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Review

Liquidity and volatility around large trades: Evidence from the Tunisian market

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ABSTRACT

Whether temporary or permanent, price effects of large trades routed upstairs or downstairs do exist. These price movements have an impact on market liquidity and volatility. If it is admitted that block markets have seen a great expansion, it would be interesting to check if these upstairs markets cream skim the central market by reducing its liquidity. It would be also convenient to check if institutional investors would cause a persistent volatility on asset prices. This paper shows that in the Tunisian Stock Exchange, block trades do not harm market liquidity. The results also show that the volatility that accompanies these trades is not persistent. No more than five trading sessions are needed to offset the temporary increase of the volatility.

Keywords: Block trade, upstairs, resiliency, liquidity, volatility.

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INTRODUCTION

The majority of empirical studies discussing the relationship between block trades and asset prices support the fact that large trades affect asset returns, even if we observe some differences in sample periods and in the models used. The existence and the extent of these effects have been the subject of several studies. The purpose was to quantify, to decompose and to explain these effects. Among the pioneering works we can cite, Kraus and Stoll (1972), Mikkelson and Partch (1985), Holthausen et al. (1990), Keim and Madhavan (1995), etc.

On one hand, block trades induce a temporary effect on stock prices. The insufficient order book depth in addition to the costs involved by the need of building a pool of counterparties as well as market makers inventory costs, could explain these temporary effects. Explicit or implicit [1] commissions can materialize these various costs and will not result in a lasting change in prices.

On the other hand, block trades induce a permanent price effect when assets are imperfect substitutes [2] or after the arrival of new information about fundamentals. Thus, a change in the expectations of economic agents occurs as excess demand is absorbed or when block trades convey new information (Oriol, 2008).

In explaining price movements following block trades, market liquidity plays an important role. It is assumed that a liquid market is a market that can absorb a large volume of transactions without substantial variation in prices and within a short time. As such, this liquidity facet has received considerable attention especially with fast growing importance of institutional investors, who are interested in block trades and quantities beyond the depth of the order book.

Anderson et al. (2006) following Kyle (1985) noticed that there exist three aspects of liquidity. Tightness refers to the change from the efficient price usually measured by the bid ask spread. Resiliency involves how quickly prices revert to fundamental values after a large transaction. Finally, depth is defined as the quantity that can be exchanged at or close to the efficient price.

Around block trades, the explanatory assumptions of price movements can also explain the spread movements. Accordingly, if a block trade is motivated by private information, there can be permanent changes in the spread before as well as after the trade.

[1] While exchanging at an unfavorable price compared to the standard price.
[2] Also called imperfect elasticity of supply and demand curves.

Otherwise, if the block is justified by liquidity needs, we have a temporary change in the spread.

emerging markets and evaluates the role of upstairs market in assessing the liquidity of the central book.

Second, the block market renewed reflection on the

If before the block trade, liquidity is low, the announcement of the off-market trade can generate transactions on the downstairs market and increase its liquidity. Besides, if the block traded upstairs causes an information leak to the floor, information asymmetry may increase and cause a higher spread. Hence, we would expect a decrease in the spread if we assume that the block publication is revealing information to the market.

Fong et al. (2004) support the findings of Seppi (1990). They showed that the upstairs market does not have measurable harmful effects on the downstairs market liquidity because of the non-anonymity, which filters and punishes the informed investors. Their results should moderate the comments arguing that the upstairs market cream skim the downstairs market. The authors highlight, on the contrary, the price improvement offered by the block market. This result is also confirmed by Chen (2004), on the Italian stock exchange.

Notably, the authors found that this price improvement is more important for the most liquid securities. This may reflect a greater number of brokers and a greater competition among the most liquid securities. The price improvement resulting from trading upstairs is in agreement with most previous empirical works (Keim and Madhavan, 1995; Madhavan and Cheng, 1997; Booth et al., 2002).

Lefebvre (2010) analyzed the upstairs market on Euronext Paris. He also supported the risk-sharing hypothesis instead of the cream-skimming hypothesis and noted that the upstairs market is a complement for downstairs market.

Bosetti et al. (2014) introduced a novel measure of illiquidity encompassing all orders seen by investors at a given time in the Italian market. Their analysis showed that large orders attract liquidity.

Besides, we know that stock markets around the world are engaged in a competition to attract institutional investors. This volatile clientele can easily migrate from one stock exchange to another depending on the quality of the offered services. Actually, each place must ensure the adequate conditions for these actors who trade mainly in blocks. In other words, there must be some liquidity for block trades. Thus, liquidity has prompted renewed interest with the emergence and sustained growth of institutional investor activities. That is why it is also important to evaluate the effect of these activities on market liquidity and volatility as well. Based on this background, we proposed to determine the impact of large on and off-market trades on the Tunisian market liquidity and volatility.

The paper is relevant for several reasons. First, it is the premier empirical analysis of blocks and large on-market trades in the Tunisian Stock Exchange (TSE) using upstairs trades and intraday data. It extends the previous research on block trades by giving additional insights on

markets efficiency. Indeed, in efficient markets, prices incorporate and reflect all available information. The academic literature on efficiency often focuses on fair values and on the ability to exchange securities quickly and without substantial variation in prices. So if markets are efficient, the quantity exchanged does not impact prices. The efficiency on the Tunisian market was treated in several articles and the results are not unanimous. Despite the implementation in 1996, of an Electronic Trading System to ensure efficient and transparent prices of securities, Benouda and Mezzez (2003) had tested the change in market efficiency before and after the transfer to the automated trading mechanism and found that the transfer did not have a clear effect on pricing errors.

In that sense, measuring the effect of large trades on the liquidity enables us to conclude on market efficiency. Indeed, if the liquidity improves after large trades this would contribute to more efficiency. Finally, it is important to know whether such large trades destabilize a small emergent market, like the TSE, by increasing its volatility or whether, on the contrary, it contributes to making it more attractive.

The TSE is an emerging order driven market where liquidity is provided by investors limit orders. The Tunisian block market is governed by very restrictive rules as mentioned by Limem and Jilani (2014). Multiple proxies, including resiliency, adverse selection as well as depth were used to approximate liquidity. Excess measures were computed and an event study was conducted. Our findings on liquidity effects were not used to conclude on the effects of large trades on volatility[3]. So several investigations together with a comparison of mean tests helped us assess the relationship between large trades and stock prices volatility.

