Trading Volume, Volatility, Order Flow and spread: Evidence of Tunisian dealer.

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Abstract

This paper analyses the relation between trading volume, order flow, volatility and bid-ask spread of dollar/dinar (*TND/USD*) and euro/dinar (*TND/EUR*) of a Tunisian dealer. Generalized Method of Moments show that dollar spread increases with volatility, consistent with inventory and asymmetric models. However, nor volume, or order flow have an information content on spread.

Using GARCH method, we find that volatility for the two series is only affected by order flow, as suggested by the MDH. Its supports the informative role of order flow for the two series. Unfortunately, the volume has no information content on volatility.

Key Word:
Tunisian dealer, Order flow, transaction volume, exchange rate volatility, bid-ask spread, information.

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Résumé:

Dans cet article, nous avons essayé de tester les déterminants de la fourchette du taux de change, dans le cadre de la théorie de la microstructure, pour un teneur de marché tunisien. Ces hypothèses sont testées pour les taux de changes *USD/TND* et *EUR/TND*. En appliquant la méthode des moments généralisés, nous avons confirmé les paradigmes de position et asymétrie d'information, seulement pour le dollar. En effet, plus le taux de change $/TND est volatil, du aux afflux des informations, plus teneur de marché, averse au risque, élargit sa fourchette de prix.

En deuxième lieu, nous avons testé l'hypothèse de mélange de distribution. Cette dernière a été confirmée pour les deux taux de change. En effet, nous avons trouvé que les flux d'ordre ont un effet informationnel sur la volatilité. Enfin, le volume de transaction n'exerce aucun effet informationnel ni sur la fourchette ni sur la volatilité.

Mots clefs :

Teneur de marché de change tunisien, Flux d'ordre, fourchette du taux de change, volume de transaction, volatilité du taux de change, flux informationnel.

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Trading Volume, Volatility, Order Flow and spread: Evidence of Tunisian dealer.

I- Introduction

Since the failure of traditional exchange rate modelling, a growing body of microstructure of exchange rate has been developed. This literature study the trading activity of foreign exchange market with the effects of markets organization, the existence of transactions costs, liquidity, risk and private information. In particular, it analyses the basic determinants of the spread at short-term. This issue is important, since it has implications on market liquidity, risk and asymmetric information.
A number of studies have looked at this issue from empirical area only for the developing foreign exchange market. However, a few empirical studies have looked it at exchange rate of emerging market, like Galati (2000).

This paper examines the microstructure of a medium-sized bank in Tunisia foreign exchange market. In other words, the objective is to test models of spread determination of the spot dinar/dollar (*TND/USD*) and dinar/euro (*TND/EUR*). In addition, we test the relation between volatility with volume and order flow via mixture of distributions hypothesis (MDH).

The main results of the study, confirm inventory and asymmetric models, only for the dollar. In fact, the spread of dollar is positively correlated with his volatility. However, the two models are not confirmed for the euro. Nor volume, or order flow have an information content on spread.

Second, the MDH is proven only for the relation between order flow and volatility for the two series. Its supports the informative role of order flow for the two series. Unfortunately, the volume has no information content on volatility.

The remainder of the paper is organized as follows; Section 2 reviews the spread theory. Section 3 checks the main contributions to the literature on the relationship between trading volumes, volatility, order flow and spreads. Section 4 describes the Tunisian foreign exchange market. Section 5 describes the data set that is used. In Section 6, we present the regression analysis to test whether the mixture of distributions hypothesis and microstructure in dealer foreign exchange markets holds. Section 7 concludes.

II- Spread Theory

The microstructure theory identifies three channels trough which the bid-ask spread is determined : transactions costs, inventory cost, and information costs (adverse selection).

First, The transactions costs models (Demsetz, 1968), assume the existence of cost of "predictable immediacy" as the service of the compensation required by the market makers. These costs may include, the cost of subscriptions to electronic information and trading systems (for example, Reuters). When the dealer expects the increase of trading volume in the next trading period, ceteris paribus, his expected profit goes up. However, the competition between dealers will force him to narrow his spread. Therefore, the predictable volume should reduce the spread.

