Informed Trading around corporate event announcements: Stock versus Options

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1 Introduction

This research focuses on the type of security market which is the most conducive to price discovery and information incorporation prior to takeover announcements. The market chosen by the informed based trader will probably be the security market which provides the greatest benefit level. Consequently, the options market cannot be rejected of the choice of the investor because this market offers surely more leverage. Furthermore, according to Cao et al. (2000), the payoff of an option is truncated at the strike price and thus the leveraged offered comes with a specifically limited risk. And it seems that options are not redundant securities because in asymmetric information environment and with trading frictions, it is not possible to replicate an option with the underlying asset[1].

However, options are also generally associated with higher proportional transaction costs, less liquidity and trading in options may be more transparent due to lower volume levels[2]. Therefore, it seems to be an interesting empirical question to assess whether an informed trader will choose between trading in the security market or in the options markets. Nevertheless, without focusing on a particular information-revealing events, one cannot be sure whether the lead-lag activity link between the options and the stocks markets is simply due to transmitting speculative noise from one market to another. By focusing on market activity prior to corporate events announcements, we can assess the attractiveness of the informed trading for the different type of security market. Indeed, these operations are known to have a large positive stock price impact around the announcement data (see the classical reference of Jensen and Ruback, 1983). Trading before the announcement date can thus be very rewarding for the trader who has an important information.

In other words, our analysis will try to determine empirically which markets will be chosen by the informed trading for his price discovery activity. We begin our research by investigating option market activities through relevant variables like open interest, volume and implied volatility. For each of these variables, we have studied their evolution for calls and puts between two periods: a benchmark period and a pre-announcement period. Afterwards, we have refined our analysis by distinguishing the options across moneyness categories (out of the money OTM, at the money ATM and in the money ITM). The quality of the results leads us to develop a theoretical model inspired from the model proposed by Easley et al. (1998). It's a sequential trade microstructure model in which traders have

[1] Back (1993) proves this affirmation.

[2] See Cao et al.(2000).

the choice to transact between options and stock markets with risk neutral competitive market makers.

Results confirms our intuition that around business combination event, informed traders prefer to trade on option markets than on stock market. It could be an indication that option market carries more information than stock market. Moreover our analysis also shows that informed traders prefer to trade options offering the greater leverage, that is to say they buy OTM options and they sell ITM options. In the specific case we have examined, it also seems that ITM puts are preferred to OTM calls in case of good event.

The paper is organized as follows: section 2 presents the theoretical model. Section 3 presents our data. Section 4 focuses on the empirical results. These empirical results come, on the one hand, from our preliminary investigation (descriptive statistics) and on the other hand, from our model estimation. And finally, section 4 concludes.

2 The sequential model

In this section, we present a sequential trade microstructure model in which trade takes place in continuous time. The model is inspired from the model proposed by Easley et al. (1998) in which trader has the choice to transact in option or in stock markets with risk neutral competitive market makers.

In the model, there is an asset which could be traded on a security market S and options on that security which could be traded on an option call market C or on an option put market P. Trades arise from market buy and sell orders submitted by a large number of traders. A fraction of these traders is potentially informed.

Prior to the beginning of the trading day, nature determines whether an information event takes place. Information events are assumed to be independent across days and to occur with probability α. If no information event takes place the asset value is V^*. If an information event occurs, the asset value is $V^g > V^*$ with probability δ and $V^b < V^*$ with probability $1 - \delta$. The asset value is revealed at the end of the trading day.

There are two groups of traders. Uninformed traders neither know the asset value nor do they observe whether an information event occurred. They trade for liquidity reasons or for hedging reasons. Informed traders know whether an information event took place and observe the true asset value. Because the value change of the security will also affect the put and call option prices, the informed traders will have the choice of the venue to benefit from their information. If the value is high, they will choose between buying the asset, buying the corresponding call or selling the corresponding put. If the value is low, they will decide between selling the asset, selling the corresponding call or buying the corresponding put. They also will not trade when there was no information event.

Because we would like to prove that the informed trader will choose the venue in which he obtain the greatest benefit level, we decide to refine the sequential model, to allow the informed trader to choose between option of different moneyness. Indeed, if the value of the security is high and that the informed trader choose to buy a call, he will decide between buying a call OTM (out-of-the-money), buying a call ATM (at-the-money) or buying a call ITM (in-the-money). Inversely, if he decide to sell a put, he will choose between selling a put OTM, selling a put ATM or selling a put ITM.

If the informed trader is rational, he will decide to buy or sell the option of a particular moneyness which offers him the great leverage level. In particular, if he buys an option, he will theoretically decide to buy an OTM option, because its price is the smallest one and offers the greatest leverage. Inversely, if he decides to sell an option, he will choose to sell an ITM option, because he will receive the greatest premium.

On any day, arrivals of uninformed buyers and uninformed sellers are determined by independent Poisson processes. Uninformed buyers and uninformed sellers arrive at rate ϵ, defined per minute of the trading day. On days for which information events occur, informed traders also arrive at rate μ. All of these arrival processes are assumed to be independent. Among the informed trader arrivals, a proportion γ_i will choose to trade on the security market and will buy stock (B_S) or sell stock (S_S). And among the informed traders that have chosen to trade on the option markets, a proportion β_i will trade call options and $(1 - \beta_i)$ put options. Similarly, γ_u of the uninformed traders will trade on the security market and β_u of the remaining uninformed traders will trade call options.

The informed traders who decide to buy an option will choose the OTM category with probability $\omega_{i,b}$ (buy a OTM call -$B_{C,O}$- or a OTM put -$B_{P,O}$-), and if it is not their choice, they will choose the ATM category with probability $\lambda_{i,b}$ (buy a ATM call -$B_{C,A}$- or a ATM put -$B_{P,A}$-). In case of informed traders who decide to sell an option, they will trade the ITM category with probability $\omega_{i,s}$ (sell a ITM call -$S_{C,I}$- or a ITM put -$S_{P,I}$-). If it is not the case, they will choose to trade the ATM category with probability $\lambda_{i,s}$. Furthermore, the uninformed traders who choose the option markets, will trade the OTM category with probability ω_u. If they decide to not choose the OTM category, they will trade the ATM categroy with probability λ_u.

