Time and dynamic Volume-Volatility Relation around Option Listing: Evidence from the French Underlying Stocks

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Abstract

We empirically investigate the impact of option listing on the underlying stock efficiency by looking at the volume-volatility relation of underlying stock. We use a time-consistent bivariate VAR (Vector Autoregressive Regression) model that includes time duration between trades. This model considers both the contemporaneous and the lagged relation between variables and is consistent with both theories of the informational flux and of the dispersions of beliefs. Besides, it is convenient framework to decompose volatility into two categories: informed and uninformed traders. We compare post-listing to pre-listing model results over a sample including 34 stocks for which options were listed between 1996 and 2006. Despite a significant rise of raw and diurnally adjusted price durations, we find evidence of a positive impact attributable to option listing on the underlying stock volume-volatility relation. This better adjustment to new information is observable jointly on contemporaneous and delayed relation. However, after decomposing volatility, we document no migration of informed traders to underlying stock market after option listing. The option effect seems to be not sufficient to attract informed traders into the underlying stock market. We conclude to the existence of option listing impact on the underlying stock efficiency, but to neutrality toward informed trading. We put forward four potential explanations for these findings.

Key words: Option listing, efficiency, price duration, Volume-volatility relation, Bivariate VAR model.

JEL classification : C12, C13, C41, C51, G14,

1. Introduction

The various impacts of option listing on the underlying stock, such as the effects on volatility and volume, have been at the core of a vast body of financial literature. Despite the importance of volume-volatility relation issues, as formally introduced by Karpoff (1987), the effect of option listing on this relation of underlying stock has received little research attention.

This is an alternative way to study the interrelation between option and underlying stock. The volume-volatility relation brings lights into the understanding of the adjustment process of prices to new information and therefore the contribution of option market to informational efficiency. This way needs to be investigated further.

There are two competing views in the theoretical literature about the role that option markets may play. One view posits that option listings contribute to informational efficiency by helping the market incorporate information into prices. This view is originated by an option market leading the underlying stock market as in Manaster and Rendelman (1982). Many arguments corroborate this idea. First, as Black (1975) and Figlewski and Webb (1993) suggest, the low transaction costs and high leverage achievable through options may attract informed investors. Chakravarty *et al* (2004) provide evidence that trading by these agents contributes to price discovery in the underlying stock market. Second, introducing derivative assets may increase incentives to collect information about asset payoffs, as suggested by Cao (1999). This increase in information collection makes the price of the underlying asset more informative. Third, the ability of options to complete the market has been demonstrated by theoretical works such as Arrow (1953) and Ross (1976). As pointed out by Diamond and Verrechia (1987) and Figlewski and Webb (1993), trading in options contributes to the informational efficiency of the stock market by reducing the effect of constraints on short sales. Since options market provides higher leverage, lower transaction costs and consequently attracts more informed investors, therefore options market may lead the stock market in information transmission process and the link between stock price volatility and stock trading volume may be reduced upon option listing.

The second view predicts less informative prices for optionable stocks. The main related argument is that the stock market leads the option market as according to Stephan and Whaley (1990). In the same way, Stein (1987) argues that the high leverage properties of options enable short term profit strategies. These potential profits may entice entry of speculative and less informed agents into the stock market, which may result in lower price efficiency. The model by Artus (1990) claims the same idea of a destabilizing effect of future markets. Consequently, options market may not lead the stock market in information transmission process, and the link between volume and volatility of underlying may be raised after option listing.

In the financial literature, volume-volatility relation is an important way to understand the information transmission process. Trading volume can be generally used to proxy for the rate of private information arrival. Therefore, price volatility is conjectured to be proportional to trading volume. Knowledge of the volume-volatility dynamic is fundamental for studying information transmission process, market efficiency and liquidity. Karpoff (1987) provides a good survey and explains the importance of the volume-volatility relation.

Early studies of option trading effects on the efficiency focused on underlying stock price process. For example, Jennings and Starks (1986) and Skinner (1990) studied the price response of optionable stocks to earnings announcements and find a positive impact. Damodaran and Lim (1991) use a model for price behaviour described in Amihud and Mendelson (1987) and find that the underlying stock price adjusts much more quickly after option listing on the CBOE market. These prior tests of the American markets support the positive effect of option trading on the underlying stock market efficiency[1]. On the other hand, more recent studies have not yielded a consensus result. Cao and Wei (2007) conclude to an improvement of informational efficiency upon option listing. Chakravarty *et al* (2004) study the effect on NYSE traded stocks of CBOE option listing using a modification of Hasbrouck's information share approach and estimate the option market's contribution to price discovery. They document to an important informational role attributable to options. However, on the same market and using a GARCH model, Mazouz (2004) finds no impact of option listing on the speed at which information is incorporated into stock prices.

For non US markets, Chamberlain *et al* (1993) and Gjerde and Saettem (1995) find no increase in the market efficiency attributable to option listing in the Canadian and Norwegian markets, respectively. Gjerde and Saettem (1995) use a model for price behaviour described in Amihud and Mendelson (1987). Their result is justified by the low trading volume on option markets and by the low number of traded stocks.

On the other hand, using a sample of 13 stocks, Sahlström (2001) on the Finland market concludes to an improvement of efficiency upon option listing. In fact, the author documents

[1] Mayhew (2001) gives a thorough list of empirical studies of effect of option listing on the American markets.

a positive return autocorrelation that lowers after option listing when compared to a benchmark sample and find a diminished relative spread. Similarly, Liu (2007) tests the random walk hypothesis over the Japanese underlying stocks return series and concludes to a higher efficiency after option listing.

There are very few studies of option listing effects on the French market. Ayachi (1998) examines the impact of option listing on volatility, volume and efficiency. The author uses the same model as in Damodaran and Lim (1991) and finds an improvement of the underlying stock efficiency. This result is, however, statistically strong only seven days after option listing.

There have been insightful previous studies of the effects of option listing on underlying stock efficiency but there are very few studies attempt to measure the change in underlying stock volume-volatility relation that option listing may induce. If volume-volatility relation is documented on derivative markets, research doesn't focus on underlying market. Some authors, such as Faff and Hillier (2005) and Chen and Chang (2008), only mention it as a potential feature to be tested. Poon (1994) is one rare example of existing studies of volume-volatility relation in the underlying stock market. This study on the CBOE market uses a time deformation market model and finds a decline in the link between daily stock volatility and volume upon option listing which is consistent with the theory that option listings contribute to informational efficiency.

