Takeover announcements and the components of the bid-ask spread *

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Abstract

The aim of this paper is to examine changes in information asymmetry around takeover announcements. Empirical studies generally find evidence of a significant reaction of stock prices, trading volumes or bid-ask spreads before the formal announcement date, but they do not consider separately the different components of the spreads, nor do they take into account the implications of the market microstructure on the reaction of traders to takeovers announcements. Using high frequency data, we investigate empirically the behavior of the components of 70 target firms bid-ask spreads around takeover announcements on the Paris Bourse between January 1995 and December 2000. We apply the Lin, Sanger and Booth (1995) method to estimate these components, i.e. adverse selection costs, order processing costs and an order persistence component. Our results confirm previous findings on French markets as we do not find evidence of the presence of informed traders before announcement dates. After the announcement, results suggest a decrease in information asymmetry, as adverse selection costs felt by around 60 %. Order processing costs, representing the limit order trader's gross profit, also decline by 54 %, probably because of the higher competition between liquidity suppliers, driving to a global reduction of the bid-ask spread. We conclude that takeovers announcements allow the release of information about target firm value, but that traders do not react before the *Bloomberg* press release.

Keywords: Takeover announcements, Spread decomposition, Informed traders, Information asymmetry

JEL Classification: G14, G34

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1 Introduction

The aim of this paper is to analyse changes in information asymmetry on target firms value around takeover announcements. More precisely, the bid-ask spread is decomposed through its different components, and their variations are estimated before and after the tender offer announcements on the Paris Bourse, comparatively to a benchmark period. This analysis is motivated by the fact that previous studies often come to the conclusion that there is a change in information asymmetry on target firms value around takeover announcements, but they do not measure quantitatively this variation. This study is the first, to our knowledge, to estimate it through the different costs beard by the (market order) traders. Only a few attempts have been made to empirically investigate the behavior of the components of the bid-ask spread around specific events, and we found none on takeover announcements (Krinsky and Lee (1996) around earnings announcements, Alphonse and Hallot-Gauquié (2001) around financial analysts meetings).

The ideas we develop are the following: if no informed trader is present on the market, no changes in spread must be observed before takeover announcements. On the contrary, the presence of informed traders before the release of information may be detected by uninformed traders who observe for instance an increase in market activity (Easley and O'Hara (1987, 1992)). Hence, liquidity suppliers can prevent themselves from loosing against informed traders by widening the bid-ask spreads before tender offers announcements, i.e. increasing the adverse selection costs. Then, once the takeover is announced, traders may modify their opinion about the target firms value. In that case, because the tender offer allows to reveal the "true" value of the stocks, a reduction in information asymmetry must be observed, allowing a decrease in bid-ask spreads by decreasing the adverse selection component.

This article contributes to the literature in two ways. First, contrary to other microstructure studies around takeover announcements, changes in asymmetry of information is analyzed specifically through the decomposition of spread, and not only considering spread taken as a whole. Previous studies which only consider changes in bid-ask spreads provide conflicting evidence about the reaction of liquidity suppliers. Even if they all conclude that spreads do not increase before announcements, they remain inconclusive about the evolution of spreads after information release. For instance, Conrad and Niden (1992), on the NYSE, and Draper and Paudyal (1999), on the LSE, find a decrease in spreads respectively one and two days before announcements, that they interpret as a reduced information asymmetry between market-makers and traders. Then, they both observe a decline in the level of the spreads at and after the announcement. Thauvron (2000), on the French market, does not observe significant increases in spreads prior to takeover announcements, which does not support the hypothesis of the presence of informed traders before the information release. Finally, Jennings (1994), while the studies described above were all done on daily data, chooses a very short term intraday analysis of spreads around takeover announcements. He did not find significant variations in the five spreads preceding the announcements, but spreads widen right after. According to the author, the takeover announcement induces the production of private information from some traders, such as financial analysts or large shareholders, who have a higher ability to treat information than other investors.[1]

Second, we take into account the specificity of the Paris Bourse, by choosing a method that does not consider inventory holding costs. Indeed, liquidity is supplied by limit orders trader, who, contrary to market-makers, do not have to hold an active inventory in securities. We also consider the robustness

[1]See also Kim et Verrechia (1994) who provide an explanation to this effect. They show that right after an information release, these traders process public information into private information, until the whole traders get the informations driving to a consensus on prices. During that period, asymmetry of information increases, and liquidity suppliers widen the spreads in order to protect themselves against the temporary information advantage held by processors of public information. In Jennings (1994), the spreads widening can be due to the absence of trading suspensions, contrary to French markets. Indeed, once the bidding firm informs the market authority it is intended to propose an offer, trading is suspended on target firms. Traders hence have enough time to collect and treat information, and no private information is produced after announcements; therefore, it doesn't seem relevant to consider this hypothesis in this study.

of the method in the estimation of the bid-ask spread components. Those criteria lead us to use the Lin, Sanger and Booth (1995) method, among the many previous papers which have estimated models to decompose the spread into its various components.

Using high frequency data provided by *Euronext Paris*, we decompose the bid-ask spread of 70 target firms between 1995 and 2000 around takeover announcements. Three periods are considered: a predisclosure period before the takeover announcement, an event period beginning the day of the information release, and a benchmark period, which allows us to estimate reference values. Empirical findings confirm previous studies on takeover announcements. Indeed, we do not provide evidence of informed trading before takeover announcements, because of the absence of significant changes in adverse selection costs. On the contrary, we observe a decrease in adverse selection costs by 60.3 %. This finding implies that takeover announcements allow the release of information about the target value. Finally, the two other spread components vary too. Order processing costs, representing the limit order trader's gross profit, decline by 53.8 %, probably because of higher competition between liquidity suppliers, driving to a global reduction of the bid-ask spread. Order persistence component only slightly increases, and the probability of a continuation, that is to say a buy order followed by a buy order or a sell order followed by a sell order, rises from 61 % before the announcement, to 68 % after, probably because of the fact that traders specifically post buy market orders.

