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# Estimation of Transaction Costs on the Tunisian Stock Exchange: An Empirical Research via A Tobit Model with Frictions

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**ABSTRACT**

The purpose of this paper is to estimate transaction costs on the Tunisian Stock Exchange (TSE). We will use the methodology proposed by Lesmond, Ogden and Trzcinka (1999). Our study is done on an order-driven market whether the Lesmond and al. study was done on a quote-driven market.

The data is composed of stocks listed on the TSE for the period 2000-2004. We estimate the spread using the Roll (1984), George, Kaul and Nimalendran (1991) methods and compare these estimations with the results obtained by the Lesmond and al. model. The George and al. model over-estimate the spread. Lesmond and al. model seems to be the appropriate estimation of the transaction costs on the TSE.

*JEL Classification: G12; G14; G15*

*Keywords: Spread; Transaction costs; Order-driven market; Tobit*

## I. INTRODUCTION

Estimation of transaction costs is an important topic for empirical analyses of market efficiency and microstructure. Transaction cost affects considerably returns and volatility. Despite this important role, their estimates are not available, or where available, are subject to expense or error. Major studies estimate the transaction costs using the bid-ask spread.

The valuation of spread requires an intraday dataset including the volume and the better prices quoted. The size of this data will increase with the number of stocks quoted in the market. Declerck (2002) listed 5 millions transactions and the same number of bid ask spreads for the period between January and June 1998 for the CAC 40 stocks. For emerging markets (including the TSE) such databases are not available. So that two methods have been developed to evaluate the spread: methods using direct valuation from the variance of successive prices of shares [Roll (1984) and George, Kaul and Nimalendran (1991) (here after GKN)] and methods using estimation of the spread from proxies such as trading volume, firm size, number of shares outstanding, abnormal return etc. [Gredoriou, Ionnidis and Skeratt (2005) Atkins and Dyle (1997) and Boubaker and Naoui (2005)].

The limit of the second group of models is that the estimation of the spread is done by variables, which explain at most 15% to 21% of spread changes. The purpose of these models is to study the effect of adverse selection as a component of transaction costs and not a direct estimation of these costs.

The first group of models provides a more appropriate and used estimation of the transaction costs. Using these models, the transaction costs are equal to the sum of the spread and the commissions. Many authors [Grossman and Miller (1988), Lee and Ready (1991), Peterson and Fialkowski (1994) and Johnson (1994)] argue that the spread plus the commissions overstate the effective transaction costs.

Lesmond, Ogden and Trzcinka (1999) (here after LOT) propose a model in the framework of adverse selection of Glosten and Milgrom (1985) and Kyle (1985). The marginal informed investor does not transact until the anticipated benefit of the trade exceed his cost. The transaction cost represents a limit that must be exceeded before the security's return will reflect new information. A zero return is observed every time the anticipated return does not cover the transaction cost. This cost is positively correlated with the number of daily zero returns over a period. The results of LOT indicate a high correlation between the percentage of zero return and the spread on the NYSE and the AMEX over the period 1963-1990. Also, they pointed out a significant impact of the market value and the price of shares on the transaction cost.

The aim of this paper is to estimate the transaction cost in the Tunisian Stock Exchange (TSE) by using the LOT methodology and to compare these estimates to those obtained by Roll and GKN spreads. Contrarily to the American stock market, a quote-driven market, the TSE is an order-driven market. In a quote-driven market, both the commission and the spread are fixed by the market makers, whereas in an order-driven market, the commissions are fixed by the brokers and the spread results from investors limit order and transaction-flows.

The remaining of this paper is organized as follows. Section II presents an overview of the TSE and describes the existing models of spread estimation. Will be presented successively the quoted spread, Roll's spread, and GKN's spread. In section III, the LOT model will be developed and our results of the transaction costs estimations for the TSE over the period 2000-2004, will be presented. Summaries and conclusions are in section IV.

## II. DATA DESCRIPTION

### A. TSE Overview

Securities listed in the TSE are negotiated according to two modes:

1. Continuous Quotation

It progresses in three phases. A first phase of pre-opening from 9 am to 10 am, during which the orders are entered without causing transactions, a theoretical opening price (TOP) is systematically displayed. A second phase of the opening of the market is by fixing at 10h and determination of a single opening price. This price maximizes the number of exchanged securities, minimizes the number of securities not been used and approaches the reference price (one day before closing price). In the third phase, from 10h to 11h30, the entry of an order causes a transaction since there is a compatible limit of opposite direction.

2. Fixing Quotation

The confrontation of the orders on the securities quoted according to this mode proceeds in the following way: Phase of pre-opening from 9 am to 10 am, during which the orders are entered without causing transactions and a theoretical opening price (TOP) is systematically displayed. Opening of the market by fixing at 10h and determination of a single opening price, which maximizes the number of exchanged securities, minimizes the number of securities not been used and approaches the reference price (one day before closing price). Second fixing at 10h15, necessary if an opening price is not attained during the first fixing, the brokers can in this case intervene for their own account. Last fixing is at 11h00.

