# Systematic liquidity: commonality and inter-temporal variation in the Portuguese stock market

# Liquidez sistemática: movimientos comunes y variación intertemporal en el mercado de valores portugués

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**Abstract:**

*The aim of this paper is to study systematic liquidity at the Euronext Lisbon Stock Exchange. The motivation for this research is provided by the growing interest in financial literature about stock liquidity and the implications of commonality in liquidity for asset pricing since it could represent a source of non-diversifiable risk. Namely, it is analysed whether there exist common factors that drive the variation in individual stock liquidity and the causes of the inter-temporal variation of aggregate liquidity. Monthly data for the period between January 1988 and December 2011 is used to compute some of the most used proxies for liquidity: bid-ask spreads, turnover rate, trading volume, proportion of zero returns and the illiquidity ratio. Following Chordia et al. (2000) methodology, some evidence of commonality in liquidity is found in the Portuguese stock market when the proportion of zero returns is used as a measure of liquidity. In relation to the factors that drive the inter-temporal variation of the Portuguese stock market liquidity, the results obtained within a VAR framework suggest that changes in real economy activity, monetary policy (proxied by changes in monetary aggregate M1) and stock market returns play an important role as determinants of commonality in liquidity.*

**Keywords:**

*Stock market, liquidity, commonality, macroeconomic factors, Portugal; vector autoregression.*

**Resumen:**

*El objetivo de este estudio es analizar la liquidez sistemática en el mercado bursátil portugués. El motivo de esta investigación está en el creciente interés en la literatura financiera por la liquidez de los activos y las*

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*implicaciones de sus movimientos comunes en los procesos de valoración, ya que podría representar una fuente de riesgo no diversificable. Concretamente, analizamos si existen factores comunes que conducen las variaciones en la liquidez individual de los activos así como las causas de la variación intertemporal en la liquidez agregada del mercado. Empleamos datos mensuales para el periodo temporal comprendido entre enero de 1988 y diciembre de 2011 y empleamos como medidas de liquidez: el diferencial bid-ask, el ratio de rotación, el volumen de transacción, la proporción de días de negociación con rentabilidad cero y el ratio de iliquidez. Siguiendo la metodología de Chordia et al. (2000), encontramos evidencia de movimientos comunes en la liquidez del mercado bursátil portugués cuando ésta es medida por la proporción de rentabilidades cero. En cuanto a los factores que conducen las variaciones intertemporales en la liquidez del mercado portugués, los resultados obtenidos en base a un modelo VAR sugieren que los cambios en la actividad económica real, la política monetaria (aproximada por los cambios en el agregado monetario M1) y las rentabilidades del mercado juegan un papel fundamental como determinantes de los movimientos comunes en la liquidez.*

**Palabras clave:**

*Mercado bursátil, liquidez, movimientos comunes, factores macroeconómicos, Portugal, vectores autorregresivos.*

## 1. **INTRODUCTION**

In recent years a large part of financial investigation has been devoted to the study of equity market liquidity. Initial studies concentrated on idiosyncratic characteristics of the liquidity of individual assets and their impact on returns (Amihud and Mendelson 1986; Eleswarapu and Reinganum 1993; Brennan and Subrahmanyam 1996; Datar et al. 1998). Beginning with Chordia et al. (2000), the identification of the common determinants of liquidity, or commonality in liquidity, emerged as a new and fast growing strand of literature on liquidity.

Commonality in liquidity means 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. Many studies have documented the existence of commonality in the US stock market, in particular the New York Stock Exchange (NYSE), a quote-driven market (Chordia et al. 2000; Hasbrouck and Seppi 2001; Huberman and Halka 2001; Korajczyk and Sadka 2008; Kamara et al. 2008). Nevertheless, recent studies also provide evidence of commonality in order-driven markets, namely in the Stock Exchange of Hong Kong (Brockman and Chung 2002, 2006, 2008), the Australian Stock Exchange (Fabre and Frino 2004; Sujoto et al. 2008a), the Stock Exchange of Thailand (Pukthuanthong-Le and Visaltanachoti 2009), among others, or in changing regimes (Galariotis and Giouvris 2007).

Despite the progress made in understanding the effects of systematic liquidity, the knowledge of the determinants of its inter-temporal variation is still very limited. However, it is important to understand the sources of systematic liquidity variation due to its impacts on returns. The latest and incipient research has been directed at filling this gap (Chordia et al. 2001; Chordia et al. 2005; Miralles-Marcelo et al. 2007; Goyenko and Ukhov 2009; Lu and Glascock 2010; Jensen and Moorman 2010; Næs et al. 2011; Fernández-Amador et al. 2013). The empirical evidence reported is at some extent ambiguous, but some macroeconomic factors were identified as determinants of time variation of liquidity. One of the most important factors in explaining inter-temporal variation of stock liquidity is monetary policy. In effect, an expansionary monetary policy appears to be associated to an increase in the aggregate liquidity of stocks.

This paper provides first time evidence of commonality in liquidity and of the dynamic relation between macroeconomics factors and systematic liquidity for the Euronext Lisbon Stock Exchange and thus supports a better understanding of this market and extends related empirical evidence. Reporting empirical results from other data sets is also important to check the robustness of the available evidence, which is mainly from the US markets.

The present study also contributes to the published literature by testing for the existence of commonality in liquidity in an order-driven market. Differences in the market structure of Euronext Lisbon and quote-driven markets could result in differences in liquidity commonality. As Fabre and Frino (2004) point out, commonality in liquidity may be less pronounced in order-driven markets than in quote-driven markets. In addition, studying the Portuguese stock market is appealing, since it is different in many ways from other developed equity markets: it presents a comparatively small number of listed companies, market capitalisation 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.

In addition to the novelty empirical evidence reported and the contribution for a better understanding of a developed but small equity market such as Euronext Lisbon Stock Exchange, motivation for this study also arises from the implications of commonality for asset pricing. 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. Consistent with this proposition, several authors provide evidence that expected returns are positively related to market-wide illiquidity,[3]extending previous research that documents a positive relationship between the level of liquidity and expected returns. So, we believe that the analysis of commonality in liquidity should be a pre-requisite to investigate the role of liquidity in asset pricing.

Additionally, the existence of commonality suggests the assumption that there must be at least one common factor that simultaneously influences the liquidity of all stocks in a market. Possible candidates for these factors are macroeconomic fundamentals. Therefore, it is worthy to know which factors are driving time variation of systematic liquidity in the Portuguese stock market.

To our knowledge, Escalda (1993) and Mello and Escalda (1994) are the only that analyse liquidity in the Portuguese stock market. The objective of both of these studies is to 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. Their results reveal that liquidity is priced in the Portuguese stock market. In addition, trading frequency and turnover rate are the most significant liquidity proxies. Hence, it seems that the liquidity feature that is more important to investors is the time of waiting for the transaction. However, in contrast to previous evidence for other markets, they show that most traded stocks exhibit larger returns. Nevertheless, this evidence is limited, outdated and needs to be extended.

Therefore, we seek to address the question of systematic liquidity in the Portuguese stock market, first looking for the existence of commonality and then trying to disentangle the factors that drive the inter-temporal variation of aggregate liquidity. Monthly data for the period between January 1988 and December 2011 is used to compute some of the most used proxies for liquidity, like bid-ask spreads, turnover rate, trading volume, proportion of zero returns and the illiquidity ratio proposed by Amihud (2002). Regarding this aspect, our paper is also innovative by employing some untested liquidity proxies in this field of study, namely the proportion of zero returns.

