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Measures, Determinants and Commonality in Liquidity: Empirical Tests on Tunisian Stock Market

Tarek Bouchaddekh [α] & Abdelfatteh Bouri [σ]

Abstract- This paper examine empirically variables that can be significantly correlated with inter-temporal changes of measures of the individual's securities, for example: trading volumes, number of transactions, return, volatility, arrival of new information etc. Before a study of a sample of 40 quoted securities in Tunisian financial market, on the period of February 07, 2011 until January 31, 2013, results appear conclusive. First, as expected, depth has negative correlation with all spread measures. Besides, we observe perfect positive correlations between spread measures. This shows the validity of these liquidity measures on the Tunisian stock market. Furthermore, the results suggest that volume, return and arrival of new information contribute to explain significantly the inter-temporal changes of various measures of the securities liquidity. Finally, we can consider, probably, the arrival of new information as a common factor for the different liquidity measures for all stocks in our sample.

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I. Introduction and Background

Traditionally, asset pricing models (option pricing model [MEO], capital asset pricing model [CAPM] and arbitrage pricing theory model [APT]) are formulated under the hypothesis of a "perfect" market without frictions (transaction costs, asymmetry information costs etc.…). However, the empirical studies show that these frictions, known under «market microstructure", have an influence on price formation and on market liquidity.

In a more and more competitive environment, the financial markets try to guarantee an important quality: the liquidity. Indeed, the liquidity becomes an element of investment choice between the financial rooms that quote the same values of fact that the investor wishes to exchange without delay and without loss whatever is the volume.

In spite of the importance of concept of liquidity, researchers in finance don't have very successful to give him a standard measure. Indeed, liquidity depends on structure of market, nature of the exchange and other factors. Market microstructure literature has, at least since Demsetz (1968), based primarily on the bid-ask spread. This last is considered as a measure of transaction cost and market efficiency. It is admitted for a long period that the quoted bid-ask spread is inadequate for measuring market liquidity. According to Stoll (1985) and Grossman & Miller (1988), for example, the bid-ask spread measures liquidity precisely only when the market maker simultaneously crosses a trade at the bid and ask.

Hasbrouck (1993) discusses the defect of the traditional measures of transaction costs (such as bid-ask spread) and propose new improved measures of the liquidity: trading restrictions. Brennan, Chordia and Subrahmanyam (1998) measure liquidity by two variables: trading volume and securities rate rotation. Chordia, Roll and Subrahmanyam (2000) measure the liquidity by: quoted spread, effective spread and quoted depth. Several others measures are used, for example: volatility, lambda, CRT (cost of round trip trade), etc.

Several researches are interested to the identification of variables that can influence liquidity. To this stadium, several empirical studies have been done. Brennan and al (1998) identify a negative relation between returns and trading volume (considered as "proxy" of liquidity). Chordia, Roll and Subrahmanyam (2000) detect a strong correlation between trading volume and measures of liquidity (spread, depth etc.…). Other authors tried to examine the nature of relation between liquidity and others variables, such as: volatility, number of transactions, information, quoted tick size etc.

This paper proceeds to a sweep of an extensive literature permitting to examine the problematic relative to the identification of the determinants of liquidity. Our survey is incorporated in context of market microstructure aiming to describe the evolution of various measures of liquidity and study the factors that can be contributed to explain these different measures of securities quoted in continuous on the Tunisian stock market.

Our survey presents an institutional and methodological interest. On the first plan, it is about bringing a contribution to the reflection on the concepts, such as: theory of market microstructure, theory of bid-

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ask spread, measures and determinants of market liquidity.

On the methodological plan, we widened the approach of the event survey to the new parameters measuring liquidity, such as: spread and depth. Indeed, if this methodology is applied extensively to returns and volume, it is only used little for spread and depth.

The rest of the paper is organized as follow. Section 2 recalls and studies the literature of *"marketmicrostructure"* while insisting on the theory of the bid-ask spread. Section 3 defines market liquidity measures. Section 4 exposes theoretical and empirical works that study the influence of the strategically variables of microstructure (trading volume, returns, volatility, information, tick size etc.) on market liquidity. In section 5 we empirically study the evolution of the different measures of liquidity/illiquidity, variables influencing the market liquidity on the Tunisian stock market.

II. Market Microstructure Theory: Frictions and Dealer Heterogeneity

In the canonical model of efficient markets, price reflects all public information. In this model, agents are supposed to have homogeneous anticipations and frictions are negligible. Therefore market prices converge to the anticipated values. It is the example of asset pricing models (MEDAF, MEO, APT) that are formulated independently of transaction cost, dealers behaviour and market design.