We fill this gap in the literature and focus on the effects of option listing on the underlying stock volume-volatility relation. Our analysis is different from prior research interested in this issue in two important ways. First, we investigate the effect of option listing on the underlying stock by measuring changes in volume-volatility relation. Second, we allow for price duration while studying volume-volatility relation. Indeed, the time interval between two consecutive trades, i.e. price duration, has an informational role. In Glosten and Milgrom (1985) model, price duration reflects the delayed response of the market to an information event. Diamond and Verrechia (1987) associate long duration between transactions with bad news, whereas according to Easley and O'Hara (1992), a long duration is interpreted as the absence of new information and small duration (i.e., higher trading intensity) is associated to a high volatility. Dufour and Engle (2000), provide that the higher intensity of trading is associated to the higher informational content in trades. It comes that the time duration between trades depends on the price process. As in Engle and Russel (1998) autoregressive conditional duration (ACD) model, the time until prices change can be interpreted as the rate at which information is released and the rate at which the market incorporates this information into prices. Therefore, changes in price duration following the listing of options may provide insights about the importance of options for the allocation of information in financial markets.

We use intraday irregularly spaced transaction data from the French stock market Euronext.Liffe around new option listing that occurred over the period 1996 – 2006.

In order to assess the option listing effect on the underlying stock volume-volatility relation, we use a time-consistent bivariate VAR (Vector Autoregressive Regression) model as developed by Xu *et al* (2006) with the price duration as the time between price changes. This model considers both the contemporaneous and the lagged relation between variables which is consistent with the theory of the heterogeneity of beliefs and is related to the informational flux theory.

We use the absolute value of midquote price changes to measure volatility and the trade size to quantify the volume. These two variables are normalized by the time duration between trades and diurnally adjusted. We compare post; listing to pre; listing model results over a sample including 34 French stocks for which options were listed between 1996 and 2006 and then, we decompose the volatility into two components: informed and uninformed traders.

Our main results show a significant rise in underlying stock price duration after option listing meaning that informative trades become less frequent. Despite this finding, we do not document a deterioration of the underlying stock efficiency. The results of VAR model comparison show no shift in the link between stock price volatility and stock trading volume upon option listing. We interpret these findings as being consistent with the volatility-driven strategies suggested by Capelle-Blancard (2003) and Foucault *et al.* (2007).

The rest of the paper is organised as follows. Section 2 presents the model and the key hypotheses. Section 3 describes data and methodology, while section 4 contains the empirical results. The conclusions are in section 5.

2. Model and key hypotheses

Our goal is to investigate the impact of option listing on the underlying stock efficiency by studying its effect on the underlying stock volume-volatility relation.

The volume-volatility relation is an important way to understand the information transmission process and market efficiency. So, Easley and O'hara (1987), show that volume has a useful informational content about future price. Blume *et al* (1994) document that the information content of volume is different from the informational content of price and therefore the related information volume is interesting for the price dynamic. Chordia and Swaminathan (2000) find that trading volume is a key factor in the cross-autocorrelation of stock returns. They explain this finding by the response power of volume to market wide information.

Empirical studies generally use trading volume to proxy the rate of private information arrival and to measure the speed of price adjustment to new information. Therefore, price volatility is conjectured to be proportional to trading volume.

The financial literature has been studied volume-volatility relation with various methods and the most empirical research documents a positive correlation between these two variables considering the absolute price change or the squared price change as a measure of volatility[2]. However, after decomposing volume into informed and liquidity components, Li and Wu (2006) find a negative correlation between volume and liquidity traders driven volatility. They attribute this result to the nature of information flow. Actually, volume-volatility relation depends on the expected value of the asset. In the one hand, the informed trading has a permanent effect resulting in a change in the expected value, and in the other hand, liquidity trading effect is transitory and does not affect it. Thus, the volume-volatility relation is negative when it is driven by the liquidity trader.

Two main theories explain the relation between volume and volatility. The first one is the informational flux which predicts that volume and volatility are jointly determined and that information governs the relation between the two variables. Clark (1973) is among the early researchers whose supports this theory supposing the mixture distribution hypothesis (MDH) to document a correlation between volume and volatility. Tauchen and Pitts (1983), Lamoureux and lastrapes (1990), Andersen (1996), Fleming et al (2006) extend the same way. However, this class of models doesn't consider the dispersion of beliefs. The theory related to the heterogeneity of beliefs which explains the abnormal volume associated to higher volatility seeks to remedy this limitation. Therefore, Copeland (1976), Epps & Epps (1976), Shalen (1993), Daigler & Wiley (1999), develop a Sequential information model (SIM) and suppose the lagged relation between variables.

In this paper, we use a time-consistent bivarite model as developed by Xu et al (2006) to assess the short- run option effect on the volume-volatility relation of underlying stocks. Xu

[2] Karpoff (1987) gives a good survey in this area

et al (2006) demonstrate that time-consistent bivarite VAR model is better than models based on the mixture distribution hypothesis (MDH) which takes into account only contemporaneous relation. The time-consistent bivarite VAR model considers both the contemporaneous and the lagged relation between variables. Moreover, price duration is introduced into the model since it is a source of the information available consistent with microstructure theory. We define price duration as in Xu *et al* (2006), i.e. the time between two trades, with the condition that the second trade results in a mid-spread change. The trades that occur without a mid-spread change are discarded in order to ensure informative trades.

Therefore our bivarite VAR model is as follows:

$$Z_t = \sum_{i=1}^{5} a_i Z_{t-i} + h^Z Open_t V_t + \sum_{i=0}^{5} (c_i + d_i \tau_{t-i}) V_{t-i} + u_t \qquad (1)$$

$$V_t = \sum_{i=1}^{5} b_i Z_{t-i} + h^V Open_{t-1} V_{t-1} + \sum_{i=1}^{5} (f_i + g_i \tau_{t-i}) V_{t-i} + \varepsilon_t \qquad (2)$$

The first equation of the model specifies the volatility Z_t, as a mixing process and the second equation specifies the autoregressive volume V_t. The two equations are modelled simultaneously.

In this VAR model, we use the absolute value of midquote price changes $|r_t|$ at time t to measure volatility and the trade size v_t (in 1000 shares) at time t to quantify the volume. These two variables are normalized by the time duration x_t (in seconds) between trades t_{i-1} and t_i and expressed in logarithm. All variables are stationary[3].

Therefore, $Z_t = ln\ [|r_t|/x_t]$ is the log volatility per unit of time and $V_t = ln\ [v_t / x_t]$ is the log volume per unit of time

According to Engle (2000), volume and volatility normalized by the time duration between trades are more accurate measures in empirical microstructure models such that the information between trades is incorporated properly into the volume-volatility relation.

$\tau_{t-i} = \ln (x_t)$ is defined as the logarithm of unadjusted time duration x_t, with duration (x_t) being the time elapsed between two consecutive trades resulting in a mid-quote changes. This condition ensures informative durations. Trades are realized at times t_{i-1} and t_i, so duration is defined as $x_t = t_i - t_{i-1}$. The volume coefficients vary with τ_{t-i} in both volatility and volume equations.

[3] We conduct ADF test to all variables diurnally adjusted to study stationarity.