Our results reveal some evidence of commonality in liquidity for the proportion of zero returns construct of liquidity. Moreover, the results obtained within a VAR framework suggest that changes in real economy activity, monetary policy and stock market returns play an important role as a determinant of the time-variation of commonality in liquidity, when it is measured by proportion of zero returns.

The remainder of the paper is organised as follows. Section 2 presents literature review related both to liquidity commonality and inter-temporal variation of systematic liquidity. Section 3 describes data and constructs. The empirical results are in section 4. Finally, section 5 concludes the paper.

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[3] See, for example, Amihud (2002), Pástor and Stambaugh (2003), Acharya and Pedersen (2005), Chan and Faff (2003, 2005), Martínez et al. (2005), Miralles-Marcelo and Miralles-Quirós (2006), among others.

## 2. **LITERATURE REVIEW**

### 2.1. **Liquidity commonality**

The first empirical study of commonality in liquidity was conducted by Chordia et al. (2000). Using transactions data for NYSE during 1992 and five measures of liquidity,[4] they regress individual stock daily percentage changes in liquidity on market and industry liquidity. Their results reveal that firm-level liquidity is significantly influenced by both a market and an industry-wide liquidity component. This common component remains significant even after controlling for individual determinants of liquidity, such as price, volume and volatility. These authors also document a significant size effect, as liquidity betas generally increase with firm size, especially when spreads are used to proxy for liquidity. Contemporaneously to this work, Hasbrouck and Seppi (2001) and Huberman and Halka (2001) also investigate common factors in liquidity, respectively for thirty Dow Jones stocks during 1994 and for NYSE stocks during 1996. However, their results are contradictory. While Hasbrouck and Seppi (2001) find strong evidence for common factors in order flows and stock returns but weaker evidence for commonality in liquidity proxies, Huberman and Halka (2001) obtain evidence suggesting the existence of a systematic liquidity component.

More recent studies of commonality in US markets also prove earlier results. In fact, Korajczyk and Sadka (2008) and Kamara et al. (2008) find evidence of commonality. Korajczyk and Sadka (2008) use monthly data for NYSE stocks, over the period 1983-2000, to estimate latent factor models of liquidity, aggregated across various liquidity measures. The set of liquidity measures includes absolute returns to volume ratio based on Amihud (2002), turnover, quoted and effective bid-ask spreads and four price impact components. Their results show that there exist common liquidity factors, which are mainly exhibited in spreads and in the fixed components of price impact. Kamara et al. (2008) uses Chordia et al. (2000) methodology to estimate the sensitivity of liquidity of stocks listed in NYSE to variations in market liquidity, over the period 1963-2005. To proxy for changes in liquidity they use the daily change in the illiquidity ratio proposed by Amihud (2002). As Chordia et al. (2000), these authors also find that large firms are more sensitive than small firms to market-wide liquidity variations for almost the entire period. Moreover, they find that commonality in liquidity has decreased significantly for small capitalisation firms, but increased significantly for large capitalisation firms, which can be explained by the patterns of institutional ownership over the sample period.

As mentioned before, there is also some empirical evidence on commonality reported for other developed non-US markets, most of which are order-driven markets. However, the results are similar to the ones reported for quote-driven US market.

Although the main purpose of Miralles-Marcelo and Miralles-Quirós (2004) and Martínez et al. (2005) is to evaluate if a liquidity risk factor is priced in the Spanish stock market, they also provide evidence of commonality for this order-driven market. They use slightly different methodologies. Miralles-Marcelo and Miralles-Quirós (2004) use the illiquidity

[4] Liquidity measures used by Chordia et al. (2000) were quoted and effective bid-ask spreads, proportional quoted and effective spreads and quoted depth.

ratio of Amihud (2002) as liquidity proxy and illiquidity-sorted portfolios data for the period from January 1994 to December 2002 while Martínez et al. (2005) look at relative bid-ask spreads of individual stocks for the period from January 1991 through December 2000. Nevertheless, both studies prove that individual liquidity co-moves with market liquidity and that commonality in liquidity exists in the Spanish market.

Galariotis and Giouvris (2007) offer evidence on the presence of systematic liquidity in the United Kingdom using FTSE100 and FTSE250 stocks, for the periods between October 1996 and May 2001 and January 2003 and August 2004, respectively. During the period studied, the London Stock Exchange changed its trading regime: from a quote-driven to an order-driven regime for FTSE100 stocks and from a quote-driven to a hybrid regime for FTSE250 stocks. Their results indicate that commonality is quite strong for FTSE100 stocks at individual and portfolio level, while for the FTSE250 it is strong only at portfolio level. Furthermore, overall commonality is on average similar across trading regimes, irrespective of the nature of the provision of liquidity.

Liquidity commonality in the Frankfurt Stock Exchange is analysed by Kempf and Mayston (2008) using intraday limit order book data for the 30 constituents of the DAX30, from January 2, 2004 to March 31, 2004. Since liquidity at the inside spread only determines the systematic liquidity risk of small and medium trades, they expand the existing literature by studying commonality in liquidity beyond best prices, which determines the systematic liquidity risk of large trades. They show that liquidity commonality beyond the inside spread is much larger than it is at the inside spread. Hence, the systematic liquidity risk of large stocks portfolios is substantially higher than the liquidity risk of small stocks portfolios. In addition, it is not constant but depends on the time of day and the conditions of the market: systematic liquidity risk is especially high in the morning and when markets are falling.

Using data from one of the world's largest and most active order-driven markets, the Stock Exchange of Hong Kong, for the period 1996-1999, Brockman and Chung (2002, 2006, 2008) show that commonality in liquidity includes both market and industry components. In contrast to quote-driven market results, they do not find a positive relation between firm size and sensitivity to changes in market-wide bid-ask spreads. However, during periods of market stress they show that commonality increases and larger firms tend to be more susceptible to changes in commonality than smaller firms.

With respect to Australian Stock Exchange, Fabre and Frino (2004) study commonality in liquidity for the year 2000. Using the quoted and proportional quoted spreads and depth as proxies for liquidity, they report some evidence of market-wide and no evidence of industry-wide commonality in liquidity for ASX stocks, but with lower significance and lesser persistence than that observed in other markets such as the NYSE. However, in contrast to Fabre and Frino (2004), Sujoto et al. (2008a, 2008b) find strong evidence of a pervasive liquidity beta, particularly for turnover and spread-based liquidity proxies. In addition, the results also show that the evidence of systematic liquidity is most pervasive for the largest size quintile of sample stocks, which is consistent with the concentrated nature toward large capitalisation stocks of this market.

## 2.2. **Inter-temporal variation of systematic liquidity**

The identification of commonality in liquidity by Chordia et al. (2000), Hasbrouck and Seppi (2001) and Huberman and Halka (2001) has raised a new question regarding the role of liquidity in asset pricing. In fact, these studies motivated the investigation of the effects of aggregated liquidity on returns and there is evidence that the fluctuation of aggregate liquidity is an important factor in explaining the cross-section of asset returns (Pástor and Stambaugh 2003; Acharya and Pedersen 2005; among others) and the times series of aggregate returns (Amihud 2002; Bekaert et al. 2007; among others).

However, empirical literature of inter-temporal variation of systematic liquidity is yet very scarce, and its main focus is on US markets. Almost all studies link macroeconomic fundamentals to systematic liquidity variation. It is expected that market liquidity is influenced by factors that affect simultaneously the risk of many firms, so macroeconomic variables seem to be good candidates. Despite the prevalence of some ambiguity, main results suggest that monetary policy plays an important role in explaining time variation of systematic liquidity (Watanabe 2004; Chordia et al. 2005; Goyenko and Ukhov 2009; Fernández-Amador et al. 2013, among others). It seems that an expansionary (a recessive) monetary policy is associated with an increase (a decrease) in stock market liquidity.