Thus by definition, $\omega_{i,b}$ will be the proportion of informed traders who have decided to buy the option which offers them the greatest leverage, the OTM category, if they have already decided to buy an option. And $\omega_{i,s}$ will be the proportion of informed traders who have decided to sell the option which offers them the greatest leverage, the ITM category, if they have already decided to sell an option.

The tree given in figure 1 describes the structure of the trading process. At the first node of the tree, nature selects whether an information event occurs. If an event occurs, nature then determines if it is a good news or bad news event. Nodes to the left of the dotted line occur once per day. Subsequent nodes reflect the trader selection probabilities and occurs throughout the trading day.

Easley et al. (1996) propose a method to estimate the model parameters $\Theta = \{\alpha, \delta, \epsilon, \mu, \gamma_i, \beta_i, \gamma_u, \beta_u\, \omega_{i,b}, \omega_{i,s}, \omega_u, \lambda_{i,b}, \lambda_{i,s}, \lambda_u\}$. Let denote $X_{A,B}$ with

- X designs the direction of the trade, B if it is a buy or S if it is a sell
- A designs the venue, S for the stock market, C for the call market and P for the put market
- B designs the moneyness category in case of option market, O for out-of-the-money, A for at-the-money and I for in-the-money.

Therefore, the likelihood of observing $\Omega = \{X_{A,B}\,|\,X = B, S\,;\, A = S, C, P\,;\, B = O, A, I\}$ on a good-event day of total time T is given by:

$$
\begin{aligned}
LI_g(\Omega) &= e^{-(\mu\gamma_i+\epsilon\gamma_u)T}\frac{\big[(\mu\gamma_i+\epsilon\gamma_u)T\big]^{B_S}}{B_S!}\times e^{-(\epsilon\gamma_u)T}\frac{\big[(\epsilon\gamma_u)T\big]^{S_S}}{S_S!} \\
&\times\ e^{-\left(\mu(1-\gamma_i)\beta_i\omega_{i,b}+\epsilon(1-\gamma_u)\beta_u\omega_u\right)T}\frac{\big[\big(\mu(1-\gamma_i)\beta_i\omega_{i,b}+\epsilon(1-\gamma_u)\beta_u\omega_u\big)T\big]^{B_{C,O}}}{B_{C,O}!} \\
&\times\ e^{-\left(\mu(1-\gamma_i)\beta_i(1-\omega_{i,b})\lambda_{i,b}+\epsilon(1-\gamma_u)\beta_u(1-\omega_u)\lambda_u\right)T} \\
&\times\ \frac{\big[\big(\mu(1-\gamma_i)\beta_i(1-\omega_{i,b})\lambda_{i,b}+\epsilon(1-\gamma_u)\beta_u(1-\omega_u)\lambda_u\big)T\big]^{B_{C,A}}}{B_{C,A}!} \\
&\times\ e^{-\left(\mu(1-\gamma_i)\beta_i(1-\omega_{i,b})(1-\lambda_{i,b})+\epsilon(1-\gamma_u)\beta_u(1-\omega_u)\lambda_u\right)T} \\
&\times\ \frac{\big[\big(\mu(1-\gamma_i)\beta_i(1-\omega_{i,b})(1-\lambda_{i,b})+\epsilon(1-\gamma_u)\beta_u(1-\omega_u)\lambda_u\big)T\big]^{B_{C,I}}}{B_{C,I}!} \\
&\times\ e^{-\left(\epsilon(1-\gamma_u)\beta_u\omega_u\right)T}\frac{\big[\big(\epsilon(1-\gamma_u)\beta_u\omega_u\big)T\big]^{S_{C,O}}}{S_{C,O}!} \\
&\times\ e^{-\left(\epsilon(1-\gamma_u)\beta_u(1-\omega_u)\lambda_u\right)T}\frac{\big[\big(\epsilon(1-\gamma_u)\beta_u(1-\omega_u)\lambda_u\big)T\big]^{S_{C,A}}}{S_{C,A}!} \\
&\times\ e^{-\left(\epsilon(1-\gamma_u)\beta_u(1-\omega_u)(1-\lambda_u)\right)T}\frac{\big[\big(\epsilon(1-\gamma_u)\beta_u(1-\omega_u)(1-\lambda_u)\big)T\big]^{S_{C,I}}}{S_{C,I}!} \\
&\times\ e^{-\left(\epsilon(1-\gamma_u)(1-\beta_u)\omega_u\right)T}\frac{\big[\big(\epsilon(1-\gamma_u)(1-\beta_u)\omega_u\big)T\big]^{B_{P,O}}}{B_{P,O}!} \\
&\times\ e^{-\left(\epsilon(1-\gamma_u)(1-\beta_u)(1-\omega_u)\lambda_u\right)T}\frac{\big[\big(\epsilon(1-\gamma_u)(1-\beta_u)(1-\omega_u)\lambda_u\big)T\big]^{B_{P,A}}}{B_{P,A}!} \\
&\times\ e^{-\left(\epsilon(1-\gamma_u)(1-\beta_u)(1-\omega_u)(1-\lambda_u)\right)T}\frac{\big[\big(\epsilon(1-\gamma_u)(1-\beta_u)(1-\omega_u)(1-\lambda_u)\big)T\big]^{B_{P,I}}}{B_{P,I}!} \\
&\times\ e^{-\left(\mu(1-\gamma_i)(1-\beta_i)(1-\omega_{i,s})(1-\lambda_{i,s})+\epsilon(1-\gamma_u)(1-\beta_u)\omega_u\right)T} \\
&\times\ \frac{\big[\big(\mu(1-\gamma_i)(1-\beta_i)(1-\omega_{i,s})(1-\lambda_{i,s})+\epsilon(1-\gamma_u)(1-\beta_u)\omega_u\big)T\big]^{S_{P,O}}}{S_{P,O}!} \\
&\times\ e^{-\left(\mu(1-\gamma_i)(1-\beta_i)(1-\omega_{i,s})\lambda_{i,s}+\epsilon(1-\gamma_u)(1-\beta_u)(1-\omega_u)\lambda_u\right)T} \\
&\times\ \frac{\big[\big(\mu(1-\gamma_i)(1-\beta_i)(1-\omega_{i,s})\lambda_{i,s}+\epsilon(1-\gamma_u)(1-\beta_u)(1-\omega_u)\lambda_u\big)T\big]^{S_{P,A}}}{S_{P,A}!} \\
&\times\ e^{-\left(\mu(1-\gamma_i)(1-\beta_i)\omega_{i,s}+\epsilon(1-\gamma_u)(1-\beta_u)(1-\omega_u)(1-\lambda_u)\right)T} \\
&\times\ \frac{\big[\big(\mu(1-\gamma_i)(1-\beta_i)\omega_{i,s}+\epsilon(1-\gamma_u)(1-\beta_u)(1-\omega_u)(1-\lambda_u)\big)T\big]^{S_{P,I}}}{S_{P,I}!} \qquad (1)
\end{aligned}
$$