The second model is inventory costs models [Ho, 1978; Ho& Stoll, 1981,1983, O'hara and Oldfield,1986; among others]. This approach assumes that uncertainly in arrival of order flow, limits the *risk averse dealers*, to maintain their optimal inventory position. Consequently, as transaction volume or order flow increase, the risk averse dealers increase the spread.

Information cost models emerge when dealers adjust price in response to the existence of private information [Copeland and Galai (1983), Golsten and Milgrom (1985), and Kyle (1985), among others]. In fact, The market maker is exposure to the adverse selection problem because he cannot identify the transaction motivation of his customer (informed or liquidity customer). Hence, the bid-ask spread is used by the dealers in order to defend themselves from adverse selection. Consequently, as adverse selection, measured by the rate of information arrival, increases, the spread is large.

However, the empirical implementation of the model requires the estimation of the rate of information arrival or the share of information trading in overall trading. These variables are unobservable. The use of unpredictable market activity is proposed in most paper (unexpected volume, unexpected order flow).

With averse neutrality dealer, Kyle((1985), Admati and Pfleiderer (1988) reveal that, market liquidity increases the transaction volume, decreases adverse selection and consequently the spread is tight. While, the short sale constraints (Easley et O'hara 1987,1992), informative advantage (Foster et Viswanathan 1990) or risk aversion of agents [Subrahmanyam, 1992; among other], increase the spread proportionally with order flow or the transactions volume.

The two microstructure models (inventory and information) imply that expected return volatility pushes up the spread. Except, Kyle (1985) and Admati and Pfleiderer (1988) model, reveal that, when the price become more volatile the spread is tight. The spread model can be written as follow[2]:

$$S = f(\sigma^{p}, I, MA^{p})$$

S : The spread

I : The information flow, measured by the unpredictable volume or order flow.

σ^{p} : Predictable return volatility.

MA^{p}: predictable market activity.

III -Literature review

The microstructure hypothesis in foreign exchange market has initiated by Glassman (1987). She finds, with a constant volatility, that the spread increases with volume. Bessembinder (1994) show that unpredictable volume is measured by ARIMA model. The spread is positively correlated with unexpected volume. However, this correlation is not statistically significant. In this study, Bessembinder use foreign exchange future volume from Chicago International Monetary market (IMM) as a proxy variable of global spot volume.

[2] See Hartmann (1999)

These researches suppose that the volatility is constant. Although, the exchange rate is characterized by the existence of volatility clustering, described by ARCH-type models [Engle (1982].

Bollerslev et Melvin (1994) measure expected volatility by GARCH(1,1) forecast. Using asymmetric information model They find that volatility augments spread. Their study is based on an ordered Probit analysis in order to capture the discreteness in the spread distribution. Lee (1994) confirms this correlation with conditional heteroskedasticity of prediction error of foreign exchange rates.

With an option implied standard deviation (ISD) from market currency future on the Chicago Mercantile Exchange used as a proxy of volatility, Jorion (1996) confirms the positive and significant correlation between volatility, volume and spread. Hartmann (1999) uses bank of Japan's data set on brooked transaction in Tokyo yen/dollar market as a proxy of spot volume. He supports the Jorion's results. However, the Hartmann's data represent less than 5% of the global yen/dollar spot. Hence, Galati (2000) uses daily data on trading volume, volatility and spread from emerging foreign exchange markets. Evidence of a positive correlation between volatility and spreads, as suggested by inventory cost models, has been found, but no evidence of a significant impact of unexpected trading volumes on spreads.

The effect of order flow on volatility have been, firstly, analysed by Ito, Lyons and Melvin (1998). They argue that deregulation in trading restrictions resulted a highly significant shift in the volatility pattern across the entire Japanese trading day, indicating that private information is an important component of the price formation in the FX market. According to the microstructure theory, this result supports, indirectly, an information role for the order flow.

Bollerslev and Domowitz (1993) use intra-daily data to investigate the behaviour of order flow, volatility and spread over trading day, across geographical locations and across market participants The find, with risk aversion of traders, the market maker increases his spread with increasing order, consistent with Subrahmanyam's model.