Chordia et al. (2001) and Chordia et al. (2005) are pointed out as the first to study the impact of macroeconomic factors on liquidity. Chordia et al. (2001) study the daily variation of stock market liquidity and trading activity looking for the causes of this variation[5]. They find evidence that stock market returns and volatility, short-term interest rates and term spread influence stock market liquidity and trading activity. They also report that trading activity and depth rise before scheduled macroeconomic announcements of GDP and unemployment rate, but they fall back toward normal levels on the announcement day itself. This behaviour is consistent with the increased trading induced by differences of opinion before the announcement and with an increase in the number of informed investors as the announcement day approaches.

Based on these findings, Chordia et al. (2005) investigate the joint dynamics of liquidity, trading activity, returns and volatility in both stock and bond markets. They report that there are cross-market dynamics flowing from volatility to liquidity and that there are common influences across the markets, since the correlations in liquidity and volatility innovations between bond and stock markets are positive and significantly different from zero. With a vector autoregressive (VAR) framework and with measures of monetary policy stance and aggregate mutual fund flows as candidates for macroeconomic liquidity drivers, they show that innovations to net borrowed reserves are contemporaneously associated with increased liquidity and also have modest ability to predict liquidity during periods of crises. These results suggest that monetary loosening is associated with increased liquidity. They also find that innovations to flows to the stock and government bond sectors play a key role in forecasting liquidity.

[5] Chordia et al. (2001) use quoted and effective spreads and depth as stock market liquidity proxies and trading activity is measured by trading volume and number of transactions. The variables chosen to explain time variation of liquidity comprise short- and long-term interest rates, term spread, default spread, market returns and volatility and some indicators of major macroeconomic announcements.

Following Chordia et al. (2005), Goyenko and Ukhov (2009) wide the empirical evidence about liquidity in US bond and stock market and cross relations between these markets. They use bid-ask spreads to proxy for Treasury bond liquidity and Amihud (2002) illiquidity ratio for stock market liquidity. Using a VAR framework, the authors show that bond and stock markets are linked via both volatility and illiquidity. They find evidence that a positive shock in stock market illiquidity decreases bond market illiquidity and, by contrast, a positive shock in bond market illiquidity increases stock market illiquidity. This effect is related to the fact that, while bond market illiquidity is affected contemporaneously by monetary policy, stock market illiquidity only reacts to monetary policy changes with a lag. Moreover, bond market illiquidity acts as a channel through which monetary shocks are transmitted to stock market.

In her study of time variation of US stock market liquidity, Watanabe (2004) find that macroeconomic factors affect stock market liquidity but their influence is stronger before the mid 1980's, when business cycle dynamics are more volatile. As Chordia et al. (2005), she shows that stock market liquidity improves substantially in response to monetary policy expansionary shocks. In addition, there is evidence that macroeconomic shocks not only influence stock market liquidity directly but also indirectly, through their effects on market return, volatility and turnover, which are found to be other important drivers of liquidity.

Related to this strand of literature but with a different focus, Lu and Glascock (2010) and Jensen and Moorman (2010) analyse the causes of time variation of the liquidity premium in US stock market. Both show that an expansionary monetary policy induces a reduction in liquidity price and that on periods of economic recession the investors require a greater compensation for holding illiquid stocks, which justifies the higher illiquidity premium.

Nevertheless, the finding that time-variation of systematic liquidity is influenced by macroeconomic factors is not US market exclusive. In fact, there is empirical evidence about some other countries that corroborates the previous results: for example, Choi and Cook (2006) for Japan, Miralles-Marcelo et al. (2007) for Spain, Söderberg (2008) for Denmark, Norway and Sweden, Næs et al. (2011) for Norway and Fernández-Amador et al. (2013) for France, Germany and Italy. More precisely, Choi and Cook (2006) show that in Japan, for the period 1990-2001, stock market liquidity is significantly influenced by economic activity and stock price shocks. Using data from the Spanish stock market for the 1990-2004 period, Miralles-Marcelo et al. (2007) find that stock market liquidity is directly influenced by stock market returns and default spread and indirectly by the other factors considered, namely the industrial production index changes, non-expected inflation and term spread. So, these authors conclude that systematic liquidity variations are affected by both economic and stock market cycles. The results of Söderberg (2008) show that in Scandinavian stock markets liquidity variations are mainly affected by stock market related variables, like aggregate return, volatility and turnover rate. However, liquidity forecasts are improved if the prediction model includes policy rate at Copenhagen, broad money growth at Oslo, and short-term interest rate and flow from mutual funds at Stockholm Stock Exchange. For Norway, Næs et al. (2011) also provide evidence that time variation in equity market liquidity is related to changes in participation in the stock market, especially for the smallest firms. Participation in small firms decreases when the economy (and market liquidity) worsens, which is consistent with a "flight to quality" effect during economic downturns. Finally, Fernández-Amador et al. (2013) suggest that an expansionary monetary policy intervention of European Central Bank leads to an increase of aggregate stock market liquidity in all of the markets studied (France, Germany and Italy). Furthermore, the effect of monetary policy is significantly stronger for smaller stocks, implying a non-linear impact of monetary policy on stock liquidity.

## 3. **DATA**

### 3.1. **Liquidity measures**

In this study we use monthly and daily data for the period from January 2, 1988 to December 31, 2011. The data was retrieved from Thomson Datastream and includes the following variables: closing bid price, closing ask price, closing price, closing trading volume and number of shares outstanding for each stock. The sample comprises all stocks traded in Euronext Lisbon Stock Exchange with available data to calculate the liquidity measures for at least 24 months. The final sample is composed of 233 different stocks, which were traded during some period of time between 1988 and 2011.

Monthly time series are constructed for eight different measures of (il)liquidity, namely quoted, effective and proportional bid-ask spreads, turnover, logarithm of trading volume in euros, proportion of zero returns and illiquidity ratio.[6] The spreads, turnover and trading volume have been some of the most used (il)liquidity measures in the literature since earlier studies. In addition, more recent illiquidity measures as the proportion of zero returns and the illiquidity ratio of Amihud (2002) are also considered. The most relevant aspect of the liquidity construct to Portuguese investors is expected to be captured by using these different (il)liquidity measures.

The spreads measure trading costs directly.[7] The quoted bid-ask spread is the most commonly used proxy to quantify immediacy costs and the economic value of such costs can be assessed by the relative spread. The effective spread captures the notion that if a price improvement occurs, the bid-ask spread would overestimate the immediacy costs. Nevertheless, their availability is scarce: they are not available in all markets or for all time periods. In our case, data availability of spreads begins in November 1993.

Turnover[8] captures trading frequency, that is, a stock with a higher (lower) turnover rate indicates that investors tend to hold the stock over a shorter (longer) time horizon, hence the stock is more (less) liquid. This is consistent with Amihud and Mendelson (1986)'s argument that illiquid assets would be held by investors over a longer time horizon. Two other attractive features of the turnover rate are the ready availability of data and its simple calculation. However, it fails to account for the cost per trade, which varies considerably across assets.

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[6] See Appendix A for details of the definition and computation of the (il)liquidity measures.

[7] The bid-ask spread was the illiquidity measure used in the first studies related to liquidity. See, for example, Amihud and Mendelson (1986, 1989), Eleswarapu and Reinganum (1993), Brennan and Subrahmanyam (1996), Chordia et al. (2000, 2001), Huberman and Halka (2001).

[8] Turnover was used as a liquidity proxy by Campbell et al. (1993), Datar et al. (1998), Gervais et al. (2001), Bekaert et al. (2007), among others.