The remainder of the article is organized as follows. Section 2 presents the choice of the method for the decomposition of the bid-ask spread and the Lin, Sanger and Booth (1995) method we use. The institutional framework of the Paris Bourse is given in section 3; we then present the high frequency data and the construction of the time series. Results are given in section 4. Section 5 concludes.

2 The methodology

2.1 The bid-ask spread decomposition

On order-driven markets, like the Paris Bourse, the spread is given by the order book, and corresponds to the difference between the best price associated with a selling limit order (ask price) and the best price associated with a buying limit order (bid price).[2] The existence of two prices is justified by the costs beard by liquidity suppliers, i.e. limit order traders in an order-driven market. Market microstructure literature shows that the spread comprises three components: order processing costs, adverse selection costs, and inventory holding costs. First, since liquidity suppliers bear costs in transacting, an order processing component must be included in the spread to compensate the liquidity suppliers for the routine costs of conducting business (Tinic (1972)). Second, providing immediacy requires market makers to hold an active inventory in the security. This inventory is costly for two reasons: (1) invested capital must be compensated for its time value; and (2) inventory holdings subject the market makers to non-diversifiable risk (Stoll (1978), Ho and Stoll (1981)). Inventory holding costs represent compensation for these two factors. Third, the adverse selection component of the spread compensates the liquidity suppliers for transacting with better informed traders, and increases with the degree of information asymmetry. Bagehot (1971) argued that some traders possess superior information as compared to liquidity suppliers, and these informed traders buy when the price is too low and sell when the price is too high.[3]

[2] On quote-driven markets, it corresponds to the difference between the price at which the market marker is willing to sell the stock and the price at which he is willing to buy the stock.

[3] Market makers in dealer markets, or limit order traders in order-driven markets, are mostly considered as uninformed traders. Actually, Madhavan (2000) reports that "dealers do not possess information superior to that of the average trader." Concerning limit order traders, Rock (1991) conjectures that informed traders will use market orders, while uninformed traders will be the ones placing limit orders and possibly also market orders. His reasoning is as follows: "If an investor has short lived information that the stock is mispriced, then placing a market order makes sense because the immediate execution of that order enables the investor to take a position before the information leaks out. With a limit order not only is there no guarantee of timely execution, the conditions under which the limit order is executed are relatively unlikely to occur in light of the investor's

Consequently, liquidity suppliers always lose when they trade with an informed trader. They are able to remain solvent only by offsetting these losses with trading gains from uninformed traders (Copeland and Galai (1983), Glosten and Milgrom (1985)).

Empirically, several analyses present methods to estimate the spread components. Huang et Stoll (1997) propose to consider two broad classes of spread decomposition models.[4] The first class decomposes the spread using serial covariance properties of quotes and transaction prices. Models were developed by Stoll (1989) and George, Kaul, and Nimalendran (1991), based on Roll (1984), and Choi, Salandro, and Shastri (1988) estimations of the spread.[5] A second class uses a trade direction indicator regression to decompose the spread. These trade indicator models are mainly driven by whether incoming orders are purchases or sales and the response of the price to this order arrival. Models are those of Glosten and Harris (1988), Lin, Sanger and Booth (1995), Madhavan, Richardson, and Roomans (1996) and Huang and Stoll (1997).[6]

Among the different methodologies, two criteria determine our choice of the method for the decomposition of the spread. The first criteria regards the compatibility of the decomposition of the bid-ask spread with the microstructure of the Paris Bourse. Actually, in an order-driven market, limit order traders supply liquidity, just like market makers in quote-driven markets ; but the main difference between the two agents is that limit order traders do not have an "affirmative obligation to make a fair and orderly market" (*NYSE Guide - Constitution and Rules, NYSE Rule 104*). Hence, it is plausible to consider that there are no inventory costs on the Paris Bourse.

Consistent with this observation, we exclude models which propose a two-way decomposition model, with a single component comprising the order processing costs and the inventory holding costs (Glosten and Harris (1988), Madhavan *et al.* (1997)) and models which consider order processing costs, inventory holding costs and adverse selection costs separately (Stoll (1989), Huang and Stoll (1997)). Finally, only two methods do not take into account inventory costs: George *et al.* (1991) and Lin, Sanger and Booth (1995). While the former adopt a two-way decomposition of the spread, with an adverse selection component and an order processing component, and simply omitting inventory holding costs, the seconds estimate in addition an order persistence component, which is due to the observation that buy (sell) orders tend to follow buy (sell) orders (Choi, Salandro, and Shastri (1988), Hasbrouck (1991)). The extent of order persistence influences the decomposition of the spread into adverse selection and order processing costs components. According to the authors, the order persistence could be caused by several factors including the splitting of large orders into two or more small-orders or the slow adjustment of limit orders when new information arrives on the market.

The second criteria we consider is the quality of the estimations provided by the models. Actually, the decompositions provide a wide range of values for the components, and can hardly be compared because they are applied to different samples of stocks.[7] Little is known about the relative merits or

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own information."

[4]A third class of model does not decompose bid-ask spreads but estimates a measure of market depth which, like the spread, is positively correlated with the market maker's adverse selection problem (Hasbrouck (1991), Foster and Viswanathan (1993)).

[5]They estimate an implicit spread which provides an estimate of execution costs simply using transaction price data. Indeed, in many markets, quoted spreads are the basis for negotiation and hence may overstate true costs for trades by investors who can extract favorable terms from dealers; for other trades, such as large-block trades, quoted spreads may understate true costs.

[6]Huang and Stoll (1997) develop a general model for decomposing the spread that subsumes many (but not all) of the quoted models.