In contrast to the model of efficient markets above, market microstructure theory interests to study the impact of the various market frictions and heterogeneity of anticipations[1]on price formation process. The central idea of the microstructure theory is that prices cannot be reflected all available information because of the variety of markets frictions (transaction costs, disagreement between dealers etc.). These frictions drive to have bid-ask spread prices that become, since Demsetz (1968), the central theme of the market microstructure theory.

The bid-ask spread is the difference between seller price (ask) and buyer price (bid). In the development of the theoretical components of the bid-ask spread, Glosten& Harris (1988) and others decompose the bid-ask spread into to parts. In the first part, due to informational asymmetries, the bid ask spread constitutes a potential loss indemnity supported by the market makers while he executed transaction with informed traders. In the second part, due to inventory control considerations, we can distinguish order processing costs (include exchange fees and taxes as well as the more immediate costs of handling transactions) and inventory holding costs components (compensation costs so that market maker accepts to detain no optimal portfolio).

III. Definitions and Measures of the Liquidity

a) *Definitions*

One of the first definitions of the liquidity comes to J.M Keynes (1930) according to which "an asset is as much more liquid if it is transformable in short-term currency and without loss ". This definition permits to put in evidence the two aspects of the liquidity: the temporal factor expressed by "short-term" and price factor translates by "without loss".

This definition can be adapted to financial markets: "A financial room is said liquid if intervening parties can buy and sell at all times an important quantity of securities to a fixed price ".

The previous definitions emphasize, always, the two dimensions of liquidity: time and cost. These two dimensions have tendency to evolve in an inverse sense: more the investor is hurried to achieve his transaction, more the cost generated by this one is important while more it is patient, more the cost of execution is advantageous.

Because she clothes several facets, the liquidity is a notion that is not simple to define and to measure. In their studies, researchers (Black [1971] and others) distinguish, generally, four dimensions of liquidity: *immediacy, depth, tightness and resiliency.*

The immediacy refers to the time that passes between the placing of a market order and its execution. *Depth* is the maximal amount of an operation for a determined spread; a market is *deep* if large orders can be executed without much effect on prices. *Tightness* refers to the cost of obtaining liquidity in the market and is directly measured by the bid-ask spread. *Resiliency* refers to the speed with which the bid and the ask schedules move back to their initial positions after an order has been executed.

b) *Liquidity measurements*

Some of the most interesting researches in microstructure theory deposit a problem of determination of a suitable measure of liquidity. It has been demonstrated that the choice of the "proxy" of liquidity is a very delicate task and depend on the room of quotation and the market design. In the literature, several measures of liquidity have been proposed, such as: trading volume, ratio of liquidity, the rotation rate, spread, depth, CRT, VNET, etc.

- Trading volume: Traditionally (Demsetz (1968)), liquidity is measured by the trading volume. This is maladjusted, because it disregards properties of the concept of liquidity (immediacy, tightness, depth and the resiliency).

[1] Heterogeneity of anticipations results in the presence of the informed traders, liquidity traders and market makers. Dealers are facing problem of asymmetric information when they display their prices ask/bid because they don't distinguish insiders to outsiders.

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- Liquidity ratio: Bernstein (1986) defines it as the report of the absolute variations of prices to the trading volumes. It is considered as measure of liquidity degree of securities.
- Turnover: Turnover is generally used to measure the financial asset liquidity. It is equal to the number of securities exchanged divided by the number of securities in circulation. This measure is criticisable in the sense that it doesn't integrate features of the concept of liquidity.
- The ask-bid spread: the spread is generally considered as the best measure of the concept of liquidity. Under this term, we distinguish the quoted spread and the effective spread. Generally, the spread is considered as a measure of illiquidity.
- Depth: One of the most measures abundantly used as proxy of liquidity is depth. Depth is the number of units offered to "ask" price plus the number of units demanded at "bid" price. Depth can be measured by the number of securities exchanged (depth quantity) or by the number of monetary units (dollars depth). The depth is a quality offered by the electronic markets in the difference to floor-based markets, where we meet a big number of participants supplied of liquidity but incapable to execute some orders.
- Lambda: Kyle (1985) watch that the tie between prices and quantities in a note orders-book[2] can be used to appraise the degree of illiquidité of securities while supposing a linear relation between prices and quantities exchanged on the market; the lambda is the slope of the linear line.

$$\lambda = \frac{(ask - bid)}{(ask\ size + bid\ size)} \quad (1)$$

$$P = \mu + \lambda Q \quad (2)$$

P: price of securities,
Q: trading volume. Q> 0, if it corresponds to a purchase and Q <0, if it corresponds to a sale,
μ: represent the informational value of asset.