Additionally, given the specific focus on only trading volume, turnover is likely to increase during liquidity crisis rather than decrease to reflect the decline in market liquidity.

As turnover rate, trading volume[9] is related to the velocity at which an investor reverts its position and is positively linked with liquidity.

Proportion of zero returns was first used by Bekaert et al. (2007) to study liquidity in emerging markets.[10] As argued by Lesmond et al. (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 or the proportion of zero returns can be considered a measure of liquidity. The biggest advantage of this measure is that it only requires a time series of daily equity returns. One of its caveats is that it is possible that this zero returns measure artificially reflects other characteristics of the stock market. For example, markets with many small stocks may automatically show a higher level of non-trading compared to markets with larger stocks (Bekaert et al. 2007).

The illiquidity ratio is based on the measure proposed by Amihud (2002). It gives the percentage price change per euro of daily trading volume, or the daily price impact of the order flow. The advantage of using the illiquidity ratio is three-fold. First, it has a strong theoretical appeal since this ratio more closely follows the Kyle (1985) price impact definition of liquidity, or the response of price to order flow. Second, data required to compute the illiquidity ratio is relatively easy to obtain. Third, it can be calculated for days when there is no price change. Though, zero volume days also occur, which leaves this estimator undefined.

Table 1

**Summary statistics**

*Panel A: Cross-sectional statistics for time series means*

| | Units | Mean | Median | Standard deviation |
|---|---|---|---|---|
| **QSPR** | € | 0.492 | 0.211 | 0.725 |
| **PQSPR** | None | 0.107 | 0.043 | 0.170 |
| **ESPR** | € | 1.273 | 0.946 | 1.421 |
| **PESPR** | None | 0.238 | 0.160 | 0.212 |
| **TRNVR** | None | 0.085 | 0.018 | 0.222 |
| **LVOL** | ln € | 11.604 | 11.197 | 3.299 |
| **ZR** | None | 0.564 | 0.571 | 0.258 |
| **ILIQ** | %/€ | 16.134 | 4.276 | 30.856 |

*Panel B: Cross-sectional means of time series correlations between liquidity variable pairs for an individual stock*

| | QSPR | PQSPR | ESPR | PESPR | TRNVR | LVOL | ZR |
|---|---|---|---|---|---|---|---|
| **PQSPR** | 0.83** | | | | | | |
| **ESPR** | 0.30** | 0.63** | | | | | |

[9] Trading volume was used by Gervais et al. (2001), Keene and Peterson (2007), among others.

[10] Proportion of zero returns exhibits high correlation with spreads which demonstrates its validity as a illiquidity measure (Lesmond et al., 1999; Lesmond, 2005; Bekaert et al., 2007; Goyenko et al., 2009; Lee, 2011).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PESPR** | 0.76** | 0.20** | 0.84** | | | | |
| **TRNVR** | -0.07 | -0.06 | 0.90** | 0.20** | | | |
| **LVOL** | -0.05 | -0.27** | 0.25** | 0.65** | 0.63** | | |
| **ZR** | 0.08 | 0.70** | -0.85** | -0.61** | -0.27** | -0.48** | |
| **ILIQ** | 0.05 | 0.24** | -0.09 | -0.04 | -0.20** | -0.40** | 0.05 |

*QSPR is the quoted spread; PQSPR is the proportional quoted spread; ESPR is the effective spread; PESPR is the proportional effective spread; TRNVR is the turnover rate; LVOL is the logarithm of trading volume; ZR is the proportion of zero returns and ILIQ is the illiquidity ratio. Each variable is calculated for every stock and every month for which data is available during the years from 1988 to 2011. The spreads are calculated from November 1993 onwards. Panel A reports the cross-sectional mean, median and standard deviation of time series means for each variable. Panel B shows the correlations between liquidity variable pairs. ** indicates statistical significance at the 5% level.*

*Source:* Authors elaboration.

Table 1 presents summary statistics for the eight liquidity measures. There is some right skewness in the cross-section of the monthly averages of our measures, as the sample means exceed medians, especially in the case of proportional quoted spread, turnover and illiquidity ratio (Panel A). The right skewness of the spreads is consistent with Chordia et al. (2000). Panel B reports correlations among the liquidity variables. All measures of spread are positive and considerably correlated with each other across time: these correlations range from 0.20 to 0.84. As expected, turnover and trading volume are positively correlated with each other and negatively correlated with illiquidity ratio and proportion of zero returns, since turnover and trading volume are negatively related to illiquidity costs. The proportion of zero returns is positively correlated with proportional quoted spread and negatively correlated with turnover and trading volume, as mentioned.

### 3.2. **Macroeconomic and financial variables**

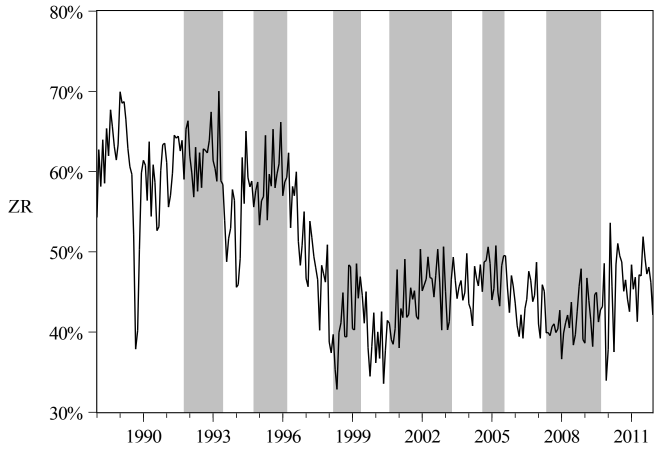
As candidates for explaining the inter-temporal variation of systematic liquidity, we select some macroeconomic variables and variables directly related to stock market used in previous related empirical research. As stated before, macroeconomic variables affect simultaneously the risk of many firms and hence are expected to influence market liquidity as well. So, the variables chosen are monthly variation of Industrial Production Index (IPI), monthly variation of Consumer Prices Index or inflation rate (IPC), monthly variation of Interbank Monetary Market overnight interest rate (R), monthly variation of Portugal contribution to M1 monetary aggregate (M1), stock market monthly return (RM), proxied by the equal-weighted average of all sample stocks returns, and monthly stock return volatility (VOLAT), computed as the standard deviation of daily market stock return in each month.[11] All variables are expressed in percentage.

[11] All of the macroeconomic variables were previously used in the literature. Namely, growth rate of industrial production was used by Watanabe (2004), Miralles-Marcelo et al. (2007), Söderberg (2008), Goyenko and Ukhov (2009) and Lu and Glascock (2010); inflation rate was used by Watanabe (2004), Miralles-Marcelo et al. (2007), Söderberg (2008), Goyenko and Ukhov (2009) and Lu and Glascock (2010); short term rate was considered by

Except for stock market return and volatility, all macroeconomic variables data is from BPstat|Estatísticas online from Banco de Portugal, which is an Internet online access to the Banco de Portugal Statistical Interactive Database.[12] All of these variables are available from January, 1988 to December, 2011. The only exception is Interbank Monetary Market overnight interest rate, which is available from January, 1989.

Figure 1

**Stock market illiquidity, 1988-2011**




*Stock market illiquidity is computed as the average in each month of proportion of zero returns (ZR) of all stocks in the sample. Shaded areas correspond to periods of economic recession identified for Portugal with Bry and Boschan (1971) algorithm and with Industrial Confidence Index data for the period from January, 1987 to December, 2011.*

*Source:* Authors elaboration.

