_4			-10,255 (-0,88)	-5,318 (-0,71)
$\bar{R}^2$	0,22	0,47	0,36	0,53
Panel B: Non-January months				
γ_0	-0,487 (-0,77)	-0,492 (-0,77)	-0,681 (-0,86)	-0,686 (-0,86)
γ_1	0,059 (0,11)	0,258 (0,37)	0,464 (0,60)	0,801 (0,75)
γ_2		-0,016 (-0,01)		-0,112 (-0,07)
γ_3		0,095 (0,07)		1,376 (0,70)
γ_4			0,640 (0,35)	-0,385 (-0,14)
$\bar{R}^2$	0,15	0,36	0,26	0,42

This table contains the time series average of the monthly coefficients in cross-sectional asset pricing tests using Fama-Macbeth methodology. The cross-sectional regressions for each month are $r_{jt} = \gamma_{0t} + \gamma_{1t}\hat{\beta}_{jMt} + \gamma_{2t}\hat{\beta}_{jSMBt} + \gamma_{3t}\hat{\beta}_{jHMLt} + \gamma_{4t}\hat{\beta}_{jIMVt} + \omega_{jt}$. Panel A includes results estimated for January months and Panel B includes results estimated for non-January months. The dependent variable is the monthly return on illiquidity-sorted portfolios. The explanatory variables are the betas of the different factors estimated with 23 previous monthly returns and the corresponding month return. Each γ coefficient represents the risk premium associated with each risk factor. In total, the results are based on 193 monthly observations. In parentheses we report the Fama-Macbeth *t*-statistic. *, **, *** denotes significance at 10%, 5% and 1% levels, respectively.

6. CONCLUSIONS

In this paper, we examine the role of illiquidity, proxied by the proportion of zero returns, in asset pricing in the context of CAPM and Fama-French three-factor model. The motivation for our study was provided by the growing interest in liquidity that has emerged in the asset pricing literature over recent years.

Specifically, we analyze the role of illiquidity as an additional risk factor in asset pricing. To do this, we compute a mimicking portfolio by extending the Fama and French (1993) procedure and form each factor while controlling for the effects of the other ones.

Our empirical results show that all of the asset pricing models can explain the effect of characteristic liquidity and the time-variation of stock returns. But, the risk of illiquidity is not priced in the Portuguese stock market. Nevertheless, we show that the explanatory power of the models improves when the illiquidity factor is added.

Overall, it can be stated that the main purpose of the paper has been reached. However, the observed results suggest further empirical work. In particular, it would be of interest to explain time series and cross-sectional variation in illiquidity employing alternative measures of liquidity and different illiquidity risk factor generation techniques, such as the one suggested by Pástor and Stambaugh (2003).

7. REFERENCES

Acharya, V. V., and L. H. Pedersen (2005), "Asset pricing with liquidity risk", *Journal of Financial Economics*, Vol. 77, Nº. 2, pp. 375-410.

Afonso, A. (1997), "Normality and efficiency in Portuguese stock exchange indexes", *Estudos de Economia*, Vol. 16-17, Nº. 1, pp. 101-106.

Afonso, P. A., and J. C. Teixeira (1999), "Non-linear tests of weakly efficient markets: Evidence from Portugal", *Estudos de Economia*, Vol. 9, Nº. 2, pp. 169-187.

Aitken, M., and C. Comerton-Forde (2003), "How should liquidity be measured?", *Pacific-Basin Finance Journal*, Vol. 11, Nº. 1, pp. 45-59.

Alpalhão, R., and P. Alves (2005), "The Portuguese equity risk premium: What we know and what we don't know", *Applied Financial Economics*, Vol. 15, Nº. 7, pp. 489-498.

Amihud, Y. (2002), "Illiquidity and stock returns: Cross-section and time-series effects", *Journal of Financial Markets*, Vol. 5, Nº. 1, pp. 31-56.

Amihud, Y., and H. Mendelson (1986), "Asset pricing and the bid-ask spread", *Journal of Financial Economics*, Vol. 17, Nº. 2, pp. 223-249.

Areal, N. M., and M. J. R. Armada (2002), "The long-horizon returns behaviour of the Portuguese stock market", *The European Journal of Finance,* Vol. 8, Nº. 1, pp. 93-122.

Balbina, M., and N. C. Martins (2002), "The analysis of seasonal return anomalies in the Portuguese stock market", *Banco de Portugal Working Paper*, Nº. WP 11-02.

Ball, R. (1978), "Anomalies in relationships between securities' yields and yield-surrogates", *Journal of Financial Economics*, Vol. 6, Nº. 2-3, pp. 103-126.

Banz, R. W. (1981), "The relationship between return and market value of common stocks", *Journal of Financial Economics*, Vol. 9, Nº. 1, pp. 3-18.