The remaining of this paper is organized as follows: an overview of price resiliency after a block trade; liquidity measures and estimates the block trades impact on liquidity, description of the different volatility measures; and conclusion.

Focus on asset price resiliency after a block trade on the Tunisian Stock Exchange

Holthausen et al. (1990) studied the speed at which the asset prices adjust and reach again their previous level after a block trade in the NYSE. The results showed that on average, the temporary effect of a block trade is dissipated by the transaction that immediately follows it. Thus, only one transaction is necessary for the prices to adjust following a buyer-

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[3] A number of authors have espoused a theoretical negative relationship between and price volatility.

initiated transaction. On the other side, no more than three transactions are necessary for prices to adjust to a new post-block equilibrium for a seller-initiated transaction. Moreover, the authors showed that the response speed depends on the block size, the larger the block, the lower the speed. This bouncing movement leads to offset the observed shift on the prices after the block trade, and bring prices back to their fundamental values.

Riva (1999) found that abnormal and positive returns continue to be displayed for 68% of the block buys until the second transaction following the trade. On the other hand, none of these effects were detectable around the block sales on the French market.

Alzahrani et al. (2013) argued that the price effect of block trade is small and short-lived suggesting that resiliency is high in the Saudi stock market.

Besides, Frino et al. (2013) noted the effect of larges trades on liquidity might be affected by the market's regulation of information disclosure. They found that liquidity around block trades increased following the adoption of International Financial Reporting Standards (IFRS) in the Italian stock exchange.

Frino et al. (2009) attempted to refine the analysis by assuming that transaction prices contain microstructural biases. They explained that measuring price returns using the transaction prices shows a significant price return following the block trade in accordance with previous research. By contrast, with returns calculated using bid and ask prices, such reversals do not exist and there is a continuation in price movements. In this sense, prices continue to rise following block purchases and decline after block sales. Thus, it is worth to estimate resiliency using transaction prices and quote prices.

Data and methodology

Tunisian Stock Exchange is a pure order-driven market where the confrontation of supply and demand orders is supposed to be executed in an electronic and blind order book, which respects the price and time priority. The Tunisian Stock Exchange has created his upstairs market in 1997 in order to facilitate block trades. The Minimum Amount of a Block (MAB) is set at 100,000 TND.

In our study, we classify the blocks as follows. We initially follow the work of Frino et al. (2003), that is, a combination between the "tick test" and the "bid-ask" method. Then we perform a second classification using the method of "the true value" of Martinez et al. (2005). A block is finally classified as buyer or seller initiated, when both classifications converge.

Identifying the sense of a large on-market order is done without any ambiguity. A large on-market buy (sale) is represented by a purchase (sell) order executed against several sell (purchase) orders. This distinction is necessary since the price effects are opposite, and their aggregation can neutralize them.

The final sample collected from the Tunisian Market, from January 1999 until November 2007, contains 556 block trades and 930 large on-market trades. Despite

their low frequency of occurrence approximately 0.19% of all orders placed on the central order book, orders of more than 10,000 titles represents a significant part (44.90%) of trading volume on the Tunisian Stock Exchange.

The sample is composed by 286 block buys, 486 large on-market buys, 270 block sales and 444 large on-market sales.

In order to verify these trades impact on the liquidity of the Tunisian stock exchange. We proceed to the calculation of the market adjustment speed. Indeed, this latter is analyzed from the study of abnormal returns observed around the block trade. The conducted study, security by security, focuses on abnormal returns of transactions -5 to +5 trading days surrounding the day of the announcement of the block trade or the large on-market trade. The abnormal returns are defined as follows:

$$\overline{XR_{i,t}} = \frac{\sum_{b=1}^{N_i}\left[R_{b,t} - Ben_b\right]}{N_i}, t = -5, \dots\dots\dots, +5$$

With

$$Ben_b = \frac{\sum_{t=-21}^{-11} R_{b,t}}{11}, \quad b = 1, \dots\dots, N.$$

$R_{b,t}$ refers to the return of the exchange t of the block b for security i and N_i indicates the number of the block trades for security i.

These calculations were performed using transactions prices at first and then they were recalculated using quotes prices as detailed below.

Transaction price results

In accordance with the work of Gemmill (1996) and Frino et al. (2009), Table 1 shows that an abnormal and significantly positive price increase of 1.354% is associated with block purchases and an abnormal and significant decrease of 0.605% is associated with block sales. The table also shows that the abnormal and positive price reaction continues to be observed until the fifth day following the block buy. Thus, there is no price reversal following block purchases on the Tunisian Stock Exchange. However, concerning block sales, there exists a significant price reversal of 0.77%. This price reversal goes beyond the fall that accompanies the block sale, and thus only one trading session is enough to correct the price reaction. This price reversal is observed until the second day following the block sale.

The results also show that concerning block purchases, abnormal and positive returns are present two days before the exchange. This shows that block purchases are made when securities prices are increasing. These results showed that block sales are associated with temporary effect whereas block buys are accompanied

Table 1. Price reaction to block trades.

Trade to trade	Purchases				Sales			
	Mean (%)	T-stat	Median (%)	p-value	Mean (%)	T-stat	Median (%)	p value
- 5	0.151	0.94	0.00	0.544	0.000	0.00	0.047	0.569
- 4	-0.540	-1.38	-0.022	0.674	-0.001	-0.00	0.025	0.972
- 3	0.064	0.38	-0.016[a]	0.052	0.080	0.46	0.060	0.325
- 2	0.497[b]	2.33	0.152[b]	0.038	-0.011	-0.07	0.060	0.709
- 1	0.521[b]	2.36	0.285[b]	0.010	0.125	0.76	0.012	0.403
0	1.354[c]	6.72	1.050[c]	0.000	-0.605[c]	-3.13	-0.050[b]	0.028
1	0.852[c]	3.44	0.119	0.012	0.776[c]	4.00	0.564[c]	0.000
2	0.372[a]	1.77	0.036[a]	0.091	0.600[c]	3.71	0.295[c]	0.000
3	0.470[b]	2.18	0.080[b]	0.048	0.216	1.42	0.117[b]	0.048
4	0.378[a]	1.96	-0.008	0.345	0.066	0.52	0.066	0.381
5	0.562[b]	2.11	0.033	0.240	0.246[a]	1.71	0.012	0.209

[a], [b] and [c] indicate statistical significance at 0.1, 0.05, 0.01 levels respectively.