- *VNET:* Robert, Engle and Joe Lange (1997) propose a new intraday measure of market liquidity, VNET. This measure is constituted by the excess volume of buys or sells during events observed on the market defined by movements of prices. If price increase with a weak excess buys, the market is considered as illiquide, but if this same price increase with a large excess of buys, the depth would be more important. VNET is defined as follows:

$$VNET = \left| \sum_{i=1}^{n} d_i \times vol_i \right| \quad (3)$$

d: is an indicator of trading (buys =+1 and sells = -1), vol: is the trading volume.

VNET measures the net directional volume that can be traded before prices are adjusted. If VNET converge to zero, the market is considered as being very liquid.

- CRT (the cost of round trip trade): Paul Irvine and George Benston (2000) propose an ex-ant measure of market liquidity, CRT. All low values of buyer prices "bid" and those of the high values of seller prices "ask" are respectively: P-1> P-2> P-3>….. and P1 <P2 <P3 <…. Quantities of securities offered and asked are represented by the vector: Q [… .Q-2 Q-1 Q-0 Q0 Q1 Q2….). The number of securities that we can sell it to mid price " is:

$$T(D) = \frac{2D}{P_{-0} + P_0} \quad (4)$$

[2]A note orders-book unites (by dates, volumes and categories) the waiting orders according to the asked price (on pouring it superior of the notebook) and the offered prices (on pouring it lower).

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We define two indicators: I_k and I_{-k} that correspond to buyer and seller orders expressed in dollars respectively.

$$I_{-k}=\begin{cases}1 & if \quad T(D)\geq\sum_{i=-0}^{-k}Q_i\\ \left[T(D)-\sum_{i=-0}^{-k+1}Q_i\right]/Q_k & if \sum_{i=-0}^{-k+1}Q_i\leq T(D)\leq\sum_{j=-0}^{-k}Q_j\\ 0 & if \quad not\end{cases} \quad (5)$$

$$I_k=\begin{cases}1 & if \quad T(D)\geq\sum_{i=0}^{k}Q_i\\ \left[T(D)-\sum_{i=0}^{k}Q_i\right]/Q_k & if \sum_{j=0}^{k-1}Q_j\leq T(D)\leq\sum_{i=0}^{k}Q_i\\ 0 & if \quad not\end{cases} \quad (6)$$

$$CRT=\frac{\sum_{k=0}^{+\infty}(I_kP_kQ_k)-\sum_{k=0}^{+\infty}(I_{-k}P_{-k}Q_{-k})}{D} \quad (7)$$

We can say that market i offer a higher liquidity than market j if $CRT_i(D) < CRT_j(D)$.

IV. The Theoretical and Empirical Studies Relating of Actors Influencing Liquidity

The market design, regulators and management of investment can be all improved by the knowledge of factors influencing liquidity. A good understanding of these determinants can improve the confidence of investors on the financial markets and in this fact, to heighten the efficiency of resources allowance.

In the market microstructure literature, several researches (notably those led by Kyle (1985); Amihud and Mendelson (1986); Admati and Pfleiderer (1988); Harris (1995) as well as of others) note that liquidity is conditioned by several factors that will be studied in the following of the paper.

a) Information and insider's transactions impact

A set of empirical studies tempted to measure the impact of the asymmetric information on the bid-ask spread. Gajewski (1996) achieves a survey of event on data around announcements of earnings. Two types of situation of asymmetric information can appear. The first is that some investors can be informed exceptionally before the announcement, either because they collected information (financial analysts), either because they are insiders (majority shareholders, chief of enterprise…). The second type of situation of asymmetric information results the public information. Investors having a better capacity to interpret information arrange an informational advantage on others. Morse and Ushman (1983) study the evolution of the bid-ask spread around the quarterly result announcement on the period 1973-76 on a composed sample of 25 securities quoted on the OTC (Over The Conter). The authors don't put in evidence meaningful change of the size of the bid-ask spread around the date of quarterly earnings announcement.

To study the impact of insiders transactions on liquidity, Lee, Macklow & Ready (1993) study the evolution of the quoted spread and quoted depth (considered as "proxy" of liquidity) on 53 intervals of a half-hour where makes himself the announcement of earnings. The empirical results reinforce the hypothesis that the intervention of insiders results in the widening of quoted spread and therefore a deterioration of the market liquidity. In the goal to verify this prediction on the Paris Bourse, AnnaïckGuyvar'ch (2001) studies empirically the evolution of the quoted spread following insiders transactions. This survey shows that the quoted spread enlarges on the days where insiders achieve their criminal transactions, and recover his normal level on the end of the quotation session.

b) Liquidity and returns

The idea that measures of liquidity can influence returns is well accepted. Several studies (Amihud and Mendelson,1986) show that expected returns are in decreasing function of liquidity because investors must

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be compensated for the higher transaction costs that they bear in less liquid markets.