We can compute similarly $LI_b(\Omega)$ and $LI_n(\Omega)$, respectively the likelihood of observing Ω on a bad event day and on a no-event day. The overall likelihood of observing Ω for a single trading day is:

$$L(\Omega|\Theta) = (1-\alpha) \times LI_n(\Omega) + \alpha\delta \times LI_g(\Omega) + \alpha(1-\delta) \times LI_b(\Omega) \qquad (2)$$

Since days are independent, across the I trading days the likelihood to maximize with regard to T is the following:

$$L(M|\Theta) = \prod_{i=1}^{I} L(\Omega_i|\Theta) \qquad (3)$$

Maximization of (3) with respect to the parameter vector Θ yields maximum likelihood estimates of the parameters of interest. This model allows us to use observable data on the number of buys and sells per day and per market to make inferences about unobservable information events and about the division of trades between informed and uninformed.

3 Data

Our sample consists only of one particular business combination selected from the database of the Directorate General for Competition (DGC), which is the European Commission's antitrust authority. The case studied is the acquisition of Paribas Belgium by the Bacob bank. We have decided to restrict our research to Paribas Belgium, because it's the target of the operation and many studies have shown that target firms display higher cumulative abnormal returns around the announcement date than bidder firms do. In order to determine the announcement date, two separate sources are checked: the financial press (*Les Echos and Financial Times*) and the archives of the European Commission's DGC[3].

Daily stock prices are obtained from Datastream, which is accessed at *Université de Lille 2*. For every day of the studied period, we use the Euronext database (BDM) to obtain intraday best quotes, orders and trade prices of the security. This database contains the reference information, all orders and trades for all securities traded on the "Premier Marché" and the "Second Marché" of Euronext Paris. The Euronext database provides also all trades and prices of the options traded on the MONEP (Marché des Options Négociables de Paris). For the firm, we have extracted intraday option and security data from 120 opening days before the announcement date to the day prior to it. We define the announcement date as date 0; the period from date -120 to -61 ([-120,-61]) is defined as the *benchmark*

[3]Much information is available on http://www.europa.eu.int/comm/competition, the official DGC web site.

period and the one from -30 to -1 ([-30,-1]) as the *pre-announcement period.* By convention, a call-option is said to be *at-the-money* (ATM) if its stock price divided by its strike price $(\frac{S}{K}) \in (0.95, 1.05)$, *out-of-money* (OTM) if $(\frac{S}{K}) \leq 0.95$ and *in-the-money* (ITM) if $(\frac{S}{K}) \geq 1.05$. Similar terminology is defined for puts by replacing $\frac{S}{K}$ by $\frac{K}{S}$.

For this study, we also need the number of transactions initiated by the buyers and the number of transactions initiated by the sellers for both options and stock markets. Since this information is not provided by the BDM Euronext intraday database, we must use an algorithm in order to classify each trade. For the security market, we use a method which corresponds partially to the technique developed by Lee and Ready (1990) to infer trade direction in a quote-driven market. Indeed, since the French market is an order-driven market, there is no designed market maker who has the obligation to provide liquidity. In such a context, limit order traders play a pivotal role in providing liquidity to the market. Therefore, in an order-driven market the spread corresponds to the difference between the best selling and buying limit orders. The BDM Euronext intraday database provides these limits for each trade. A transaction is classified as buyer (seller) initiated if its price is bigger (lesser) than the mid quote (average between the corresponding best selling and buying limit orders). For the option trades, since the BDM database does not provide these best limits, we need to use a simpler algorithm to classify trades. We use a modified "tick rule" method in which a trade is classified as buyer (seller) initiated if the current trade is followed by a trade with a higher (lower) price. [4]

Furthermore, we think that the size of each trade matters. Thus, when a stock trade is classified, we take the trade size. In case of option trades, we take the number of contracts negotiated times the size of the contract.

4 Empirical results

4.1 Pre-announcement activities

Our first task is to describe what happens across markets prior to takeover announcements. Table 1 presents some interesting descriptive statistics and the percentage changes in these statistics between both periods for three kinds of assets: calls, puts and stocks. The dramatic increase of the daily mean of put contracts (98.5%) and, most especially, of the capital negotiated (611.8%), strikes immediately. Price, open interest and implied

[4]The level of misclassification of this method is greater than the level of the Lee and Ready rule, but because the liquidity of the option market is low, this misclassification level is attenuated.

volatility show similar changes and seem to indicate that something very unusual is happening on the market: it could be a clue of informed trading. The evolution of the same descriptive statistics on the call market is less spectacular, though it displays an identical (but less significant) trend. If we compare the evolution of the volume between stock and options, we can notice that activity increases on the options market are much more pronounced than on the underlying stock market. Indeed, the percentage increase in capital negotiated is 84.9% for calls, 611.8% for puts and only 46.7% for the stock.