### B. Spread Estimations

The data for this paper is provided by the BVMT[1]. It contains closing day prices, best quoted ask (the lowest limit price of all sell orders for a security), best-quoted bid (the highest limit price of all buy orders for the security), a market index, TUNINDEX[2], and number of outstanding shares. These data cover the period December 1999 to December 2004. Number of securities changes over the period and the number of the same firms appearing each year of the study is 15. The firms and the years for which the required data are available are listed in Table 1.

**Table 1**
Data by year and firm size classification

| | Number of equities | | | Number of observations | | | Average market values (in millions) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Low | Middle | High | Low | Middle | High | Low | Middle | High |
| 2000 | 15 | 14 | 15 | 3249 | 3375 | 3690 | 21.91 | 76.91 | 558.88 |
| 2001 | 11 | 12 | 11 | 2488 | 2733 | 2713 | 18.64 | 53.52 | 342.45 |
| 2002 | 8 | 7 | 8 | 1984 | 1736 | 1984 | 23.27 | 77.76 | 223.09 |
| 2003 | 8 | 7 | 8 | 1952 | 1708 | 1952 | 13.98 | 54.07 | 182.58 |
| 2004 | 7 | 8 | 7 | 1792 | 2048 | 1792 | 14.93 | 67.09 | 219.53 |
| Aggr. | 49 | 48 | 49 | 11465 | 11600 | 12131 | 18.55 | 65.87 | 305.31 |

A total of 146 company-year observations are available with at least 150 daily observations. The market value of each firm, in the year n, is given by multiplication of outstanding shares by average price of December (n-1). Firms were classified, each year, in three groups of size: low, middle and high.

As shown in the introduction, transaction costs are equal to the spread plus the commissions. Generally, it is assumed that the spread is a good indicator for transaction costs in normal market conditions. Nevertheless, in the case of large size transactions, this assumption is not valid [Chan and Lakonishok (1995) and Riva (1999)]. The transaction costs are the sum of the proportional bid-ask spread calculated using current best limit orders and a representative commission from a brokerage firm. In the TSE this commission varies from a brokerage firm to another and can not exceed 0.8%. The bid-ask spread can be obtained by different manners. Will be presented here the quoted spread, Roll's spread and GKN's spread.

The quoted spread is obtained by:

$$S_{it}^{q} = \frac{A_{jt} - B_{jt}}{(A_{jt} + B_{jt})/2} \tag{1}$$

where $S_{jt}^{q}$ is the quoted spread for share j at time t; $A_{jt}$ and $B_{jt}$ are ask and bid closing day t prices for share j. The mean relative quoted spread for the year n is equal to (for m observations per year):

$$S_{jn}^{q} = \frac{\sum_{t=1}^{m} S_{jt}^{q}}{m} \tag{2}$$

The daily closing bid and ask quotes do not represent the market day conditions that's why the spread must be estimated. Roll (1984) derives a simple measure of the effective bid-ask spread. This measure uses the first order covariance of security price changes. Under the assumptions of an informationally efficient market and the stationarity of price changes, Roll shows that trading costs induce negative serial

dependence in successive observed market price changes. The covariance of successive price changes is given by:

$$\mathrm{Cov}(\Delta P_t, \Delta P_{t-1}) = -\frac{S^2}{4} \tag{3}$$

where S is the spread. In order to obtain a relative spread, the covariance of successive returns is used:

$$\mathrm{Cov}(R_t, R_{t-1}) = -\frac{S^2}{4} - \frac{S^4}{16} \tag{4}$$

The last term $(S^4/16)$ is very small and can be safely ignored. So, the spread can be obtained by:

$$\hat{S}_{jn}^{R} = 2\sqrt{-\hat{c}_{jn}} \tag{5}$$

where $\hat{S}_{jn}^{R}$ is the spread for share j at period n; and $\hat{c}_{jn}$ is the estimated covariance for share j at period n.

The problem with the Roll's measure is that the sample autocovariance is frequently positive due to the non-stationarity of the probability distribution of price changes. In order to make the estimate calculable, Harris (1990) suggests converting all positive autocovariance to negative.

GKN propose a model where the assumption relating to the sationarity of the probability distribution of observed price changes is abandoned. The GKN's measure is as follows:

$$RD_t = R_t - RB_t \tag{6}$$

$$\mathrm{Cov}(RD_t, RD_{t-1}) = -\frac{S^2}{4} \tag{7}$$

$$\hat{S}_{jn}^{GKN} = 2\sqrt{-\hat{c}_{jn}^{e}} \tag{8}$$

where $RB_t$ is the return calculated with the inferior limit of the bid ask spread and $RD_t$ is the difference between the stock return and $RB_t$. $\hat{c}_{jn}^{e}$ is the estimated autocovariance of returns of share j on the period n. The GKN's measure requires the best limit of the bid ask spread and the return of the stocks. This measure is independent of data frequency.