Amihud and Mendelson (1986) leave of the hypothesis that investors require an elevated expected return for an enlarged spread to compensate transaction costs. Thus, investment decisions don't depend solely on specific risk hound to securities, but also to their liquidity risk. Besides, it is important to note that when investors can reduce a risk bound to the securities by the diversification of his portfolio or by techniques of hedging, it is difficult to make it to eliminate illiquidity costs[3] .

In order to support the idea that liquidity has a measurable effect on returns, Amihud and Mendelson (1986) examine the importance of introduction of liquidity (measured by the bid-ask spread) in asset pricing. They test the hypothesis that expected returns are an increasing concave function of ask-bid spread. Empirical result, on the NYSE/AMEX common stocks in the period 1961-1980, indicate there is a significantly positive relation between returns and the bid-ask spread.

These results have a number of implications for the investment and for the portfolio choice. One of implications, is that investments of weak liquidity generate some elevated returns for their holders.

c) Liquidity and tick size

Tick size constitutes the minimum price variation for quoting and trading stocks. It is determined of two ways: either in percentage of prices level, which limits his impact, either by authorities of the market; independently of prices. A number of papers examine theoretically and empirically the effect of a tick size reduction on market liquidity.

Harris (1994) applies that a reduction in tick size should reduce liquidity; since the tick size represents the subsidy paid to liquidity providers. Specifically, in the wake of a reduction tick size, liquidity providers could choose to reduce their interventions on the market. Therefore, market liquidity provision decrease.

Empirically, several studies done on the international markets (Stockholm Stock Exchange band others) confirm the theoretical survey of Harris (1994), others invalidate it. Engel (1997) argues that a small tick size increase liquidity by allowing for a small bid-ask spread. Niemeyer and Sandâs (1994) also the arguments in Harris (1994), showing that the tick size is positively related to the bid-ask spread and negatively related to trading volume.

d) Liquidity and trading volume

The takes in account of volume as resulting of the strategic intervention of operators puts in evidence the importance of studies for the impact of trading volume on liquidity. The empirical results recorded show that researchers were in situation of conflict.

Chordia, Roll and Subrahmanyam (2000) recommend a positive relation between trading volume and liquidity; negative relation (positive) between trading volume and quoted spread (quoted depth). These results confirm the strategic behavior of operators that choose to negotiate on the moments where the securities are most liquid (narrow spread and elevated depth).

Of their part, Clyman, Allan and Jaycobs (1997) reject the idea that a strong liquidity requires an elevated volume. They appraise that, on a liquid market, we must predict a symmetrical variations of the bid and ask prices, but on an illiquid market these variations being asymmetric. This is imply that only the bid price go up toward the ask price or that only the ask price lower toward the bid price.4.5

e) Liquidity and volatility

The spread is also related to the volatility. This predicts the inventory and asymmetry information models. Several studies showed a negative relation between liquidity and prices volatility (Domowitz, Glen and Madhavan (2000) and others…). In particular, it has been observed that an increase of volatility takes, generally, to an enlargement of the bid-ask spread. Theoretically, this result can be explained by the fact that in period of a strong volatility, market makers are going to require a more elevated return (enlargement of the bid-ask spread) to compensate the free loss of an unexpected prices variations.

f) Seasonality in liquidity

The first empirical studies describing the evolution, in sitting, of liquidity measures have been achieved on the American stocks markets. Handa (1992) analyzes a behavior of an intraday spreads calculated at intervals of a half-hour for 1902 quoted securities on the NYSE/AMEX. He observes a curve in U of quoted spread of market makers during the quotation sitting.

In the goal to test seasonality in liquidity, Chordia, Roll and Subrahmanyam (2000) show that the liquidity, in NYSE, is affected by days of the week. They prove that Tuesdays, Wednesdays and Thursdays have a negative and significant effect on the spread and a positive and significant effect on the depth. Specifically, they observe that Tuesdays have some more elevated coefficients in absolute value than the other days of the week. The authors show, also, that liquidity decreases in Friday and that depth has tendency to increase around the holiday days.

[3] Let's note that investors can eliminate no systematic risk by the diversification and can form a portfolio with zero beta to eliminate the systematic risk (bound in market). However, investors cannot eliminate illiquidité costs.

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V. Application to the Tunisian Stock Market

The Tunisian stock market knew since 14 November 1994 (law n° 14-117 carrying reorganization of the financial market) mutations characterized by the following criteria: security (guarantee put in room by mediators), transparency and necessity of a diffusion of information in real time and liquidity that constitutes criteria of judgment of the market. This reform can contribute to facilitate the activity of exchange and to improve the liquidity on the Tunisian stock market.