Bartholdy, J., and P. Peare (2005), "Estimation of expected return: CAPM vs. Fama and French", *International Review of Financial Analysis,* Vol. 14, Nº. 4, pp. 407-427.

Basu, S. (1977), "Investment performance of common stocks in relation to their price-earnings ratios: A test of the efficient market hypothesis", *The Journal of Finance*, Vol. 32, Nº. 3, pp. 663-682.

Basu, S. (1983), "The relationship between earnings' yield, market value and return for NYSE common stocks: Further evidence", *Journal of Financial Economics*, Vol. 12, Nº. 1, pp. 129-156.

Bekaert, G., C. R. Harvey, and C. Lundblad (2007), "Liquidity and expected returns: Lessons from emerging markets", *The Review of Financial Studies*, Vol. 20, Nº. 6, pp. 1783-1831.

Black, F. (1972), "Capital market equilibrium with restricted borrowing", *The Journal of Business*, Vol. 45, Nº. 3, pp. 444-455.

Blume, M. E., and I. Friend (1973), "A new look at the Capital Asset Pricing Model", *The Journal of Finance,* Vol. 28, Nº. 1, pp. 19-33.

Borges, M. R. (2007), "Random walk tests for the Lisbon stock market", *Working Papers*, Nº. 14/2007, Department of Economics.

Brennan, M. J., T. Chordia, and A. Subrahmanyam (1998), "Alternative factor specifications, security characteristics, and the cross-section of expected stock returns", *Journal of Financial Economics*, Vol. 49, Nº. 3, pp. 345-373.

Brennan, M. J., and A. Subrahmanyam (1996), "Market microstructure and asset pricing: On the compensation for illiquidity in stock returns", *Journal of Financial Economics*, Vol. 41, Nº. 3, pp. 441-464.

Brockman, P., and D. Y. Chung (2002), "Commonality in liquidity: Evidence from an order-driven market structure", *Journal of Financial Research*, Vol. 25, Nº. 4, pp. 521-539.

Brockman, P., and D. Y. Chung (2006), "Index inclusion and commonality in liquidity: Evidence from the Stock Exchange of Hong Kong", *International Review of Financial Analysis*, Vol. 15, Nº. 4-5, pp. 291-305.

Brockman, P., and D. Y. Chung (2008), "Commonality under market stress: Evidence from an order-driven market", *International Review of Economics and Finance*, Vol. 17, Nº. 2, pp. 179-196.

Brockman, P., D. Y. Chung, and C. Pérignon (2009), "Commonality in liquidity: A global perspective", *Journal of Financial and Quantitative Analysis*, Vol. 44, Nº. 4, pp. 851-882.

Chan, H. W., and R. W. Faff (2003), "An investigation into the role of liquidity in asset pricing: Australian evidence", *Pacific-Basin Finance Journal*, Vol. 11, Nº. 5, pp. 555-572.

Chan, H. W., and R. W. Faff (2005), "Asset pricing and the illiquidity premium", *The Financial Review*, Vol. 40, Nº. 4, pp. 429-458.

Chordia, T., R. Roll, and A. Subrahmanyam (2000), "Commonality in liquidity", *Journal of Financial Economics*, Vol. 56, Nº. 1, pp. 3-28.

Chordia, T., R. Roll, and A. Subrahmanyam (2001a), "Market liquidity and trading activity", *The Journal of Finance*, Vol. 56, Nº. 2, pp. 501-530.

Chordia, T., A. Subrahmanyam, and V. R. Anshuman (2001b), "Trading activity and expected stock returns", *Journal of Financial Economics*, Vol. 59, Nº. 1, pp. 3-32.

Cortez, M. C. R., D. A. Paxson, and M. J. R. Armada (1999), "Persistence in Portuguese mutual fund performance", *The European Journal of Finance*, Vol. 5, Nº. 4, pp. 342-365.

Costa, J. C., M. E. Mata, and D. Justino (2009), "Portuguese average cost of capital", *FEUNL Working Paper Series*, Nº. WP543.

Curto, J. J. D., E. Reis, and J. P. Esperança (2003), "Testes à forma fraca da eficiência dos mercados: Aplicação aos índices PSI20, DAX e DJIA", *Economia*, Vol. 27, pp. 53-88.

Datar, V. T., N. Y. Naik, and R. Radcliffe (1998), "Liquidity and stock returns: An alternative test", *Journal of Financial Markets*, Vol. 1, Nº. 2, pp. 203-219.

Dimson, E., and P. Marsh (1999), "Murphy's law and market anomalies", *Journal of Portfolio Management*, Vol. 25, Nº. 2, pp. 53-69.