The results of effective spread, Roll's spread, GKN's spread, and by group of firm size are given in Table 2.

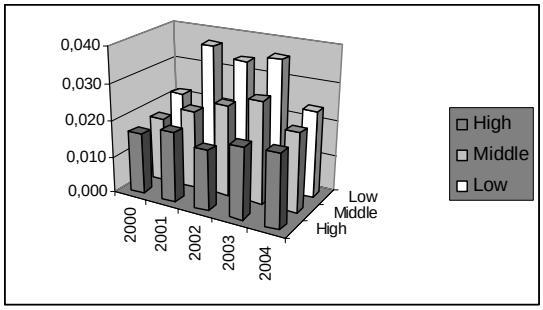
**Table 2**
Average values of quoted spread, Roll's spread, GKN's spread for the TSE

| | Low size firms | | | Middle size firms | | | High size firms | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Quoted** | **Roll** | **GKN** | **Quoted** | **Roll** | **GKN** | **Quoted** | **Roll** | **GKN** |
| **2000** | 0.145 | 0.013 | 0.022 | 0.140 | 0.010 | 0.018 | 0.185 | 0.010 | 0.017 |
| **2001** | 0.203 | 0.011 | 0.037 | 0.144 | 0.010 | 0.022 | 0.164 | 0.011 | 0.019 |
| **2002** | 0.189 | 0.010 | 0.036 | 0.169 | 0.013 | 0.025 | 0.129 | 0.006 | 0.016 |
| **2003** | 0.203 | 0.010 | 0.036 | 0.206 | 0.015 | 0.028 | 0.132 | 0.005 | 0.020 |
| **2004** | 0.189 | 0.009 | 0.024 | 0.167 | 0.008 | 0.022 | 0.126 | 0.008 | 0.020 |

We used the measures, developed in relations (2), (5) and (8), to estimate respectively the quoted, the Roll's and the GKN's spreads. The quoted spread is always (for all firm sizes and years) greater than the effective spread. The quoted spread in the TSE is relatively high comparatively to those of other limit order markets. This result can be explained by the fact that many investors provide orders so distant from the closing day prices. The average value of the quoted spread is 16.6% with a minimum of 2.3% (for SPCD-2000) and a maximum of 35.6% (SOTUMAG-2003). Over the period of the study, the quoted spread seems to be stable. The effective spread is calculated through the Roll's and the GKN's methods. In accordance with the theory, the GKN's measure is always superior to the Roll's measure. The average value of the Roll's spread is 1% with a minimum of 0.05% (for UBCI-2003) and a maximum of 3.59% (STIL-2003). The Roll's spread tends to diminish over time. The minimum and maximum of GKN's spread are respectively 0.21% (BDET-2000) and 9.67% (ATL-2002), with a mean value of 2.7%. From 2000 to 2002 the GKN's spread increases and from 2002 to 2004 it decreases.

Table 2 shows the average spread for the TSE on the period 2000-2004. As expected, all average values decrease as firm size increases. This result confirms the negative relation between spread and market value as shown in Figure 1 for the GKN's spread.

**Figure 1**
GKN's spread by year and market value



These results are conformed to those obtained by other studies [Stoll (1989), Atkins and Dyl (1997), LOT (1999), Boubaker and Naoui (2005)]. Consequently, spread can be considered as a good indicator of the transaction costs. However, it constitutes only one component of these costs. It is necessary, therefore, to proceed to a global estimation. The next paragraph presents the model developed by LOT (1999) where the transaction costs are directly estimated from daily returns.

## III. ESTIMATION OF TOTAL TRANSACTIONAL COSTS

### A. Transaction costs and zero returns

Following Glosten and Milgrom (1985), LOT (1999) assume that if the transaction costs are not zero, the marginal investor (informed or not) will compare the costs of trading and the expected gain of the trade. So, there will be no transaction until the transaction cost threshold is exceeded. A relation between zero returns and transactions costs is then established. The idea is interesting because we have no need to observe whether the marginal investors are informed or uninformed nor to directly measure the return net of transaction cost. Zero returns are considered as evidence that the expected gain of the trade does not exceed the transaction costs. Also, zero returns reflect all sorts of transaction costs (not only the spread plus the commissions, but also the expected price impact costs and opportunity costs). This relation between zero returns and transaction costs is illustrated by Figure 2, which plots security return versus market return for two securities (a small firm one, ATL, and a big firm one, SFBT) in 2004.