A dummy variable $Open_t$ is introduced in the model in order to account for differences in the volume-volatility relation at the market open. It equals 1 if transaction falls in the opening half-hour and zero, otherwise.

The model specified by the two equations above shows that volatility and volume are driven by two uncorrelated shocks, u_t is the shock linked to the uninformed investor and ε_t is the shock related to informed investor. Then, we decompose variance into two components: informed and uninformed.

Using this specification of the bivariate VAR model, we structure our empirical tests around the following hypotheses that derive from the literature we outline above.

Hypothesis 1. Option listing improves the informational efficiency of the underlying stock market.

If option listing has a positive effect on informational efficiency, the magnitude of coefficients related to volume-volatility relation, c and b should be smaller after option listing.

Hypothesis 1.a. There is a lagged adjustment to new information and option listing reduces the magnitude of this lagged adjustment.

If option listing reduces the magnitude lagged adjustment to new information, the lagged coefficients c and b should be significant and smaller after option listing.

Hypothesis 2. Option listing leads to an increase in the informational role of time between transactions.

If option listing leads to an increase in the informational role of time between transactions, since d and g measure the informational content of previous duration, these coefficients should be significant and smaller after option listing compared to their values before.

Hypothesis 3. Option listing increases the proportion of informed traders.

If option listing leads to an increase in the proportion of informed traders, the informed variance should be higher after option listing compared to its value before.

To deal with these hypotheses, we run the model defined in equations (1) and (2) on underlying stocks around first option listing. Our data and methodology are detailed in the next section.

3. Data

We obtain option listing dates from Euronext Paris, with an option listing date being the first option listing for a given underlying stock. The sample contains a total of 36 option listings from 1996 to 2006. We restrict the sample using the following criteria. First, the listing date must be available. Second, the underlying stock must trade at least once over a 180-day period before the option listing and over the same number of days after option listing. This precludes option listings for which information is not totally available and those coincident with stock listings. Our final sample includes option listings on 34 underlying stocks continuously traded on Euronext Paris. A list of the firms composing the sample is presented in the appendix.

Figure 1 is a histogram of the time distribution of option listing dates. A peeck is observed in 2001 with a maximum number of 12 listings. Nevertheless, option listings took place in all sample years except 2003. The dispersion of events over almost all the study period reduces the potential bias due to temporary market phenomenon such as extreme volatilities.

For each stock in the sample, we collect detailed information about each transaction occurring on the consolidated order book during regular trading hours. Our data includes transaction prices, bid and ask quote movements, the trade size v_t (in 1000 shares), and the time stamp, measured in seconds after midnight, reflecting the time at which the transaction occurred.

We restrict our sample to trades resulting in a mid-quote change. So, successive trades that are matched to the same bid and ask quotes are deleted. Thus, duration is defined as the time interval between trades resulting in a mid-quote change[4]. We compute durations for the underlying stocks sample over ten days before and ten days after first option listing.

As on the US markets, trading intensity on the French market is characterized by a seasonal effect over the trading day. Several empirical studies find high trade frequency after opening and prior to closing times[5]. The time-of-day functions for Renault stock over pre and post option listing periods are given in Figure 2. The functions exhibit shorter durations in the morning and in the end of the day and verify the inverted U shape. The corresponding functions of the other stocks display the same shape as for Renault. The shape is however not

[4] We also tried using a threshold to define mid-price change, but this rule led a too small data set that could not be exploited.

[5] For studies on the French market, see for example Hamon et Jacquillat (1992) and Aubier (2000)

as well clear for the volume and volatility functions. Over the pre-listing period, Figures 2.a and 2.b show a volume and a volatility functions close to the U shape that exhibit higher values in the morning and in the end of the day. Though, this feature is not verified over the post-listing period. These *a priori* observations suggest that the option listing seem to have a significant effect on the trading characteristics of the underlying stock.

As in Engle and Russel (1998), we assume that the daily seasonal factor $\phi(t_{i-1})$ can be approximated by a cubic spline. We set nodes on each hour except for the end of the day period where an additional node is set on the last half -hour. Since 2000, French markets have opened at 9:00 am whereas they opened at 10:00 am before that date. To account for this change in trading hours, we estimate the seasonal factor separately before and after the changing date using different cubic splines functions.

The durations, volume and volatility inferred into equation (1) and (2) are adjusted for the seasonal effect dividing each variable by the $\phi(t_{i-1})$.

We estimate coefficients of equation (1) and (2) for each underlying stock over two periods of ten days centred on the option listing date. In order to account for possible structural and macroeconomic changes we also divide the total period into two sub samples. The first sub-sample (S1) includes all option listings that occur before 2002. This date is not arbitrary and coincides with the implementation of a new trading system after the Euronext merger with the Liffe market. This first period is characterised with many crisis resulting in a higher volatility. The subsequent listings are in the second sub-sample (S2) and cover a period exhibiting a smaller volatility. Indeed, the mean annual volatility of the SBF250 index over this period is equal to 19.84% while it equals 14.91% in the rest of the period.

In order to assess the option listing impact on the volume-volatility relation of the underlying stock, we compare the means of model coefficients and volatility of informed (uninformed) over the post; option listing period to the means and volatility over the pre; option listing period. We check for statistical significance of the means differences using the Student t-statistic and the Wilcoxon non- parametric test.

Results for the full sample are presented in the next section.

4. Results and discussion

In this section, we first present an analysis of the price duration used in the VAR model. We then comment the volume-volatility relation and put forward the nature of this link on the underlying stock market. Finally, we present and discuss the impact of option listing on this relation.

4.1. Price duration analysis

As shown in Table 1, it takes in mean a 43.67 seconds between two successive trades in the pre listing period. This mean of raw duration increases to 45.51 seconds in the post listing period, and the difference is statistically significant at the 1% level. The standard deviation of price raw duration is also significantly higher after option listing. The minimum price duration is equal to one second while the maximum is 13, 345 seconds (3 hours, 42 minutes, and 25 seconds).

The diurnally adjusted duration has a mean of 1.01 before option listing, which rises to 1.03 in the post listing period. This change is statistically significant at the 1% level. As for raw duration, the Fisher test of equality of variances shows a significant increase in the diurnally adjusted duration variance after option listing.

These significant changes in the two first moments of the duration distribution are supportive of the idea that option listing induces a substantial modification in the rate at which trades occur. Actually, the time interval between trades is increased for a given stock once an option is listed on it. From this preliminary analysis, the option listing seems not to improve the informational efficiency of the underlying stock market as suggested by hypothesis 1. Furthermore, it seems to be a potential cause for a decline in efficiency of the underlying asset. This question is addressed in the following tests.

4.2. VAR model estimates and the volume-volatility relation

The mean parameters estimates for equation (1) over the total sample and the two sub samples (S1) and (S2) described previously are presented in Table 2, those for equation (2) in Table 3. The volatility decomposition into informed and uninformed variance is shown in Table 4.