The microstructure has reported a strong contemporaneous correlation between trading volume and volatility. The literature suggests that transaction volume or order flow is positively correlated to volatility driven by an unobservable variable. This latter is supported by the mixture of distributions hypothesis [MDH, Clark (1973)]. Tauchen and Pitts (1983) have identified this variable in their seminal paper. The authors find, that with a fixed numbers of trades at short term, higher trading volume reveals higher disagreement among traders and thus is associated with higher price variability. This link is due to new information arriving to the market. Thus, unexpected risk and unexpected volume are positively correlated through their dependence on an information flow. Bessembinder (1994), Galati (2000) and Hartman (1999) find that unexpected trading volumes and volatility are positively correlated. They both respond to the arrival of new information, as the mixture of distributions hypothesis predicts. (For more detail, see Sarno2000).

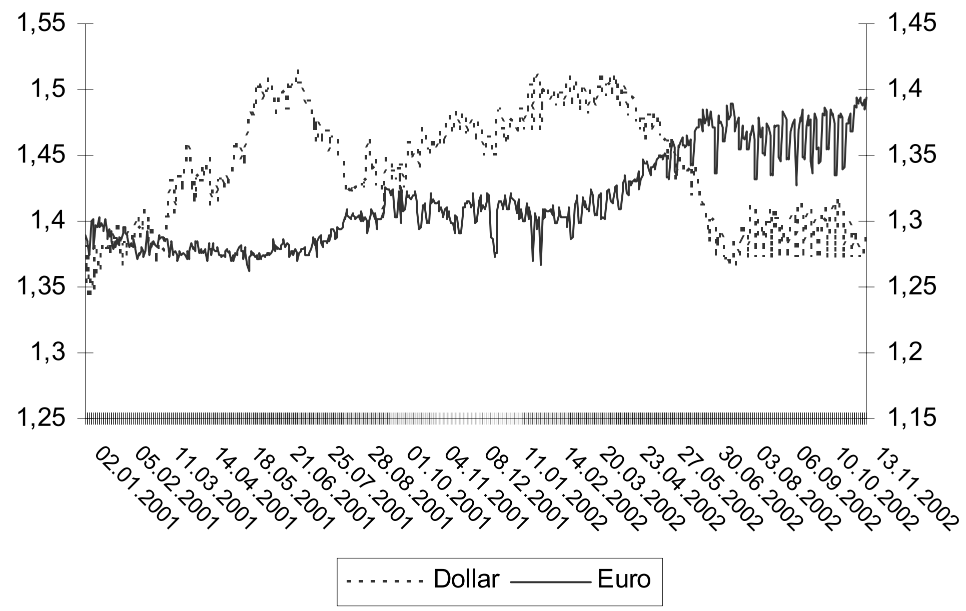
IV- The Tunisian Foreign Exchange Market

The liberalization process of foreign exchange regulation that, has started since 1987, led in December 1992 to the dinar current convertibility. In addition the creation of foreign exchanges market in March 1st, 1994. The exchange rate of the Tunisian dinar is freely determined on the foreign exchange market between official intermediates of the Tunis area including offshore banks operating on behalf of their resident customers. The Central Bank of Tunisia intervenes on this market and publishes the interbank exchange rate of currencies and banknotes at the latest the following day. Global turnover in traditional foreign exchange market[3] segments was, in 2002 about 28,775 millions dollars[4] per day. Spot instruments were in a dominate position relative to forward and swaps transaction, with a market share of 80%. The foreign exchange market was dominated by interbank business, about 60%. The interbank is a decentralised dealer market. The interdealer transactions are a direct trading trough the Reuters D2000-1 and phone. Indirect trading through a broker does not exist in this market.

[3] Traditional FXM includes spot, forward and swap transaction.

While the major currencies are traded globally and constitute very liquid markets, smaller currencies like TND are primarily traded trough national center and are less liquid. The US dollar was, the most actively traded currency, being involved in 50% of all transaction in Tunisian foreign exchange. The euro followed, with almost 40%. Over the period cover this paper, the dinar depreciated against the 8.1%euro and the 1.4%US dollar. But, we remark an appreciation of dollars about 10%, for the 16 first month followed by a depreciation of 8%. (fig 1)

Fig1 :Trend of the exchange rate TND/USD and TND/EURO



The figure1 exhibits a negative and asymmetric correlation between the two exchange rates. In fact, an appreciation of euro is accompanied by a depreciation of dollar. It is consistent with the international market. However, the depreciation of dollars is more than the appreciation of euro and thus the dollars are more volatile than euro. This latter has been explained by the international context when the dollar has been higher depreciated against the euro.