However, if the increase in volume loses some significance, the steep increase of open interest does not. 96.4% for puts, 87.8% for calls: such a change needs to be emphasized. Indeed, a variable like the open interest is much more robust and reliable than a variable like the volume (number of trades or number of contracts) in order to detect the possible presence of informed traders[5]. Concerning stocks, we can easily observe the increase (from -5% to 2%) of the cumulative abnormal return between the two periods [6].

At the stage of the analysis, we can already draw the following conclusions: puts seem more attractive to (informed) traders and appear to carry more information; the increase in volume seems globally at least as true for options as it does for stocks; options implied volatility increases (26.1% for calls and 19.2% for puts), which indicates that investors indeed pay a higher premium for options prior to takeovers; and open interest appears as the most interesting signal of a forthcoming event.

4.2 Which option contracts do traders prefer?

The preceding analysis was still quite rough. Our next step will thus be to deepen the analysis and to address a crucial question: which types of options do traders prefer? Therefore we introduce a supplementary discrimination between the options: the moneyness. We can now distinguish three kinds of options: OTM (out of the money), ITM (in the money) and ATM (at the money).

Which of them will choose an informed trader? A typical informed trader tries to maximize her expected returns and minimize her trading costs. As it is discussed in Easley et al. (1998), increasing the price of a call (even making the call out of the money) has the effect of increasing the leverage and hence the incentive for the informed to use that option.

[5]See further for explanation.

[6]Abnormal returns are obtained by using a simple market model.

Therefore, among option contracts informed traders should prefer those with high leverage and high liquidity. OTM options offer higher leverage but are generally less liquid (with higher relative bid-ask spreads) than ATM options. But, if the expected price movements are large, the leverage effect should tend to dominate the liquidity effect, making OTM options an informed trader's instrument of choice.

So theory tells us: in case of informed trading prior to takeover announcement, we should observe a large increase of the activity of OTM calls and ITM puts. Moreover, we also should observe a increase of ratio of the buyer-initiated transactions ("buys") to the seller-initiated transactions ("sells") for the OTM calls and a decline of the same ratio for the ITM puts. Indeed, a buyer will choose OTM options (because the prime is low) while a seller will choose ITM options (because the prime is high) and sometimes ATM ones because of their high time premium. Of course, it implies that the investor is nearly 100%- confident that the stock price is going to rise.

4.2.1 Implied volatility and option volume

In table 2 and 3, two variables deserve special attention: implied volatility and open interest. Among calls, implied volatility change is the largest for the OTM and the ATM (about 26.5%), while the largest change among puts is due to the ITM options (26.9%). All the volatility increases are significant according to the t-test. These increases in implied volatility suggest that investors pay a higher premium for call and put options during the pre-announcement period than during the benchmark period. This is particularly true for OTM and ATM calls and for ITM puts, which seem to be the most informative.

These results are very similar to those of Cao et al. (2000) who also observes more information content in OTM calls and ITM puts, though our data do not display the disequilibrium that he notices between (higher) calls-implied volatility and (lower) puts-implied volatility. On the contrary, it appears to us that trading on puts is at least as informative as trading on calls. Another divergence between our results and those of Cao et al. (2000) is the globally higher change we observe in implied volatility (around 25%) compared to the change observed by Cao et al. (2000) (between 4.8% and 17.8%). So we cannot conclude like them that "call option premiums go up more than their put option counterparts prior to takeovers".

Next, we examine the pattern of option volume change across moneyness categories. For calls, the greatest percentage increase in volume occurs with the ITM options. The number of OTM calls increases from 278 to 361, a 29.7% increase between the benchmark and the pre-announcement period. Yet, trading volume increases by 531.3% from 12 to 80 contracts for ITM calls. According to Cao et al. (2000), it is interesting to note that, although the increase in volume in percentage terms is the largest for ITM calls, the increase in number of contracts is the largest for OTM calls. One possible reason for ITM calls experiencing the highest percentage volume increase is that, as documented in the takeover literature and as shown in table 1, stock prices tend to increase significantly prior to takeover announcements. Consequently, relatively more calls become in-the-money during the pre-announcement period. If the options exchange does not introduce call options with higher strike prices soon following the stock price run-up, there will be fewer OTM calls remaining for investors to trade. Indeed, for some firms that experience large price run-up, we find fewer OTM calls available prior to takeover announcements. Thus, large stock-price run-ups tend to cause more calls to become ITM and more puts to become OTM during the pre-announcement period.

Unfortunately for Cao et al. (2000), our data do not support their point. Table 4 shows that the number of available OTM calls and ITM puts increases between the two periods, though the stock price significantly increases. In our case, the explanation for the large change in ITM call volume is maybe simply the very low number of contracts during the benchmark period (a small 5 in table 3). And for the puts, the dramatic increase in ITM put volume (2948%) clearly indicates an abnormal activity of traders.

Another feature of crucial importance is the open interest. Compared to the classic measure of volume (daily mean of the number of contracts), the open interest offers two decisive advantages. First of all, it is much less volatile than volumes, which hence gives more significant results. Secondly, while daily volume can be contaminated by transactions of "locals" and speculators who open a position in the morning and close it in the evening, the open interest is not affected by this kind of very short-term speculation and give us a much clearer idea of the presence on the market of real informed traders who keep a position during at least a few days and often more. Results here are impressive: OTM, ATM and ITM call open interests increase respectively by 307.2% (from 4503 to 18339), 2% (from 5925 to 6004) and -44.5% (from 3622 to 2009), while the OTM, ATM and ITM put open interests increase respectively by 50.9% (from 9952 to 15020), 126.5% (from 2375 to 5379) and 937.7% (from 452 to 4696) (all 5%-significant, except for the ATM calls). At our sense, the fact that investors suddenly take so many positions on OTM calls and ITM puts can only indicate the presence of informed traders expecting an increase of the stock price.