[7]We are not interested in components values, as we focus on changes in costs. But we can note that, empirically and focusing on the adverse selection component of the spread, a wide range of values is found, from about 10 % for George *et al.* (1991) through more than 40 % for Stoll (1989). George *et al.* (1991) study the weekly and daily quoted spreads for NYSE/AMEX firms between January 1969 and December 1985, and for NASDAQ firms between January 1969 and December 1987. The adverse selection cost represents between 8 and 13 % of the spread. Stoll (1989), from October through December 1984, and more than 750 NASDAQ firms, find that the quoted spread consists of an inventory cost of 10 %, and an order processing cost of 47 %. Lin *et al.* (1995) find results closer to Stoll (1989), since the information asymmetry component represents 39,2 % of the effective spread, considering trades sizes between 500 and 1500 shares. The study is done on 150 NYSE firms

drawbacks of the different models. Even if Huang et Stoll (1997) theoretically illustrate the underlying similarity of some of these models, they do not empirically examine and compare the estimates of the components obtained from each of them. Two empirical studies, Clarke and Shastri (2001) and Van Ness, Van Ness and Warr (2001) compare the different decompositions of the spread using a single sample.[8] Among the methodologies, they estimate Lin *et al.* (1995) and the George *et al.* (1991) models and their conclusions converge. Clarke and Shastri (2001) and Van Ness *et al.* (2001) find that the assumptions underlying the George Kaul Nimalendran model are not consistent with transactions data and that the restrictions imposed by the model are particularly inappropriate for small firms.[9] As a result, the correlation between the trade indicator models and the spread-covariance model of George *et al.* (1991) decreases substantially for small firms and firms with low trading volume. On the contrary, the Lin, Sanger and Booth (1995) model seems particularly interesting, because it induces only a 0.40 % lose of observations for Clarke and Shastri (2001), and 0.47 % for Van Ness *et al.* (2001). The reject of the observations is due to the estimates of the adverse selection component of the spread outside the plausible 0 and 1 bounds. Hence this method appears to be the most appropriate for the Paris Bourse and also the most robust concerning components estimation. The methodology is exposed in the next section.

2.2 The Lin, Sanger and Booth (1995) spread decomposition

Lin *et al.* (1995) consider three components of the bid-ask spread: the adverse selection costs, the order processing costs and an order persistence component. The latter component could be caused by several factors including strategic breaking up of large orders into smaller trades, the sequential exercise of stale limit orders, the fact that traders imitate each other, or the observation that traders tend to react in the same way, but successively, to the same events (Biais *et al.* (1995)). Therefore, the extent of order persistence influences the decomposition of the spread into adverse selection and order processing costs components.

Components are estimated based on the underlying model that we briefly review (a more detailed discussion is available in Lin *et al.* (1995)). Let A_t and B_t be the ask and bid quotes at time t, and let π be the probability of a continuation (a sell (buy) order followed by another sell (buy) order). Then, conditional on a sell order at time t, a liquidity supplier's expected profit at time $t+1$ is

$$\pi(B_{t+1} - B_t) + (1 - \pi)(A_{t+1} - B_t) = E_t(P_{t+1}) - P_t \tag{1}$$

during year 1998. It focuses on the relation between trade size and the components of the spread. Indeed, the adverse selection component should increase with trade size, since those trades are supposed to be motivated by private information (Easley et O'Hara (1987)). The results are consistent with this hypothesis. The order processing cost is 28,2 %, once taken into account the adverse selection and the order persistence (32,6 %). Huang et Stoll (1997) conclude that the main component of the spread is the order processing cost, which is estimated as 61,8 %. They analyse 19 stocks highly traded on the NYSE during 1992. The component due to asymmetry of information is 9,6 %, and the one due to inventory holding is 28,7 %. Finally, Madhavan *et al.* (1997) observe a gradual decrease in the adverse selection cost during the trading day: it stands at 51,1 % of the implicit spread between 9.30 a.m. and 10 a.m. and ends at 36,0 % between 3.30 p.m. and 4 p.m. The study is done for 274 NYSE firms during 1990.

[8] Clarke et Shastri (2001) use a random sample of 320 NYSE firms between December 1996 and December 1998. Van Ness, Van Ness and Warr (2001) use 856 companies traded on the NYSE during April, May, and June 1999. Clarke et Shastri (2001) estimate the adverse selection component of the spread from the Madhavan, Richardson, and Roomans (1997), the Lin, Sanger, and Booth (1995), the Huang and Stoll (1997), and the George, Kaul, and Nimalendran (1991) models. They found the estimates are highly correlated with each other, which is consistent with the theoretical links showed by Huang and Stoll (1997). Van Ness *et al.* (2001) also consider the Glosten and Harris (1988) model.

[9] For example, the correlation between the George Kaul Nimalendran estimate and the Huang and Stoll (1997) estimate is 0.29 for small firms and 0.70 for large firms, while the correlation between the Lin Sanger Booth estimate and the Huang and Stoll (1997) is 0.61 for small firms and 0.75 for large firms. One of the restrictions in George *et al.* (1991) is the fraction of the spread due to order processing costs and the fraction due to information asymmetry should sum to one. But, conducting a Wald Test, Clarke and Shastri (2001) find these restrictions are overwhelmingly rejected by the data. See Clarke and Shastri (2001) and Neal and Wheatley (1998) for more details.

where $E_t(P_{t+1}) = \pi B_{t+1} + (1-\pi)A_{t+1}$ is the expected future transaction price conditioned on the trade at time t, and $P_t = B_t$ the transaction price at time t.

Let $M_t = (A_t + B_t)/2$ be the quote midpoint at time t. Huang et Stoll (1994) state that $z_t = P_t - M_t$ is one-half the signed effective spread. To reflect possible adverse information revealed by a trade at time t, quote revisions are assumed to be $B_{t+1} = B_t + \lambda z_t$ and $A_{t+1} = A_t + \lambda z_t$, where $0 < \lambda < 1$ is the portion of the spread due to adverse selection. A liquidity supplier's gross profit for a sell order at time t is then related to the effective spread by

$$\begin{aligned} E_t(P_{t+1}) - P_t &= [\pi B_{t+1} + (1-\pi)A_{t+1}] - P_t \\ &= \lambda z_t + [1-2\pi]\left[\frac{(A_t+B_t)}{2} - B_t\right] + \left[\frac{(A_t+B_t)}{2}\right] - P_t \\ &= -(1-\lambda-\theta)z_t \end{aligned} \tag{2}$$

where $\theta = 2\pi - 1$ and $(1-\lambda-\theta)z_t$ is the liquidity supplier's gross profit. The profit for a buy order can be obtained in the same fashion and is identical.