The evolution of illiquidity, measured by proportion of zero returns, in the Portuguese stock market in the 1988-2011 period is presented in Figure 1. As it can be seen, periods of higher illiquidity coincide with periods of economic recessions, suggesting the linkages between economic and stock market activity. It is at the beginning of 1993 that illiquidity reaches its highest levels, starting to decline from that year forward. This improvement in liquidity is due to the reorganisation and regulation of the Portuguese stock market, which lead to the international recognition as a developed market in 1997. In 1998-99 illiquidity

Chordia et al. (2001), Choi and Cook (2006), Söderberg (2008) and Fernández-Amador et al. (2013); a monetary aggregate was used by Choi and Cook (2006), Söderberg (2008), Lu and Glascock (2010) and Fernández-Amador et al. (2013). The return and volatility of the stock market was also used by Chordia et al. (2001), Chordia et al. (2005), Watanabe (2004), Söderberg (2008), Goyenko and Ukhov (2009) and Næs et al. (2011).

12 BPstat|Estatísticas online is available at http://www.bportugal.pt/EstatisticasWEB.

rises caused by the instability related to Asia and Russian crisis. The end of the speculative bubble in year 2000 also contributes to deteriorate the liquidity levels. Afterwards, stock market liquidity is negatively affected by worldwide financial crisis in 2007-2008, which was followed by the strong economic recession and sovereign debt crisis in Eurozone, and the international financial assistance program to the Portuguese economy.

Table 2

**Macroeconomic and financial variables summary statistics**

*Panel A: Descriptive statistics*

| | Mean | Median | Standard deviation |
|---|---|---|---|
| **IPI** | 0.035 | 0.500 | 14.948 |
| **IPC** | 0.349 | 0.285 | 0.478 |
| **R** | -1.058 | -0.583 | 25.513 |
| **M1** | 0.627 | 0.430 | 4.109 |
| **RM** | -0.454 | -0.773 | 4.160 |
| **VOLAT** | 0.558 | 0.491 | 0.310 |
| **ZR** | 0.490 | 0.469 | 0.084 |

*Panel B: Correlations*

| | IPI | IPC | R | M1 | RM | VOLAT |
|---|---|---|---|---|---|---|
| **IPC** | 0.019 | | | | | |
| **R** | 0.183 | 0.067 | | | | |
| **M1** | 0.020 | -0.136** | -0.017 | | | |
| **RM** | -0.082 | 0.010 | -0.020 | 0.060 | | |
| **VOLAT** | 0.005 | -0.133** | -0.060 | -0.120** | -0.170** | |
| **ZR** | -0.068 | 0.363** | 0.010 | 0.152 | -0.153 | -0.363** |

*IPI is the monthly variation of Industrial Production Index; IPC is the monthly variation of Consumer Prices Index; R is the monthly variation of Interbank Monetary Market overnight interest rate; M1 is the monthly variation of Portugal contribution to M1 monetary aggregate; RM is stock market monthly return, proxied by the equal-weighted average of all sample stocks returns; VOLAT is monthly stock return volatility, computed as the standard deviation of daily market stock return in each month; and ZR is proportion of zero returns. All variables are in percentage. Each variable is calculated for every month during the years from 1988 to 2011. The Interbank Monetary Market overnight interest rate is calculated from January 1989 onwards. Panel A reports the mean, median and standard deviation for each variable. Panel B shows the correlations between liquidity variable pairs. ** indicates statistical significance at the 5% level.*

*Source:* Authors elaboration.

Table 2 presents summary statistics for the macroeconomic and financial variables. Panel A reports the mean, median and standard deviation for each variable. In 1989-2011 period, industrial production average rate of growth is 0.035% per month and monthly average inflation is 0.349%. This period is also characterised by a reduction trend of the overnight interest rate and by a slightly increase of Portugal contribution to M1 monetary aggregate. The overnight interest rate decreases on average 1.058% per month and Portugal contribution to M1 monetary aggregate increases on average 0.627% per month. With respect to stock market specific variables, in our sample period the monthly average market return is negative and equal to -0.454% and the average of monthly stock return volatility is 0.558%. Panel B shows the correlations between the variables. All the coefficients are low but there are a few statistical significant at the 5% level. Namely, the illiquidity measure (ZR) exhibits a significant negative relation with stock market volatility and a positive relation with inflation. This means that increases in stock market volatility and reductions of inflation are accompanied by improvements in stock market liquidity.

## 4. RESULTS

### 4.1. Evidence of commonality

For testing the presence of market-wide commonality, a model similar to that proposed by Chordia et al. (2000) is used:

$$DL_{it} = \alpha_i + \beta_{1i} DL_{Mt} + \beta_{2i} DL_{Mt-1} + \beta_{3i} DL_{Mt+1} + \phi_{1i} R_{Mt} + \phi_{2i} R_{Mt-1} + \phi_{3i} R_{Mt+1} + \eta DR_{it}^2 + \varepsilon_{it} \quad (1)$$

where $DL_{it}$ is the monthly percentage change in liquidity variable $L$ for stock $i$ from month $t$-1 to $t$ and $DL_{Mt}$ is the concurrent change in a cross-sectional average of the same variable for all stocks. Following Chordia et al. (2000), percentage changes rather than levels are examined in order to address some econometric problems (like non-stationarity) that are more likely to affect time series of liquidity levels. The one period lead and lag of the market average liquidity variable are included in order to allow for non-contemporaneous adjustments in liquidity. Current, lead and lag equally-weighted market returns ($R_{Mt}$) are also included in order to remove any spurious dependence induced by an association between returns and liquidity measures. This could have particular relevance for the effective spreads, the proportion of zero returns and the illiquidity ratio since they are functions of the transaction price and their changes are thus functions of individual returns, known to be significantly correlated with market returns. Finally, the contemporaneous change in the individual stock squared return($DR_{it}^2$) is added to the model to proxy for volatility which could influence liquidity. In each individual regression, the market average excludes the dependent variable stock.

Equation (1) is estimated for each individual stock by Ordinary Least Squares (OLS). The cross-sectional averages of the estimated coefficients and $t$-statistics adjusted for cross-equation correlations according to Hameed et al. (2010) are in Table 3.

Regarding the spreads, the mean coefficients of the current market liquidity are positive but only statistical significant for the proportional effective spread: 13.069, with a t-statistic of 2.43. This means that, on average, individual stock proportional effective spread increases about 13% when aggregate proportional effective spread increases by 1%. Despite more than half of the individual coefficients are positive just a few is statistical significant. The higher proportion of positive and significant individual coefficients is 17.3% obtained for proportional effective spread. Therefore, individual stock spread respond to stock markets spread changes for only less than 17% of sample stocks.