4.2.2 Buyer- versus seller-initiated option volume

In table 5, we present the daily average of buyer-initiated and seller-initiated option volume for both calls and puts of various moneyness combinations. For all calls, $B - S$ does not show any indication of informed trading, because it seems to remain pretty stable. However, if we look deeper at the data, we may observe that this difference increases for OTM calls but decreases for ITM and ATM calls, which is coherent with the thesis that informed traders choose OTM calls rather than ITM and ATM ones. For all puts, we can notice a 5%-significant decline of $B - S$. More interestingly, the same difference $B - S$ strongly decreases for ATM and ITM puts while it increases for OTM puts, which continues to support the main idea of this paper: informed traders expecting an increase of the stock price buy OTM calls and sell ITM puts.

Another interesting point is the evolution of the $B - S$ standard deviation. For almost all kinds of options (except the ATM call), this standard deviation increases, which surely indicates growing uncertainty among investors and beliefs about a forthcoming event. People become nervous: they buy, they sell, volumes and volatility dramatically increase which prevent to draw clear conclusions about the significance of the percentage change we observe, except for all puts and ITM puts where the percentage change of $B - S$ is 5%-significant.

4.3 The model

In this section, we estimate the model presented in section 2 for the two periods of interest, the benchmark period [-120,-61] and the pre-announcement period [-30,-1]. The estimates are obtained through the maximization of the likelihood function given in equation 3 and are reported in table 6.

First, we observe that the arrival rate of informed traders μ increases between the two periods, suggesting that traders informed about the business combination have traded prior to the announcement date. Indeed, Table 6 shows that μ increases from 0.137 to 0.282 arrivals per minute. This corresponds to an increase of 107% which is more important than the one observed for the arrival rate of uninformed traders ϵ (78%). The probability of having a good event δ also increases as supposed before the announcement of a business combination. What is more surprising is that the probability of having an event decreases slightly: α goes from 0.351 to 0.311.

We also observe an increasing proportion of informed traders who choose to trade on the option market, sign that this market could be very rewarding for traders who detain some information. Indeed, the proportion of informed traders choosing the option market $(1-\gamma_i)$ goes from 5.1% to 7.6%, so an increase of 50%. This result is reported on table 7. This increase is mostly due to the increasing proportion of informed trading on the put market, since $(1-\gamma_i)(1-\beta_i)$ shows an increase of 87% between the two periods, compared to an increase of 22% for the call market.

What is also interesting to note is that the proportion of informed buyers who choose to trade OTM options $(\omega_{i,b})$ strongly increases[7]. It reaches 97% of the informed buyers who choose the option markets, which supports what have been obtained in the previous section. The results for the informed sellers are also similar to the results of the previous section. We observe a large increase of informed traders selling ITM options. Nevertheless, among the informed sellers who choose the option markets, the proportion of informed traders selling ATM options remains important (53%).

The second part of table 7 provides also the distribution of informed traders who choose the option markets across moneyness categories. To compute these statistics, we have supposed that we lie on the good event branch of the tree, which is really the case because we investigate the behavior of the markets activity prior to business combination and it is known that this kind of event is value-creating. We can see an increase of 107% of OTM call buyers and an increase of 3843% of ITM put sellers, confirming again that the informed trader chooses the security which provides him the greatest leverage. By this way, if he is a buyer, he chooses OTM options and if he is seller he chooses ITM options. Nevertheless, the proportion of OTM call buyers is larger than the proportion of ITM put sellers because the proportion of ATM put sellers remains important, results already seen in the previous section.

4.4 Conclusion

We have analyzed pre-takeover-announcement trading in the options versus stock markets. Firstly, we have observed clear evidence of abnormal activity on both markets before the corporate event announcement day. Moreover, this abnormal activity turns out to be more intense in the options market. More interestingly, results seem to show that a variable like the open interest is of crucial importance in order to detect the presence informed

[7] This result is provide on the first part of the table 7.

trading. Indeed, it is a more robust and reliable variable than volume and its increase is 5%-significant for calls and puts.

The moneyness' favorite options also provide information about the pending event. When we distinguish options across moneyness categories, we notice that some interesting trends appear. The more the call (put) is OTM (ITM), the more its open interest and its implied volatility increase. This common relation (and correlation) between the open interest and the implied volatility is striking because it suggests that the open interest, like the implied volatility, carries a significant and valuable amount of information about future event occurrence. Furthermore, in table 5, we find with great interest that the difference |B-S| displays a similar pattern: the more the call (put) is OTM (ITM), the more its |B-S| increases. This variable delivers us another crucial information too: the direction of each trade (buyer or seller initiated). Knowing that informed traders expecting a good event are willing to buy OTM calls and sell ITM puts, we are glad to observe an important increase of OTM calls $B - S$ and a dramatic decrease of ITM puts $B - S$ (5%-significant), which confirms our above intuition of informed trading on the options market. Finally, the last interesting result to point out is the global increase of the volatility (measured by the standard deviation) of the differences $B - S$ of almost all options, which probably indicates growing uncertainty about the possibility of a decisive forthcoming event.