Duque, J., and G. Madeira (2004), "Effects associated with index composition changes: Evidence from the Euronext Lisbon Stock Exchange", *Working Papers*, Nº. 5/04, Department of Management.

Duque, J., and I. Pinto (2004), "How sensitive are price sensitive events?", *Working Papers*, Nº. 4/04, Department of Management.

Eleswarapu, V. R., and M. R. Reinganum (1993), "The seasonal behavior of the liquidity premium in asset pricing", *Journal of Financial Economics*, Vol. 34, Nº. 3, pp. 373-386.

Escalda, A. (1993), "Risco e liquidez - Uma análise do mercado accionista português", Master's Thesis, Universidade Técnica de Lisboa, Instituto Superior de Economia e Gestão, Lisboa.

Fama, E. F., and K. R. French (1992), "The cross-section of expected stock returns", *The Journal of Finance*, Vol. 47, Nº. 2, pp. 427-465.

Fama, E. F., and K. R. French (1993), "Common risk factors in the returns on stocks and bonds", *Journal of Financial Economics*, Vol. 33, Nº. 1, pp. 3-56.

Fama, E. F., and K. R. French (1995), "Size and book-to-market factors in earnings and returns", *The Journal of Finance*, Vol. 50, Nº. 1, pp. 131-155.

Fama, E. F., and K. R. French (1996), "Multifactor explanations of asset pricing anomalies", *The Journal of Finance*, Vol. 51, Nº. 1, pp. 55-84.

Fama, E. F., and J. D. Macbeth (1973), "Risk, return, and equilibrium - Empirical tests", *The Journal of Political Economy*, Vol. 81, Nº. 3, pp. 607-636.

Fletcher, J., and J. Kihanda (2005), "An examination of alternative CAPM-based models in UK stock returns", *Journal of Banking & Finance*, Vol. 29, Nº. 12, pp. 2995-3014.

Galariotis, E. C., and E. Giouvris (2007), "Liquidity commonality in the London Stock Exchange", *Journal of Business Finance & Accounting*, Vol. 34, Nº. 1-2, pp. 374-388.

Hasbrouck, J. (2009), "Trading costs and returns for U.S. equities: Estimating effective costs from daily data", *The Journal of Finance*, Vol. 64, Nº. 3, pp. 1445-1477.

Hasbrouck, J., and D. J. Seppi (2001), "Common factors in prices, order flows, and liquidity", *Journal of Financial Economics*, Vol. 59, Nº. 3, pp. 383-411.

Horowitz, J. L., T. Loughran, and N. E. Savin (2000), "Three analyses of the firm size premium", *Journal of Empirical Finance*, Vol. 7, Nº. 2, pp. 143-153.

Huberman, G., and D. Halka (2001), "Systematic liquidity", *Journal of Financial Research*, Vol. 24, Nº. 2, pp. 161-178.

Kamara, A., X. Lou, and R. Sadka (2008), "The divergence of liquidity commonality in the cross-section of stocks", *Journal of Financial Economics*, Vol. 89, Nº. 3, pp. 444-466.

Kyle, A. S. (1985), "Continuous auctions and insider trading", *Econometrica*, Vol. 53, Nº. 6, pp. 1315-1335.

Lee, K.-H. (2011), "The world price of liquidity risk", *Journal of Financial Economics*, Vol. 99, Nº. 1, pp. 136-161.

Lesmond, D. A. (2005), "Liquidity of emerging markets", *Journal of Financial Economics*, Vol. 77, Nº. 2, pp. 411-452.

Lesmond, D. A., J. P. Ogden, and C. A. Trzcinka (1999), "A new estimate of transaction costs", *The Review of Financial Studies*, Vol. 12, Nº. 5, pp. 1113-1141.

Lintner, J. (1965), "The valuation of risk assets and the selection of risky investments in stocks portfolios and capital budgets", *The Review of Economics and Statistics*, Vol. 47, Nº. 1, pp. 13-37.

Liu, W. M. (2006), "A liquidity-augmented capital asset pricing model", *Journal of Financial Economics*, Vol. 82, Nº. 3, pp. 631-671.

Lo, A. W., and A. C. MacKinlay (1990), "Data-snooping biases in tests of financial asset pricing models", *The Review of Financial Studies*, Vol. 3, Nº. 3, pp. 431-467.

Machado-Santos, C., and A. C. Fernandes (2005), "Skewness in financial returns: Evidence from the Portuguese stock market", *Czech Journal of Economics and Finance (Finance a uver)*, Vol. 55, Nº. 9-10, pp. 460-470.

Martínez, M. A., B. Nieto, G. Rubio, and M. Tapia (2005), "Asset pricing and systematic liquidity risk: An empirical investigation of the Spanish stock market", *International Review of Economics and Finance*, Vol. 14, Nº. 1, pp. 81-103.