Empirically, we can estimate the different parameters λ and θ using regressions. Because λ reflects the quote revision in response to a trade as a fraction of the effective spread and because θ reflects the extent of order persistence, the following regressions are estimated using the GMM:

$$M_{t+1} - M_t = \lambda z_t + \varepsilon_{t+1} \tag{3}$$

$$z_{t+1} = \theta z_t + \eta_{t+1} \tag{4}$$

where the disturbance terms ε_{t+1} and η_{t+1} are assumed to be uncorrelated.

The order processing component $\gamma = (1-\lambda-\theta)$, is estimated using the regression:

$$P_{t+1} - P_t = -\gamma z_t + \mu_{t+1} \tag{5}$$

where μ_{t+1} is the disturbance term.
[10]

We try to determinate if informed traders are present or not on the French market before takeover announcements. Indeed, as empirical studies mostly find evidence of an increase in target firms' stocks prices around the announcement date, traders are interested in buying shares before the information

[10] Recent studies have applied this spread decomposition, like Danielsen and Harrison (2000) who analyse how private information affects the liquidity of the market for NYSE, AMEX and NASDAQ real estate investment trusts (REITs). They find that REITs trading on organized specialist exchanges (NYSE, AMEX) are more liquid than those trading in the over-the-counter market (NASDAQ), exhibiting lower spreads and a greater number of transactions. They show that estimates of adverse selection costs are slightly higher on the organized exchanges, but order processing costs are dramatically higher in the over-the-counter market. Components are then compared across portfolio holdings, that is to say equity REITs which must hold at least 75 % of their investment portfolio in the form of equity claims (i.e., direct property ownership) and mortgage REITs which must hold at least 75 % of their investment portfolio in the form of debt (i.e., mortgages and lease receivables) claims. According to the authors, mortgage loans and leases are more opaque assets and thus more difficult to value in the marketplace than equities. Indeed, they observe mortgage REITs have wider adverse selection costs than equity REITs. Their results indicate liquidity improves as the percentage of the firm's investment portfolio held as direct property (i.e., equity) investments rises. Dey and Radhakrishna (2001) try to determine the nature and effect of institutional trading on spreads. They argue that institutional trading is not completely information driven, part of it is liquidity trading in nature. Actually, they find evidence that information induced institutional trading increases the adverse selection component. However, large volume (liquidity) trading reduces the order processing costs. Finally, they conclude that the net effect of institutional trading on spread is consistently negative. Heflin and Shaw (2001) test if the size of a trade relative to the depth quoted at the time of the trade is potentially a better indicator of informed trading than is trade size alone. They show that much of the variation in adverse selection estimates can be explained by variation in the ratio of trade size to depth. Finally, Barclay and Hendershott (2001) compare the components of the spread for NASDAQ firms after hours and during the trading day. They show that realized spreads are higher after hours, and that this increase is caused by higher adverse selection and order persistence, and do not reflect higher dealer profits.

is released, because they can sell them later or bring them to the bidder, and earn the difference in stock prices.[11] Easley and O'Hara (1987, 1992) show that the market marker can infer the presence of informed traders by the higher frequency of transactions or the increased trading volume. Indeed, informed traders will trade until the stock price incorporates the private information, trading frequently and always on the same side of the market. The adverse selection paradigm postulates that liquidity suppliers can prevent themselves from informed traders by widening the bid-ask spread (Copeland and Galai (1983), Glosten and Milgom (1985)) In that case, in the presence of informed traders, the adverse selection component of the spread increases before takeover announcements. On the other side, if no abnormal changes in adverse selection costs is observed, we can conclude that informed traders do not trade before takeovers announcements.

Price run-ups following takeover announcements may be explained by the motivations underlying the acquisitions. Indeed, Bradley *et al.* (1983) suppose the acquiring firm management can take advantage of an asymmetry of information. The information hypothesis postulates that the acquiror has information about the target firm that is not available to the others traders. The information may be that the target firms' stocks price is undervalued, based on publicly available information, or that there are more efficient operating strategies that could be used by the target management, and if the existing management knew these strategies, it could become more efficient and the stock price would increase. The takeover announcement then allows to reveal information about the value of the firm, decreasing the information asymmetry. It consists in a signal that the "true" target firm's stock price is higher. Therefore, if we observe a decrease in adverse selection component, we can consider takeover announcement allow to reveal information about the firm value.

Concerning the other components of the spread, i.e. the order processing cost (liquidity suppliers'profit) and the order persistence, we expect takeover announcements to induce a higher order persistence, because traders mostly buy stocks, as they believe the "true" firm stock price is higher. On the other side, since competition in more important between limit order traders, their gross profit must be weaker, inducing the order processing cost to decrease.

The behavior of the components, adverse selection costs, order processing costs and order persistence are compared over the benchmark, the predisclosure and the event periods. Results of the test using the Lin *et al.* (1995) method are given in the next section.

3 Institutional framework and data

In a first subsection, we introduce the French Stock Exchange: the Paris Bourse. We then describe the data and the way we construct our series.