At the light of these impressive results, we have decided to build a sound theoretical framework inspired by Easley et al. (1998). It's a sequential trade microstructure model in which traders have the choice to transact between options and stock markets with risk neutral competitive market makers. Our estimates confirm our intuition that around business combination event, informed traders prefer to trade on option markets than on stock market. It could be an indication that option market carries more information than stock market. Indeed, the proportion of informed traders on options market has increased by 50%. Moreover our results also confirms that informed traders prefer to trade options offering the greater leverage, that is to say they buy OTM options and they sell ITM options, since the percentage of informed buyers who choose OTM options increases by a significant 69%, whereas the percentage of informed sellers who choose ITM options increases by an incredible 2003%. In the specific case we have examined, it also seems that ITM puts are preferred to OTM calls in case of good event: the proportion of informed traders who buy OTM calls increases by 107% while the proportion of informed traders who sell ITM puts increases a comfortable 3843%.

In the near future, we wish to extend our analysis to a full sample of firms (targets and bidders). By this way, we will be able to perform a cross-sectional relation. That will lead you to establish a possible trading rule to earn abnormal profit and to prove the reality of the information content of options market. This cross-sectional analysis will also gives us the opportunity to show the superiority of the variable ”open interest” on the variable ”volume” in order to detect informed trading. Up to now, we have implemented a modified tick rule to classify trades into buys and sells. We would like to use more robust techniques like Lee and Ready algorithm in order to achieve that. Theses techniques require very specific data, namely best limits of orders’ book, currently not available. Finally, for computational efficiency, we plan to develop a equivalent but simpler likelihood function (inspired from Easley et al. (2000)).

References

[1] K. Back. Assymmetric information and options. *Review of financial studies*, 6:435–472, 1993.

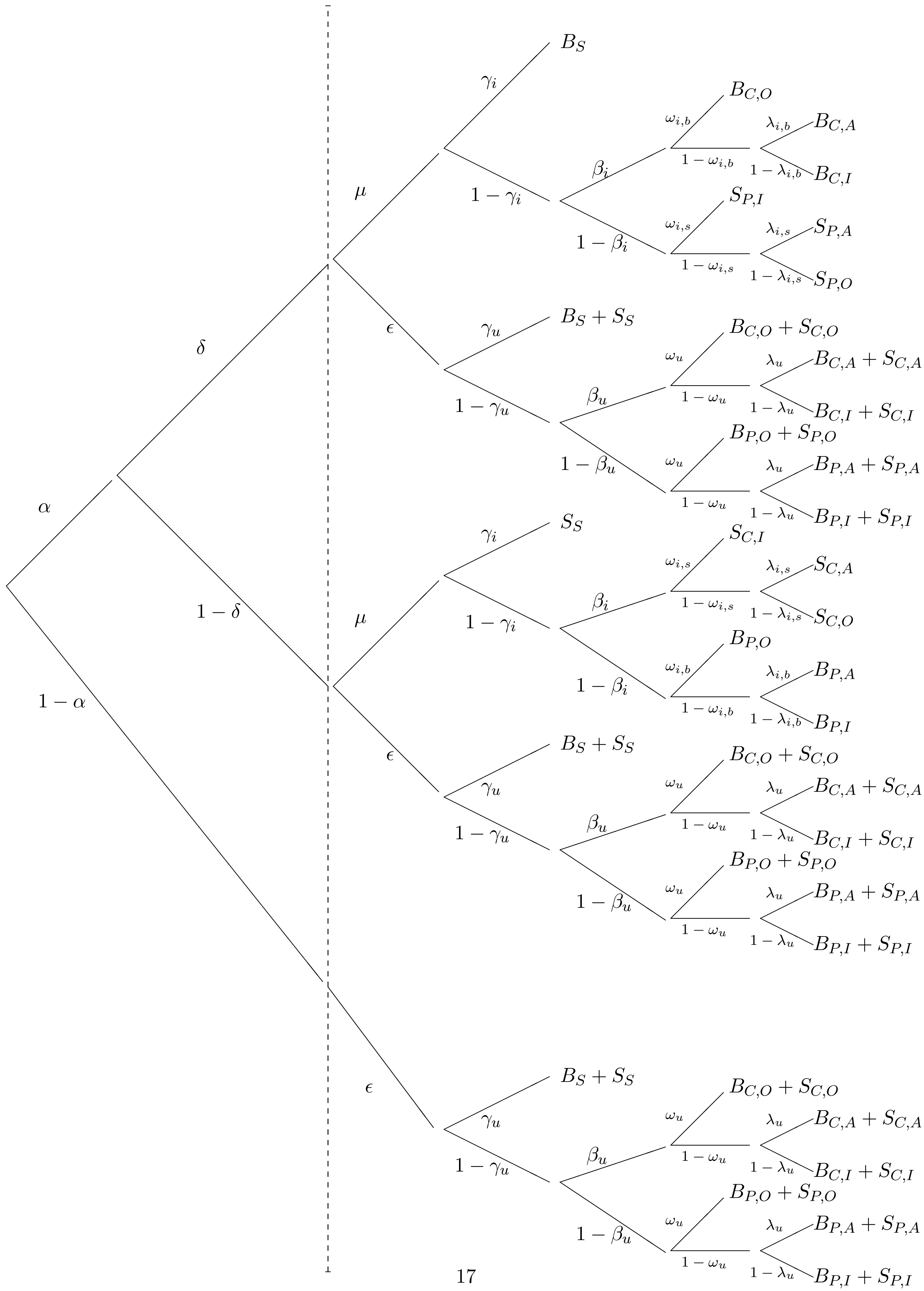
[2] C. Cao, Z. Chen, and J.M. Griffin. The informational content of option volume prior to takeovers. working paper, october 2000.

[3] D. Easley, N. Kiefer, M. O'Hara, and J. Paperman. Liquidity, information, and less-frequently traded stocks. *Journal of Finance*, 51:1405–1436, 1996.

[4] D. Easley, M. O'Hara, and P.S. Srinivas. Option volume and stock prices : Evidence on where informed traders trade. *Journal of Finance*, 53, 1998.

[5] D. Easley, M. O'Hara, and L. Wu. Time-varying arrival rates of informed and uninformed trades. 2001.