As shown in equation (1) estimates, all the lagged coefficients *a*, are positive and highly significant at 1% level. Therefore, there is a positive correlation between volatility and its lagged value over the two periods. This result reveals the persistence of volatility when volume is accounted for.

The same equation related to volatility shows a highly significant negative contemporaneous relation between volume and volatility over the two periods. The mean (median) coefficient of contemporaneous volume (c_0) is equal to -0,06 (-0,07) over the pre option listing and to -0,04 (-0,06) over the post option listing period. The five lagged coefficients of volume are positive and significant over the two periods. These results confirm the existence of a relation between volatility and contemporaneous as well as lagged volume. It appears that volume moves prices and that the response of price to volume shock continues to occur with delay.

The mean of current interaction d_0 between volume-volatility relation and time duration is positive and highly significant over the two periods. Further, all lagged coefficients d are negatives and significant. This signifies that the magnitude of negative contemporaneous relation between volume and volatility is increased when duration is shorter. The mean of all lagged interaction d variables between volume and time duration is negative and highly significant over the two periods. This indicates that the positive relation between volume and volatility is higher when the duration is shorter. Our findings highlight the importance of time between transactions in the volume-volatility dynamic and point up that shorter duration is associated with a high volatility effect.

The equation (2) related to volume process estimates show positive and significant lagged volume and volatility coefficients b_1 and b_4. These findings suggest a lagged adjustment to new information, i.e. the new information is incorporated with delay into the price. In addition, the volume process exhibits a positive and significant autocorrelation; all the f coefficients are positive and significant.

The g parameters represent the link between the diurnally adjusted duration and the volume coefficients. They capture the persistent effect of the previous duration on the current volume. The relationship is statistically negative for g_1 and g_5 over the two periods denoting an effect on volume of these lagged durations.

Dummy variables $Open_t$ are introduced in the two equations of the model in order to account for volume-volatility relation differences at the market open. However, both of coefficients h^z and h^v are not significant neither in the pre nor in the post option listing. This result is predictable since data are deseasonalised and filtered for the intraday patterns.

Our results show a highly significant negative contemporaneous relation between volume and volatility and a highly significant positive lagged relation for the 5 lags. The negative relation between volume and volatility is in line with the results of Liu and Wu (2006) who explain it by uninformed trading effect. The volatility decomposition in Table 4 confirms the role attributed to uninformed trading effect in explaining the negative volume-volatility relation. Uninformed variance is equal to 85.62% in the pre listing period and to 84.31% after.

These results prove that the new information is incorporated with delay in the price. This finding is consistent with both theories of the informational flux and of the dispersions of beliefs. They are in line with the findings of Chen *et al* (2001) in the French market, Xu *et al* (2006), Chang *et al* (2009) but don't confirm the results of Rogalski (1978), Clark(1973), Andersen(1996).

Moreover, volume-volatility relation and time duration is highly and significantly correlated. Our results show that duration between two consecutives trades plays an important role in volume-volatility dynamic and contains information: small duration is associated to a high volatility which is consistent with Easley and O'hara (1992), Dufour and Engle (2000). In Easley and O'Hara (1992), a long duration is interpreted as the absence of new information and a small duration (i.e., higher trading intensity) is associated to a high volatility. Dufour and Engle (2000) stipulate that a higher trading intensity is associated to a higher informational content in trades.

4.3. VAR model estimates and the effect of option listing on the volume-volatility relation

When VAR model results are compared over the periods surrounding option listing, the Wilcoxon test shows significant decrease in the magnitude of coefficients c_0 and c_4 at the 10% level. Actually, c_0 (c_4) is equal to -0.06 (0.036) before option listing and to -0.04 (0.033) after. This drop in the magnitude of these coefficients indicates that volume adjusts more quickly to volatility after option listing which is consistent with a positive effect on the volume-volatility relation attributable to option listing as conjectured in hypothesis 1. In addition, the existence of a better delayed adjustment to new information corroborates hypothesis 1.a, though the change is significant only at the 10% level.

On the other hand, d_0 takes 0.068 in the pre option period and is reduced to 0.065 in the post period. The Wilcoxon test shows that this coefficient decreases significantly at the 10% level. Since this coefficient measures the information content of previous duration, its decrease indicates an increase in the informational role of time between trades. Consequently, the option listing reduces duration between transactions and induces more information. This partially confirms hypothesis 2.

The volatility decomposition in Table 4 shows that informed variance is not different over the two periods. Both tests, Student and Wilcoxon, accept the equality hypotheses. Thus, we find no evidence of a migration of informed traders to the underlying stock market after option listing as conjectured in hypothesis 3.

Despite the negative impact on price duration documented formerly, the VAR model results support the idea of a positive impact of option listing on the underlying stock volume-volatility relation. This better adjustment to new information is observable jointly on contemporaneous and delayed relation. Further, the volatility decomposition is not found to be different after option listing. Thus, we document no migration of informed traders to underlying stock market after option listing. The option effect seems to be not sufficient to attract informed traders into the underlying stock market.

The contemporaneous and lagged declines of c_0 as well as the drop of d_0 are confirmed in sub sample (S1) but not in (S2). The sub sample (S2) doesn't show any significant effect. These results shed more lights to the comprehension of the total sample coefficients declines since they can be attributed to the stocks of the first more volatile period 1996-2002.

5. Conclusion

We empirically investigate the impact of option listing on the underlying stock volume-volatility relation. We use a bivarite VAR model which accounts for time duration between transactions as in Xu, et al (2006). We find evidence of no significant changes in the post-listing period.

We find evidence of a highly significant negative contemporaneous relation between volume and volatility and a highly significant positive lagged relation for the 5 lags. We link this negative relation to the uninformed trading effect after decomposing volatility into informed and uninformed components. The delayed in new information incorporation into prices is consistent with both theories of the informational flux and of the dispersions of beliefs.

Our results support the idea of a positive impact of option listing on the underlying stock volume-volatility relation. This better adjustment to new information is observable jointly on contemporaneous and delayed relation. However, after decomposing volatility, we document no migration of informed traders to underlying stock market after option listing. The option effect seems to be not sufficient to attract informed traders into the underlying stock market.

We conclude to the existence of option listing impact on the underlying stock efficiency, but to neutrality toward informed trading. This neutral effect of option was first documented by Chamberlain et al (1993) for the Canadian market, Gjerde and Saettem (1995) for the Norwegian market and Mazouz (2004) for the CBOE. However, both of our findings and these are not in line with those of Jennings and Starks (1986), Damodaran and Lim (1991), Poon (1994) and Chakravarty et al (2004) for NYSE stocks listed on the CBOE, of Liu (2007) for the Tokyo market and Sahlström (2001) for the Finland market. Our results are particularly contrary to the findings of Ayachi (1998) for the French market.