**Figure 2**
Daily security behavior vs. daily equally weighted market returns

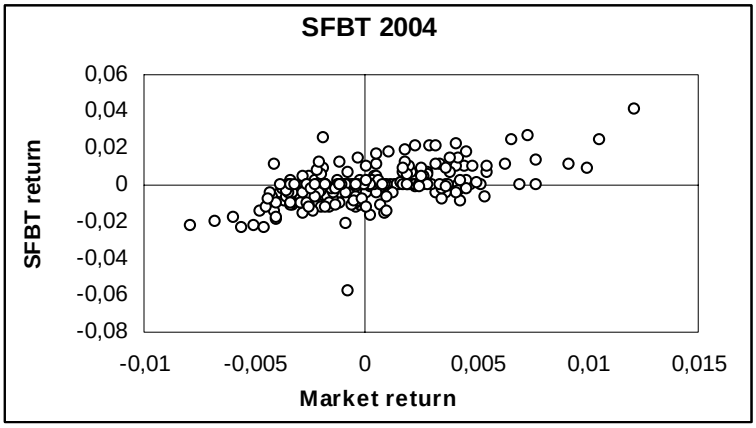
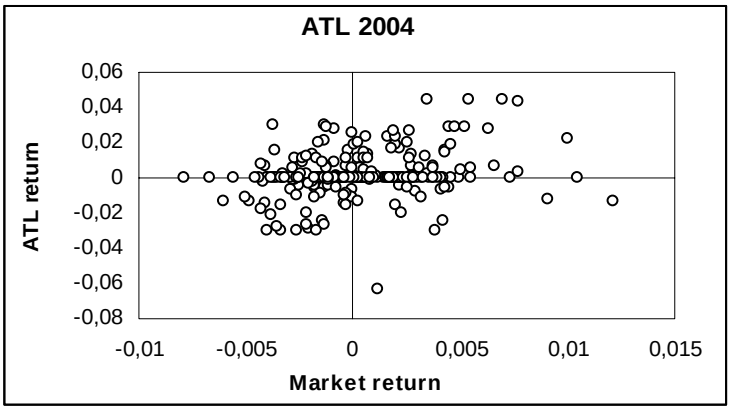


**Figure 2 (continued)**




This figure shows that there are a significant large number of zero returns for the ATL security compared to the same number for the SFBT security. It is also clear that for both ATL and SFBT, zero returns are more frequent when the market returns are themselves small. This fact is however more important for the small firm security ATL. In the model of LOT (1999), the marginal traders use market return as a significant factor to augment their information set. If the absolute value of market return is low, the likelihood of occurrence of transaction will be low and the probability of a zero return will be high. As the transaction costs are inversely proportional to the size of the firm, zero returns are more frequently observed for small firm securities than for big firm securities. Table 3 presents the percentage of daily zero returns for the TSE classified by group of market value. For each firm and year the proportion of daily returns equal to zero is calculated and the average of these proportion is computed for stocks in each firm size. These zero returns are scaled by the total number of available trading days to determine the zero return proportions.

**Table 3**
Average of zero return percentages by firm size

| | **Low size** | | | **Middle size** | | | **High size** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Min** | **Max** | **Mean** | **Min** | **Max** | **Mean** | **Min** | **Max** | **Mean** |
| **2000** | 11.8 | 90.5 | 56.6 | 11.8 | 87.7 | 51.3 | 8.5 | 76.0 | 34.3 |
| **2001** | 10.3 | 65.9 | 38.8 | 13.2 | 84.4 | 50.9 | 6.5 | 51.2 | 32.5 |
| **2002** | 21.0 | 54.4 | 35.6 | 6.9 | 51.6 | 30.0 | 13.3 | 82.3 | 44.2 |
| **2003** | 13.9 | 60.2 | 35.9 | 8.2 | 48.0 | 25.8 | 23.0 | 61.9 | 41.5 |
| **2004** | 12.1 | 48.0 | 23.6 | 11.7 | 68.0 | 38.0 | 26.6 | 63.7 | 48.0 |
| **Aggregate** | 13.8 | 63.8 | 38.1 | 10.4 | 67.9 | 39.2 | 15.6 | 67.0 | 40.1 |

The TSE, the percentages of zero returns are not clearly negatively correlated to the market value. On the aggregate level, these percentages are approximately equal for the three groups, around 40%, compared to 36.6% and 11.9% respectively for small and big capitalizations in the American market [LOT (1999, p. 1125)]. The market capitalization of the TSE tends to decrease over the period 2000-2004 (see Table 1) this reflects the global decreasing tendency of the market. Another possible explanation of the unusual large number of zero returns is the decreasing number of observation and shares through the period of the study (see Table 1).

(1) The LDV Model

The LOT model of security returns, in the presence of transaction costs, is based on the limited dependant variable (LDV) model of Tobin (1958) and Rosett (1959). Security returns are given by market model (without the intercept) and constrained by the effects of transaction costs. As explained by LOT (1999, p. 1120), the suppression of the intercept does not affect the estimation of transaction costs since the analysis is based on the difference $(\alpha_2 - \alpha_1)$ of the threshold trades on positive information ($\alpha_2$) and for trades on negative information ($\alpha_1$).