[6] M. Jensen and R. Ruback. The market for corporate control: The scientific evidence. *Journal of Financial Economics*, 11:5–50, 1983.


α
$1-\alpha$
δ
$1-\delta$
μ
ϵ
γ_i
$1-\gamma_i$
γ_u
$1-\gamma_u$
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$\omega_{i,b}$
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$\omega_{i,s}$
$1-\omega_{i,s}$
ω_u
$1-\omega_u$
$\lambda_{i,b}$
$1-\lambda_{i,b}$
$\lambda_{i,s}$
$1-\lambda_{i,s}$
λ_u
$1-\lambda_u$
B_S
$B_{C,O}$
$B_{C,A}$
$B_{C,I}$
$S_{P,I}$
$S_{P,A}$
$S_{P,O}$
$B_S + S_S$
$B_{C,O} + S_{C,O}$
$B_{C,A} + S_{C,A}$
$B_{C,I} + S_{C,I}$
$B_{P,O} + S_{P,O}$
$B_{P,A} + S_{P,A}$
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$S_{C,I}$
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$S_{C,O}$
$B_{P,O}$
$B_{P,A}$
$B_{P,I}$

Table 1: Descriptive Statistics for the different periods

The table reports the daily average volume, option price, open interest and implied volatility for calls and puts options. For the underlying stock, the daily average price, volume and the cumulative abnormal return are provided. For the options, the daily volume is measured either by the number of trades occurring per day or by the number of contracts traded every day or by the capital negotiated every day. These summary statistics are reported for the benchmark period [-120,-61] and for the pre-announcement period [-30,-1]. For each variable of interest, we test the null hypothesis of no difference in means between the two periods by using a t-test.

	Variable	[-120,-61]	[-30,-1]	% change
CALLS	No. of trades	15	19	29,2%
	No. of contracts	542	759	40 %
	Capital negotiated (in 10^3 FRF)	625	1156	84.9%*
	Price	12.88	13.61	5.6%
	Open Interest	14051	26392	87.8%**
	Implied Volatility	21.56	27.2	26.1%**
PUTS	No. of trades	5,2	6,5	23.2%
	No. of contracts	349	693	98.5%**
	Capital negotiated (in 10^3 FRF)	309	2203	611.8%**
	Price	11.84	18.15	53.3%**
	Open Interest	12780	25097	96.4%**
	Implied Volatility	22.33	26.62	19.2%**
STOCK	Price	365.9	378.2	3.3%**
	Volume (in 10^6 FRF)	341	640	46.7%**
	Cumulative Abnormal return	-5%	2%	

Table 2: Statistics for different periods across moneyness categories (1)

The table reports the daily open interest and implied volatility for both calls and puts options across moneyness categories (OTM, ATM or ITM). These summary statistics are reported for the benchmark period [-120,-61] and for the pre-announcement period [-30,-1]. For each variable of interest, we test the null hypothesis of no difference in means between the two periods by using a t-test.

	Moneyness	[-120,-61]	[-30,-1]	% change
		Open Interest		
CALLS	OTM	4503	18339	307.2%**
	ATM	5925	6004	2%
	ITM	3622	2009	-44.5%**
PUTS	OTM	9952	15020	50.9%**
	ATM	2375	5379	126.5%**
	ITM	452	4696	937.7%**
		Implied Volatility		
CALLS	OTM	21.9	27.7	26.4%**
	ATM	20.9	26.4	26.6%**
	ITM	23.6	28.3	19.8%**
PUTS	OTM	22.8	26.3	15.3%**
	ATM	21.7	26.7	23%**
	ITM	22.5	28.5	26.9%**

Table 3: Statistics for different periods across moneyness categories (2)

The table reports the daily number of contracts, capital negotiated and option price, for both calls and puts options across moneyness categories (OTM, ATM or ITM). These summary statistics are reported for the benchmark period [-120,-61] and for the pre-announcement period [-30,-1]. For each variable of interest, we test the null hypothesis of no difference in means between the two periods by using a t-test.

	Moneyness	[-120,-61]	[-30,-1]	% change
		Number of contracts		
CALLS	OTM	278	361	29.7%
	ATM	251	318	26.5%
	ITM	12	80	531.3%*
PUTS	OTM	220	388	76,2%
	ATM	123	142	15%
	ITM	5	163	2948%*
		Capital Negotiated (in 10^3 FRF)		
CALLS	OTM	214	310	44.7%
	ATM	361	601	66.2%
	ITM	49	245	393.6%*
PUTS	OTM	143	422	195.4%**
	ATM	149	492	229.3%*
	ITM	17	1289	7337.4%*
		Price		
CALLS	OTM	7.1	7.2	2.2%
	ATM	13.9	17.2	23.3%**
	ITM	38.1	39.6	4.1%
PUTS	OTM	6.3	10.6	68.5%**
	ATM	14	21.6	54%**
	ITM	37.7	53	40.5%**

Table 4: Evolution of the number of options across moneyness categories

The table reports the evolution of the number of contracts existing across the benchmark and the pre-announcement periods. This statistic is reported for both calls and puts options across moneyness categories.

		[-120,-61]	[-30,-1]	% change
CALLS	All	31	36	14.8%
	OTM	10	15	50.2%
	ATM	6	8	28.7%
	ITM	15	13	14.8%
PUTS	All	31	36	14.8%
	OTM	17	17	-1.3%
	ATM	6	8	28%
	ITM	8	11	38.5%

Table 5: Buyer-Initiated and Seller-Initiated Volume

The table reports the daily buyer-initiated and seller-initiated volume measured by the number of contracts traded per day for all stocks, and by the number of contracts times the size of the contract for calls and puts and across moneyness categories. These summary statistics are reported for the benchmark period [-120,-61] and for the pre-announcement period [-30,-1]. For each variable of interest, we test the null hypothesis of no difference in means between the two periods by using a t-test.