Figure 1. The speed of price adjustment surrounding a block trade.

with permanent effect and may be motivated by superior information.

Patterns taken by transaction prices around block purchases and sales are shown in Figure 1.

Quote results

In order to control the possible microstructural biases contained in transaction prices, returns were recalculated using ask to ask and bid to bid prices, consistent with the work of Frino et al. (2009). The results ask-ask and bid-bid returns are presented respectively in Tables 2 and 3. Concerning the returns ask to ask, the results for block purchases are similar to those found using the transaction prices. Indeed, the price impact is significantly positive and of 1.02%.

This result is, however, lower than that found with the transaction price. It seems that the use of transaction prices overestimate the price impact compared to the returns ask to ask. Moreover, there is no price reversal. We note on the other hand that the upward trend is not significantly different from zero.

With regards to the bid to bid returns around block sales, results show that the impact is significantly negative, equal to 0.46% and it is lower than what was found with the transaction prices. In addition, there is also a significant price reversal the next day and the day after, the block trade publication. The result is similar to that found with the transaction price and is contrary to those found by Frino et al. (2009).

Regarding the results of bid to bid block purchases, the result is significantly greater than zero (0.96%) and it is lower than that calculated from the Ask prices. The following returns are not significantly different from zero. The results for block sales calculated using ask to ask returns are similar to those found with the bid-to-bid returns.

Table 2. Ask price reactions surrounding block trades.

	Purchases				Sales			
	Mean (%)	**T-stat**	**Median (%)**	**p value**	**Mean (%)**	**T-stat**	**Median (%)**	**p value**
- 5	0.077	0.46	0.016	0.713	0.125	0.87	0.049	0.209
- 4	-0.226	-1.08	0	0.680	-0.060	-0.38	0	0.701
- 3	0.126	0.82	0	0.798	0.103	0.71	0.076	0.187
- 2	0.347[a]	1.79	0.00	0.315	0.329	0.96	0.00	0.358
- 1	0.228	1.06	0.104	0.225	-0.084	-0.42	0	0.864
0	1.018[c]	5.47	0.377[c]	0.000	-0.166	-1.01	0.008	0.906
1	0.154	0.60	0.061	0.581	0.565[b]	2.23	0.253[c]	0.000
2	-0.229	-1.08	-0.079	0.234	0.254[a]	1.87	0.051[a]	0.07
3	0.090	0.43	0.00	0.865	0.297[a]	1.95	0.151[b]	0.011
4	-0.100	-0.49	-0.055	0.426	0.139	0.99	0.105[a]	0.075
5	0.158	0.78	0.00	0.824	0.040	0.24	0.088	0.275

[a], [b] and [c] indicate statistical significance at 0.1, 0.05, 0.01 levels respectively.

Table 3. Bid price reactions surrounding block trades.

	Purchases				Sales			
	Mean (%)	**T-stat**	**Median (%)**	**p value**	**Mean (%)**	**T-stat**	**Median (%)**	**p value**
- 5	0.070	0.575	0.000	0.774	-0.038	-0.244	0.000	0.869
- 4	-0.046	-0.302	-0.005	0.949	-0.080	-0.428	0.001	0.760
- 3	-0.085	-0.476	-0.097	0.231	0.002	0.019	0.017	0.746
- 2	0.514[a]	2.993	0.179[a]	0.016	-0.067	-0.446	0.000	0.995
- 1	0.150	0.698	0.102	0.321	0.261	1.417	0.105[b]	0.096
0	0.962[a]	4.225	0.315[a]	0.000	-0.460[a]	-2.590	-0.059[a]	0.020
1	0.141	0.705	-0.114	0.825	0.684[a]	3.151	0. 173[a]	0.000
2	0.005	0.026	0.018	0.795	0.276[a]	2.062	0.054[b]	0.057
3	-0.054	-0.273	0.020	0.978	0.034	0.259	0	0.790
4	0.062	0.333	0.000	0.936	0.114	0.956	0.052	0.160
5	0.163	0.986	0.024	0.392	0.176	1.199	0.011	0.545

[a], [b] and [c] indicate statistical significance at 0.1, 0.05, 0.01 levels respectively.

The results thus obtained show that prices, move to their pre-block levels following block sales, but continue to raise following block purchases. The study notes that the investigation using bid and ask prices turned up similar results. Thus, the presence of microstructural biases in transaction prices is not confirmed in the Tunisian stock exchange. We just wanted to point out that the use of transaction prices in return calculation, tend to overestimate them.

REVISITING THE OTHER FACETS OF LIQUIDITY MEASURES BASED ON THE TIGHTNESS AND DEPTH

Liquidity is relatively easy to define but difficult to measure because it is multidimensional. Bosetti et al. (2014) pointed out that it is an infamously vague concept that can hardly be recapitulated in one measure. Aitken and Comerton-Forde (2003) divided the liquidity measures into two categories: measures based on transactions and measures based on orders. The authors found that different proxies of liquidity give various results. They also showed that a weak correlation exists between these two categories of liquidity measures.

Therefore the choice of the appropriate measure has a great impact on the appreciation of the liquidity.

The former include the value of an exchange, the number of securities traded, the ratio of securities traded over the number of Securities outstanding at the time (relative volume) and the number of exchanges (frequency). These are ex-post measures that provide information on the liquidity available in the past.

Table 1 shows the abnormal returns calculated using transaction prices for eleven trading sessions surrounding the block trade (time 0). The statistical significance emanates from the test for whether the mean abnormal return is significantly different from zero. Whereas the Wilcoxon signed rank test tend to verify the absence of an abnormal return of the median. The sample consists of 286 block buys and 270 blocks sales traded on the Tunisian Stock Exchange during 9 consecutive years starting from 01/01/1999.

They are easy to calculate but they do not inform on the ability of investors to exchange their securities and the associated costs.

To overcome the gaps of the first measures, the second category of measures can capture the capacity and the cost of an immediate exchange.

The bid ask spread (BAS) represents the cost incurred by an investor who wishes to trade immediately. By calculating the BAS as a percentage of a security price, we would be able to compare the liquidity of various prices securities. However, the relative spread may underestimate the incurred cost of a trade and may also overestimate the liquidity for a large investor[4]. This is why, it is necessary to incorporate the depth of the market to measure the liquidity (Aitken and Comerton-Forde, 2003).