3.1 The microstructure of the Paris Bourse

The Paris Bourse is an order-driven (agency) and fully computerized market without designated market makers, which implies that liquidity supply is assured by the willingness of traders to submit limit orders. The stock exchange operates a screen base electronic system called NSC which manages the matching of buying orders and selling orders, respecting rules of priority. Price dynamic is given by the interaction between the order book and the continuous flow of new orders. Transactions occur when a trader on the opposite side of the market hits the quote, continuously from 10 a.m. or 9 a.m., to 5 p.m. or 5.30 p.m.,

[11] See Dodd (1980), Bradley *et al.* (1988), Franks *et al.* (1991) for the United States; see also Eckbo and Langhor (1989), Charlety-Lepers and Sassenou (1994), Phelizon (2001) and Vandelanoite (2001) for France. This increase in stock prices implies that traders who possess the information about the acquisition are expected to trade in order to exploit at the most their informational advantage.

depending on the period.[12] The order book is conveyed publicly in real time, giving the five selling orders with the weaker prices and the five buying orders with the higher prices. As a result, market benefits from the large transparency, which is not the case in quote-driven (dealer) markets, such as the London Stock Exchange or the NASDAQ for instance.

Investors can submit limit orders at any price on a prespecified pricing grid, defined by the tick size. Limit orders, representing around 83 % of the global amount of orders conveyed to the market, specify a quantity and a price under which the order will not be executed for a sell order, or a price above which nothing will happen for a buy order. These orders supply liquidity, while market orders consume it. Market orders represent around 7 % of the global amount of orders. They only specify a quantity, but as they can not be split into several orders, they have to be executed on several limits if the quantity is not sufficient at the first best limit.[13]

3.2 Data sources and construction of series

Announcement dates of takeovers are taken from *Bloomberg* press agency.[14] We choose this announcement date in order to take into account the possibility that media release the information about the takeover prior to the formal announcement. Indeed, if it was the case, it prevents us from concluding wrongly to the presence of informed traders.

We then settle three periods: event, predisclosure and benchmark periods. We decide to choose a single length for every period, based on the last significant reaction of spreads Vandelanoite (2001) detected in her event study on liquidity and market activity around takeovers announcements, and that was found to be four days after the information release. Therefore, each period involves four trading days.[15] The benchmark window is defined between day -50 and day -47 before the announcement date, and is used to get "reference values" for the components of the spread.[16] We choose a period more distant than Krinsky and Lee (1996), who choose a two-days length interval two weeks before the announcement, in order to be sure that the information will not bias the values obtained on the benchmark period. The predisclosure window involves four days, starting on day -4 and ending the day before the information release, and the event period comprises the announcement date given by *Bloomberg* and the three following trading days.

The sample includes French target firms of a takeover between January 1995 and December 2000. The total of all succeeded takeovers having occurred with a target firm listed on the Paris Bourse on this period is about 200. Series are taken from the *Euronext Paris* database. For each security, it provides the time, price, and number of shares traded for each transaction. Concerning best limits, time, ask prices, bid prices, and depths associated are reported. 42 firms are eliminated because of buy-out operations close to the takeovers, or because data were not available, as firms were traded on the *Marché Libre* for instance. In addition, in order to get bid-ask spreads, only firms continuously traded - Continu A and Continu B - during the three periods can be studied, and not only twice a day like on the Fixing A and Fixing B, which reduces our sample from 158 to 83 firms.

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[12]Since the 06/02/1998, stocks were traded between 10 a.m. and 5 p.m. Trading started at 9 a.m. since the 09/20/1999. Finally, stocks are traded until 5.30 p.m. since the 04/04/2000.

[13]The remainder is composed of kind of market orders, which are executed against the best price on the opposite side of the order book, but whose any excess that cannot be executed at that price is converted into a limit order at that price (around 8 %). We can also mention stop orders (around 1 %). See Biais *et al.* (1995) for a study on price discovery and order placement on the Paris Bourse.

[14]If there is no press release, we choose the date of the trading suspension for the target firm. Actually, contrary to American markets for example, on the Paris Bourse target firms are suspended before the formal announcement of the takeover in order to prevent informed trading. We can fairly suppose that on that date, traders know which firms are involved in the tender offer.

[15]Note that this length is close to those of Krinsky et Lee (1996) who set the length of each window to two days, while Alphonse and Hallot-Gauquié (2001) widen it to five days.

[16]Tests have also been applied on a benchmark period between day -30 and day -27. Results are only slightly modified.

Table 1: **Descriptive statistics**

	Benchmark period			Predisclosure period			Event period		
	Min	*Moy*	*Max*	*Min*	*Moy*	*Max*	*Min*	*Moy*	*Max*
Quoted spread (euros)	0.04	0.90	8.63	0.03	0.97	9.48	0.01	0.53	3.70
Quoted relative spread (%)	0.12	0.95	3.28	0.14	1.01	4.68	0.04	0.56	6.50
Effective spread (euros)	0.04	0.95	8.87	0.03	1.04	9.78	0.01	0.56	4.02
Effective relative spread (%)	0.13	1.01	3.41	0.15	1.10	6.09	0.04	0.58	6.43
Share price (euros per share)	5.29	106.05	690.81	4.74	112.58	655.05	9.45	130.68	862.54
Daily share volume (000's of shares)	0.06	47.49	615.68	0.22	69.97	740.30	0.31	292.67	2,118.57
Daily euro volume (euro000.000's)	5.37	4,095.15	82,523.29	4.43	5,922.45	82,170.55	5.61	29,344.95	335,974.33
Number of trades per day	4.25	119.51	1,019.50	4.75	148.24	1,132.75	7.00	365.29	3,547.00
Trade size	12.81	236.28	1,019.93	18.70	288.52	1,069.44	23.98	749.45	4,771.86

Notes: The sample consists in 70 takeover announcements for French target firms between January 1995 and December 2000. The announcement date is given by the *Bloomberg* press agency. The *benchmark period* is defined as 4 trading days beginning 50 days prior to the information release, while the *predisclosure period* includes 4 trading days just before the announcement. The *event period* comprises the announcement day and the 3 following trading days. Denote A_t, B_t and P_t, the ask price, the bid price and the transaction price at time t. For each stock and each period, the quoted euro spread is the mean of $(A_t - B_t)$, and the quoted relative spread is expressed in pourcentage, as the mean of $(A_t - B_t)/M_t$, with $M_t = (A_t + B_t)/2$. The effective euro spread is the mean of $2|P_t - M_t|$, and the effective relative spread is the mean of $2|ln(P_t/M_t)|$. The share price is the mean transaction price expressed in euros, the daily share volume is computed as the mean of all shares traded; the daily euro volume is the sum of all shares traded, weighted by the transaction prices. The trade size is defined as the share volume divided by the number of trades per day. Finally, the values reported are the minimum, maximum and mean for the whole of the sample on each period.