Several factors may explain our findings. First, we use a methodology which is different from previous studies as we focus on the underlying stock volume-volatility process. Second, the French stock market trading system is in its major part an order book system. Some authors, for example Gresse (2001), put forward that order driven markets better disseminate information compared to price driven ones. Thus, the likely option listing positive impact may be hardly noticeable in those markets. Third, the option market may not attract informed traders and therefore not lead to efficiency in the improvements underlying stock market. In theory options markets provide a high leverage and low transaction costs that's why it can be the favourite place where the informed participant can operate. When options allow participants to trade and make profits from private information, they lead the underlying stock market and help in disseminate information. As suggested by Fleming et al (1996), the low transaction costs, combined with high trading volume, in the US market enhance the price discovery process. Nevertheless, in an empirical study of index options, Capelle-Blancard and Vandelnoite (2002) suggested that the French option market (Monep) is not the leading market for information transmission. The authors conclude that the cash market leads the option market. This situation occurs when the market is not liquid enough and when the transactions costs in the options markets are not lower than in the cash market. Finally, option trading may attract a large set of operators and not necessarily the informed ones. For instance, Ayachi (1996) in a study of variance decomposition only attributes 19% to private information in the explanation of underlying stock price volatility. Indeed, Capelle-Blancard (2003) develops a theoretical model suggesting that the option market is dominated by underlying stock's volatility driven trading. These specific strategies disturb the connection between option and underlying stock markets and trim down the informativeness and the predictive power of option prices. Besides, Foucault *et al.* (2007) present a model in which limit order traders possess volatility information. Further, in their empirical investigation, they discover that the Euronext Paris limit order book contains information about future volatility. These findings may rationalize our results of a neutral effect of the option listing on the underlying stock efficiency.

Figure 1. Time distribution histogram of option listings

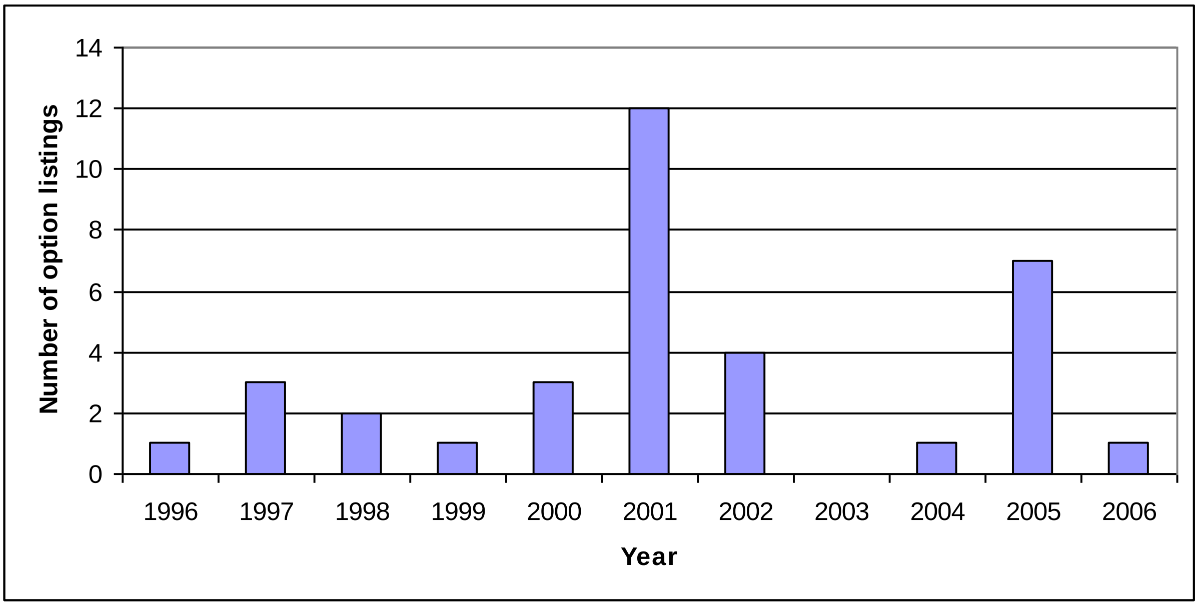

Figure 2.

Time-of-day Functions for Renault Price Duration, Volume and Volatility

PRE-OPTION LISTING PERIOD POST-OPTION LISTING PERIOD

Figure 2.a. Time-of-day Functions for Price Duration

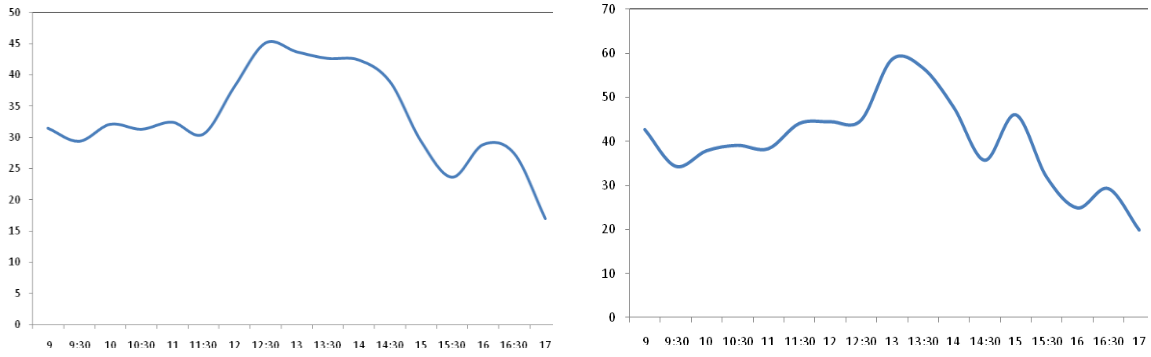

Figure 2.b. Time-of-day Functions for Price Volume (trade size)