In the following, we will examine liquidity regarding its price aspect (spread) and its quantity aspect (depth). Referring to Ibikunle et al. (2014) and Chen (2004), we will calculate the following measures of liquidity.

$$S_t = (Pask_t - Pbid_t)/[(Pask_t + Pbid_t)/2]$$
$$D_t = Dask_t + Dbid_t$$

S_t is the spread divided by the midquote. $Pask_t$ and $Pbid_t$denote the ask quote and the bid quote at time t. $Dask_t$ and $Dbid_t$ indicate respectively the quantities available to the best limits for purchase and sale at a given point in time. However, Bosetti et al. (2014) proposed to measure the depth by the average multi-level availability of liquidity in both the ask side and the bid side of the limit order book.

We also calculate other measures of quoted liquidity supply curve, that is, the quote slope of liquidity and its logarithm:

$$QS_t = (Pask_t - Pbid_t)/\left(log(Dask_t) + log(Dbid_t)\right)$$

QS_t is the slope of the quoted liquidity supply curve[5]. The smaller is the slope the more liquid is the market.

$$log(QS_t) = \frac{log(Pask_t/Pbid_t)}{\left(log(Dask_t) + log(Dbid_t)\right)}$$

Table 2 shows the abnormal returns calculated using ask quotes for eleven trading sessions surrounding the block trade (time 0). The statistical significance emanates for whether the mean abnormal return is significantly different from zero. Whereas the Wilcoxon signed rank test tend to verify the absence of an abnormal return of the median. The sample consists of 286 block purchases and 270 blocks sales traded on the Tunisian Stock Exchange during 9 consecutive years starting from 01/01/1999.

Table 3 shows the abnormal returns calculated using bid quotes for eleven trading sessions surrounding the block trade (time 0). The statistical significance emanates for whether the mean abnormal return is significantly different from zero. Whereas the Wilcoxon signed rank test tend to verify the absence of an abnormal return of the median. The sample consists of 286 block purchases and 270 blocks sales traded on the Tunisian Stock Exchange during 9 consecutive years starting from 01/01/1999.

These two last liquidity measures are summary measures since they combine information on price and quantity available at the best limit of the order book.

All these liquidity measures are calculated in order to study the impact of block trades on liquidity in an event study.

$$\overline{XS_t} = \frac{\sum_{b=1}^{N}\left[S_{b,t} - Ben\, S_t\right]}{N_i}, t = -5, \dots\dots\dots.., +5$$

With

$$Ben\, S_i = \frac{\sum_{b=1}^{N}\sum_{t=-20}^{-11} S_{b,t}}{N_i}, i = 1 \dots N$$

$Ben\, S_i$ is a series of benchmark spread for each block trade b on security i.

[4] In this sense, if an investor requests to purchase 100,000 securities and there exist only 10 000 securities available at the best ask, he should dig deeper in the order book to meet his request. This result in a more unfavorable price (higher than the ask) but this shows that the market is much more liquid than suggested by the bid-ask spread.

[5] As drawn in prior work of Hasbrouck and Seppi (2001).

Each benchmark is the average of the quoted spread from the eleventh to the twentieth transaction prior to the block trade.

Thereafter the excess spreads are calculated for the five transactions proceeding and the five transactions following the block trade.

Similarly, the same methodology will be used to calculate the liquidity using quantity dimension.

$$\overline{XD} = \frac{\sum_{b=1}^{N}\left[InsD_{b,t} - Ben\ D_t\right]}{N_{:}}, t = -5, \dots\dots\dots.., +5$$

With

$$Ben\ D_i = \frac{\sum_{b=1}^{N}\sum_{t=-20}^{-11} InsD_{b,t}}{N_i}, i = 1 \dots\dots..N$$

Table 4. Impacts of block trades on liquidity approximated by the midquote.

	Spread relative to bloc trade (Transaction 0)					
	Common		Bloc purchases		Bloc sales	
	Mean	**T-statistic**	**Mean**	**T-statistic**	**Mean**	**T-statistic**
-5	-0.0573	(-0.445)	-0.1939	(-0.937)	-0.2144	(-1.242)
-4	-0.0434	(-0.410)	-0.0680	(-0.506)	-0.1023	(-0.525)
-3	-0.1275	(-0.992)	-0.2229	(-1.217)	-0.2460	(-1.179)
-2	-0.1082	(-0.890)	-0.0914	(-0.566)	-0.3592 [b]	(-1.974)
-1	-0.0861	(-0.621)	-0.2685	(-1.412)	-0.0600	(-0.279)
0	-0.1594	(-1.139)	-0.2518	(-1.331)	-0.1583	(-0.813)
1	-0.1848	(-1.200)	-0.2391	(-1.061)	-0.0545	(-0.283)
2	-0.0500	(-0.340)	-0.0425	(-0.231)	-0.2482 [a]	(-1.700)
3	-0.3224 [b]	(-1.976)	-0.1958	(-0.678)	-0.1823	(-1.074)
4	-0.0372	(-0.185)	-0.2052	(-0.922)	-0.1869	(-1.023)
5	-0.2776 [a]	(-1.737)	-0.2754	(-1.114)	-0.1053	(-0.512)

[a], [i] indicate statistical significance at 0.1, 0.05 levels respectively.

We proceed in the same way for the other liquidity measures.

Moreover, presuming that at best quotes we find only small quantities, and knowing that $InsD_{b,t}$ refers to the quantity available at the two best limits of the spread, this variable may therefore provide a poor estimate of the market depth.

To rectify this, we propose the sum of the quantities available on the five best limits of the order book. Thus:

$$D_{5\ best\ limit} = Dask_{t(5\ best\ limit)} + Dbid_{t(5\ best\ limit)}$$

These various liquidity measures will be presented in the following Tables 4 to 9.

The results show that the excess spreads are negative indicating an improvement of the central market liquidity, however they are non-significant. There has been a significant improvement in the liquidity two days before block sales. There is also a narrowing of the spread 3 to 5 days following a block trade.