[4] The exchange rate is 1,3341TND/$ at 31/12/2002.

Monetary policy

The main purpose of the monetary policy, of the Central Bank of Tunisia, is to preserve the value of the currency, by keeping inflation rate as low as that of its partners and competitors. The intermediary objective is to match the money supply growth with economic activity growth. The inflation rate is about 2.9%.[5]
Monetary policy privileges interest rate. It must play a vital role in mobilizing savings and maximizing the allocation of resources. The interest rate is about 5.53%.The monetary market rate is the reference to banks when fixing their credit and debit interest rates. Banks are free to fix interest rates. This liberalization has been achieved progressively. They concern the credit rates, except for those relating to the earnings of small savings (deposits kept in special savings accounts) and sight deposits, the maximum earning of which must not exceed 2%. The debit rates vary within a 3% margin around money market rates, except for those applicable to loans given to essential activities.

V- Data

This data set employed in this study consists of daily transactions of Dollar and Euro against Dinar. The data is appropriate to a commercial and private Tunisian middle-sized bank over the sample period 02 January 2001 to 15 November 2002. The market share is about 5%. His market is dominated by interbank transaction, 70%.

The first component includes the transaction volume. The second and the third component are respectively volatility and bid-ask spread. Finally, we use the order flow as a key of transaction.

This section reviews the main characteristics of the variables investigated. It starts with a description of the data on transaction volume. It then analyses in detail the exchange rates and their volatility. Finally, it describes the behaviour of bid-ask spread and order flow.

5.1 Transaction Volume

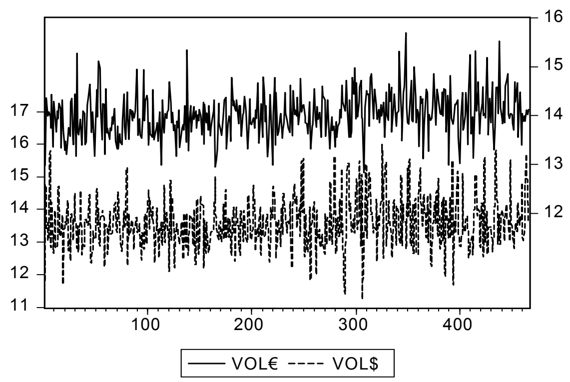
The transaction volume is measured by the sum of aggregated daily buy and selling order. Table 1 gives some summary statistics of transaction volume, which is plotted in Figure 2.

Table 1: Descriptive analysis of transaction volume(100.000TND)

	VOL$	Vol€
Mean	13.56688	14.29106
Median	13.50726	14.23958
Std. Dev.	0.779040	0.540668
Skewness	0.442770	0.484358
Kurtosis	3.545643	3.776953
Jarque-Bera	21.00702	30.00601

Euro Transaction volume, is more important than Dollar but this latter is more volatile. The higher volume of Euro is explaining by that 80% of bank's customer transact with the European Union (table1 and figure2). There kurtosis is higher than three. Therefore, they are asymmetric.

Fig2: transaction volume



In order to measure the information content of volume, we decompose transaction volume into predictable and unpredictable. This decomposition is taken in two steps. First, by testing for non-stationary. Second, by applying standard Box-Jenkins time-series analysis to fit the appropriate AR process.

The stationary test, summarized in table 2, reject the null hypothesis for the two volumes. Consequently, the two series are stationeries and can be written as AR process.

[5] Report of Tunisian central Bank 2002

$$MA_t = \alpha + B(L)MA_t$$

With Z: the transaction volume.

B(L):the operator.

Table 2: test of stationary

	Dollar	Euro
ADF	-15.999	-15.129
1% Critical Value	-3.9820	
5% Critical Value	-3.4214	
10% Critical Value	-3.1331	

AR (1) seemed to be appropriate to dollar and Euro transaction volume (table 3).