Table 3

**Market-wide commonality in liquidity**

| | DQSPR | DPQSPR | DESPR | DPESPR | DTRNVR | DLVOL | DZR | DILIQ |
|---|---|---|---|---|---|---|---|---|
| **Current** | 0.116 | 0.360 | 2.020 | 13.069 | 0.238 | 0.413 | 1.201 | 0.480 |
| | (0.25) | (1.00) | (0.57) | (2.43)** | (0.02) | (5.42)*** | (7.87)*** | (1.00) |
| % Positive | 55.118 | 51.563 | 58.594 | 62.205 | 58.382 | 82.022 | 87.624 | 49.580 |
| % + Significant | 5.512 | 7.031 | 9.375 | 17.323 | 17.341 | 24.157 | 41.584 | 5.042 |
| Lag | 0.107 | -0.224 | 2.348 | 6.568 | -1.726 | 0.053 | 0.117 | -0.125 |
| | (0.28) | (-0.67) | (0.54) | (1.17) | (-0.21) | (0.74) | (0.80) | (-0.25) |
| % Positive | 49.606 | 42.969 | 46.875 | 45.669 | 53.757 | 51.124 | 50.495 | 63.025 |
| % + Significant | 8.661 | 3.906 | 3.906 | 8.661 | 10.983 | 12.360 | 9.406 | 9.244 |
| Lead | -0.059 | 0.490 | -2.674 | 2.049 | 0.578 | 0.236 | -0.126 | 0.168 |
| | (-0.14) | (1.11) | (-0.99) | (0.54) | (0.07) | (3.04)*** | (-0.88) | (0.39) |
| % Positive | 51.181 | 49.219 | 41.406 | 44.882 | 52.601 | 63.483 | 49.505 | 50.420 |
| % + Significant | 8.661 | 5.469 | 3.125 | 10.236 | 5.202 | 10.674 | 8.416 | 7.563 |
| Sum | 0.164 | 0.626 | 1.694 | 21.686 | -0.910 | 0.702 | 1.191 | 0.523 |
| | (0.16) | (0.76) | (0.21) | (1.80)* | (-0.04) | (4.53)*** | (3.41)*** | (0.51) |
| Median | 0.056 | 0.127 | 0.212 | 0.132 | 0.310 | 0.502 | 0.925 | 0.071 |
| Arj.R2 | | | | | | | | |
| Mean | 0.012 | 0.007 | 0.338 | 0.354 | 0.018 | 0.031 | 0.049 | 0.038 |
| Median | -0.012 | -0.013 | 0.287 | 0.299 | -0.006 | 0.031 | 0.035 | 0.000 |

*Monthly proportional changes in an individual stock's liquidity measure are regressed in time series on proportional changes in the equally-weighted average liquidity for all stocks in the sample, excluding the dependent variable stock. QSPR is the quoted spread; PQSPR is the proportional quoted spread; ESPR is the effective spread; PESPR is the proportional effective spread; TRNVR is the turnover rate; LVOL is the logarithm of trading volume; ZR is the proportion of zero returns and ILIQ is the illiquidity ratio. "D" preceding the acronym denotes a proportional change in the variable across successive trading days. Cross-sectional averages of time series slope coefficients are reported with t-statistics adjusted as proposed by Hameed et al. (2010) in parentheses. "Current", "Lag" and "Lead" refer, respectively, to the same, previous and next month observations of market liquidity. "% Positive" reports the percentage of positive slope coefficients, while "% + Significant" gives the percentage with t-statistics significant at the 5% critical level. "Sum" = Current + Lag + Lead coefficients. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively. The coefficients of current, lag and lead values of the equally-weighted market return and the proportional monthly change in the individual stock squared return are not reported, but are available upon request. Each variable is calculated for every stock and every month for which data is available during the years from 1988 to 2011. The spreads are calculated from November 1993 onwards.*

*Source:* Authors elaboration.

For the turnover rate, the mean coefficient of the current market liquidity is positive but statistical insignificant. In spite of 58.382% of the individual coefficients are positive only 17.3% of them are statistical significant at 5% level. These results suggest that individual turnover responds to stock market turnover fluctuations for only 17% of stocks but on average this reaction is null.

The mean coefficient of the logarithm of trading volume is 0.413 and it is significant at 1% level, suggesting that on average individual stock logarithm of trading volume only varies 0.4% in response to a 1% change in aggregate logarithm of trading volume. Additionally, more than 80% of the individual coefficients are positive and 24.2% of them are significant. Thus, about 24% of sample stocks logarithm of trading volume increases when aggregate logarithm of trading volume increases.

For the proportional average of zero returns, the mean coefficient of the current market liquidity is positive and statistical significant at 1% level: 1.201 with at-statistic of 7.87. Above 85% of the individual coefficients are positive and about 42% of them are significant at the 5% level. When illiquidity is proxied by the proportion of zero returns, individual stock illiquidity reacts to stock market illiquidity changes for almost half of the stocks and on average individual illiquidity increases 1.2% due to a 1% increase in stock market illiquidity. These results suggest that there is some commonality that is captured by this construct of illiquidity, because illiquidity of a considerable number of stocks is sensitive to market illiquidity changes.

Finally, the results of the estimations with the illiquidity ratio reveal that the mean coefficient for current liquidity is positive although not significant. Moreover, about 50% of the individual coefficients are positive but only 5% of them are significant. Hence, for this measure of illiquidity only a few stocks illiquidity responds to aggregate illiquidity variations.

For all (il)liquidity proxies, the lagged and leading terms of market liquidity are in general positive and not statistical significant, which suggests that there is a rapid adjustment in liquidity changes. As found by Chordia et al. (2000), among others, the explanatory power of the typical individual regression is low, which could mean that noise or other influences are affecting the monthly changes in individual stock liquidity variables.

### 4.2. **Macroeconomic sources of systematic liquidity**

The results of the previous section suggest that there is commonality in liquidity in Portugal when liquidity is measured by proportional zero returns. In this section, the factors that drive inter-temporal variation of aggregate stock market liquidity are investigated. We use a VAR methodology and the proportion of zero returns as illiquidity proxy, since this is the liquidity measure for which there is evidence of commonality, as stated before.

As the majority of previous researches, a vector autoregressive (VAR) framework is used in order to analyse the time dynamics between the considered variables and liquidity.

Before VAR specification it is important to analyse if time series are stationary, because if all variables in a VAR are stationary the model could be estimated by Ordinary Least Squares and the resulting estimates are consistent and asymptotically efficient. In order to test for level stationarity of the variables we use the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The number of optimum lags for ADF test is determined with Akaike Information Criterion and PP test follows Newey-West procedure.

Table 4

**Unit roots tests**

| | ADF | PP |
|---|---|---|
| **IPI** | -2.58* | -109.92*** |
| **IPC** | -2.16 | -9.76*** |
| **R** | -4.93*** | -28.17*** |
| **M1** | -1.99 | -20.67*** |
| **RM** | -12.50*** | -12.68*** |
| **VOLAT** | -3.34** | -12.53*** |
| **ZR** | -2.28 | -4.36*** |

*Unit roots test for the following variables: monthly variation of Industrial Production Index (IPI); monthly variation of Consumer Prices Index (IPC); monthly variation of Interbank Monetary Market overnight interest rate (R); monthly variation of Portugal contribution to M1 monetary aggregate (M1); stock market monthly return (RM), proxied by the equal-weighted average of all sample stocks returns; monthly stock return volatility (VOLAT), computed as the standard deviation of daily market stock return in each month; and proportion of zero returns (ZR). All variables are in percentage. Each variable is calculated for every month during the years from 1988 to 2011. The Interbank Monetary Market overnight interest rate is calculated from January 1989 onwards. The number of optimum lags for Augmented Dickey-Fuller (ADF) test is determined with Akaike Information Criterion (AIC) and Phillips-Perron (PP) test follows Newey-West procedure. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.*

*Source:* Authors elaboration.

The results of these tests are presented in Table 4. For some variables, as IPC, M1 and ZR, the conclusions are contradictory: with ADF the null hypothesis of a unit root is not rejected and it is rejected with PP test. In these cases, the presence of a unit root is admitted and therefore the first differences of IPC, M1 and ZR are included in the VAR model. The other variables are stationary.