The model distinguishes between the measured return $R_{jt}$ and the true return $R^*_{jt}$. In the case of no transaction costs, measured return is equal to the true return. But in presence of transaction costs, investors form expectations on the net of cost returns. The model can be expressed as follows:

$$R^*_{jt} = \beta_j R_{mt} + \varepsilon_{jt}$$

$$\begin{cases} R_{jt} = R^*_{jt} - \alpha_{1j} & \text{if } R^*_{jt} < \alpha_{1j} \\ R_{jt} = 0 & \text{if } \alpha_{1j} < R^*_{jt} < \alpha_{2j} \\ R_{jt} = R^*_{jt} - \alpha_{2j} & \text{if } R^*_{jt} > \alpha_{2j} \end{cases} \tag{9}$$

with $\alpha_{1j} < 0$ *and* $\alpha_{2j} > 0$. $\varepsilon_{jt}$ i.i.d, residuals of the estimation with variance $\sigma^2_j$. The parameters, $\beta_j$, $\sigma^2_j$, $\alpha_{1j}$ and $\alpha_{2j}$, are solved by maximising this log-likelihood function:

$$\begin{aligned} \ln L = & \sum_{t\in\psi_1} \ln \frac{1}{(2\pi\sigma^2_j)^{1/2}} - \sum_{t\in\psi_1} \frac{1}{(2\sigma^2_j)} (R_{jt} + \alpha_{1j} - \beta_j R_{mt})^2 \\ & + \sum_{t\in\psi_2} \ln \frac{1}{(2\pi\sigma^2_j)^{1/2}} - \sum_{t\in\psi_2} \frac{1}{(2\sigma^2_j)} (R_{jt} + \alpha_{2j} - \beta_j R_{mt})^2 \\ & + \sum_{t\in\psi_0} \ln \left[ \phi\left( \frac{\alpha_{2j} - \beta_j R_{mt}}{\sigma_j} \right) - \phi\left( \frac{\alpha_{1j} - \beta_j R_{mt}}{\sigma_j} \right) \right] \end{aligned} \tag{10}$$

where $\psi_1$ is the first group of observations (when $R^*_{jt} < \alpha_{1j}$); $\psi_0$ is the second group of observations (when $\alpha_{1j} < R_{jt} < \alpha_{2j}$); $\psi_2$ is the third group of observation ( when $R^*_{jt} < \alpha_{2j}$); and $\phi(.)$ is the normal centred distribution function with variance equal to $\sigma_j^2$. This log-likelihood function is maximised using a GAUSS program, the convergence is obtained by the Newton-Raphson algorithm[3].

**B. TSE transaction costs**

We used the LDV model to estimate transaction costs for the TSE firms for the period 2000-2004. LOT developed a Tobit model with frictions initially proposed by Rosett (1959) and where parameters can be appraised by maximising the likelihood function. The estimation of parameters, $\beta_j$, $\sigma_j^2$, $\alpha_{1j}$ and $\alpha_{2j}$, has been achieved year by year for all equities by maximizing the log likelihood function (10). Table 4 shows the costs of sell trades $\alpha_1$, buy trades $\alpha_2$ and round trip transaction costs $\alpha_2 - \alpha_1$. The results are relative to firms of the TSE in 2004. Estimations for 2000 to 2003 are reported in Appendix 1.

Estimates of $\alpha_1$ and $\alpha_2$ are almost usually significant at 1% level. However, some exceptions have been observed: on the 146 year-firm of the sample, 7 are not significant at 1% level, 4 from these are not significant at 5% and 3 at 10%. It must be noted that 4 out of the 7 cases concern the SOTETEL (2001, 2002, 2003 and 2004), the other cases are SPDIT-2000, TUNISIE LEASING-2000 and STEQ-2001. The sign of $\alpha_1$ is, as expected, negative for all the stocks of the sample except for SOTETEL-2001. Also, the estimates of $\alpha_2$ admit the proper positive sign positive for the entire sample except three cases where the signs are negative (SFBT-2000, SIAME-2000 and TUNISIE LEASING-2000). Average value of $\alpha_1$ is very close to the corresponding average value of $\alpha_2$. Only 44% of sell trades $\alpha_1$ are superior to buy trades $\alpha_2$. This means that on the TSE, the transaction costs do not depend on whether the trader is a seller or a buyer[4].

The round trip costs vary from 0.27% (SIAME-2000) to 16.09% (AIRLIQUIDE-2001), but generally have plausible values: 60% of the transaction costs range from 1% to 3% and 39% are near 1%. For the 15 stocks existing over the 5 years of the study, the transaction costs tend to increase until 2003 and to decrease in 2004.