Our empirical survey was integrated in the domain of market microstructure aiming to describe the evolution of the different measures of the liquidity and to study the impact of factors that can contribute to explain these different measures of quoted stocks in continuous on the Tunisian stock market.

Data concerning the daily prices, the nearest preceding bid and ask prices, number of shares the specialist had guaranteed to trade at the bid and ask quoted , the trading volume and the number of trades are provided by a financial intermediary (broker). It is to note that we are going to exclude Saturdays, Sundays, the holiday and days for which stocks have not been quoted. The study is conducted on the period going February 07, 2011 until January 31, 2013. The sample is constituted by 40 quoted securities in Tunisian stock market.

a) Evolution of liquidity measures on the Tunisian stock market

The first stage of our survey consists to calculate for four liquidity measures the weekly average of: quoted spread (S), proportional effective spread (SP), effective spread or lambda (SE) and quoted depth (DE). Measures of the liquidity used are formulated as follows:

- The quoted spread: S = Log(Ask/Bid) ; (where Ask, is the seller price and Bid, is the buyer price).
- The proportional effective spread : $S_p = 2\dfrac{\left|Log(P) - \left[Log(ask) + Log(bid)\right]/2\right|}{Log(P)}$

  (Where P is the price shares).
- The depth : DE = Log(Q ask) + Log(Q bid)
  (Where Q ask and Q bid denote the quantity guaranteed available for trade at the quotes ask and bid)
- Another measure of liquidity (lambda) proposed by Handa (1992) that combines two measures of liquidity, quoted spread and depth, : $SE = \dfrac{Log(ask/bid)}{Log(Q_{ask}) + Log(Q_{bid})}$

Second, we try to test the hypothesis that all measures of spread are positively correlated with each other across time and negatively correlated with depth.

Table 1 documents the correlations between the aggregate market liquidity measures

Table 1 : Correlations between liquidity market measures

	SPM	SM	SEM	DEM
SPM	1			
SM	0.9203404	1		
SEM	0.9315732	0.971523	1	
DEM	-0.156081	-0.23458	-0.29524	1

As expected, depth (DEM) has negative correlation with all spread measures. Besides, we observe perfect positive correlations between spread measures. This shows the validity of these liquidity measures on the Tunisian stock market.

b) Influence of market liquidity on individual stocks liquidity

We first estimate autoregressive model of the liquidity proxy for individual stocks and examine whether the residuals from the autoregressive model are correlated for the different individual stocks.

$$L_{i,t} = \chi_{0,i} + \chi_{m,i} L_{i,t-1} + \xi_{i,t} \quad (8)$$

Li,tet Li,t-1 are the liquidity measures for stock i at the dates t and t-1.

Note that the 40 individual stocks (or regressions for each liquidity measure) are arranged alphabetically by stock name. So we run 39 time series regressions between adjacent residuals;

$$\xi_{i+1,t} = \kappa_{i0} + \kappa_{i1}\xi_{it} + \theta_{it} \quad (9)$$

- κ_{i0} *and are estimated coefficients.*

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- *ξ_{it} is an estimated disturbance for stock in equation (1).*

We interpret positive correlations for thirty four regressions among thirty nine for each liquidity measures. The average correlation is to 0.23 for Depth, 0.36 for quoted spread, 0.31 for proportional effective spread and 0.33 for lambda. This result is compliant to Huberman & Halka (2001) and proves the presence of the common liquidity factors in Tunisian stock market.

These common factors can be associated to factors that can vary with these different measures, such as: trading volume, number of trades, return, volatility and lag variable of liquidity measure, etc…

According to Chordia, Roll and Subrahmanyam (2000), we going, initially, to estimate simple "market model" time series regressions; liquidity variables for an individual stock regressed on market measures of liquidity:

$$L_{i,t} = \beta_{0,i} + \beta_{m,i} L_{m,t} + \mu_{i,t} \quad (10)$$

$L_{i,t}$et $L_{m,t}$are the liquidity measures for stock i and market respectively.

$\beta_{m,t}$, is sensibility of stock liquidity to the aggregate market.

$\mu_{i,t}$, is the innovations.

The estimation in (10) by OLS method[4] clears a Durbin-Watson value near to unit for all measures of liquidity. This implies the existence of positive auto-correlations in innovations. These auto-correlations are in order 1[5] for all stocks liquidity measures in our sample.

To solve this problem of auto-correlations in innovations, we estimate model (11), while using the Eviews 6 Software that permits to estimate by OLS method the auto-correlation coefficients:

$$L_{i,t} = \beta_{0,i} + \beta_{m,i} L_{m,t} + \rho\, \mu_{t-1} + \nu_t \quad (11)$$

ρ, *are* the auto-correlation coefficients in innovations between dates t and t-1.