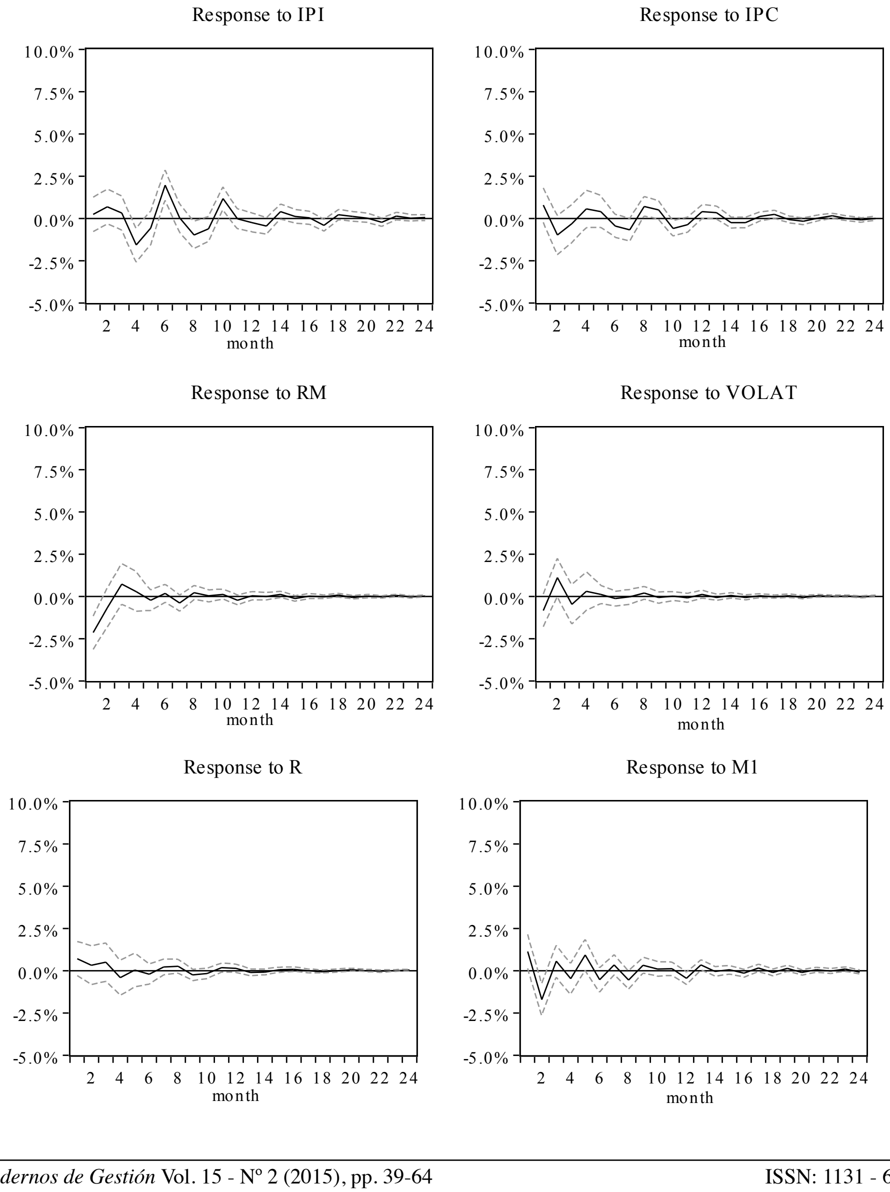
The traditional Cholesky decomposition is used to identify the structural shocks, compute impulse response functions and decompose the prediction error. Cholesky decomposition assumes that residuals form a recursive system and because of this an innovation in the first variable immediately affects all the other variables, but an innovation in the second variable does not immediately affect the first variable, only the subsequent and so on. Therefore, the ordering of the variables in a VAR model is important and could influence the results. The ordering of the variables in the VAR model estimated is consistent to previous literature. In first place is the real economy related variable, which is the variation of Industrial Production Index (IPI), and in second place the inflation rate (IPC). Following, the variables that account for monetary policy are included: the variation of overnight interest rate (R) and the variation of Portugal contribution to M1 monetary aggregate (M1). Then stock market variables are added, which are market return (RM) and volatility (VOLAT). In last place is illiquidity, measured by proportion of zero returns (ZR), in order to study the response of illiquidity to innovations in all the other variables. The Schwartz Bayesian Criterion is used to determine the optimum number of lags to include in our VAR model, which leads to the inclusion of 3 lags.

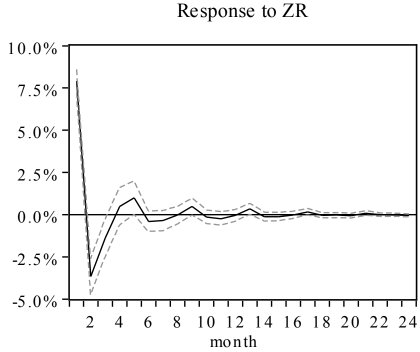
The impulse response functions, presented in Figure 2, show that macroeconomic effects on liquidity are more persistent than the effects of a shock to market return or volatility. Hence, macroeconomic factors are important in affecting the dynamic path of stock market liquidity.

Figure 2

**Impulse response functions**

**Response to Cholesky One S.D. Innovations ± 2 S.E.**






*ZR impulse response functions to Cholesky one standard deviation innovations of the following variables: monthly variation of Industrial Production Index (IPI); monthly variation of Consumer Prices Index (IPC); monthly variation of Interbank Monetary Market overnight interest rate (R); monthly variation of Portugal contribution to M1 monetary aggregate (M1); stock market monthly return (RM); monthly stock return volatility (VOLAT); and variation of proportion of zero returns (ZR). All variables are in percentage. Each variable is calculated for every month during the years from 1988 to 2011. The Interbank Monetary Market overnight interest rate is calculated from January 1989 onwards.*

*Source:* Authors elaboration.

In a VAR model, lagged values of all variables are included in each equation. Nevertheless, this does not imply that all variables are important to determine other variables in the system. However, Granger causality tests allow ascertaining the importance of one variable or group of variables as determinant of another variable. The test results are in Table 5 and reveal that the primary variables that contribute to predict illiquidity variation are changes in industrial production, in monetary aggregate M1 and stock market returns. Nevertheless, the hypothesis that all variables cause ZR variations cannot be rejected.

Table 5

**Granger causality tests**

| causes | **IPI** | **IPC** | **R** | **M1** | **RM** | **VOLAT** | **ZR** | **All** |
|---|---|---|---|---|---|---|---|---|
| **IPI** | – | 15.764*** | 4.298 | 35.248*** | 4.513 | 3.670 | 5.481 | 92.384*** |
| **IPC** | 4.499 | – | 6.648* | 13.835*** | 2.657 | 0.081 | 6.841* | 35.181*** |
| **R** | 7.956** | 6.905* | – | 1.964 | 12.125*** | 4.896 | 5.056 | 41.252*** |
| **M1** | 123.133*** | 1.408 | 1.047 | – | 5.455 | 1.875 | 5.011 | 155.980*** |
| **RM** | 6.137 | 2.097 | 5.408 | 3.954 | – | 6.137 | 0.902 | 24.357 |
| **VOLAT** | 12.871*** | 3.919 | 2.707 | 1.448 | 0.384 | – | 4.278 | 25.949 |
| **ZR** | 27.309*** | 5.069 | 2.846 | 11.430*** | 8.057** | 2.425 | – | 55.807*** |

*Granger causality tests based in a VAR(3) model with the following variables: monthly variation of Industrial Production Index (IPI); monthly variation of Consumer Prices Index (IPC); monthly variation of Interbank Monetary Market overnight interest rate (R); monthly variation of Portugal contribution to M1 monetary aggregate (M1); stock market monthly return (RM), proxied by the equal-weighted average of all sample stocks returns;*

*monthly stock return volatility (VOLAT), computed as the standard deviation of daily market stock return in each month; and proportion of zero returns (ZR). All variables are in percentage. Each variable is calculated for every month during the years from 1988 to 2011. The Interbank Monetary Market overnight interest rate is calculated from January 1989 onwards. Statistical significance of the causality relation from column variable to row variable at 10%, 5% and 1% levels is indicated by*, ** and ***, respectively.*

*Source:* Authors elaboration.