Table 4 represents the average excess spreads regarding the entire sample of data (column 1), block purchases (column 2) and block sales (column 3). Excess spreads refer to the excess of spreads relative to a spread benchmark. The latter is the average spread on the trading sessions -20 to -11 preceding the block trade. Values in parentheses represent the T-statistic to test whether the spreads in excess equalize zero.

Table 5 represents the average excess depths regarding the entire sample of data (column 1), block purchases (column 2) and block sales (column 3). The depth refers to the sum of quantities available on the five best limits of the order book. Excess depths refer to the excess of depths relative to a depth benchmark. The latter is the average depth on the trading sessions -20 to -11 preceding the block trade.

Table 6 represents the average excess depths regarding the entire sample of data (column 1), block purchases (column 2) and block sales (column 3). The depth refers to the sum of quantities available on the best limits of the order book. Excess depths refer to the excess of depths relative to a depth benchmark. The latter is the average depth on the trading sessions -20 to -11 preceding the block trade.

Table 7 represents the average excess slope quotes regarding the entire sample of data (column 1), block purchases (column 2) and block sales (column 3). The excess slope quotes refer to the excess of slope quote relative to a slope quote reference. The latter is the average slope quote on the trading sessions -20 to -11 preceding the block trade.

Observing the depth approximated by the sum of the quantities on the five best limits on both purchase and sale sides, the results showed that depths in excess are negative before the block exchange, indicating a reduction in liquidity. However, the results are not significant. Regarding the depth approximated by the sum of the quantities available at the five best limits, the results show that the excess depths are negative before a block trade, noting a decline in liquidity. However, the results are not significant.

Concerning block sales, from the date of the publication of the block trade to the fifth day following it, the excess depths are positive and the liquidity seems to improve. We also note that the excess depths are positive the day following the block publication for the three panels.

The results were almost unchanged when the depth is approximated by the sum of the quantities available at the best limits.

Table 7 shows that the excess slopes have a negative sign. This improvement of the liquidity is significant the day of the announcement of block sales and the day after the announcement block purchases.

Table 5. Impacts of block trades on liquidity approximated by the depth (5 best limits).

	Depth relative to bloc trade (Transaction 0)					
	Common		Bloc purchases		Bloc sales	
	Mean	T-statistic	Mean	T-statistic	Mean	T-statistic
-5	-1157.338	(-1.29)	-1384.05	(-0.99)	-938.0081	(-0.76)
-4	-1335.181	(-1.19)	-1057.568	(-0.49)	-1305.288	(-1.08)
-3	-1050.508	(-1.04)	-507.226	(-0.29)	-1290.508	(-1.09)
-2	-873.301	(-0.86)	-207.483	(-0.11)	-1243.925	(-1.04)
-1	-870.068	(-0.76)	-1134.319	(-0.52)	-1075.304	(-0.90)
0	-964.875	(-0.85)	-1544.664	(-0.69)	497.863	(1.45)
1	8.747	(0.007)	338.439	(0.14)	1214.012	(1.25)
2	-670.517	(-0.582)	-259.947	(-0.11)	339.489	(0.75)
3	-826.485	(-0.728)	-239.341	(-0.10)	19.124	(0.06)
4	-1047.266	(-0.916)	-1007.512	(-0.44)	292.637	(0.72)
5	-977.902	(-0.857)	-917.715	(-0.40)	338.385	(0.96)

Values in parentheses represent the T-statistic to test whether the spreads in excess equalize zero.

Table 6. Impacts of block trades on liquidity approximated by the depth (best limits).

	Depth relative to bloc trade (Transaction 0)					
	Common		Bloc purchases		Bloc sales	
	Mean	T-statistic	Mean	T-statistic	T-statistic	Mean
-5	-1117.339	(-1.367)	-1485.989	(-1.050)	-847.555	(-0.879)
-4	-1336.437	(-1.312)	-1320.056	(-0.634)	-1207.821	(-1.273)
-3	-1167.312	(-1.251)	-852.972	(-0.464)	-1272.094	(-1.341)
-2	-829.872	(-0.872)	-526.916	(-0.281)	-902.677	(-0.943)
-1	-1068.693	(-1.029)	-1199.973	(-0.567)	-1118.381	(-1.183)
0	-1340.016	(-1.303)	-1684.626	(-0.765)	-175.972	(-0.915)
1	-142.078	(-0.122)	-270.666	(-0.118)	1215.419	(1.280)
2	-906.863	(-0.859)	-741.194	(-0.327)	55.279	(0.178)
3	-1227.2	(-1.183)	-1127.587	(-0.506)	-241.998	(-1.254)
4	-1112.962	(-1.067)	-1248.23	(-0.558)	83.766	(0.246)
5	-1053.527	(-1.0103)	-1200.62	(-0.537)	154.540	(0.566)

Values in parentheses represent the T-statistic to test whether the spreads in excess equalize zero.

This slight "improvement" in liquidity shows that block trades can reduce the information asymmetry. This reveals that even if the results do not advocate, in an unquestionable way, for an improvement of the liquidity, it can nevertheless be asserted that the upstairs market has no harmful effects on the central market liquidity.

These various liquidity measures have been restated for larges trades that fall under the category of block trades but routed on the central market.

The results presented in Table 9 show that the liquidity approximated by the relative spread tends to increase around large trades routed on the central market. Indeed, we have excess spreads positive and significant at time t-4, t-3, t, t+1, t+4.

Liquidity approximated by the sum of the quantities available at the best limits shows an increasing depth indicating an improvement in liquidity. Excess depths are significantly positive from the eve of the large trade until the fifth trading session following it. The market is deeper than usual.

Concerning summary measures of liquidity, that is, QS_t and $log(QS_t)$, which combine information on prices and quantities, the results are negative but non-significant except for the date t-4. Thus, these last two measures does not provide conclusive proof of a significant improvement in liquidity around large on market trades. The comparison between the results of the various measurements of excess liquidity calculated around large off-market trades and large-on market trades show that around the latter, the spread increases whereas it decreases around the former. On the other hand, the depth increases in a significant way following the large

Table 7. Impacts of block trades on liquidity approximated by the slope quote QS_t.