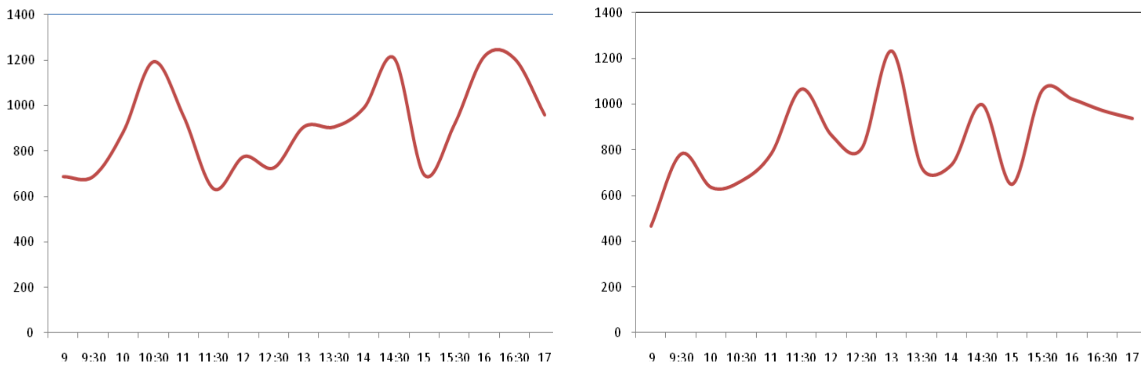

Figure 2.c. Time-of-day Functions for Price Volatility

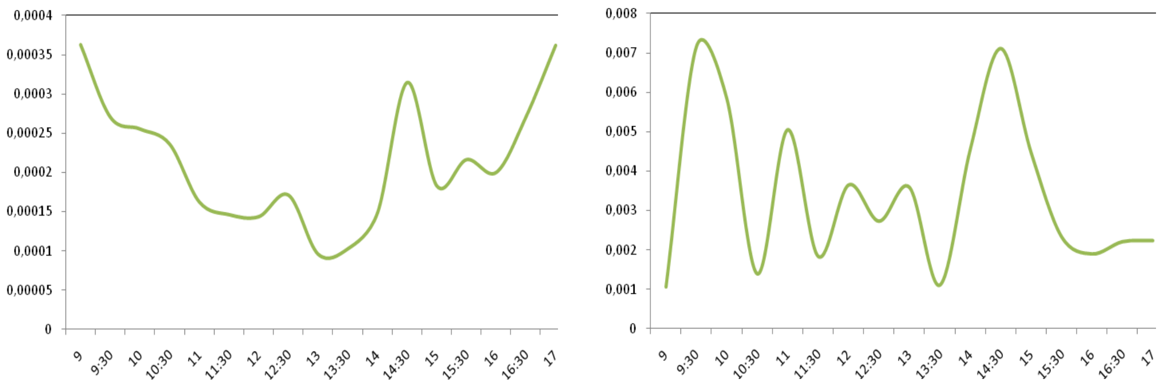

Table 1.
Raw Duration and Diurnally Adjusted Duration: Descriptive Statistics

This table gives descriptive statistics of raw and diurnally adjusted duration. We adjust duration using the following cubic spline function:

$$\phi(t_{i-1}) = \sum_{j=1}^{K} I_j \left[c_j + d_{1,j}(t_{i-1} - k_{j-1}) + d_{2,j}(t_{i-1} - k_{j-1})^2 + d_{3,j}(t_{i-1} - k_{j-1})^3 \right]$$

Where I_j is the indicator variable for the *j*th segment of the spline $\{I_j = 1 \text{ if } k_{j-1} \le t_{i-1} \le k_j, = 0$ otherwise$\}$.
The total sample includes 31 option listings on Euronext Paris from 1996 to 2006.

Period	**Raw duration (in seconds)**				
	Mean	**Median**	**Std dev**	**Max**	**Min**
Pre listing	43.67	13	132.40	10888	1
Post listing	45.51	13	142.82	13345	1
	Test of equality of means		**Test of equality of variances**		
	t-test	p-value	F-test	p-value	
	3.507921	0.000452	1.163641	0.000000	
	Diurnally adjusted duration (in seconds)				
	Mean	**Median**	**Std dev**	**Max**	**Min**
Pre listing	1.01	0.53	1.38	98.14	-33.33
Post listing	1.03	0.54	1.90	211.33	-246.80
	Test of equality of means		**Test of equality of variances**		
	t-test	p-value	F-test	p-value	
	3.483254	0.000495	1.885659	0.000000	

Table 2. Bivariate VAR model estimation and parameters comparison: Equation (1)

This table gives the mean, median and mean t ratio of estimation results of bivariate VAR model equation (1):

$$Z_t = \sum_{i=1}^{5} a_i Z_{t-i} + h^Z Open_t V_t + \sum_{i=0}^{5} (c_i + d_i \tau_{t-i}) V_{t-i} + u_t$$

Where $Z_t = \ln [|r_t|/x_t]$ is the log volatility per unit of time and $V_t = \ln [v_t / x_t]$ is the log volume per unit of time, with $|r_t|$ being the absolute value of midquote price changes and v_t the trade size (in 1000 shares) at time t. $\tau_{t-i} = \ln (x_t)$ is the logarithm of unadjusted time duration x_t, with duration (x_t) being the time elapsed between two consecutive trades resulting in a mid-quote changes. All these variables are diurnally adjusted. $Open_t$ is dummy variable equal 1 if transaction falls in the opening half-hour and zero, otherwise. u_t is the shock linked to the uninformed investor.The total sample includes 31 option listings on Euronext Paris from 1996 to 2006. The subsample S1 contains all option listings that occur before Euronext-Liffe merger in 2002 and subsample S2 all subsequent option listings. *, **, *** indicates significance at the 10%, 5% and 1% levels, respectively.

Table 2.a: Total sample

	Pre option listing			**Post option listing**			**Mean comparison tests p-value**	
	Mean	Median	Mean t. ratio	Mean	Median	Mean t. ratio.	t- Statistic	Wilcoxon
a_1	0,28***	0,28	15,34	0,26***	0,27	14,60	0,27	0,24
a_2	0,12***	0,13	6,27	0,12***	0,14	6,65	0,69	0,84
a_3	0,14***	0,14	7,71	0,14***	0,14	7,43	0,74	0,61
a_4	0,12***	0,12	6,43	0,11***	0,13	6,17	0,48	0,7
a_5	0,14***	0,15	7,92	0,14***	0,15	7,95	0,68	0,98
h^z	-0,002	-0,004	-0,47	-0,008	-0,004	-0,84	0,35	0,51
c_0	-0,06***	-0,07	-7,71	-0,04***	-0,06	-6,88	0,32	0,06**
c_1	0,08***	0,07	5,98	0,08***	0,07	6,13	0,4	0,46
c_2	0,04***	0,04	3,87	0,05***	0,04	3,92	0,18	0,22
c_3	0,04***	0,04	3,78	0,04***	0,04	3,41	0,95	0,53
c_4	0,036***	0,038	3,23	0,033***	0,033	2,89	0,66	0,08**
c_5	0,04***	0,03	3,44	0,03***	0,03	3,02	0,14	0,48
d_0	0,068***	0,07	41,43	0,065***	0,07	39,92	0,49	0,08**
d_1	-0,02***	-0,02	-10,96	-0,02***	-0,02	-10,6	0,4	0,36
d_2	-0,01***	-0,01	-5,38	-0,01***	-0,01	-5,58	0,47	0,65
d_3	-0,01***	-0,01	-6,07	-0,01***	-0,01	-5,69	0,81	0,49
d_4	-0,01***	-0,01	-5,3	-0,01***	-0,01	-4,95	0,46	0,12
d_5	-0,01***	-0,01	-5,95	-0,01***	-0,01	-5,78	0,65	0,51