Table 3: AR (p)

	Dollar AR (1)	Euro AR (1)
B(L) *t-student*	-0.053619 (-1.61)	0.148688 (3.23)
	R^2=0.2	R^2=0.22

5-2 Volatility

The second parameter taken as determinant variable in microstructure is exchange rate volatility.

The raw data for volatilities are relative returns, measured as the logged first difference of the middle exchange rate[6]. This later is the transaction price at the end of day

The characteristics of relative returns, summarized in table 4, exhibit excess kurtosis for the two exchange rates. The two distribution are symmetric. This is consistent with the existence of the fat tails of the empirical return distribution.

Table 4: Descriptive analysis of relative return

	R$	R€
Mean	0.027527	0.006946
Std. Dev.	0.916980	0.755424
Skewness	-0.065181	0.083488
Kurtosis	6.240173	9.482548
Jarque-Bera	203.7420	814.7441

The spread theory highlights the role of predictable return volatility. Common for exchange rate and other assets prices, is the existence of volatility clustering that the turbulence period are followed by period of relative calm. GARCH-type models [Bollerslev (1992) describe this phenomenon. Therefore, we use GARCH forecast volatilities from daily log returns to measure the expected return volatility.

[6] Middle exchange rate is measured by the arithmetic mean of bids and asks.

The test of GARCH effect, presented in table 5, suggests that a GARCH (1, 1) model captures the predictable return volatility of the two exchange rates.

Table 5: GARCH (1, 1) model estimation

$$R_t = c + r_t$$

$$h_t = \alpha_0 + \alpha_1 r_{t-1}^2 + \beta h_{t-1}$$

	GARCH(1,1)$	GARCH(1,1)€
β t-student	0.319 (6.31)	0.537 (4.83)

With R: exchange rate return

h: conditional volatility GARCH(1,1)

5-3 Spread

Daily relative spread is measured by the difference between ask and bid. The summary statistics of relative spread and a plot are given in table 6 and fig 3.

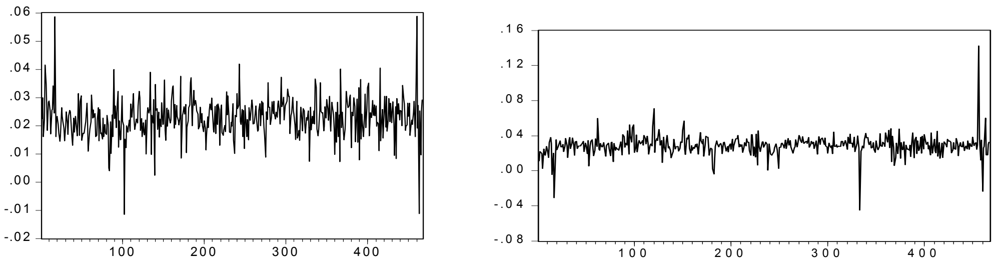
Table 6: Descriptive analysis of relative spread

	SP$	SPeuro
Mean	0.028579	0.022945
Median	0.028670	0.023281
Std. Dev.	0.010769	0.007086
Skewness	1.962438	0.035508
Kurtosis	32.22782	7.279645
Jarque-Bera	16886.10	356.4845

The dollar spread is wide then euro, due the higher depreciation of dollar in this period. The dealer will be widening in order to protect against the higher volatility of dollar exchange rate. This latter will be confirmed in the section 4.

Fig 3: Bid-ask spread

3.1 Euro *3.2 Dollar*



The unit root test shows that the spread of the two series are stationeries, as one would have expected [table7].

Table 7: test of stationary

	$	€
ADF	-7.4655	-13.681
1% Critical Value	-3.9869	
5% Critical Value	-3.4237	
10% Critical Value	-3.1345	

5-4 Order flow

The lack of macroeconomics models may be related to the existence of private information in foreign exchange markets. The microstructure theory shows that order flow is a key of convey information about fundamentals to market makers. Order flow is different from volume. In financial markets, volume is the sum of trades in absolute terms. However, order flow is transaction volume that is signed. It measures the net of buyer-initiated and seller-initiated orders. Therefore, it determines the buyer pressure or seller pressure. In market, the dealers use the direction of the flow to infer the motivates of investors. Consequently, order flow is a private information source for dealers.