Results of the estimation of market model in (11) are very powerful. Indeed, all coefficients are positive, but 11% are only not significant. This proves that the individual stock liquidity was strongly correlated with aggregated market liquidity, what again reinforces the hypothesis of the validation of a market model adapted to different liquidity measures on Tunisian stock market.

It is to note that, the explanatory power of this last model is not important. Indeed, the average determination coefficients for the different measures of the liquidity are 18% for the quoted depth, 28% for the quoted spread, 25% for the effective spread and 29.4% for the lambda. This is can be justified by the existence of noise or that it exists other factors can influenced individual stocks liquidity.

c) Empirical studies on individual determinants of the liquidity on the Tunisian stock market

In the literature of market microstructure many study reinforces the hypothesis according to which the liquidity is conditioned by the strategic indicators measuring the performance of market, among these factors we distinguish: trading volume, number of trades, return, volatility and lag variable of liquidity measure, etc.

i. *Trading volume*

The effect of trading volume on the spread is ambivalent. Trading volume is carrier of news that market maker ignored; in this case, he enlarges his spread to hedge his position. However, by reason of the competition, he could be obliged to reduce spread and play on the volume. With regard to the effect of trading volume on the depth, the different studies detected a positive relation.

To study the relation between liquidity and trading volume (measured in number of stocks exchanged), we estimate equation (12):

$$L_{i,t} = a_0 + a_1 V_{i,t} + u_{i,t} \quad (12)$$

$V_{i,t}$,is the logarithm of trading volume for stocks at the time t.

To estimate this equation we use Panel data for 40 stocks quoted in continuous and most active on the Tunisian stock market on the period going from February 07, 2011 to January 31, 2013, either 104 weekly observations for each stock. Therefore, in whole, we have 4160 observations for each variable.

Estimation of equation (12) by the OLS method[6] proves the existence of positive auto-correlations in innovations (Durbin-Watson near of 1). To solve this problem we estimate, rather, equation (13):

$$L_{i,t} = a_0 + a_1 V_{i,t} + \rho\, u_{i,t-1} + \varepsilon_{i,t} \quad (13)$$

Results of estimation are very powerful and reject the hypothesis of an ambivalent relationship between liquidity and trading volume. Indeed, we detect a negative and significant relationship between the different illiquidity measures (quoted spread, proportional effective spread and lambda) and the

[4] Note that all measures of liquidity are stationary.

[5] We used an econometric method that consists in adding to the regression (5), AR(1) AR(2)…then we tested the significant power of the auto-correlations coefficients . The result proves that only the coefficients of order 1 are significant.

[6] It is to note that the trading volume expressed in logarithm is stationary. In the same way, all other variables that we are going to use are thereafter are stationary, except variable «price (P)" that is stationary in difference (DS).

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trading volume. Besides, we detect a positive and significant relation between depth and trading volume with a t-student of 6.2. This positive and significant relation between liquidity and trading volume on the Tunisian stock market confirms the strategic behaviour of operators that chooses to negotiate just when stocks become very liquid (narrow spread and elevated depth).

ii. *Number of trades*

In order to study the link between liquidity and number of trades we estimate, using data Panel, by the OLS method equation (14):

$$L_{i,t} = b_0 + b_1 N_{i,t} + v_{i,t} \quad (14)$$

$N_{i,t}$, is the logarithm of number of trades for stocks i at a date t.

To solve the problem of mistake auto-correlation in innovations, we estimate rather equation (15):

$$L_{i,t} = b_0 + b_1 N_{i,t} + \rho v_{i,t-1} + \eta_{i,t} \quad (15)$$

Results of estimation show an ambiguousness relationship between liquidity and number of trades. On the one hand, we observe a negative and significant relation between illiquidity measures and number of trades. On the other hand, we observe a negative and significant relationship between depth and number of trades. The existence of a negative relation between the depth and number of trades can be explained by the tendency of intermediaries in stock market to exercise some trading in block because the Tunisian stock market lacks of informed traders.

iii. *Return*

In our empirical investigation we estimate by OLS method equation (16):

$$L_{i,t} = c_0 + c_1 R_{i,t} + \rho v_{i,t-1} + \eta_{i,t} \quad (16)$$

$R_{i,t} = \text{Log}(P_t / P_{t-1})$, is the return for stock i, at a week t.