(in thousands)			[-120,-61]	[-30,-1]	% change
STOCKS	ALL	Buy	299.5	778.2	61.5%**
		Sell	635.2	898.0	29.3%*
		$B-S$	-335.7	-119.7	180.4%*
CALLS	ALL	Buy	28.9	39.6	37%
		Sell	23.7	34.6	46.2%
		$B-S$	5.2	5.0	-4.3%
PUTS	ALL	Buy	14.5	20.4	40.7%
		Sell	19.1	46.9	145.7%**
		$B-S$	-4.6	-26.5	-478.5%**
CALLS	OTM	Buy	15.5	21.7	39.8%
		Sell	11.5	13.3	15.9%
		$B-S$	4.1	8.4	107%
	ATM	Buy	12.6	14.2	12.7%
		Sell	11.7	17.1	46.5%
		$B-S$	1.0	-2.8	-388%
	ITM	Buy	0.7	3.6	406%*
		Sell	0.6	4.2	666%*
		$B-S$	0.2	-0.6	-471%
PUTS	OTM	Buy	8.0	18.1	127.2%*
		Sell	13.3	19.8	48.3%
		$B-S$	-5.4	-1.7	68.9%
	ATM	Buy	0.3	0.0	-90.8%
		Sell	0.2	15.6	7775%*
		$B-S$	0.1	-15.6	-28457%*
	ITM	Buy	6.3	2.3	-63.1%*
		Sell	5.6	11.6	107.1%
		$B-S$	0.7	-9.2	-1369%**

Table 6: Parameter estimates for the sequential model

The estimates are obtained through the maximization of the likelihood function given in equation 3. α is the probability of an event occurrence, δ the probability of a good event occurrence, μ the arrival rate of informed traders, ϵ the arrival rate of uninformed traders, γ_i the proportion of informed traders who trade on the security market, γ_u the proportion of uninformed traders who trade on the security market, β_i the proportion of informed traders operating on the option market who have decided to trade call options, β_u the proportion of uninformed traders operating on the option market who have decided to trade call options, $\omega_{i,b}$ the proportion of informed buyers who choose to trade OTM options, $\omega_{i,s}$ the proportion of informed sellers who choose to trade ITM options, ω_u the proportion of uninformed who choose to trade OTM options, $\lambda_{i,b}$ the proportion of informed buyers who choose to buy ATM options among those who have chosen not to trade OTM options, $\lambda_{i,s}$ the proportion of informed sellers who choose to sell ATM options among those who have chosen not to trade ITM options, λ_u the proportion of uninformed who choose to trade ATM options among those who have chosen not to trade OTM options.

	[-120,-61]	[-30,-1]	% change
α	0,351	0,311	-11%
δ	0,000	0,333	3E+32%
μ	0,137	0,282	107%
ϵ	0,076	0,135	78%
γ_i	0,949	0,924	-3%
γ_u	0,910	0,913	0%
β_i	0,571	0,464	-19%
β_u	0,626	0,508	-19%
$\omega_{i,b}$	0,574	0,973	69%
$\omega_{i,s}$	0,021	0,446	2003%
ω_u	0,633	0,568	-10%
$\lambda_{i,b}$	0,924	0,000	-100%
$\lambda_{i,s}$	0,932	0,963	3%
λ_u	0,981	0,685	-30%

Table 7: Which options ?

The estimates are obtained through the maximization of the likelihood function given in equation 3. The first part of the table provides the proportion of informed traders, among those who trade on the option markets, across moneyness categories. $\omega_{i,b}$ represents the proportion of informed buyers who choose to trade OTM options, $(1-\omega_{i,b})\lambda_{i,b}$ the proportion of informed buyers who choose to buy ATM options, $(1-\omega_{i,b})(1-\lambda_{i,b})$ the proportion of informed buyers who choose to buy ITM options. Similarly, $\omega_{i,s}$ represents the proportion of informed sellers who choose to trade ITM options, $(1-\omega_{i,s})\lambda_{i,s}$ the proportion of informed sellers who choose to buy ATM options, $(1-\omega_{i,s})(1-\lambda_{i,s})$ the proportion of informed sellers who choose to buy OTM options. The second part of the table provides firstly the distribution of informed traders between the different venues. γ_i represents the proportion of informed traders who choose the stock market, $1-\gamma_i$ the proportion who choose the option markets, $(1-\gamma_i)\beta_i$ the proportion who choose the call market and $(1-\gamma_i)(1-\beta_i)$ the proportion who choose the put market. Secondly, this second part provides the distribution of the informed traders choosing the option markets across moneyness categories and if we suppose that we are on the good event case. Let $\pi(B_{C,O})$ corresponds to the percentage of informed trader who buy a OTM calls. The other statistics are defined similarly.

	[-120,-61]	[-30,-1]	% change
$\omega_{i,b}$	57%	97%	69%
$(1-\omega_{i,b})\lambda_{i,b}$	39%	0%	-100%
$(1-\omega_{i,b})(1-\lambda_{i,b})$	3,2%	2,7%	-16%
$\omega_{i,s}$	2,1%	44%	2003%
$(1-\omega_{i,s})\lambda_{i,s}$	91%	53%	-42%
$(1-\omega_{i,s})(1-\lambda_{i,s})$	6,6%	2%	-69%
γ_i	94,9%	92,4%	-3%
$1-\gamma_i$	5,1%	7,6%	50%
$(1-\gamma_i)\beta_i$	2.9%	3.5%	22%
$(1-\gamma_i)(1-\beta_i)$	2.2%	4.1%	87%
$\pi(B_{C,O})$	1,7%	3,4%	107%
$\pi(B_{C,A})$	1,1%	0,0%	-100%
$\pi(B_{C,I})$	0,1%	0,1%	3%
$\pi(S_{P,I})$	0,1%	1,8%	3843%
$\pi(S_{P,A})$	2,0%	2,2%	10%
$\pi(S_{P,O})$	0,1%	0,1%	-42%