**Table 4**
Estimations of transaction costs by LOT model - year 2004

| FIRM | alpha1 | t(alph1) | alpha2 | t(alph2) | alph2-alph1 |
|---|---|---|---|---|---|
| ATL | -0.0168 | -7.255 | 0.0127 | 5.923 | 0.0295 |
| BH | -0.0141 | -7.013 | 0.0134 | 6.736 | 0.0275 |
| BIAT | -0.0107 | -6.682 | 0.0104 | 6.547 | 0.0211 |
| BNA | -0.0166 | -7.192 | 0.0175 | 7.368 | 0.0341 |
| BS | -0.0111 | -5.854 | 0.0157 | 7.359 | 0.0268 |
| BT | -0.0217 | -7.474 | 0.0136 | 6.745 | 0.0353 |
| BTEI | -0.0141 | -7.474 | 0.0097 | 6.085 | 0.0238 |
| ELECTROSTAR | -0.0064 | -3.888 | 0.0014 | 0.884 | 0.0078 |
| GENERALL | -0.0361 | -5.888 | 0.0321 | 5.630 | 0.0682 |
| MONOPRIX | -0.0279 | -7.632 | 0.0198 | 6.861 | 0.0477 |
| SFBT | -0.0026 | -3.134 | 0.0063 | 6.637 | 0.0089 |
| SIAME | -0.0085 | -5.819 | 0.0058 | 4.105 | 0.0143 |
| SIPHAT | -0.0068 | -4.582 | 0.0023 | 1.620 | 0.0091 |
| SOTETEL | -0.0024 | -1.767 | 0.0083 | 5.600 | 0.0107 |
| SOTRAPIL | -0.0047 | -3.926 | 0.0054 | 4.352 | 0.0101 |
| SPDIT | -0.0121 | -5.966 | 0.0130 | 6.103 | 0.0251 |
| STEQ | -0.0039 | -3.249 | 0.0016 | 1.349 | 0.0055 |
| STIP | -0.0084 | -4.063 | 0.0056 | 2.763 | 0.014 |
| TUNISAIR | -0.0028 | -2.507 | 0.0007 | 0.293 | 0.0035 |
| TUNLEASE | -0.0216 | -7.176 | 0.0199 | 6.959 | 0.0415 |
| UBCI | -0.00336 | -7.323 | 0.0355 | 7.777 | 0.0389 |
| UIB | -0.0096 | -5.345 | 0.0116 | 6.242 | 0.0212 |

Table 5 summarizes results of transaction costs estimates $\alpha_2 - \alpha_1$ for groups of market capitalization and years.

**Table 5**
Average values of transaction costs estimates (%)

| | Low size | Middle size | High size |
|---|---|---|---|
| **2000** | 1.84 | 2.61 | 1.32 |
| **2001** | 3.24 | 4.87 | 1.61 |
| **2002** | 2.40 | 1.78 | 3.83 |
| **2003** | 4.49 | 1.80 | 3.86 |
| **2004** | 2.12 | 2.30 | 2.62 |
| **aggregate** | **2.82** | **2.67** | **2.65** |

Over the period, we observe, for the small and middle size groups, no clear tendency in the transaction costs evolution. However for the high size group these costs rise until 2003 and then fall. As for individual securities, transaction cost seems to decrease in 2004 and this is true for small and high size firm groups.

From Table 5, it appears that on average, the transaction costs decrease when the market capitalization of the firm increases. On the Tunisian market this result is not as evident as these obtained on other markets especially on quote-driven markets. In fact, LOT obtained that the small size firms transaction costs are twice the transaction costs for the high size firms on the AMEX and the NYSE for the period 1963-1990. Our result of an approximately equal cost of transaction among groups of market capitalization can be explained using the argument of zero returns. In Table 3, we have noted an almost equivalent percentage of zero daily returns for the three groups. As the LDV Model is based on the relationship between the percentage of zero returns and the transaction costs, equities supporting the same cost of transacting would have a roughly same percentage of zero returns.

To analyse the relationship between the frequency of zero returns and the transaction costs, we regress the proportions of these returns on the LDV model estimates in each size group. Results are displayed in Table 6.

**Table 6**
Results of regression of zero returns (%) on LDV Model estimates

| Size group | Firm-years | Intercept | LDV estimates | $R^2$ | F-statistic |
|---|---|---|---|---|---|
| **Low size group** | 49 | 0.340469** | 2.591806* | 0.068484 | 3.455401* |
| | | (6.952175) | (1.858871) | | |
| **Middle size group** | 48 | 0.291375** | 4.858989** | 0.428710 | 34.51956** |
| | | (8.081744) | (5.875335) | | |
| **High size group** | 49 | 0.320917** | 2.705468** | 0.117748 | 6.272781** |
| | | (9.119097) | (2.504552) | | |

* significant at 10% level.
** significant at 1% level.

As predicted by the LOT model, in all of the regressions the LDV estimates coefficient is positive and significant for each size group. The $R^2$ statistics vary from 7% to 43%. The Fisher statistics are significant at 1% level for Middle and High size groups and 10% level for low size group.

### C. Comparison of LDV estimates with spread estimates

As described above, transaction costs are composed basically by spread and commissions. In order to verify the robustness of our results, we compare LDV model estimates of transaction costs, on the TSE, with the effective spread calculated by Roll and GKN methods. To obtain an approximation of the effective commission supported by investors, we also determine the difference between LDV estimates and the spread. Table 7 illustrates the ratio of LDV estimates with respectively Roll's and GKN's spreads and estimations of the effective commissions.