Recent empirical evidences show that order flow is more powerful than macroeconomic variables in explaining exchange rate [Lyons (1995),Yao (1998) Evans and Lyons (1999), among others.].

Table 8: Descriptive analysis of order flow

	$	**€**
Mean	12.36400	12.59164
Median	12.45713	12.76218
Std. Dev.	1.460680	1.203790
Skewness	-0.465668	-1.063190
Kurtosis	3.829220	5.223409
Jarque-Bera	30.19275	184.1739

Table 8 reports the statistics descriptive of order flow. The analysis of descriptive order flow is similar to this of volume. Euro order flow is important than the dollar but this later is more volatile.

The two series seem to be left asymmetric and leptokurtic. The stationary test seems reject the null hypothesis, as reported in table 9. Hence, the two series can be decomposed into unexpected and expected order via the Box-Jenkins analysis. This analysis describes the dollar and euro order as AR(1) [table10].

Fig 4: Order flow

4.1. Dollar *4.2 Euro*

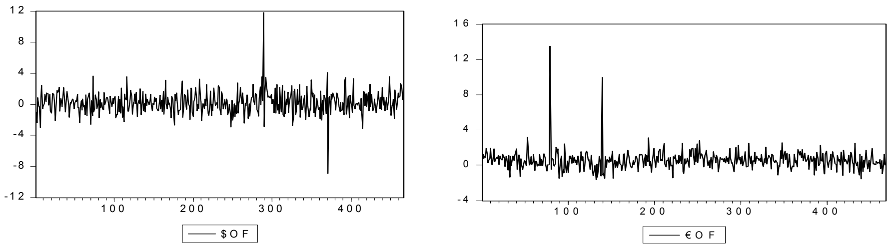


Table 9: Test of stationary

	Dollar	Euro
ADF	-16.572	-16.024
1%	-3.9820	
5%	-3.4214	
10%	-3.1331	

Table 10: AR (p) estimation of order flow

	dollar AR(1)	Euro AR(1)
B(L) t-student	-0.121 (-2.644)	-0.076 (-1.64)
	R^2= 0.4	R^2=0.5

VI- Results

6-1 Method

As already announced, we test two relations. First, the hypothesis of mixture distribution. This relation is tested via the correlation between volatility and volume or order flow. We use the GARCH method similar to the volatility. Second, we identify the basic determinant of spread via the relation between volatility, volume, order flow and spread. This relation has been tested by GMM estimation. This method is most adequate for financial data, because it does not require the normality distribution and time. In addition, This method requires that the spread is stationary.

In order to avoid the over-identification of instruments variables required by this method, we use explanatory variables as instruments like Bessembinder (1994).

6-2 Volume, Order Flow and Volatility

The effects of news on exchange rates returns are inferred from the behaviour of the conditional volatility. In this section, we examine the direct effect of market activity including order flow and transaction volume on the dependence in the returns process. The structural model estimated is given by :

$$R_t = c + r_t$$
$$h_t = \alpha_0 + \alpha_1 r_{t-1}{}^2 + \beta h_{t-1} + \mu(marketactivity)_t + \varepsilon_t \qquad (6.1)$$

With *'Market activity'* refers to absolute order flow or transaction volume.

However, before testing the structural model, we present the correlation between the three variables.

As indicated in the correlation matrix 1, the contemporaneous correlation between volume and volatility and order flow and volatility. There is a positive correlation of volume and order flow with volatility for the two series. But, the correlation between volatility and volume is near to zero, in particular for the euro.

Correlation Matrix 1

	$	Euro
Volume	0.157	0.046
Order flow	0.56	0.42

6-2-1 volume- volatility

The matrix correlation denotes a less positive correlation between volume and volatility for the two series.