To assess the importance of the different variables in explaining time variation of liquidity, we analyse the decomposition of forecast variance, which allows us to quantify the percentage of the forecast variance due to each innovation at different forecast horizons. These results are shown in Table 6. It is the variation of illiquidity that mostly explains its own movements at all forecast horizons. In fact, although the percentage of the forecast variance due to illiquidity variation innovations diminishes as the forecast horizon increases, it still remains above 70% at the 24 months forecast horizon. Consequently, the percentage of forecast variance that is explained by the other variables increases with the forecast horizon. For one month horizon, the innovations in stock market return account for 6.5% of the forecast variance and innovations in volatility account for 1.0%, that is, stock market variables innovations explain illiquidity movements in shorter horizons. For 24 months forecast horizon, industrial production variation innovations explain 9.6% and monetary aggregate variation innovations explain 6.1% of the forecast variance. This suggests that illiquidity first responds to its own innovation, then to stock market related innovations and only more slowly adjusts to the altered economic conditions.

Table 6

**Variance decomposition of the forecasting error**

| | Period | IPI | IPC | R | M1 | RM | VOLAT | ZR |
|---|---|---|---|---|---|---|---|---|
| | 1 | 0.082 | 0.875 | 0.712 | 1.822 | 6.547 | 0.980 | 88.982 |
| | 3 | 0.671 | 1.808 | 0.905 | 4.829 | 5.995 | 2.300 | 83.493 |
| **ZR** | 6 | 7.026 | 2.267 | 1.029 | 5.660 | 5.538 | 2.183 | 76.297 |
| | 12 | 9.155 | 3.802 | 1.206 | 6.017 | 5.464 | 2.120 | 72.236 |
| | 24 | 9.630 | 4.086 | 1.222 | 6.134 | 5.428 | 2.110 | 71.390 |

*ZR variation forecasting error variance decomposition, based in a VAR(3) model with the following variables: monthly variation of Industrial Production Index (IPI); monthly variation of Consumer Prices Index (IPC); monthly variation of Interbank Monetary Market overnight interest rate (R); monthly variation of Portugal contribution to M1 monetary aggregate (M1); stock market monthly return (RM), proxied by the equal-weighted average of all sample stocks returns; monthly stock return volatility (VOLAT), computed as the standard deviation of daily market stock return in each month; and proportion of zero returns (ZR). All variables are in percentage. Each variable is calculated for every month during the years from 1988 to 2011. The Interbank Monetary Market overnight interest rate is calculated from January 1989 onwards. This table presents the percentage of ZR variation that each variable explain for the 1, 3, 6, 12 and 24 month horizon.*

*Source:* Authors elaboration.

## 5. **CONCLUSIONS**

In this paper, we examine commonality in liquidity in the Portuguese stock market and subsequently the factors that drive time variation of systematic liquidity. The motivation for our study is provided by the growing interest in financial assets liquidity that has emerged in literature over recent years and the implications of commonality for asset pricing, since liquidity commonality could represent a source of non-diversifiable risk that the market prices with a higher return.

Previous studies of liquidity commonality typically span short time periods and use intraday data for the determination of liquidity proxies. These proxies are usually bid-ask spreads and depths. In contrast to the extant literature, this study examines liquidity for a sample of Euronext Lisbon Stock Exchange over a 24-year period and uses eight liquidity proxies: quoted and proportional quoted bid-ask spreads, effective and proportional effective bid-ask spreads, turnover rate, trading volume, proportion of zero returns, and the illiquidity ratio.

Following Chordia et al. (2000) methodology, our results reveal some evidence of commonality in liquidity for the proportion of zero returns measure of liquidity. With respect to the factors that drive the inter-temporal variation of stock market liquidity, the results obtained within a VAR framework suggest that changes in real economy activity, monetary policy (proxied by changes in monetary aggregate M1) and stock market returns play an important role as a determinants of commonality in liquidity, when liquidity is measured by proportion of zero returns.

Overall, it can be stated that the main objective of the paper has been reached. But the observed results suggest further empirical work. In particular, it would be of interest to investigate how liquidity of different stock groups is affected by economic fundamentals to identify possible cross-sectional differences. It will also be useful to study the dynamic nature of volatility-liquidity interactions, since market return and volatility still exhibit some predictive ability for liquidity.

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## APPENDIX. DEFINITION OF (IL)LIQUIDITY MEASURES

### A.1. Spreads bid-ask

The spreads definitions are based in Chordia et al. (2000):

- The monthly quoted bid-ask spread ($QSPR_{it}$) is calculated as the difference between the closing ask price, $P_{Ait}$, and the closing bid price, $P_{Bit}$:

$$QSPR_{it} = P_{Ait} - P_{Bit} \quad \text{(A.1)}$$

- The monthly proportional quoted spread ($PQSPR_{it}$) is measured for each asset as the ratio of the quoted bid-ask spread and the bid-ask midpoint, $P_{Mit}$:

$$PQSPR_{it} = \frac{P_{Ait} - P_{Bit}}{P_{Mit}} \quad \text{(A.2)}$$

- The monthly effective spread ($ESPR_{it}$) is measured for each asset as the absolute value of the difference between the closing price, $P_{it}$, and the bid-ask midpoint:

$$ESPR_{it} = 2\left|P_{it} - P_{Mit}\right| \quad \text{(A.3)}$$

- The monthly proportional effective spread ($PESPR_{it}$) is the, measured for each asset as the ratio of the effective spread and the closing price:

$$PESPR_{it} = \frac{2\left|P_{it} - P_{Mit}\right|}{P_{it}} \quad \text{(A.4)}$$

### A.2. Turnover

The turnover rate ($TRNVR_{it}$) is calculated as the ratio of monthly volume of shares traded in asset *i* on month *t* ($VO_{it}$) and the number of shares outstanding of asset *i* at the end of month *t* ($SO_{it}$):

$$TRNVR_{it} = \frac{VOL_{it}}{SO_{it}} \quad \text{(A.5)}$$

### A.3. Trading volume

The logarithm of monthly trading volume in euros ($LVOL_{it}$) is computed as the logarithm of the sum of the product between the daily volume of shares traded in asset *i* ($VO_{itd}$) and the correspondent daily closing price on month *t* ($P_{itd}$), where $D_{it}$ is the number of days for which data are available for stock *i* in month *t*:

$$LVOL_{it} = ln \sum_{d=1}^{D_{it}} \left(P_{itd} \times VOL_{itd}\right) \quad \text{(A.6)}$$

**A.4. Proportion of zero returns**

The monthly proportion of zero returns ($ZR_{it}$) is computed as the number of daily zero returns in month $t$ ($\#ZR_{it}$) divided by the total number of transactions days in month $t$ for asset $i$ ($D_{it}$):

$$ZR_{it} = \frac{\#ZR_{it}}{D_{it}} \quad \text{(A.7)}$$

**A.5. Illiquidity ratio**

The illiquidity ratio ($ILIQ_{it}$) is computed as the average ratio of the daily absolute return ($R_{itd}$) to the euro trading volume on that day for asset $i$ in month $t$ ($VOL_{itd}$):

$$ILIQ_{it} = \frac{1}{D_{it}} \sum_{d=1}^{D_{it}} \frac{|R_{itd}|}{P_{itd} \times VOL_{itd}} \quad \text{(A.8)}$$

In order to be included in the sample, it is required that asset $i$ have return and volume data for at least 10 days and a price equal or greater than € 1.00 in each month.


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