Table 2. Continued

Table 2.b: Subsample (S1)

	Pre option listing			**Post option listing**			**Mean comparison tests p-value**	
	Mean	Median	Mean t. ratio	Mean	Median	Mean t. ratio.	t- Statistic	Wilcoxon
a_1	0,3***	0,29	17,42	0,28***	0,28	16,64	0,48	0,68
a_2	0,10***	0,13	6,54	0,14***	0,14	7,36	0,06**	0,21
a_3	0,15***	0,14	8,64	0,14***	0,14	8,09	0,3	0,35
a_4	0,12***	0,12	6,9	0,12***	0,13	6,71	0,64	0,82
a_5	0,14***	0,16	8,75	0,14***	0,14	8,41	0,52	0,47
h^z	0,001	-0,003	-0,34	-0,005	-0,003	-0,78	0,3	0,73
c_0	-0,09***	-0,09	-8,89	-0,06***	-0,07	-7,24	0,2	0,04**
c_1	0,08***	0,07	6,17	0,08***	0,07	6,22	0,59	0,39
c_2	0,04***	0,04	4,33	0,04***	0,04	4,09	0,56	0,88
c_3	0,04***	0,05	4,45	0,04***	0,04	3,69	0,72	0,43
c_4	0,03***	0,04	3,63	0,03***	0,03	3,44	0,47	0,23
c_5	0,05***	0,04	4,07	0,03***	0,03	3,15	0,04**	0,08*
d_0	0,07***	0,07	42,21	0,06***	0,07	39,92	0,36	0,05*
d_1	-0,02***	-0,02	-11,41	-0,02***	-0,02	-11,12	0,73	0,73
d_2	-0,01***	-0,01	-5,59	-0,01***	-0,01	-5,88	0,41	0,65
d_3	-0,01***	-0,01	-6,72	-0,01***	-0,01	-5,89	0,25	0,1
d_4	-0,01***	-0,01	-5,67	-0,01***	-0,01	-5,36	0,42	0,29
d_5	-0,01***	-0,01	-6,52	-0,01***	-0,01	-5,74	0,13	0,17

Table 2. Continued

Table 2.c. Subsample (S2)

	Pre option listing			**Post option listing**			**Mean comparison tests p-value**	
	Mean	Median	Mean t. ratio	Mean	Median	Mean t. ratio.	t- Statistic	Wilcoxon
a_1	0,27***	0,28	12,38	0,25***	0,26	11,7	0,43	0,3
a_2	0,14***	0,13	5,88	0,11***	0,13	5,64	0,14	0,39
a_3	0,13***	0,14	6,38	0,14***	0,15	6,48	0,26	0,17
a_4	0,13***	0,14	5,76	0,12***	0,12	5,4	0,74	0,97
a_5	0,14***	0,14	6,73	0,17***	0,16	7,28	0,16	0,24
h^z	-0,007	-0,007	-0,68	-0,01	-0,01	-0,94	0,65	0,3
c_0	-0,05***	-0,06	-6,16	-0,05***	-0,06	-6,37	0,99	0,92
c_1	0,07***	0,07	5,72	0,07***	0,07	6,01	0,81	0,82
c_2	0,04***	0,04	3,2	0,05***	0,04	3,68	0,49	0,47
c_3	0,04***	0,03	2,83	0,03***	0,03	3,02	0,5	0,39
c_4	0,03***	0,02	2,65	0,03**	0,02	2,12	0,9	0,14
c_5	0,03**	0,03	2,53	0,03***	0,04	2,82	0,88	0,15
d_0	0,06***	0,06	40,32	0,06 ***	0,07	39,9	0,99	0,82
d_1	-0,02***	-0,02	-10,31	-0,02***	-0,02	-9,85	0,45	0,55
d_2	-0,01***	-0,01	-5,07	-0,01***	-0,01	-5,15	0,69	0,55
d_3	-0,01***	-0,01	-5,14	-0,01***	-0,01	-5,41	0,63	0,36
d_4	-0,01***	-0,01	-4,77	-0,009***	-0,01	-4,37	0,71	0,17
d_5	-0,01***	-0,01	-5,14	-0,01***	-0,01	-5,83	0,23	0,22

Table 3. Bivariate VAR model estimation and parameters comparison: Equation (2)

This table gives the mean, median and mean t ratio of estimation results of bivariate VAR model equation (2):

$$V_t = \sum_{i=1}^{5} b_i Z_{t-i} + h^V Open_{t-1} V_{t-1} + \sum_{i=1}^{5} (f_i + g_i \tau_{t-i}) V_{t-i} + \varepsilon_t$$

Where Z_t = ln [$|r_t|/x_t$] is the log volatility per unit of time and V_t = ln [v_t / x_t] is the log volume per unit of time, with $|r_t|$ being the absolute value of midquote price changes and v_t the trade size (in 1000 shares) at time t. τ_{t-i} = ln (x_t) is the logarithm of unadjusted time duration x_t, with duration (x_t) being the time elapsed between two consecutive trades resulting in a mid-quote changes. All these variables are diurnally adjusted. $Open_t$ is dummy variable equal 1 if transaction falls in the opening half-hour and zero, otherwise. ε_t is the shock related to informed investor.The total sample includes 31 option listings on Euronext Paris from 1996 to 2006. The subsample S1 contains all option listings that occur before Euronext-Liffe merger in 2002 and subsample S2 all subsequent option listings. *, **, *** indicates significance at the 10%, 5% and 1% levels, respectively.

Table 3.a. Total sample

	Pre option listing			**Post option listing**			**Mean comparison tests p-value**	
	Mean	Median	Mean t. ratio	Mean	Median	Mean t. ratio	t- Statistic	Wilcoxon
b_1	0,24***	0,22	3,43	0,22***	0,19	3,05	0,63	0,29
b_2	0,005	0,04	0,53	-0,03	0,03	0,29	0,53	0,88
b_3	0,11	0,10	1,45	0,14*	0,12	1,75	0,39	0,16
b_4	0,10	0,10	1,56	0,14*	0,13	1,86	0,21	0,12
b_5	0,19***	0,2	2,71	0,19***	0,17	2,63	0,71	0,61
h^V	0,01	0,003	0,2	-0,003	-0,005	-0,12	0,11	0,04**
f_1	0,19***	0,20	5,02	0,19***	0,19	5,09	0,89	0,95
f_2	0,06*	0,06	1,71	0,09**	0,07	2,04	0,2	0,59
f_3	0,1**	0,09	2,35	0,08**	0,07	2,34	0,27	0,27
f_4	0,08**	0,08	2,02	0,04	0,04	1,61	0,11	0,15
f_5	0,09**	0,06	1,96	0,09**	0,07	2,2	0,86	0,6
g_1	-0,02***	-0,02	-3,35	-0,02***	-0,02	-2,99	0,58	0,3
g_2	0,002	-0,0001	0,046	0,0008	-0,002	0,01	0,67	0,81
g_3	-0,01	-0,009	-1,2	-0,009	-0,009	-1,23	0,72	0,96
g_4	-0,009	-0,008	-1,17	-0,006	-0,005	-1,001	0,24	0,22
g_5	-0,01*	-0,01	-1,68	-0,01*	-0,012	-1,77	0,69	0,89