For each firm, regarding trades, we exclude opening transactions because they are conducted in a call auction. During the trading day, we keep all transactions, and no special aggregation is done. If several trades are recorded at the same time, we consider that a single trader saw his market order split into several ones because of the size he bought or sold, inducing more than one recordings. Therefore, we compute a single price, estimated as the mean of each price, weighted by the number of shares traded. Sometimes, several spreads can also be recorded at the same time. In that case, we only keep the last recording. Series are constructed such as, for each trade, we identify the prevailing bid and ask prices. The arrival of a market order modifies the order book, as mentioned above, because it hits the quotes. Hence, for one trade, the prevailing bid and ask prices are the current quotations just before the transaction.[17]

Then, as we consider intraday series, it is necessary to get enough recordings for each day. Like Alphonse and Hallot-Gauquié (2001), we decide that (1) each included stock has at least four transactions per day, and (2) no more than five trading days must separate two days for which transactions are available. Those criteria must be fulfilled for benchmark, predisclosure and event periods, and yield a sample of 76 takeover announcements.

Note also that components of the spread are expressed in proportion of the effective bid-ask spread, which induces they must be comprised between 0 and 1. We eliminated 6 firms whose components did not respect this condition. We finally analyse the components of 70 target firms.

Summary statistics are presented in Table (1). First, statistics are estimated for each day and each firm, and then in mean on the three periods. The values reported are the minimum, maximum and mean for the whole sample on each period.

Two measures of the spread are given: the quoted spread and the effective spread, each one computed in pourcentage and in euros. The quoted euro spread is the difference between the ask price and the bid price, $(A_t - B_t)$, and the quoted relative spread is expressed in pourcentage, $(A_t - B_t)/M_t$ with M_t the quote midpoint, i.e. $M_t = (A_t + B_t)/2$. We also compute the effective spread, as the the Lin, Sanger and Booth (1995) method is based on this measure. The effective spread reflects the "true" spread, since it takes into account the transaction price.[18] The effective euro spread is $2|P_t - M_t|$, and the effective relative one is $2|(P_t - M_t)/M_t|$.[19] The effective spread equals the quoted spread for trades executed at the quoted bid price or ask price, but is smaller (larger) than the quoted spread for trades executed inside (outside) the quoted spread. In fact, in order-driven markets, effective spread must be at least equal to quoted spread. This result is due to the Paris Bourse microstructure and to the trade size: if the quantity associated with the market order is too high, the trade will walk up/down the limit order book after using up depth on the inside quotes. The way we constructed our series takes this effect into account, since when several transactions occur at the same time, we compute the mean of the transaction prices. Hence, our sample is characterized by quoted spreads less than effective spreads; on average, the difference is between 0.02 and 0.03 depending on the period. Those results are consistent with Venkataraman (2001) who estimate trading costs on the Paris Bourse through different measures of the spread.

Results of differences in means are given in Table 2, providing a preliminary idea on changes in market activity, or liquidity between the three periods. As expected, (Lee *et al.* (1993), Krinsky and Lee (1996)), we find that market activity, represented by the share volume, the euro volume, the number of trades and the trade size, is higher before and after takeover announcements relative to the benchmark window. Nevertheless, the reaction is significant only when the event period is considered and compared with the others. Consistent with this observation, all spread measures decrease highly in the last period,

[17]For each firm, quotes for which the bid price, ask price, bid size or ask size is listed as zero are deleted. We also eliminate recordings for which the ask price is inferior or equal to the bid price. Series are constructed on the basis of transaction prices. A first filter consists in deleting all the trades recorded outside trading hours. For each transaction prices, we get the closest spread, recorded before the trade. It may happen that some spreads do not correspond to any trade.

[18]On the contrary, George *et al.* (1991) or Stoll (1989) methods, for instance, are based on quoted spreads.

[19]Empirically, we use the following estimation: $2|ln(P_t/M_t)|$.

Table 2: **Differences in means**

	Predisclosure less Benchmark	*Event less Benchmark*	*Event less Predisclosure*
Quoted spread	0.07	-0.37**	-0.44**
(euros)	(0.29)	(-2.01)	(-2.23)
Quoted relative spread	0.06	-0.39***	-0.45***
(%)	(0.46)	(-2.87)	(-2.87)
Effective spread	0.09	-0.39**	-0.48**
(euros)	(0.36)	(-2.04)	(-2.30)
Effective relative spread	0.09	-0.43***	-0.52***
(%)	(0.54)	(-3.06)	(-3.04)
Share price	6.53	24.64	18.10
(euros per share)	(0.29)	(0.99)	(0.72)
Daily share volume	22.49	245.18***	222.70***
(000's of shares)	(0.95)	(4.15)	(3.69)
Daily euro volume	1.83	25.25***	23.42***
(euro000.000's)	(0.84)	(3.49)	(3.23)
Number of trades per day	28.73	245.78***	217.05***
	(0.72)	(3.19)	(2.78)
Trade size	52.24	513.17***	460.93***
	(1.32)	(5.43)	(4.80)

Notes: The sample consists in 70 takeover announcements for French target firms between January 1995 and December 2000. The announcement date is given by the *Bloomberg* press agency. The *benchmark period* is defined as 4 days beginning 50 days prior to the information release, while the *predisclosure period* includes 4 trading days just before the announcement. The *event period* comprises the announcement day and the 3 following trading days. Denote A_t, B_t and P_t, the ask, the bid and the transaction prices at time t. Values reported are the differences between means given in Table 2 depending on the periods considered. The quoted euro spread is the mean of $(A_t - B_t)$, and the quoted relative spread is expressed in pourcentage, as the mean of $(A_t - B_t)/M_t$ with $M_t = (A_t + B_t)/2$. The effective euro spread is the mean of $2|P_t - M_t|$, and the effective relative spread is the mean of $2|ln(P_t/M_t)|$. The share price is the mean transaction price expressed in euros, the daily share volume is computed as the mean of all shares traded; the daily euro volume is the sum of all shares traded, weighted by the transaction prices. The trade size is defined as the share volume divided by the number of trades per day. Values in parentheses indicate t-statistics for tests of difference in means.