Mello, A. S., and A. Escalda (1994), "Rentabilidade e liquidez no mercado de acções em Portugal", *Boletim Trimestral do Banco de Portugal*, Vol. 16, Nº. 1, pp. 55-64.

Miralles, J. L., and M. M. Miralles (2000), "An empirical analysis of the weekday effect on the Lisbon stock market over trading and non-trading periods", *Portuguese Review of Financial Markets*, Vol. 3, Nº. 2, pp. 5-14.

Miralles, J. L., and M. M. Miralles (2003), "The January effect and institutional investment in Portugal", *Portuguese Journal of Management Studies*, Vol. 8, Nº. 1, pp. 105-114.

Miralles, J. L., and M. M. Miralles (2006), "The role of an illiquidity risk factor in asset pricing: Empirical evidence from the Spanish stock market", *The Quarterly Review of Economics and Finance*, Vol. 46, Nº. 2, pp. 254-267.

Miralles, J. L., and C. Oliveira (2009), "Liquidity commonality in the Portuguese stock market", *XI Congreso Hispano-Italiano de Matemática Financiera y Actuarial*, Badajoz, Spain.

Miranda, D. (1995), "Testes multivariados do Capital Asset Pricing Model com variabilidade dos prémios de risco ao longo do tempo", Master's Thesis, Escola de Economia e Gestão, Universidade do Minho, Braga.

Mossin, J. (1966), "Equilibrium in a capital asset market", *Econometrica*, Vol. 34, Nº. 4, pp. 768-783.

Nieto, B. (2001), "Los modelos multifactoriales de valoración de activos: Un análisis empírico comparativo", *IVIE Working Paper*, Nº. WP-EC 2001-19, Instituto Valenciano de Investigaciones Económicas.

Nieto, B., and R. Rodríguez (2005), "Modelos de valoración de activos condicionales: Un panorama comparativo con datos españoles", *Investigaciones Económicas*, Vol. 29, Nº. 1, pp. 33-71.

Pascoal, R. (1996), "Modelos intertemporais de avaliação de activos financeiros", Master's Thesis, Faculdade de Economia, Universidade de Coimbra, Coimbra.

Pástor, L., and R. F. Stambaugh (2003), "Liquidity risk and expected stock retums", *The Journal of Political Economy*, Vol. 111, Nº. 3, pp. 642-685.

Petersen, M. A., and D. Fialkowski (1994), "Posted versus effective spreads: Good prices or bad quotes?", *Journal of Financial Economics*, Vol. 35, Nº. 3, pp. 269-292.

Pinto, H., and M. J. R. Armada (2002), "An autoregressive approach of the arbitrage pricing model to the Portuguese stock market", *International Journal of Business*, Vol. 7, Nº. 2, pp. 37-52.

Reinganum, M. R. (1981), "Misspecification of capital asset pricing: Empirical anomalies based on earnings' yields and market values", *Journal of Financial Economics*, Vol. 9, Nº. 1, pp. 19-46.

Rosenberg, B., K. Reid, and R. Lanstein (1985), "Persuasive evidence of market inefficiency", *Journal of Portfolio Management*, Vol. 11, Nº. 3, pp. 9-16.

Rubio, G., and M. Tapia (1998), "The liquidity premium in equity pricing under a continuous auction system", *The European Journal of Finance*, Vol. 4, Nº. 1, pp. 1-28.

Sadka, R. (2006), "Momentum and post-earnings-announcement drift anomalies: The role of liquidity risk", *Journal of Financial Economics*, Vol. 80, Nº. 2, pp. 309-349.

Shanken, J. (1992), "On the estimation of beta-pricing models", *The Review of Financial Studies*, Vol. 5, Nº. 1, pp. 1-33.

Sharpe, W. F. (1964), "Capital asset prices: A theory of market equilibrium under conditions of risk ", *The Journal of Finance*, Vol. 19, Nº. 3, pp. 425-442.

Sujoto, C., P. Kalev, and R. Faff (2008), "An examination of commonality in liquidity: New evidence from the Australian stock exchange", *Journal for Studies in Economics and Econometrics*, Vol. 32, Nº. 3, pp. 55-79.

Tomé, F. J. S. (2000), "Aplicação da Arbitrage Pricing Theory aos títulos do PSI-20", *Portuguese Journal of Management Studies*, Vol. 5, Nº. 1, pp. 43-61.

Vieira, E. S., and M. J. R. Armada (1998), "A metodologia de Henriksson e Merton na detecção da performance de fundos de pensões", *Portuguese Journal of Management Studies*, Vol. 4, Nº. 2, pp. 107-118.