Table 3. Continued

Table 3.b. Subsample (S1)

	Pre option listing			**Post option listing**			**Mean comparison tests p-value**	
	Mean	Median	Mean t. ratio	Mean	Median	Mean t. ratio	t- Statistic	Wilcoxon
b_1	0,2***	0,2	3,36	0,14***	0,18	2,8	0,22	0,24
b_2	0,006	0,05	0,77	0,02	0,03	0,75	0,56	0,88
b_3	0,1	0,09	1,62	0,12*	0,12	1,93	0,55	0,41
b_4	0,12**	0,12	2,04	0,13**	0,11	2,13	0,73	0,5
b_5	0,17**	0,19	2,99	0,17***	0,16	2,86	0,92	0,88
h^v	-0,003	0,0002	-0,02	-0,001	-0,005	-0,13	0,86	0,06
f_1	0,20***	0,20	5,43	0,21***	0,19	5,74	0,67	0,88
f_2	0,58**	0,07	2,12	0,1**	0,06	2,38	0,18	0,82
f_3	0,12***	0,10	3,14	0,09***	0,07	2,74	0,08*	0,17
f_4	0,10*	0,09	2,59	0,06**	0,06	2,1	0,12	0,29
f_5	0,10**	0,07	2,48	0,12***	0,11	2,98	0,51	0,39
g_1	-0,02***	-0,02	-3,15	-0,01***	-0,02	-2,87	0,38	0,85
g_2	0,002	-0,0001	-0,05	-0,002	-0,002	-0,25	0,12	0,43
g_3	-0,01	-0,01	-1,57	-0,007	-0,009	-1,26	0,16	0,91
g_4	-0,01	-0,009	-1,55	-0,007	-0,007	-1,30	0,16	0,24
g_5	-0,01*	-0,01	-1,89	-0,01**	-0,01	-2,18	0,51	0,57

Table 3. Continued

Table 3.c. Subsample (S2)

	Pre option listing			**Post option listing**			**Mean comparison tests p-value**	
	Mean	Median	Mean t. ratio	Mean	Median	Mean t. ratio	t- Statistic	Wilcoxon
b_1	0,31***	0,25	3,53	0,34***	0,24	3,42	0,79	0,68
b_2	-0,01	0,006	0,18	-0,14	-0,006	-0,35	0,41	0,51
b_3	0,11	0,12	1,21	0,18	0,17	1,48	0,3	0,07*
b_4	0,08	0,07	0,93	0,17	0,13	1,48	0,19	0,12
b_5	0,24**	0,2	2,32	0,20**	0,21	2,28	0,43	0,33
h^v	0,03	0,005	0,57	-0,006	-0,004	-0,1	0,04	0,01
f_1	0,19***	0,20	4,44	0,17***	0,18	4,16	0,67	0,51
f_2	0,05	0,06	1,13	0,08	0,07	1,55	0,37	0,36
f_3	0,08	0,08	1,22	0,07*	0,07	1,76	0,6	0,68
f_4	0,07	0,07	1,21	0,03	0,03	0,9	0,33	0,3
f_5	0,06	0,05	1,21	0,04	0,06	1,08	0,5	0,55
g_1	-0,03***	-0,02	-3,62	-0,03***	-0,02	-3,17	0,81	0,39
g_2	0,004	0,002	0,18	0,006	$4{,}38.E^{-5}$	0,39	0,85	0,77
g_3	-0,009	-0,005	-0,66	-0,01	-0,01	-1,18	0,58	0,73
g_4	-0,007	-0,004	-0,63	-0,004	-0,004	-0,56	0,56	0,39
g_5	-0,01	-0,01	-1,39	-0,008	-0,01	-1,19	0,31	0,63

Table 4. Volatility Decomposition: Informed and Uninformed Variances.

This table gives the mean, median and standard deviation of volatility components, where I measures the informed variance (in %) and U the uninformed variance (in %). Student T and Wilcoxon tests are used to test the change in the amplitude of each component around option listing.

Table 4.a. Total sample

	Pre option listing			**Post option listing**			**Mean comparison tests p-value**	
	Mean	Median	St. dev	Mean	Median	St.dev	t- Statistic	Wilcoxon
I	14,37	13,7	0,06	15,68	12,5	0,1	0,54	0,2
U	85,62	86,29	0,06	84,31	87,49	0,1	0,54	0,2

Table 4.b. Subsample (S1)

	Pre option listing			**Post option listing**			**Mean comparison tests p-value**	
	Mean	Median	St. dev	Mean	Median	St.dev	t- Statistic	Wilcoxon
I	13,33	12,87	0,05	14,35	12,5	0,07	0,6	0,57
U	86,66	87,12	0,05	85,64	87,49	0,07	0,6	0,57

Table 4.c. Subsample (S2)

	Pre option listing			**Post option listing**			**Mean comparison tests p-value**	
	Mean	Median	St. dev	Mean	Median	St.dev	t- Statistic	Wilcoxon
I	15,86	16,38	0,08	17,57	12,35	0,13	0,7	0,27
U	84,13	83,61	0,08	82,42	87,64	0,13	0,7	0,27

Appendix

Sample composition

Stock number	Stock denomination		Stock number	Stock denomination
Stock 1	Air liquide		**Stock 19**	Veolia environnement
Stock 2	Alstom		**Stock 20**	Vivendi
Stock 3	Atos origin		**Stock 21**	Air France
Stock 4	Business objects		**Stock 22**	Alcan
Stock 5	Cap Gemini		**Stock 23**	Crédit agricole
Stock 6	Essilor International		**Stock 24**	CNP Assurances
Stock 7	Havas advertising		**Stock 25**	Clarins
Stock 8	Infogrames entertaiment		**Stock 26**	Faurecia
Stock 9	Publicis group		**Stock 27**	Hermes international
Stock 10	Renault		**Stock 28**	M6 Metropole television
Stock 11	Schneider		**Stock 29**	Vinci
Stock 12	Sodexho Alliance		**Stock 30**	Unibail
Stock 13	Technip-Coflexip		**Stock 31**	Safran SA
Stock 14	TF1		**Stock 32**	Scor
Stock 15	Thomson		**Stock 33**	Total
Stock 16	Valeo		**Stock 34**	Euronext NV
Stock 17	Dassault système			
Stock 18	Stmicroelectronics			

Source : Euronext.

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