Estimation results document a positive and significant relationship (but insignificant, solely, for the quoted spread) between return and stocks liquidity. Indeed, we observe, on the one hand, some negative coefficients for the different illiquidity measures; it is of - 0.013 with a t-student of - 0.64 for the quoted spread, - 0.045 with a t-student of - 4.54 for the proportional effective spread and of - 0.006 with a t-student of - 2.17 for the lambda. On the other hand, we detect positive and significant coefficients between the quoted depth and return. this is in contradiction with the result of Amihud & Mendelson (1986) and Brennan, Chordia & Subrahmanyam that recommend that liquid stocks procure to their holding weak return. This positive relation between liquidity and return on the Tunisian market can be explained by the tendency of intermediaries in stock market to negotiate stocks that procure the most elevated returns.

iv. *Volatility*

By reason of the absence of a sufficient number of quotations inside the week to calculate prices volatility, we use an approach that consists to estimate the volatility from the past prices. There is little evidence that stock market varies systematically with time. There is also strong evidence that ARCH models (Autoregressive Conditional Heteroskedasticity; Engel, 1982) are good descriptions of time-varying volatility in stock prices. Review article such Bollerslev (1986) documents the effective application of ARCH(p) and GARCH(p,q) (General Autoregressive Conditional Heteroskedasticity) models to financial time series across a wide variety of markets.

In our investigation we use GARCH (1.1) model to estimate volatility:

$$\begin{cases} Log(P_t) = \alpha_0 + \alpha_1 Log(P_{t-1}) + u_t & (a) \\ h_t = a_0 + a_1 u_{t-1}^2 + a_2 h_{t-1} & (b) \end{cases} \quad (17)$$

In equation (17. a), $\alpha_0 = E[\text{Log}(P_t \setminus F_{t-1})]$ is the conditional average of information in t-1 represented by the whole F_{t-1} and u_t designates the shock.

In equation (17. b), $h_t = E_{t-1}(u_t^2 \setminus F_{t-1})$ is the conditional variance to F_{t-1}. By definition, it is the expected component of the volatility. The equation (b) is a modelling of this component that is then function of the passed innovations u_{t-1} (a_1 is interpreted as the size of this shock) and of the passed volatility h_{t-1} (a_2 is an indicator of persistence).

To estimate the volatility by the GARCH (1, 1) model, we, first, examine the distributions of stocks prices using the Eviews 6software. We notice that these distributions depart of the normal distribution as indicated by tests of skewness and kurtosis. The test of skewness rejects significantly the symmetry (H0: sk = 0) with an average value of 0.63. The test of kurtosis rejects the hypothesis of a normal distribution (ku =3) with a value of 2.13. Besides, the statistical of Jarque-Bera[7] is 8.05 with a near probability of zero. Therefore, we reject

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the hypothesis of a normal distribution of the stocks prices.

The estimation of equation (a) by the OLS method puts a problem of a unit root for all stocks in our sample. The Dickey-Fuller test indicates that distributions are deference stationary (DS). Therefore, we estimate for every stock, the following model by the ARCH method:

$$DLog(P_t)=a_0+u_t \quad (18)$$

Once this last model is estimated, using the ARCH estimation method with Eviews 6 software, we generates for every stock the data of the volatility $h_{t.1}$.

$$h_t=a_0+a_1\mu_{t-1}^2+a_2h_{t-1} \quad (19)$$

Estimation results of model (19) indicate that current volatility depends of lagged volatility h_{t-1} (GARCH), whose coefficient a_2 is positive and significant for most stocks. Besides, the results suggest that current volatility depends of lagged squared innovations, u_{t-1}^2 (ARCH), whose coefficient a_1 is positive and significant.

Once, the volatility is estimated, we examine their influence on the liquidity. Therefore, it is necessary to estimate the following model while using Panel data[8]:

$$L_{i,t}=d_0+d_1h_{i,t}+\rho w_{i,t-1}+\psi_{i,t} \quad (20)$$

Estimation results in equation (20) show, on the one hand, that volatility is positively related to spreads (quoted spread and lambda). This can essentially be explained by the strategic behaviour of traders that choose to widen spread to compensate the risk of a strong prices volatility in them disfavour. On the other hand, results show a negative relationship, but not significant, between depth and volatility. This shows the absence of a strong relationship between liquidity and volatility on the Tunisian stock market.

v. *Past information*

To judge the influence of the past information on the stocks liquidity, we introduced a lagged variable because liquidity at time t-1 has an influence on the liquidity at time t. This influence is essentially owed to the incorporation in prices and volumes that are attached to information revealed by the past transactions. Some supplementary lags don't contribute to increase the explanatory power of the model. Therefore, liquidity follows an auto-regressive process of order 1.

$$L_{i,t}=e_0+e_1L_{i,t-1}+\gamma_{i,t} \quad (21)$$

Using Panel data, estimation results make appear that past liquidity contributes strongly to explain current liquidity. Indeed, coefficients of the past liquidity are positive and significant for all liquidity measures.