	QS_t relative to bloc trade (Transaction 0)					
	Common		**Bloc purchases**		**Bloc sales**	
	Mean	**T-statistic**	**Mean**	**T-statistic**	**Mean**	**T-statistic**
-5	-0.4697	(-1.18)	-0.4581	(-0.84)	-0.4516	(-0.75)
-4	-0.0042	(-0.01)	-0.0067[a]	(-1.67)	-0.0042	(-0.01)
-3	-0.3707	(-1.27)	-0.903[b]	(-2.13)	-0.5545	(-1.60)
-2	-0.8456[c]	(-2.61)	-0.5663	(-1.35)	-0.8983[a]	(-1.89)
-1	-0.254	(-0.94)	-0.469	(-0.83)	-0.134	(-0.30)
0	-0.4066	(-1.11)	-0.4834	(-1.05)	-0.9195[a]	(-1.82)
1	-0.3243	(-0.82)	-0.9981[b]	(-2.49)	-0.2604	(-0.41)
2	-0.1018	(-0.31)	-0.2082	(-0.56)	-0.6268	(-1.30)
3	-0.7288[c]	(-2.23)	-0.4049	(-0.78)	-0.1444	(-0.38)
4	-0.3088	(-0.86)	-0.3495	(-0.65)	-0.4498	(-0.87)
5	-0.4438	(-1.21)	-0.7888	(-1.59)	-0.2414	(-0.44)

[a], [b] and [c] indicate statistical significance at 0.1, 0.05, 0.01 levels respectively. Values in parentheses represent the T-statistic to test whether the spreads in excess equalize zero.

on-market trades, whereas it tends to decrease with the blocks.

The results are contradictory and mixed measures have not provided a clear-cut answer to this question because of the non-significant results on the central market. This result is confirmed by Lefebvre (2010). The author showed that liquidity and block trading are not dynamically related in Euronext Paris. Similarly, Bosetti et al. (2014) found that block trades are executed in the Italian market without worsening the liquidity.

BLOCK TRADES AND VOLATILITY

Studies on block transactions become increasingly diverse. The activity of institutional investors has increased significantly in recent years and has brought with it a considerable development of block trades. Will this growth of block trading involve an increase in volatility?

We could reasonably expect a positive relationship, if we assume that block trades require price concessions to facilitate the large exchange, and thereafter prices would turn back. It is obvious that in this scheme, block trades increase volatility. Cebiroglu et al. (2014) support that large hidden orders generate excess-volatility, which is not related to fundamentals and can increase price inefficiencies of NASDAQ stocks.

Moreover, if it is admitted that institutional investors trade on the basis of private information and they are able to manipulate securities prices, this leads to the increase of uncertainty and to the rise of market volatility.

On the other hand, those who believe in market efficiency and the perfect substitutability between assets will support that block trades have no effect on volatility. Prices react quickly to new information and even if there are transaction costs, they are low. If these increases for a given asset, investors will abandon it up in favor of a more liquid substitute.

Li and Wang (2010) noted that the relation between volatility and institutional trading depends on the informational content of the trade. In case of informational trading, the relationship is negative.

Reilly and Wright (1984) measured the relationship between block trades and asset prices volatility using a multi regression model. The results strongly indicate that block trades do not increase price volatility. In addition, the most significant results suggest a negative relationship. They concluded that the participation of institutional investors improves market liquidity.

Table 8 represents the average excess logarithm of the slope quotes regarding the entire sample of data (column

1), block purchases (column 2) and block sales (column 3). The excess logarithm of the slope quotes refers to the excess of the logarithm of the slope quote relative to a logarithm reference. The latter is the average logarithm of slope quotes on the trading sessions -20 to -11 preceding the block trade.

Table 9 shows the average excess spreads, the average excess depths, the average excess of the slopes of quoted liquidity and its average logarithms on trades within the category of blocs but routed on the central market. These values represent the excess measures calculated relative to benchmark measures. The latter are calculated on the trading sessions -20 to -11 preceding the trade block.

On the other hand, by studying the impact of the frequent large trades on security prices, Spierdijk (2004) showed that large trades have a persistent impact on prices and increase the volatility of two of the five securities sampled. The author argues that following a large order; the market maker corrects and updates its

Table 8. Impacts of block trades on liquidity approximated by the logarithm of the quoted slope.

	$log(QS_t)$ relative to bloc trade (Transaction 0)					
	Common		**Bloc purchases**		**Bloc sales**	
	Mean	**T-statistic**	**Mean**	**T-statistic**	**Mean**	**T-statistic**
-5	-0.0094	(-0.58)	-0.0357	(-1.38)	-0.0117	(-0.56)
-4	0.0068	(0.59)	-0.0180	(-1.22)	-0.000	(-0.03)
-3	-0.0182	(-1.20)	-0.0363[a]	(-1.87)	-0.0228	(-0.99)
-2	-0.0203	(-1.19)	-0.0131	(-0.80)	-0.044[a]	(-1.71)
-1	-0.0225	(-1.20)	-0.0411[b]	(-2.28)	-0.0143	(-0.47)
0	-0.0083	(-0.40)	-0.0352	(-1.60)	-0.0334	(-1.56)
1	-0.0137	(-0.76)	-0.0255	(-1.06)	-0.0093	(-0.36)
2	-0.0086	(-0.56)	-0.0073	(-0.38)	-0.0289	(-1.51)
3	-0.0454	(-2.49)	-0.0339	(-1.09)	-0.0371	(-1.55)
4	-0.0072	(-0.35)	-0.0183	(-0.63)	-0.0017	(-0.06)
5	-0.0399[b]	(-1.91)	-0.0438	(-1.62)	-0.0259	(-0.78)

Values in parentheses represent the T-statistic to test whether the spreads in excess equalize zero. [a] and [b] indicate statistical significance at 0.1 and 0.05 levels respectively.

Table 9. Effects of larges on-market trades on the liquidity.