**Table 7**
Comparison of transaction costs with spread estimates

| Year | LDV estimates/ Roll's spread | LDV estimates/ GKN's spread | Commission-R (%) | Commission-G (%) |
|---|---|---|---|---|
| 2000 | 1.83 | 1.04 | 0.86 | 0.05 |
| 2001 | 3.11 | 1.32 | 2.17 | 0.65 |
| 2002 | 3.33 | 1.12 | 1.69 | -1.16 |
| 2003 | 4.36 | 1.29 | 2.37 | 0.59 |
| 2004 | 2.83 | 1.08 | 1.51 | 0.16 |

Commission-R: equal to the difference between LDV estimates of transaction costs and Roll's spread. Commission-G: equal to the difference between LDV estimates of transaction costs and GKN's spread.

In both LDV estimates / Roll's spread and LDV estimates / GKN's spread, the ratio is greater than one for all the period. This result signifies that as expected, the spread is only one component of the total transaction cost. Other components of total transaction costs like commissions, price impact costs and opportunity costs can be deduced from the difference of LDV estimates and spread estimates. This allows us to judge the goodness of spread estimation.

In the TSE, the commission depends on the volume of transaction and cannot exceed 0.8%. This commission must be doubled to represent a round-trip commission cost. Then Commission-R and Commission-G are compared to 1.6%. Each time where the commission estimates are less than 1.6% we can conclude that the spread is over-estimated. In the Tunisian market, all the Commission-Gs are below 1.6% indicating the over-estimate of GKN's spread. Commission-R except for 2000 is approximately superior or equal to 1.6%. We deduce then that the Roll's spread constitutes a better estimate of the spread than the GKN.

**Table 8**
Results of regressions of LDV model estimates on the quoted spread

| Size group | Firm-years | Intercept | LDV estimates | $R^2$ | F-statistic |
|---|---|---|---|---|---|
| Low size group | 49 | 0.040880** | -0.075410* | 0.066011 | 3.32179* |
| | | (5.011796) | (-1.82258) | | |
| Middle size group | 48 | 0.057982** | -0.183775** | 0.207460 | 12.04126** |
| | | (6.145569) | (-3.47005) | | |
| High size group | 49 | 0.041440** | -0.111890** | 0.160321 | 8.97374** |
| | | (6.422526) | (-2.99562) | | |
| Aggregate | 146 | 0.046761** | -0.121545** | 0.136297 | 22.72400** |
| | | (10.02116) | (-4.76697) | | |

** Significant at the 1% level.
* Significant at the 10% level.

The association between LDV estimates of transaction costs and the average investors bid-ask spread is tested by regressing LDV transaction costs for TSE securities on the average best limit given orders. These tests cover the period 2000-2004. We run separate regressions for the observations in each size group. The results are displayed in Table 8.

For every size group, the slope coefficient of regression is negative, close to zero and significant at level 10% for small size group and at 1% for both middle and high groups. $R^2$ ranges from 6.6% to 20.7%. Similar results are obtained from the aggregate regression.

These results indicate that the estimated transaction costs are negatively related to the average bid-ask spread for all size and aggregate group. This relation can be explained by the fact that in an order-driven market, the commissions are fixed by the brokerage firms and the spread by the investors. Indeed, when the spread decreases, this can be interpreted by the brokers as being symmetrical information so low risked securities. Thus, the demand for these securities will increase and the brokers will increase their commissions. The total cost tends to increase but not significantly. This seems to explain why the slope coefficients are negative and close to zero.

## VI. CONCLUSION

In this paper we applied the LOT model in order to estimate the transaction costs on the TSE, which is an order-driven market. The LOT model uses the time series of daily security return and market return. The idea is to estimate the transaction costs from the proportion of zero returns via a Tobit model with frictions. We tested the commonly admitted relationship between transaction costs and market capitalization.

Our sample contains 146 year-firm equities over the period 2000-2004 tested on the TSE. We sorted the equities in three groups of market capitalization: low size firms, middle size firms and high size firms.

Three spread estimates were computed. All these measures confirm the inversely relationship between the spread and the firm size. The transaction costs obtained for the TSE are not so evidently correlated to the firm size than in the American market. From the comparison of the transaction costs and the spreads we deduced that on the TSE, Roll's measure seems to be the best spread estimation.

The regression of transaction costs on the quoted spread provided a negative and small slope coefficient. Since there are no similar studies, we argued that this result might be specific to an order driven market.

## ENDNOTES

1. Bourse des Valeurs Mobilière de Tunis.
2. A weighted index on the TSE.
3. The program is available upon request from the authors.
4. Huang and Stoll (1994) and Lesmond, Ogden and Trzcinka (1999) find that for the American market, it is easier to buy than to sell. In LOT study $\alpha_1$ is always greater than $\alpha_2$. Deville (2001) finds the same result on the components of the CAC 40; both Tunisian and French markets are limit order markets.