The regression of volatility on trading volume according following equation below (6.2) confirms the positive correlation for The euro and the dollar. However, this correlation is not significant (table 11).

$$R_t = c + r_t$$
$$h_t = \alpha_0 + \alpha_1 r_{t-1}{}^2 + \beta h_{t-1} + \mu Z_t + \varepsilon_t \qquad (6.2)$$

With Z: transaction volume

Table 11: Model Estimation : $R_t = c + r_t$; $h_t = \alpha_0 + \alpha_1 r_{t-1}{}^2 + \beta h_{t-1} + \mu Z_t + \varepsilon_t$

	$	€
α_0 t- statistic	0.07 (1.2)	0.23 (45.48)
α_1 t- statistic	1.08 (14.01)	0.15 (3.94)
β t- statistic	0.03 (9.96)	0.38 (3.38)
μ t- statistic	0.04 (0.95)	0.014 (1.42)
R^2	0.07	0.08

This result is confirmed, when, we introduce the expected and unexpected volume. Their coefficients are not significant. Hence, volume has non information content on volatility and the market is less liquid.

6-2-2 order flow-volatility

The results of equation (6.3) reported in table 12 show a significant positive correlation between order flow and volatility for the dollar and euro. However, the positive correlation is more important for the $ than the euro. In fact, a net buy of 100.000dinar order flow would affect the volatility of exchange rate about 10% for the$ and only 1% for the €. These phenomena can be explained by the dealer's risk aversion faced to the higher depreciation of $. Hence, higher order, would increase the volatility.

$$R_t = c + r_t$$
$$h_t = \alpha_0 + \alpha_1 r_{t-1}^{\ 2} + \beta h_{t-1} + \mu OF_t + \varepsilon_t \qquad (6.3)$$

Table 12: Model Estimation $R_t = c + r_t$, $h_t = \alpha_0 + \alpha_1 r_{t-1}^{\ 2} + \beta h_{t-1} + \mu OF_t + \varepsilon_t$

	$	€
α_0 t- statistic	0.01 (2.65)	0.02 (4.01)
α_1 t- statistic	1.15 (20.91)	0.17 (3.8)
β t- statistic	0.28 (9.35)	0.29 (3.003)
μ t- statistic	0.01 (1.65)	0.001 (3.97)
R^2	0.72473	0.7192

The positive dependence of order flow and volatility can been explained through the information flow. This later is not observed and measured by the unexpected order flow.

This hypothesis is proven, when we include unexpected order flow in equation (6.3):

$$R_t = c + r_t$$
$$h_t = \alpha_0 + \alpha_1 r_{t-1}^{\ 2} + \beta h_{t-1} + \mu NOF + \varepsilon_t \qquad (6.4)$$

We find that volatility and unexpected order for the two exchange rates are positively correlated. In fact, the coefficients of unexpected order for the two series are significantly positive [table13]. The unexpected order flow will increase the volatility about 11.8% and only 0.8% for the euro. so, this confirms the informative content of order flow, as suggested by MDH.

Table 13: Estimated model $R_t = c + r_t$

$h_t = \alpha_0 + \alpha_1 r_{t-1}{}^2 + \beta h_{t-1} + \mu_2 NOF + \varepsilon_t$

	$	€
α_0 t- statistic	0.054 (0.614)	0.0125 (0.498)
α_1 t- statistic	0.460 (5.931)	0.166 (3.876)
β t- statistic	0.190 (9.288)	0.314 (2.998)
μ t- statistic	0.118 (21.388)	0.008 (3.432)
R^2	0.57	0.65

A common feature of the traditional price volatility is the crucial role of macroeconomic news. All agents in the foreign exchange market base projections on the same public information, implying that private information is irrelevant. However recent studies, especially the current study, challenge this view.

For this reason, we have included a macroeconomic variable in equation (6.4). This varaiable is measured by daily differential interest rate. The results are summarised in table 14. They confirm the positive relation between order flow, interest rate and volatility. However, the effect of unexpected order flow on volatility is more important than of interest rate. While, the effect of dollar and euro unexpected order flow are about 8%, the $ interest rate is only about 0,5% and 0.2%of the euro interest rate, but statistically insignificant for the euro. These results confirm that order flow is a information source of the dealer.

$$R_t = c + r_t$$
$$h_t = \alpha_0 + \alpha_1 r_{t-1}{}^2 + \beta h_{t-1} + \mu\ NOF + \lambda \Delta(i - i*)_t + \varepsilon_t \qquad (6.5)$$

with $\Delta(i\text{-}i^*)$: differential of interest rate.