** Significance at the 5 % level

*** Significance at the 1 % level

with significant differences in mean, which may reveal a decrease in the information asymmetry after the release of information about takeovers. Differences in means are not significant for spreads between the benchmark and the predisclosure periods, even if the means are higher during the second window. But, at this level, we can not exclude that the adverse selection cost increases before the takeover announcements, since it is possible that the decrease in order processing cost offsets in part the increase in information asymmetry cost. Therefore, we propose in the next section to apply the Lin, Sanger and Booth (1995) method for the decomposition of the effective spread on target firms. The behavior of the components will be compared during the announcements and non announcements periods, in order to infer the impact of takeover announcements on information asymmetry among traders.

4 Empirical results

The estimates of the two components of the bid-ask spread, i.e. adverse selection costs and order processing costs are given in Table 3 for the 70 target firms. In Table 4, we present the order persistence component of the spread, which allows us to estimate the probability of a continuation. This latter component influences the decomposition of the bid-ask spread into adverse information cost and order processing cost. The components are expressed in proportion of one-half the effective spread, i.e. z_t. The adverse selection component is estimated using regression (3), and corresponds to the coefficient λ, while the order processing component is the coefficient γ in regression (5).[20] Thereafter, we estimate the value of each cost in euro. Actually, if the spread is modified, even if the components would remain constant in percentage, their value in euros would decrease. The adverse selection and order processing costs in euro-cents per share are computed as, respectively, λ and γ times mean $|z_t|$ time mean M_t, where M_t is the quote midpoint at time t.

On the benchmark period, the adverse selection component of the bid-ask spread represents about 25 % of the effective spread, estimated with transaction prices. This result can be compared with Alphonse and Hallot-Gauquié (2001) who estimate also components of the bid-ask spread for 93 French firms, using the Stoll (1989) method, implying they take into account inventory holding costs. They investigate changes in components of the spread around financial analysts meetings and find information asymmetry cost is about 30 % of the quoted spread during reference periods.

During the predisclosure period, the coefficient λ increases slightly until 25.2 %, but this rise is not significant. Therefore, we can not state that liquidity suppliers prevent themselves from informed traders by widening the spread. Actually, our findings are not surprising. On the same sample, Vandelanoite (2001) did not find evidence of an abnormal market activity, nor of a reduction in market liquidity on French target firms of a takeover, implying that investors do not trade on the basis of their private information before the release of the tender offer. Analyzing target firms spreads before takeover announcements, Thauvron (2000) do not find evidence of significant changes in spreads before takeovers on the French market, which is consistent with the absence of informed traders before information releases.

[20] Lin *et al.* (1995) note that the disturbance term ε_{t+1} may reflect the arrival of public information and market frictions such as price discreteness and the lag in price adjustment due to limit orders. These market frictions may cause serial dependence in the disturbance term. Indeed, we find a first order serial dependence, which means that the coefficient λ is no more BLUE. Therefore, even if we do not work on the covariance matrix, and we do not have to take this autocorrelation into account, we use Generalized Moments Method from Hansen (1982) with the Newey-West (1987) matrix to adjust the estimations. Note also that Lin *et al.* (1995) find that adjusting for these autocorrelations has only a slightly effect on the estimate of λ.

Table 3: **Estimated components of the bid-ask spread**

	Estimated components			Changes in estimated components		
	Benchmark period	Predisclosure period	Event period	Predisclosure less benchmark	Event less benchmark	Event less predisclosure
			Proportion of the relative effective spread			
Adverse selection cost	0.249	0.252	0.212	0.003	-0.037	-0.040***
Order processing cost	0.527	0.524	0.436	-0.003	-0.091**	-0.088***
			Components of effective spread in euros			
Adverse selection cost	0.125	0.146	0.058	0.021	-0.067**	-0.088**
Order processing cost	0.253	0.262	0.121	0.009	-0.132**	-0.141***

Notes: The two components of the half effective spread are estimated with the Lin *et al.* (1995) method, for 70 French target firms of a takeover between January 1995 and December 2000. The announcement date is given by the *Bloomberg* press agency. The *benchmark period* is defined as 4 days beginning 50 days prior to the information release, while the *predisclosure period* includes 4 trading days just before the announcement. The *event period* comprises the announcement day and the 3 following trading days. The adverse selection component is the coefficient λ, using the regression $\Delta M_{t+1} = \lambda z_t + \varepsilon_{t+1}$, where $\Delta M_{t+1} = M_{t+1} - M_t$, with M_t the log quote midpoint at time t; $z_t = P_t - M_t$, with P_t the log trade price at time t. The order processing component in the coefficient γ using the regression $\Delta P_{t+1} = -\gamma z_t + \mu_{t+1}$. The values reported are the means of all individual coefficients. We use GMM on the three periods. Each component is given firstly in proportion of the effective spread, and secondly in euros, by the coefficient times mean $|z_t|$ times mean M_t. Significance levels for tests on differences in means are reported.

** Significance at the 5 % level

*** Significance at the 1 % level.

On the contrary, between the predisclosure period and the event period, we can observe a large decrease of the adverse selection component (representing 21.2 % of the spread). During the same period, the effective spread decreases, from EUR 1.04 to EUR 0.56, which means the spread is reduced by 46.2 %. Therefore, it may be interesting to observe the adverse selection cost in euros. Actually, we find the information asymmetry component is about EUR 0.15 prior to the announcement date, but decreases by 60.3 % after the information release (EUR 0.06 during the event period). The information release allows to reduce adverse selection costs in euros beard by market order traders reduced by more that one half. These results are also consistent with Conrad and Niden (1992), or Draper and Paudyal (1999) who observe a reduction of the bid-ask spread after takeover announcements, and conclude that this decrease is due to the reduction of information asymmetry. Finally, we can consider that takeover announcements allow to reduce the asymmetry of information about target firms value with the information release.