	Spread, depth, QS_t, $log(QS_t)$ relative to bloc trade (Transaction 0)							
	Spread*		**Depth**		**QS_t***		**$log(QS_t)$***	
	Mean	**t-stat**	**Mean**	**t-stat**	**Mean**	**t-stat**	**Mean**	**t-stat**
-5	0.0658	(1.16)	3.188	(0.04)	-0.4669	(-1.40)	-0.0026	(-0.36)
-4	0.1238[a]	(1.81)	35.206	(0.53)	-0.6073[a]	(-1.65)	0.00102	(0.11)
-3	0.1620[b]	(2.20)	1640.985	(1.04)	-0.0541	(-0.14)	0.00248	(0.30)
-2	0.0371	(0.56)	53.860	(0.79)	-0.0580	(-0.14)	-0.0058	(-0.76)
-1	0.0389	(0.67)	160.933[b]	(2.38)	-0.1980	(-0.62)	-0.0077	(-1.18)
0	0.2749[b]	(3.61)	625.941[b]	(2.18)	0.3545	(0.88)	0.0073	(0.88)
1	0.142[b]	(2.06)	469.150[b]	(3.05)	-0.1713	(-0.42)	-3.88e-05	(-0.00)
2	0.0823	(1.18)	295.858[b]	(3.52)	-0.4995	(-1.21)	-0.0055	(-0.70)
3	0.0985	(1.40)	466.787[a]	(1.76)	-0.1644	(-0.39)	-0.0038	(-0.47)
4	0.2335[b]	(3.19)	205.563[b]	(2.57)	0.0153	(0.03)	0.0079	(0.99)
5	0.0855	(1.22)	126.507[a]	(1.78)	-0.1906	(-0.47)	-3.66e-04	(-0.04)

Values in parentheses represent the T-statistic to test whether the different excess measures equalize zero. [a] and [b] indicate statistical significance at 0.1 and 0.05 levels respectively. The star used is defined as a percentage.

beliefs, which induces a persistent impact on the prices. Hence, the positive impact of large trades on volatility can be attributed to the fact that block trades increases the risk of informed trading.

Ball and Finn (1989) studied the price impacts of block trades on the Sydney Stock Exchange, they confirmed the existence of permanent effects and disproved the existence of price reversals. This non-return of prices was interpreted as an increase in the volatility following the block trading.

Holthausen et al. (1990) argued that the volatility that accompanies block trades does not persist for more than two trades after the block and does not depend on the trade size.

Chiyachantana et al. (2006) studied the temporary changes in volatility around institutional trades as well as the persistent volatility following their exchanges. Moreover, they worked on developed markets and emerging markets to see whether there is a difference in the behavior of volatility. Indeed, emerging markets are lacking depth to cope with extreme pressures of purchase or sale. The authors found a greater volatility only over a brief period during which the institutional make their trades. They concluded that this temporary rise in volatility is not harmful to the market but simply reflects the price impacts supported by the institutional.

From a methodological point of view, Reilly and Wright (1984) proposed alternative measures of volatility. Inter

Table 10. Impact of block trades on the central market volatility.

	Ref	Pre-trade		Trade	Post-trade	
		t-5	t-2	t	t+2	t+5
Panel A: Average volatility calculated from the Hi-Lo spread						
Common	74.2	73.40	93.88 [c]	112.53 [c]	89.94 [c]	72.52
T-stat		(0.11)	(-2.42)	(-3.77)	(-2.47)	(0.22)
Block purchases	69.98	69.657	81.39	88.17	90.11	61.48
T-stat		(0.06)	(-0.99)	(-1.29)	(-1.33)	(0.80)
Block sales	76.29	94.12 [c]	104.99 [c]	128.92 [c]	90.23	73.23
T-stat		(-2.83)	(-2.51)	(-3.66)	(-1.25)	(0.32)
Difference (Purchase-Sale)	-4.76	-6.74	-23.57	-43.48 [a]	6.83	-1.60
T-stat	(-0.51)	(-0.41)	(-1.17)	(-1.76)	(0.28)	(-0.10)
Average volatility with control of the size of the block						
Block Size ≤20000	74.31	63.88	68.13	105.82 [b]	87.31	63.29
T-stat		(1.01)	(0.64)	(-2.12)	(-1.02)	(1.17)
20 000< Block Size < 50 000	75.73	84.766	107.043 [a]	113.25	109.59	89.99
T-stat		(-0.61)	(-1.86)	(-1.52)	(-1.36)	(-0.68)
Block Size ≥50 000	73.15	79.93	121.68 [c]	121.34 [c]	82.206	75.105
T-stat		(-0.61)	(-2.88)	(-2.83)	(-0.69)	(-0.15)
Panel B: Average volatility approximated by the square of returns						
Common	5.88	2.11	4.24	5.76	6.86	6.28
T-stat		(1.58)	(0.67)	(0.04)	(-0.29)	(-0.14)
Panel C: Average volatility approximated by the absolute value of returns						
Echantillon	100.81	127.19	128.2 [c]	144.7 [c]	135.46 [b]	107.46
T-stat		(-0.81)	(-2.64)	(-3.11)	(-2.18)	(-0.55)

[a], [b] and [c] indicate statistical significance at 0.1, 0.05, 0.02 levels respectively.

alia, the relative change in closing price between two consecutive trading sessions, or the fluctuations between the opening and closing price of one trading session. They also used the absolute value of returns as a proxy of volatility. However, the authors noted that prices can change considerably during a trading session and close at a price approaching the opening or the closing price of the previous day. This could underestimate the volatility calculated according to this principle. They argued that the best measure of the daily volatility is the high-low spread defined as the relative difference between the highest and the lowest price of a trading session.

Chiyachantana et al. (2006) approximated the volatility by the squared difference between logarithm prices of two consecutive trading days.

Working on the Tunisian Stock Exchange, Mezzez et al. (2003) noted that the variance of returns is often used to approximate volatility. They noted however that in the Tunisian Stock Exchange, the trading volume is not stable. On some days, limit movements are accompanied by very low trading volume and on others by very high trading volume. That is why the authors measured volatility using the Hi-Lo spread.

$$V = \frac{H - L}{(H + L)/2}$$

H refers to the highest price and L corresponds to the lowest price of a trading session.

To decide upon issues regarding the existence of a higher volatility around large blocks on the TSE, we calculate in what follows the two volatility measures proposed above. The average daily volatility for two and five days before and after the block trade was calculated. Benchmark volatility is the average volatility of trading sessions (t-20) until (t-11). The results are presented in Table 10. Panel A refers to the volatility obtained from High-Low spread. The analysis of the entire sample shows an increase in volatility on the two trading sessions preceding the block trade. Thus volatility passes from 74.2 to 93.88. This increase reached its apogee on the day of the announcement of the transaction and peaked at112.53.

This shows that institutional activity leads to an increase in volatility. This rise in volatility continues until the second trading session following the block trade. We note thereafter a subsequent return of volatility around its reference value.

Thus the volatility increase caused by the block trade is temporary and it is not a question of a persistent volatility.