Table 14: With Macroeconomic variable

	\$	€
α_0 t- statistic	0.205 (19.95)	0.012 (0.52)
α_1 t- statistic	0.703 (6.447)	0.169 (3.88)
β t- statistic	0.118 (4.36)	0.334 (3.11)
μ t- statistic	0.080 (9.65)	0.008 (3.38)
λ t- statistic	0.005 (4.39)	0.002 (0.98)
R^2	0.753	0.696

6-3 Volume, Order Flow Volatility and bid-ask spread

In this section, we examine the basics determinant of spread: volatility, transaction volume and order flow.

The structural model estimated is given by (Section2):

$$S_t = \alpha + \beta h_{t+1} + \mu MA_t + \varepsilon_t \qquad (6.6)$$

With S: spread

h: volatility GARCH(1,1)

MA: market activity; order or transaction volume

The correlation matrix exhibits a positive correlation between spread and the other variables.

Correlation Matrix 3

	Volatility	Volume	Order
Spread €	0.0002	0.0388	0.0245
Spread \$	0.0677	0.0024	0.0711

6-3-1 Volatility, Volume and Spread

First to test the correlation between volume, volatility and bid-ask spread, we regress bid-ask spread on the GARCH variance forecast and transaction volume:

$$S_t = \alpha + \beta_1 h_{t+1} + \mu_t Z + \varepsilon_t \quad (6.6a)$$

The results are presented in table 15. Consistent with microstructure theory, volatility and the spread of \$/TND are positively correlated. This correlation suggests that high volatility increase spread through risk aversion of market maker as suggested by inventory costs models. This result confirms the protection of the dealer of the higher depreciation of the dollars. Also, the more importance of information arrival, the higher volatility, the larger the spread. This result corroborates the Subrahmanyam's model. However, the euro volatility has a positive effect but statistically non-significant. Both Euro and dollar transaction volume have no significant effect in spread.

Table 15: Model Estimation $S_t = \alpha + \beta_1 h_{t+1} + \mu Z_t + \varepsilon_t$

	$	€
α t- statistics	0.003529 (1.055)	0.019 (2.35)
β t- statistics	0.000184 (1.96)	0.00017 (0.37)
μ t- statistics	-0.000247 (-1.026)	-0.04 (-0.86)
R^2	0.31	0.28

The introduction unexpected and expected volume in equation (6.7) confirm the absence of the effect of volume. In fact all coefficients are statistically non-significant

6-3-2 Volatility, order flow and Spread

We replace the transaction volume by unexpected order flow [equation 6.6b]. We find, that the coefficients of order flow for the two series are not significant. Hence the order flow has no informative effect on the spread.

$$S_t = \alpha + \beta_1 h_{t+1} + \mu NOF + \varepsilon_t \quad (6.6b)$$

Table 16 : model Estimation $S_t = \alpha + \beta_1 h_{t+1} + \mu NOF + \varepsilon_t$

	$	€
α	0.09 (2.3)	-0.008 (-0.2)
β_1	0.013 (2.24)	-0.04 (-0.86)
μ	0.0018 (1.08)	-0.000283 (-0.93)
R^2	0.37	0.29

VII-Conclusion

In this paper, we have investigated the effect of the empirical relationship between trading volumes, volatility, order flow and bid-ask spread of Tunisian private commercial bank.

This paper uses a data set that includes daily data spot on trading volumes, order flows and spread for the dollar and euro exchange rates of 2 January 2001 to 15 November 2002.

An important result is, The dollar exchange rate can confirm the microstructure hypothesis. In fact, we find a positive correlation between volatility and spread of dollar, as suggested by the inventory costs and the asymmetric information models. The MDH is verified for the relation between order flow and volatility for the two series. The order flow has a positive effect on volatility for the two series. Hence, this result supports the information of order on price volatility.

Unfortunately, the volume has no information content on volatility and spread. This independence illustrates the degree of Tunisian market illiquidity.

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