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## APPENDIX

Annual transaction costs estimates*

Estimations of transaction costs by LOT model - year 2000

| FIRM | alpha1 | t(alph1) | alpha2 | t(alph2) | alph2-alph1 |
|---|---|---|---|---|---|
| **AIRLIQ** | -0.0737 | -4.709 | 0.0763 | 4.727 | 0.1500 |
| **ALKIMIA** | -0.0477 | -7.450 | 0.0332 | 6.625 | 0.0809 |
| **ALMAZRAA** | -0.0095 | -7.450 | 0.0035 | 3.363 | 0.0130 |
| **AMENBANK** | -0.0072 | -6.237 | 0.0025 | 2.347 | 0.0097 |
| **AMENLEASE** | -0.0083 | -5.964 | 0.0041 | 2.924 | 0.0124 |
| **AMS** | -0.0090 | -4.577 | 0.0177 | 8.165 | 0.0267 |
| **ASTREE** | -0.0105 | -7.122 | 0.0078 | 5.877 | 0.0183 |
| **ATB** | -0.0328 | -5.896 | 0.0391 | 7.061 | 0.0719 |
| **ATL** | -0.0054 | -5.890 | 0.0060 | 2.933 | 0.0114 |
| **BATAM** | -0.0057 | -2.864 | 0.0026 | 2.933 | 0.0083 |
| **BDET** | -0.0102 | -6.760 | 0.0026 | 2.079 | 0.0128 |
| **BH** | -0.0053 | -4.443 | 0.0064 | 5.155 | 0.0117 |
| **BIAT** | -0.0045 | -5.261 | 0.0036 | 4.182 | 0.0081 |
| **BNA** | -0.0070 | -4.623 | 0.0037 | 2.547 | 0.0107 |
| **BNDT** | -0.0096 | -5.747 | 0.0061 | 3.921 | 0.0157 |
| **BS** | -0.0048 | -4.235 | 0.003 | 2.689 | 0.0078 |
| **BT** | -0.0077 | -7.453 | 0.0057 | 5.895 | 0.0134 |
| **BTEI** | -0.0051 | -5.627 | 0.0038 | 4.559 | 0.0089 |
| **CARTE** | -0.0130 | -5.881 | 0.0127 | 5.874 | 0.0257 |
| **CIL** | -0.0049 | -3.931 | 0.0059 | 4.571 | 0.0108 |
| **GENERALL** | -0.0063 | -4.534 | 0.0038 | 2.798 | 0.0101 |
| **ICF** | -0.0065 | -7.396 | 0.0047 | 6.168 | 0.0112 |
| **MAGG** | -0.0190 | -6.723 | 0.005 | 1.989 | 0.0240 |
| **MONOPRIX** | -0.0072 | -6.467 | 0.0035 | 3.560 | 0.0107 |
| **MOTEUR** | -0.0123 | -7.480 | 0.0097 | 6.490 | 0.0220 |
| **PALMB** | -0.0124 | -6.270 | 0.0133 | 6.720 | 0.0257 |
| **PLACTT** | -0.0172 | -7.648 | 0.0116 | 6.318 | 0.0288 |
| **SFBT** | -0.0065 | -7.396 | 0.0047 | 6.168 | 0.0112 |
| **SIAME** | -0.0098 | -7.849 | -0.0071 | -6.050 | 0.0027 |
| **SIMPAR** | -0.0102 | -8.081 | 0.0060 | 5.487 | 0.0162 |
| **SOTETEL** | -0.0127 | -7.706 | -0.0052 | -3.927 | 0.0075 |
| **SOTUMAG** | -0.0026 | -2.474 | 0.0019 | 1.775 | 0.0045 |
| **SOTUVER** | -0.0074 | -5.078 | 0.0093 | 6.361 | 0.0167 |
| **SPCD** | -0.0034 | -2.628 | 0.0031 | 2.432 | 0.0065 |
| **SPDIT** | -0.0027 | -1.911 | 0.0050 | 3.355 | 0.0077 |

| | | | | | |
|---|---|---|---|---|---|
| **STAR** | -0.0153 | -7.766 | 0.0051 | 2.950 | 0.0204 |
| **STB** | -0.0036 | -3.076 | 0.0032 | 2.861 | 0.0068 |
| **STIL** | -0.0083 | -6.762 | 0.0017 | 1.585 | 0.0100 |
| **TLAIT** | -0.0160 | -7.784 | 0.0089 | 5.112 | 0.0249 |
| **TUNINV** | -0.0090 | -6.932 | 0.0039 | 3.636 | 0.0129 |
| **TUNISAIR** | -0.0022 | -2.270 | 0.0018 | 1.865 | 0.0040 |
| **TUNLEASE** | -0.0036 | -3.849 | -0.0001 | -0.074 | 0.0035 |
| **UBCI** | -0.0046 | -4.512 | 0.0031 | 3.172 | 0.0077 |
| **UIB** | -0.0088 | -6.492 | 0.0063 | 4.996 | 0.0151 |

* We present here only the transaction costs on the TSE for year 2000. Results of 2001, 2002 and 2003 are available upon request from the authors.