This shows the importance of the past information to explain the behaviour of liquidity of stocks quoted in continuous.

d) Determinants of the common movements in liquidity on the Tunisian stock market

To examine the hypothesis of the presence of common factors in liquidity, we based on previous results indicated that the trading volume, return and lagged liquidity measures contribute significantly to explain the behaviour of liquidity measures of all stocks quoted in continuous on the Tunisian stock market. Therefore we are going to examine if these variables can be considered as common factors in liquidity.

Therefore, we estimate, using panel data for each group, the following regression (pooled cross-section time series):

[7] $JB=((N-h)/6)*\left[S^2+1/4(K-3)^2\right]$. Where, S is the skewness, K is the kurtosis, h is the number of parameters to estimate and N design the number of observations.

[8] It is to notice that we lost for every stock the first observation. To the whole, we lost 40 observations for each variable; therefore we dispose of 4160 observations.

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$$L_{i,t} = c_{i,t} + \alpha_i V_{i,t} + \beta_i R_{i,t} + \chi_i L_{i,t-1.} + \varepsilon_{i,t} \quad (22)$$

$L_{i,t}$et $L_{i,t-1}$ are the liquidity measures for stock i at the weeks t and t-1.

$V_{i,t}$, is the logarithm of trading volume for stocks at a week t.

$R_{i,t} = \text{Log}(P_t / P_{t-1})$, is the return for stock i, at a week t.

In tables 2 we report estimates coefficients for the regressions of our four liquidity proxies on the explanatory variables.

Table 2 : Determinants of the common movements in liquidity

PANEL		C	V	R	S(-1)	R^2
S		0.017485	-0.001276	-0.026352	0.254798	0.129083
	t-st	*(5.502999)**	*(-4.221660)*	*(-0.652348)*	*(5.456235)*	
SP		0.005576	-0.000432	-0.0756348	0.328254	0.219406
	t-st	*(6.893580)**	*(-3.796875)*	*(-3.65234)*	*(7.489629)*	
DE		2.712189	-0.045168	30.79190	0.488769	0.318134
	t-st	*(3.276671)**	*(-1.135465)*	*(5.6542387)*	*(13.00661)*	
SE		0.001559	-0.000146	-0.010545	0.374519	0.255791
	t-st	*(5.082276)**	*(-4.906551)*	*(-2.101210)*	*(8.489462)*	

- *Trading volume:* Table 2 shows that trading volume is negatively and significantly correlated to the different measures of illiquidity. However, the depth is negatively correlated with trading volume, but this relationship is not significant (t-student of -1.13).
- *Return:* Table 2 reveals that return is negatively correlated to the quoted spread (with a t-student of -*0.652348*), to the proportional effective spread (with a t-student of -*3.65*) and to the lambda (with a t-student of -2.10). Besides, return is positively and significantly correlated to the quoted depth (with a t-student of *5.65*).
- *Past information:* Tables 2 indicates that, even if we account for volume, return, the past information (represented by the lagged liquidity variable) remains a strategically variable that contributes strongly and significantly to explain the behaviour of the different liquidity measures of stocks.

Thus, our results contradict the hypothesis that volume and return contribute strongly to explain the behaviour of the liquidity. Therefore, volume and return don't constitute a common factor for the different liquidity measures of the stocks quoted in continuous on the Tunisian stock market.

In opposite, we can consider, probably, the past information as a common factor for the different liquidity measures for all stocks in our sample quoted in continuous on the Tunisian stock market.

VI. Conclusion

Literature of market microstructure proposed a diversity of measures, such as: the quoted spread, proportional effective spread, lambda, quoted depth … In the goal to judge the validity of these measures on the Tunisian stock market, we tried to verify the hypothesis that different illiquidity measures (quoted spread, proportional effective spread, lambda) vary in inverse sense with the quoted depth. Our survey led on 40 stocks quoted in continuous reinforces this last hypothesis for the individual stocks as well as for the whole of the market.

The main goal of this paper was to test empirically the hypothesis of the presence of variables influencing liquidity stocks quoted in continuous on the Tunisian stock market.

The most important empirical results find that:

- It exist a "market model" for liquidity.
- Trading volume has positive and significant relationship with the stocks liquidity.
- It exist ambiguousness as for the influence of the number of trades on stocks liquidity.
- Return is positively and significantly correlated with stocks liquidity.
- Relationship between liquidity and the volatility is not significant.
- Liquidity is auto-regressive of order 1. Indeed, the lagged liquidity has strong contribution to explain the current liquidity. So, we can consider, probably, the past information as a common factor for the different liquidity measures for all stocks in our sample quoted in continuous on the Tunisian stock market.

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