The greater component, whatever the period considered, is the order processing cost. It represents between 44 % and 53 % of the effective spread depending on the period. These results are once more close to those obtained by Alphonse and Hallot-Gauquié (2001) who conclude the order processing cost is more than 50 % of the spread for French firms during their benchmark period, i.e. between the day -30 and -25 prior to the analysts meetings. This component represents limit order trader's profit, that is to say the portion of the bid-ask spread necessary for the liquidity supplier to recover fees charged to post orders. Note that on the Paris Bourse, those costs are explicit costs, which means that they are not included in the bid-ask spread. Actually, when a trader submits an order he bears costs, invoiced by the broker, independently of the execution of the order. Consequently, it seems more realistic to adopt the distinction of Barclay and Hendershott (2001), who consider order processing costs comprises two parts: the costs due to the market structure and the liquidity supplier profit.[21] Like any profit, this component depends on competition. In our case, orders processing costs will depend on the competition between the liquidity suppliers, and decrease with it.

As the effective spread declines during the event period (0.58 %) relative to the predisclosure period (1.10 %), order processing costs must be lower following takeover announcements. We find evidence that liquidity suppliers' profit declines significantly from 52.4 % through 43.6 % of the spread. The cost given in euros also decrease, as the cost is reduced of 53.8 %. This effect can be explained by the fact that traders want to buy target firms stocks in order to take advantage of the offered premium, and consequently submit more aggressive limit orders, that is to say with high prices for buy orders - low prices for sell orders -. Therefore, competition between liquidity suppliers increases, which reduces their profit, but lessens the bid-ask spread.

Finally, the order persistence is disclosed in Table 4. This component has an impact on the proportions of the adverse selection component and the order processing component. The probability of a continuation lies in strategic order splitting, imitation between market participants or similarity in reaction to the same events. We find a probability of order persistence between 60 and 70 % whatever the period. This result is close to Declerck (2000) who observes this probability is 73.4 % on the CAC 40 stocks. Barclay and Hendershott (2001) also find a probability of 71 % on the NASDAQ. After information release about takeovers, the probability of a continuation increases from 61.3 % to 67.6 %. This increase reflects changes in the two other components. Indeed, traders know the target firms stocks price is higher, because the asymmetry of information is reduced on the firms value. Consequently, they buy stocks, and the probability that a buy order will be followed by the same kind of order increases. In the same time, competition between liquidity suppliers is higher, reducing their profit. This decomposition of the spread may help to understand how traders react to takeover announcements, and the way adverse selection costs and order processing costs are reduced, allowing a global decrease of the spread and increasing liquidity on the target firms stocks.

[21] According to them, this component overstates the profitability of supplying liquidity through limit orders because it does not measure the opportunity cost of waiting for an execution.

Table 4: **Probability of order persistence**

Order persistence component of the effective relative spread			Probability of a continuation		
Benchmark period	*Predisclosure period*	*Event period*	*Benchmark period*	*Predisclosure period*	*Event period*
0.226	0.226	0.352	0.613	0.613	0.676

Notes: The order persistence component of the half effective spread is estimated with the Lin et *al.* (1995) method, for 70 French target firms of a takeover between January 1995 and December 2000. The announcement date is given by the *Bloomberg* press agency. The *benchmark period* is defined as 4 days beginning 50 days prior to the information release, while the *predisclosure period* includes 4 trading days just before the announcement. The *event period* comprises the announcement day and the 3 following trading days. The component is the coefficient θ, using the regression $z_{t+1} = \theta z_t + \eta_{t+1}$, where $z_t = P_t - M_t$, with P_t the log trade price at time t and M_t the log quote midpoint at time t. We use GMM on the three periods. The component is given firstly in proportion of the effective spread. Secondly, the probability of a continuation, i.e. a buy (sell) order following a buy (sell) order, implied by the model is given by $(\theta + 1)/2$. Values reported are the means of the individual coefficients on each period.

5 Conclusion

This study investigates the behavior of the components of the bid-ask spread around takeover announcements. We distinguish two periods for the incoming information. First, before takeover announcements, based on the *Bloomberg* press releases, liquidity suppliers protect themselves by increasing adverse selection costs in the presence of informed traders. Second, if takeover announcements provide a signal that target firms stocks are undervalued by the market, the asymmetry of information is therefore reduced as traders modify their opinion about firms value. To test these different hypotheses, we use the Lin, Sanger and Booth (1995) method to decompose the bid-ask spreads. This framework has two main advantages. First, it is shown to be an efficient and robust method, contrary to Huang and Stoll (1997), George *et al.* (1991) or Madhavan *et al.* (1997) for instance. Second, it allows us to take into account the specificity of order-driven markets, because it does not consider inventory holding costs. Indeed, liquidity suppliers on an agency market are limit order traders who are willing to trade but do not have to submit orders to the market. Instead, Lin *et al.* (1995) estimate an order processing cost which is due to the fact that buy (sell) orders tend to follow buy (sell) orders, and that influences the proportions of the two other component.

We estimate bid-ask spread components, i.e. adverse selection, order processing and order persistence for 70 French takeover target firms between January 1995 and December 2000. We do not find evidence of an increase in information asymmetry before takeover announcements, meaning no informed trader trade on the basis of his informational advantage. On the contrary, after the information release, we observe a significant decrease in adverse selection and order processing components. We can consequently conclude that takeover announcements reduce adverse selection between traders. Moreover, competition between investors induces a decrease in liquidity suppliers'profit, involving a global decrease in bid-ask spreads, and a better liquidity of target firms stocks.

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