Similarly, we note that this increase in volatility increases with the size of the trade expressed in number of shares. Moreover, its value passes from 105.82 to

Table 11. Effect of large on-market trades on the central market volatility.

	Ref	Pre-trade		Trade	Post-trade	
		t-5	t-2		Ref	t-5
Panel A: Average volatility calculated from the Hi-Lo spread						
Common	104.74	105.78	111.22	168.16 [b]	115.29	115.97 [a]
T-stat		(-0.17)	(-0.98)	(-8.20)	(-1.60)	(-1.69)
Average volatility with control of the size of the block						
Block Size ≤20000	104.99	101.59	117.61	152.13 [b]	102.06	106.49
T-stat		(0.42)	(-1.32)	(-4.93)	(0.38)	(-0.17)
20 000< Block Size < 50 000	103.94	107.97	99.51	171.29 [b]	140.78 [b]	109.64
T-stat		(-0.35)	(0.39)	(-4.54)	(-3.02)	(-0.46)
Block Size ≥ 50 000	105.58	114.76	114.88	213.14 [b]	105.06	118.64
T-stat		(-0.59)	(-0.59)	(-5.16)	(0.02)	(-0.86)
Panel B: Average volatility approximated by the square of returns						
Common	2.44	2.09	3.27	5.25 [b]	2.71	3.11
T-stat		(1.02)	(-0.83)	(-2.51)	(-1.34)	(-0.55)
Panel C: Average volatility approximated by the absolute value of returns						
Common	94.13	94.48	101.98	139.77 [b]	113.24 [b]	105.38
T-stat		(-0.05)	(-1.14)	(-5.02)	(-2.34)	(-1.52)

[a], [b] and [c] indicate statistical significance at 0.1, 0.05, 0.02 levels respectively.

113.25 to reach 121.34 as the size passes from 2 MBS[6] to 5 and more than 5 MBS. When splitting the sample into block purchases and block sales, we note that block purchases are not associated with an increase in volatility whereas block sales cause it to increase. This may be due to the fact that around large purchases, prices begin to rise one month before the acquisition and therefore the title is already in a bullish trend and know a greater volatility. This increase is significant for the five trading sessions preceding the block trade and continues its rise until day 0, the initial public announcement of the block trade. Moreover it passes from 76.29 to 128.92 before returning to normal values.

Panel B focuses on the volatility calculated using the square of returns, in a way similar to that of Chiyachantana et al. (2006) and Frino et al. (2009). The results show no significant increase in volatility. So with this approximation, it appears that institutional trading does not affect the volatility.

Panel C focuses on the volatility approximated by absolute value of returns and results are similar to those arguing in favor of a temporary increase in volatility. However, it is noted that this method of calculation gives much higher values and consequently tends to overestimate the volatility.

These calculations are repeated identically for large trade routed to the central order book. The results are presented in Table 11. Whichever method is used to approximate the volatility, the results show an increase in volatility on the day of the large trade. In panel A volatility is approximated by the high-low spread and its value increases from 104.74 to 168.16 the day of the large trade. There is a subsequent decrease in volatility but it is still a bit higher compared to the reference volatility till the fifth day after the large trade. Likewise to block trades, the level of volatility tends to increase with the size of

[6] Is the Minimum Block Size or 10 000 securities

large on-market trades. Thus, when the size increases from 2 to 5 to more than 5 MBS, volatility increases from 152.13 to 171.29 to reach 213.14.

Unlike block trades, large on-market transactions show a rise in volatility approximated by the square of return (Panel B).

Indeed, volatility increases in a significant way and passes from 2.44 to 5.25. Then it turns back to found values similar to the volatility benchmark, once the trade has occurred. Similarly, the Panel C focuses on the volatility approximated by the absolute value of the returns and results are similar to those found previously. It is worth noting that compared to the volatility surrounding block trades; volatility around the large trades carried on the central market shows higher values. The prices are much more agitated when a large trade passes through the central order book.

Table 10 shows the average daily volatility around block trades. All volatility values are expressed in base point. t is the trading session in which there was announcement of the block trade. The reference volatility refers to the average of the volatilities of the -20th to the –11th trading sessions preceding the block trade.

Table 11 shows the average daily volatility of large trades made across the central order book. All volatility values are expressed in base point. t is the trading session at which there was a large on-market trade. The reference volatility is the average volatility of the -20th to the -11th trading sessions preceding the block trade.

CONCLUSION

This article proposed to verify whether the increase in institutional investors' activity comes with a decrease of the market liquidity and implies in a consequent logic a rise in prices volatility on the Tunisian Stock Exchange.

The objective is to see whether the development of the block market does not cream skim the central order book and contributes to decrease its liquidity.

We initially proposed to see the impact of block trades on the central market liquidity. The aim is to see if the block market really exhausts the liquidity of the order book on the Tunisian Stock Exchange or on the contrary, it contributes to its improvement. Various measures of liquidity and different proxies were used attempting to combine the price dimension and the quantity dimension of liquidity. Unfortunately, the results have not provided a clear-cut answer to this question.

Even if we cannot affirm in a categorical way that the block market improves the central market liquidity, we can affirm without loss of generality that the block market does not exhaust the liquidity of the central order book. This result supports the findings of Fong et al. (2004). Upstairs market has not got a harmful effect on the central market liquidity and therefore the upstairs market can lead to more efficiency. However, unlike Riva (2000) we could not assume that the block market assist the central market by bringing an additional and unobserved liquidity.

The different results mentioned above do not, however, shed light on the relationship that governs block trades and the central market volatility. In order to elucidate it, we had in a second step, referring to the work of Chiyachantana et al. (2006), calculated volatility benchmark and did a comparison test of the latter with the average volatility of various trading sessions around the block transaction. To achieve this, we used different measures to approximate the volatility. The results show that block trades increase the volatility of security prices especially the day of the announcement of the upstairs trade. This result is similar to one of Cebiroglu et al. (2014) who found an excessive volatility, which is not related to fundamentals.

However, it is a temporary and non-persistent volatility. Similarly, we noted that this rise in volatility is increasing with the block size expressed in number of shares traded.

Besides, we noticed that block sales are preceded by a rise in volatility. On the other hand, the block purchases do not cause significant changes in volatility. This could be explained by the fact that a large sale may be viewed as a trade based on bad information.

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